THE ROLE OF TECHNOLOGY IN DISTRIBUTED TEAM COORDINATION

A multi-method investigation of a technology change process in the field

Proefschrift

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Remember: Y’all is singular. All y’all is plural.
All y’all’s is plural possessive.

Kinky Friedman
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Distributed working is not a new phenomenon – trading ventures or military campaigns, for instance, have been organized over tremendous distances for millennia. Yet, the scale and scope of distributed working we experience today is surely unprecedented. From car design and software programming to customer services, the management of global companies, distance learning, and academic research, remote working seems to be everywhere. Today nearly 60% of professionals are part of distributed teams and up to 15% of employees in EU countries telework from outside their company (Welz & Wolf, 2010). Similarly unprecedented is the range of technologies that promise to connect people anywhere and anytime.

Unfortunately, our understanding of what happens, if people work across distances and how information and communication technologies influence work processes, has not kept up with the rise of the phenomenon itself. My PhD project aimed to fill these gaps – concentrating on distributed teams and the role of technology for shaping intra-team coordination.
Chapter 1. Introduction

1.1. Background and project rationale

The early founders of the internet could have had little idea of the rapid success and the impact of their invention on our life today. When a first version of the internet (ARPAnet) was created in 1969, it constituted a 4-node network to provide scientists with access to large, powerful computers, and eventually to support military operations (Leiner et al., 2003). Only four decades later the internet has invaded nearly all areas of life: mail has moved from paper to electronic, cinema receives competition from You-Tube and video streaming, video-applications allow face-to-face conversations with people half-way around the globe, news tickers and blogs keep us up-to-date on last minute developments, and commercial sites offer to procure us anything from groceries to new partners for life without even leaving the house. Not surprising therefore that the internet has also changed the way we work.

Internet-based technologies allow access to services and personnel independent of their geographic location. Organizations make use of this new freedom, for instance, to link up personnel for a common task without need for travel or relocation, to guarantee continuous operations by moving projects across time zones, or to transfer work to places with cheaper labor while still retaining control and oversight of processes. Remote work arrangements have so become an integral part of many organizations.

Remote work arrangements come in various forms. At the one end are individual employees, who dial in from home or a different location of the same company (i.e., telework). Employees in teams can be either partly distributed, in that individual members or subgroups work separated from the core group, or completely virtual, in that members and managers rarely or never meet face-to-face. The most extreme form of remote working at present is probably ‘crowdsourcing’, in which organizational tasks are given to a collective ‘crowd’ of internet users unconnected to the organization. Remote working is also a normal part in areas such as flight control, military campaigns, or space exploration, in which central control centers monitor and guide activities in airplanes, combat troupes, or space shuttles. In this thesis I focused on intra-organizational distributed teams with clear boundaries and an identifiable task within the organization. More specifically, teams in this project were composed of two geographically dispersed subgroups, which were internally homogeneous, but differed considerably compared to each other. I therefore refer to these teams as asymmetric distributed teams.

Thanks to the rapid development of internet-based services and applications, or-
ganizations these days can choose from a wide range of technologies to support work processes across distances. ‘Traditional’ media like phone and email can be augmented by more advanced options such as high-quality audio- and video-connections, real-time data transfer, desktop sharing, or high-end modeling and visualization applications. Often these technologies are applied together. Such a collection is referred to as group-ware or increasingly as Collaborative Environments (CEs).

CEs constitute “a class of applications that build upon cyber-infrastructure to support communication and collaboration using high quality audio and video connections and interfaces to computational resources, storage systems and high-end applications” (Hofer, Lin, & Finholt, 2004, p. 1). CEs come close to the original idea of internet-based collaboration formulated by such early visionaries as Vannevar Bush, J. C. R. Licklider, or Edward E. David. As early as 1968 Licklider and Taylor argued that “there has to be some way of facilitating communication among people without bringing them together in one place” (p. 29) suggesting continuous face-to-face connections through ‘TV screens’, group manipulation of data, and real-time visualization of content. Only 40 years later Collaborative Environments have made their vision a reality.

The design and implementation of CEs remains a challenge, however. From finding the right mix of technologies to their integration into existing organizational structures, designing and implementing technologies is not a straightforward exercise. Reports of technology implementations continually showcase unexpected rejections by users or failures to achieve projected benefits. In 2004, the American pharmacy company Wellpoint, for instance, lost over $42 million US dollars implementing an e-prescription system, physicians were unwilling to use (Havenstein, 2007). In 1994, the American drug-distribution company Fox Meyer even had to file
for bankruptcy after installing a $65 million enterprise resource planning system, which ultimately proved unable to keep up with the volume of its orders. While the company insisted that the problem lay solely with the software, an independent review identified faulty management decisions, a questionable implementation strategy, and unskilled personnel as main reasons for the failure (Scott, 1999). That these are not single cases demonstrates the 2009 CHAOS report. Here, only 32% of reviewed projects were delivered on time, on budget, and with the required features and functions (Standish Group, 2009).

The most important causes for such failures are attitudes and behaviors of personnel (65%), followed by lacking resources (41%), organizational culture (40%), and lacking engagement of management (35%) (Jørgensen, Albrecht, & Neus, 2007). Human factors thus account for the majority of failed or ineffective implementations.

Despite a growing awareness of the importance of human factors in change initiatives, organizations by and large still have difficulties to act appropriately. Often they lack an adequate knowledge of factors that influence acceptance and adoption of new technologies.

Organizational tasks are frequently done in teams, and technologies are thus increasingly used and implemented in a team context. I therefore argue that team characteristics and intra-team dynamics need to be taken into account, when designing and implementing new technologies. Technology implementation and adoption, however, are generally understood either as decisions by individuals or whole organizations. It is therefore time to put groups as users into the focus of interest. Problematic is further that despite the growing number of distributed work arrangements and the importance of technology for their support, little work has been done to understand the challenges of (a) designing technologies for distributed teams and (b) implementing them in distributed contexts. These two gaps in the literature – neglect of the team level and neglect of geographical distribution – make it hard for organizations and designers to anticipate reactions of technology implementations in these settings. At the same time, the theoretical knowledge how the combination of various information and communication technologies influence distributed team processes is underdeveloped.

To close these gaps, I studied the use of CEs and their implementation in distributed teams in the context of offshore oil production operations. The PhD project reported in this thesis had two objectives. The first objective was to obtain a better understanding of the impact of technology on processes and outcomes in distributed teams. It thus aimed to increase our theoretical knowledge about the impact of tech-
1.2. Thesis outline

This thesis is structured as follows (see also Figure 1.2): Chapter 2 reviews the theoretical and empirical literature providing the general theoretical framework of my research. Based on this review the research questions are developed, which led to the six empirical studies reported in this thesis. Chapter 3 describes the industrial and organizational context of the offshore oil and gas industry in the North Sea sector, in which this project took place. The general methodological approach
Chapter 1. Introduction

Figure 1.1.: Work processes as (hypothesized) link between system design and organizational design

of this project is described in Chapter 4. Chapters 5 to 10 report the empirical studies. Study 1 in Chapter 5 investigated the effect of asymmetry and distribution on team processes and relationships. This study provided a description of the phenomenon of asymmetric distributed teams and thus the background to evaluate effects of CE implementations. Study 2 in Chapter 6 investigated the implementation process itself. Its objective was to identify factors that impact CE acceptance and adoption in asymmetric distributed team settings developing a theoretical model of team-based technology adoption. The subsequent empirical studies examined the effects of CE implementations for the functioning of asymmetric distributed teams. In Study 3 (Chapter 7) the focus was on the coordination between subgroups investigating media use and the effect of changes in information and communication technologies on every-day coordination processes. In Study 4 (Chapter 8) I investigated alternatives for the purely technological support of distributed coordination. In this study three CE designs – a purely technological, one based on structural integration of subgroups, and a hybrid solution – were compared in their impact on team processes and subgroup relations to capture the respective advantages and disadvantages of technological or physical integration. Study 5 in Chapter 9 examined the impact of media capabilities on cooperation expectations. The focus was here on expectations about the lateral integration of tasks and processes between subgroups and the degree of vertical decentralization. The comparison of teams before and after CE implementations yielded insights into the effect of media capabilities on direction and alignment of cooperation expectations.

The final study presented in Chapter 10 was a quantitative investigation into
1. Theoretical Part

1. Background and project rationale -- Chapter 1
2. Literature review and research questions -- Chapter 2
3. Industrial and organizational context -- Chapter 3
4. General methodological approach -- Chapter 4

2. Empirical Part

1. Study 1: Impact of asymmetry on distributed team processes -- Chapter 5
2. Study 2: Implementation and adoption -- Chapter 6
3. Study 4: Differential effects -- Chapter 8
4. Study 3: Distributed coordination -- Chapter 7
5. Study 5: Cooperation expectations -- Chapter 9
6. Study 6: Longitudinal team processes and outcomes -- Chapter 10

3. Discussion and Integration -- Chapter 11

Theoretical implications for distributed coordination
Practical implications for CE implementers, organizations, designers
Limitations, open questions, and further research

Figure 1.2.: Outline of the thesis
the impact of CE implementation on identification, intra-team conflicts, and team outcomes over the two and a half years of the project. An integration of the empirical results is presented in Chapter 11. Here also the theoretical for distributed team cooperation and the practical implications for CE implementers, organizations, and designers are discussed. In Chapter 11 I further discuss limitations of the empirical studies, open questions, and possibilities for further research.
The decision to implement Collaborative Environments is driven by the expectation that more advanced media capabilities will lead to more efficient team processes and thus higher performance. CEs, in consequence, have been endowed with high hopes. As a report by the European Commission (2006) states, CEs are expected “to increase the productivity as well as the creativity [of organizations and society] by enabling new forms of work in production and knowledge intensive businesses” (p. 7).

CEs are foremost a technological solution to support distributed teams. Every year organizations commit considerable financial and personnel resources to the implementation of new technologies with the aim to improve operation efficiency, reduce costs, and increase competitiveness. Reviews show, however, that despite high commitments between 40-75% of implementation projects fail (e.g., Kotter, 1995; Markus & Keil, 1994). One reason for these failures is that too often organizations still consider such initiatives a mere technological problem. Technology adoption, however, is most seldom a matter of simply providing technological alternatives.

The acceptance of technologies is influenced by the perceptions, beliefs, experi-
ences, and attitudes of (potential) users (Dennis, Wixom, & Vandenberg, 2001; Pollard, 2003; Zigurs & Buckland, 1998). In distributed teams, and more specifically asymmetric distributed teams, these aspects frequently differ across subgroups, as dispersed members hold subgroup-specific norms, values, and attitudes. In addition, subgroup-specific tasks and work environments can lead to disparate requirements for the support of work processes. These differences have to be taken into account in the design of CEs, which leads to the question, how to choose or design technologies, if heterogeneous groups of users are involved.

The acceptance and use of technologies are also influenced by the implementation process itself (e.g., Grover, Teng, Segars, & Fiedler, 1998; Karahanna, Straub, & Chervany, 1999). The success of CE implementations is thus not only a question of offering the best capabilities, but also of tailoring the process to the people and the setting, in which the technologies will be used. In other words, finding the right process is just as important as finding the right design.

Hence, the design (or choice), implementation, and use of technologies are not unconnected events, but interlinked stages along a process that influence each other. Consequently, in my PhD project I focused on both aspects: the process of implementing new technologies in the context of CEs, as well as the effects of this technological change on the functioning of existing asymmetric distributed teams. These aspects touch on four interlinked, but mostly separate research areas, namely (1) distributed teams, (2) team diversity, (3) computer-mediated communication, and (4) technology implementation and adoption. The following sections provide a review of the relevant literature in these areas. Distributed team work and diversity and are discussed under the heading of distributed working in complex team arrangements. The subsequent section discusses the applicability of theoretical and empirical implementation and adoption literature for asymmetric distributed team settings. The third section reviews our knowledge on short and long-term effects of technology and technology changes. In the context of the literature review I also develop the research questions and objectives for the empirical investigations in this thesis.

2.1. Distributed working in complex team arrangements

Virtual or distributed teams are defined as “groups of geographically and/or organizationally dispersed coworkers that are assembled using a combination of telecommunications and information technologies to accomplish an organizational task” (Towns-end, DeMarie, & Hendrickson, 1998, p. 17). Distributed teams can be found
2.1. Distributed working in complex team arrangements

in areas ranging from multi-national top management teams to software development, consulting teams, or academic research collaborations.

Most of the early work on distributed teams has concentrated on the fully dispersed or ‘virtual’ team, in which members communicate only through media. Yet, the fully dispersed team must be considered an extreme case of distributed working, and is probably rather the exception than the norm in organizations. In consequence, the concepts of distribution, dispersion, and virtualness themselves came under closer scrutiny over the last years (e.g., Fiol & O’Connor, 2005; Martins, Gilson, & Maynard, 2004; O’Leary & Cummings, 2007). As a result, virtualness has developed from a binary concept to denote a gradual change according to “the extent of face-to-face contact of team members (encompassing amount as well as frequency of contact)” (Fiol & O’Connor, 2005, p. 20). Virtualness is now understood as a fluid transition from collocated teams to purely virtual teams. Dispersion likewise has received a differentiation into disparate forms. O’Leary and Cummings (2007), for instance, recently suggested a split into three types – spatial, temporal, and configurational dispersion – with disparate impacts on the functioning and outcomes of distributed teams. Spatial dispersion, as the geographic distance between members, should be linked to a reduction in spontaneous communication, while time differences between members (temporal dispersion) should decrease the likelihood of synchronous interaction. The authors further discern three forms of configurational dispersion: site (locations where members work), isolation (locations where members work alone), and imbalance (locations with uneven distribution of team members), which are expected to raise coordination complexity, decrease awareness, and increase intra-group conflict.

Although ‘virtual team’ is considered the main label to indicate dispersed teams arrangements, it tends to refer to completely dispersed teams, in which members rarely or never meet face-to-face. As the teams studies in this project consisted of dispersed subgroups of collocated members, this term seems inappropriate. I therefore prefer the use of ‘distributed team’ as a more generic term, which also includes work arrangement with partly dispersed and collocated members. This term will be used throughout the thesis. The teams studied in this project further combined spatial dispersion with a long-term focus, as well as an asymmetric structure. I therefore refer to them as longitudinal asymmetric distributed teams or LADTs. In the following sections I discuss the main characteristics and challenges of LADTs.
2.1.1. Challenges of longitudinal asymmetric distributed teams

The main advantage of distributed teams is commonly seen in a greater flexibility for both organizations and individual employees. Dispersed collaborations allow organizations to pool resources independent of physical location and to change team composition more easily and on short notice. At the same time, individuals gain independence from a specific office space (Bell & Kozlowski, 2002; DeRosa, Hantula, Kock, & D’Arcy, 2004; Thompson & Coover, 2003). The subsequent reduction in travel time and expenses can lead to considerable time savings for employees, as well as financial savings for organizations (Priest, Stagl, Klein, & Salas, 2006). Distributed team work has also been linked to positive outcomes such as a reduction of hierarchical boundaries (Brennan & Rubinstein, 1995; DeSanctis & Monge, 1999), more participation of low status members (Dubrovsky, Kiesler, & Sethna, 1991), and reduced stress for individuals due to the elimination of distractions from co-workers (Kiesler & Cummings, 2002).

But distributed team work also has its problematic aspects. In contrast to conventional teams, in which the close proximity of members allows frequent face-to-face interactions, the geographic separation in distributed teams limits or even excludes direct contacts. Instead distributed teams rely on technology to mediate interactions and to exchange information. The loss of immediate, face-to-face interaction removes contextual cues that are important for the organization of communication such as allocating turns, monitoring understanding, or managing audience attention (Daly-Jones, Monk, & Watts, 1998). The prevalence of technology-mediated communication leads to what Fiore, Salas, Cuevas, and Bowers (2003) term team opacity, where “distribution decreases awareness of team member actions by changing from a data rich perceptual/cognitive environment to a data lean and primarily cognitive experience” (p. 342). In consequence, distributed teams often have more difficulties in developing trust, cohesion, and partner acceptance (Aubert & Kelsey, 2003; Jarvenpaa & Leidner, 1999; Sheldon, Thomas-Hunt, & Proell, 2006; Wilson, Straus,
2.1. Distributed working in complex team arrangements

& McEvily, 2006). The lack of personal interactions can moreover result in the social isolation of team members (Cooper & Kurland, 2002; Vega & Brennan, 2000), lower commitment to team goals, and social loafing (Karau & Williams, 1993). Distributed teams frequently show lower satisfaction with processes and results than collocated groups (Burke, Aytes, & Chidambaram, 2001; Thompson & Coovert, 2002; Warkentin, Sayeed, & Hightower, 1997). Also, misunderstandings and frictions tend to occur more often than in face-to-face interactions (Hinds & Bailey, 2003; Mortensen & Hinds, 2001; Zornoza, Ripoll, & Peiro, 2002). In computer-mediated settings even the meaning of silence can become problematic (Panteli & Fineman, 2005). These problems are made worse, if distribution is accompanied by diversity, as is the case in LADTs.

Asymmetry as extreme form of team diversity

Distributed teams are often comprised of dispersed, but interdependent subgroups, in which some members are collocated, but cooperate with members of other groups located somewhere else. These subgroups can be part of the same organization (intra-organizational teams) or include multiple organizations (inter-organizational teams), and often span various functions, demographic groups, or national and company cultures. In consequence, distributed teams tend to be more heterogeneous than collocated teams, when it comes to knowledge, skills, work-related experiences, attitudes, and demographics (Griffith & Neale, 2001). Diversity is thus an important element of distributed team work that adds considerably to its complexity.

Team diversity is frequently linked with expectations for higher team performance and innovativeness (e.g., Miller, 2001; Pelled, 1996). Yet, high levels of heterogeneity can also have a detrimental impact on teams. More conflicts (Jehn, Northcraft, & Neale, 1999), higher stress levels (Keller, 2001), and lower satisfaction (Yeh & Chou, 2005) are some of the effects found repeatedly. Homogeneous teams can rely on a certain degree of pre-existing common ground based on comparable experiences and education; heterogeneous teams do not possess this initial advantage. The overlap between knowledge areas and frames of reference in the latter are often relatively small and may not go beyond stereotypes and general assumptions of what the other person knows and does (public common ground sensu Clark, 1997). Yet, with too little overlap in the backgrounds of team members the team might not be able to profit from unique information only held by individual members (e.g., Stasser & Titus, 1985; Stasser, Stewart, & Wittenbaum, 1995).
Diversity is related as much to variety in the type of information available in a team as to the differences in styles of information use and processing (e.g., Cohen & Levinthal, 1990; Kilduff, Angelmar, & Mehra, 2000). While heterogeneity can increase the range and depth of information use in teams, above a certain threshold heterogeneity seems to impair these processes (Dahlin, Weingart, & Hinds, 2005). With increasing differences, understanding each other can become more difficult as terminologies and ways of argumentation drift apart (Krauss & Fussell, 1990). While psychologists and sociologists, for instance, might still be able to reach an understanding on common concepts and theories, the gap between designers and nurses in a project for the development for health care products might be harder to bridge. Coordination on tasks can thus be problematic, even if all participants are aware and accept the existence of different ‘world views’. As Massey et al. (2006) in their description of a multi-disciplinary project between psychologists, agriculturists, and academics from a business school demonstrated, differences in world-views persisted and still negatively impacted cooperation even after a period of three years. Deep-rooted differences are hard to overcome.

Diversity research has commonly treated heterogeneity as an uni-dimensional construct in terms of either demography (e.g., age, gender, nationality), expertise, or job function. Yet, (distributed) teams often differ not only in one, but in several of these aspects. Given the reality of multiple or parallel types of diversity in natural teams, newer research agrees that this uni-dimensional view is insufficient to explain and predict team processes. The faultline concept introduced by Lau and Murnighan (1998) proved a fruitful alternative for the study of heterogeneity in teams. Group faultlines are the “hypothetical dividing lines that may split a group into subgroups based on one or more attributes” (Lau & Murnighan, 1998, p. 328). Especially, in times of stress, scarce resources, or in highly competitive situations prior unobserved differences may become salient changing the identification of members from the wider team to other attributes and thus increasing the probability that a team disintegrates along specific features. Underlying this process is the identification with team members with similar characteristics, as well as a higher attraction to people similar to one self (Thatcher, Jehn, & Zanutto, 2003). Similarity can be based on one or more attributes such as affiliation to a specific team, company, national culture, discipline, gender, etc. The more attributes align, the higher the probability for groups to split into subgroups (Li & Hambrick, 2005).

Geographical dispersion can act as a powerful dividing line – especially if team members identify more strongly with their local subgroup than with the overall
team (Polzer, Crisp, Jarvenpaa, & Kim, 2006). This effect is strongest, if subgroups are internally homogeneous, but heterogeneous when compared to each other, i.e., diversity features align along the geographic dividing line. Such internally homogeneous subgroups are a likely occurrence in distributed teams, as people with similar or closely related tasks and functions tend to work in closer proximity. Moreover, members in these subgroups often have highly specialized roles and responsibilities, which are bound to their specific locations (e.g., pilots and air traffic controllers). These location-specific roles and responsibilities find expression in diverse educational backgrounds, knowledge bases, professional cultures, subgroup-specific priorities, etc. In consequence, subgroups are comparatively homogeneous internally, but highly diverse, when compared to each other. Such attributes can either be easily observable such as age and gender (surface-level diversity attributes), or only become discernible after closer contact; e.g., differences in experiences, personal values, or areas of expertise (deep-level diversity attributes; Harrison, Price, & Bell, 1998).

The alignment of several diversity attributes within remote subgroups leads to asymmetries in teams. Asymmetry, as defined in this thesis, refers to systematic differences in task-related, deep-level, and surface-level diversity attributes that align along the geographic divide. In the resulting teams, remote subgroups are comparatively homogeneous internally, but highly diverse when compared to each other (see Figure 2.1). Asymmetry as defined here is thus a particular constellation of faultlines, in that all faultlines align along the same groupings. An example for such settings are emergency rescue teams, which combine subgroups of fire fighters, emergency medical technicians, hospital emergency room and recovery teams, each with their own internal profile of functions, expertise, team structures, and demographics (e.g., Marks, DeChurch, Mathieu, & Panzer, 2005; Mathieu, Marks, & Zaccaro, 2001). The mining industry or space exploration are two other examples with dispersed and asymmetric subgroups (e.g., Caldwell, 2005).

Empirical results are not equivocal on whether faultlines impact groups in a positive (e.g., Gibson & Vermeulen, 2003; Lau & Murnighan, 2005) or negative (Li & Hambrick, 2005; Rico, Molleman, Sanchez-Manzanares, & Van der Vegt, 2007; Thatcher et al., 2003) way. Newer results indicate that their impact on team functioning and outcomes differ depending on the type of faultline. Bezrukova, Jehn, Zanutto, and Thatcher (2009), for instance, differentiated between social category and information-based faultlines. In their study, strength of social category faultline (age, gender) was negatively related to team performance, while information-based faultlines (level of education, tenure) were not. At the same time, it has frequently
been argued that the relative obscurity of computer-mediated communication should make easily observable surface attributes such as age, gender, or race less important (cf. DeSanctis & Monge, 1999). In line with this argument, Bhappu, Griffith, and Northcraft (1997) found that individuals in distributed teams paid less attention to gender in-group/out-group differences than individuals in face-to-face groups. A further complication in ascertaining the effect of diversity are findings, which indicate that not the actual degree of heterogeneity might be problematic, but a group’s belief on whether these differences are positive or negative for team performance (Homan, van Knippenberg, van Kleef, & De Dreu, 2007).

The somewhat contradictory findings from diversity literature point towards a complex interplay of diversity and distribution on team processes. So far, the majority of research on diversity and faultlines has been done in collocated settings, while the problem of diversity in distributed teams has not received comparable attention (cf. Martins et al., 2004). The few existing studies have concentrated mostly either on demographic (e.g., Bhappu et al., 1997; Savicki, Kelley, & Lingenfelter, 1996) or national diversity (Staples & Zhao, 2006; Tan, Wei, Watson, Clapper, & McLean, 1998). It is therefore not clear, how more complex patterns such as asymmetry influence distributed team processes and outcomes. The clarification of the combined effects of distribution and asymmetry was one objective of this thesis (Study 1; see Chapter 5).
2.1. Distributed working in complex team arrangements

Distributed teams with a long- or short-term focus

So far, studies of distributed teams have largely been restricted to a specific type of team: the fully dispersed temporary or project team with more or less homogeneous members. Characterizations accordingly tend to emphasize the temporary or project nature of distributed teams (e.g., Cramton & Webber, 2005; DeRosa et al., 2004; Kristof, Brown, Sims, Jr., & Smith, 1995). Ahn, Lee, Cho, and Park (2005), for instance, argue that “virtual teams are usually organized for temporal objectives” (p. 563). Kelsey (1999) similarly defines virtual teams as “a boundaryless network organization form where a temporary team is assembled on an as-needed basis for the duration of a task” (p. 104).

Interestingly, the discussion about the virtual workplace tends to ignore that remote working is and has been a common practice in a number of industries for many years. Examples are air traffic control, construction, mining, or the offshore oil and gas industry. First experiences with exploration and production from offshore platforms, for instance, started in the 1940s in the Gulf of Mexico, and remote working has been a consistent part of the industry ever since.

Teams with a longer-term focus differ from temporary teams in important ways. Temporary teams are restricted to a specific time-bound goal and disbanded once this goal is achieved. Ongoing teams, in contrast, are characterized by recurring processes or long-term functions without a preconceived end. Ongoing teams further differ from temporary ones in that their tasks are usually of a cyclical, repetitive nature (e.g., in production or services; Putnam, 1992). In consequence, roles within the team are often relatively stable and members can anticipate remaining in the same team for an unspecified time. Over time, ongoing teams develop routines, as well as a common group history that form the background for current and future interactions. Coordination of tasks and processes in mature ongoing teams can thus rely on existing routines, mutual knowledge about roles and responsibilities, and ‘shared cognitions’ of members, i.e., “similar, overlapping, compatible, or complementary knowledge or belief structures that represent features of the context such as task-specific knowledge, task-related knowledge, knowledge of team-mates, and attitudes/beliefs” (Cannon-Bowers & Salas, 2001). Rather than explicitly planning and negotiating tasks and processes, these structures allow the implicit coordination of team activities (Rico, Sanchez-Manzanares, Gil, & Gibson, 2008). They thus not only reduce the probability for frictions, but also the overall need for communication among members.
As Saunders and Ahuja (2006) argue, the anticipation of an indefinite life-span also affects the social orientation of teams. Much more than in temporary teams, the main concern for ongoing teams must be to guarantee their continuous existence and to allow members to cooperate on a permanent basis. These teams should therefore have a strong social orientation and put a stronger emphasis on member satisfaction and the resolution of relationship and process conflicts. Temporary teams in contrast tend to be more concerned with performance and effectiveness. In consequence, team processes in ongoing distributed teams will differ from those in shorter team arrangements. Equally, ongoing distributed teams will probably have different requirements, when it comes to the support of their work than temporary or project teams.

Is maturity a benefit for asymmetric distributed teams? Diversity in teams can be overcome through the exchange of information, mutual experiences, the negotiation of expectations, tasks, and routines, and in a broader sense team learning (Baba, Gluesing, Ratner, & Wagner, 2004; Yeh & Chou, 2005). Team learning behaviors are “activities by which team members seek to acquire, share, refine, or combine task-relevant knowledge, through interaction with one another” (Argote, Gruenfeld, & Naquin, 1999, p. 370). The more team members learn from each other, the easier and the more effective communication and cooperation will be (Van der Vegt & Bunderson, 2005). Asymmetric distributed teams appear here at a clear disadvantage. Not only are remote subgroups characterized by considerable heterogeneity in most task-relevant characteristics, they frequently operate in very dissimilar contexts and – depending on existing media capabilities – with little opportunity for direct communication and knowledge exchange. These restrictions in direct contacts reduce the possibility for team learning among dispersed subgroups.

Considering mature distributed teams, it could be expected that members possess a good understanding about their mutual roles and responsibilities, as well as well established routines and norms on how tasks and processes should be undertaken. The familiarity with the team task and the team itself should thus reduce the complexity of coordination, decrease the probability of conflicts, and remove hurdles for team performance (Espinosa, Slaughter, Kraut, & Herbsleb, 2007). The development of accurate shared mental models among team members is crucial, especially when considering the often safety-critical nature of tasks and the dynamic environments, in which asymmetric distributed teams can be found (e.g., air traffic control, mining, emergency response, or space exploration). As Baba et al. (2004) point
out, “conditions of high interdependency and complexity require more elaborate and precise interaction among team members, which in turn could require considerable sharing or overlap of cognition related to task and team” (p. 554).

In an optimal state, mature distributed teams should be able to coordinate implicitly, and to anticipate and dynamically adjust behaviors based on established rules, plans, roles, and routines, decreasing the need for explicit negotiation and communication (Cannon-Bowers, Salas, & Converse, 2003; Rico et al., 2008). Yet, empirical studies suggest that maturity may have in fact the opposite effect. Studying software development projects distributed across multiple sites, Sole and Edmondson (2002), for instance, found that members had little difficulty accessing knowledge-resources at their own location. When accessing knowledge at other locations, however, the recognition and identification of relevant resources were often hampered by locale-specific practices and unfamiliar routines (i.e., situated knowledge). Despite prior experiences, team members at different geographical locations often lack the shared background and personal experiences to establish a solid understanding of others’ knowledge. The lower awareness of team processes and activities renders the integration of actions, knowledge, and objectives more difficult, when compared to collocated settings (Fiore et al., 2003).

In a longitudinal investigation of 62 software development project teams over three and a half months, Levesque, Wilson, and Wholey (2001) further found that shared mental models of team members may actually diverge over time. In the course of the cooperation team members developed clear role differentiations and routines. Due to this specialization and the decreased need for interaction, mental models in more mature teams became increasingly dissimilar. Longer experience may thus not automatically lead to better team knowledge or easier coordination (Cramton & Webber, 2005; Gibson & Gibbs, 2006). As Davis (2004) succinctly sums up the situation in distributed teams, “distance amplifies dysfunction, distance dilutes leadership, distance weakens human relationships and team processes” (p. 48). Yet, maturity in distributed teams seems no panacea for these problems.

While the difficulties of distributed teams in their early stages are well recognized (e.g., Chidambaram, 1996; Hart & Mccleod, 2003; Jarvenpaa & Leidner, 1999), much less is known of the problems mature distributed teams need to overcome. Similarly, the majority of research on diversity and faultlines has been done in collocated settings, while the problem of diversity in distributed teams has not yet received much attention (cf. Martins et al., 2004). It is therefore unclear, how the additional challenges of subgroup asymmetry affect team processes. However, this
knowledge is important, when making decisions on the appropriate design of CEs. To obtain a better understanding of the combined impact of asymmetry and distribution in ongoing teams, the first study in this thesis took an exploratory approach to examine coordination processes and relationships in mature LADTs. This first study thus provided the background to understand the consequences of CE implementations in distributed asymmetric team settings.

**Study 1: The impact of asymmetry on team processes and relationships**

*Objectives:*

1. Explore the effect of subgroup asymmetry on team functioning in LADTs
2. Obtain a ‘baseline’ for the evaluation of effects of CE implementations

*Main research question:*

1. What impact does subgroup asymmetry have on processes and relationships in mature longstanding distributed teams?

### 2.2. Implementation and adoption of Collaborative Environments

The implementation of new technologies is essential to maintain the competitiveness of organizations (Edmondson, Bohmer, & Pisano, 2001). Globalization, a stronger focus on short-term returns, faster product cycles, and customer demands for better and quicker services increase pressures on organizations, and technological innovations are one way to react to these pressures.

The implementation of new technologies is a complex process. It starts with the decision of an organization to implement a new technology (*organizational adoption*) over the deployment of the new technology to its members (*implementation*) and the initial decision by users to accept and use it to the integration of the technology as a routine part of the work environment (*individual acceptance and adoption*).
2.2. Implementation and adoption of CEs in LADTs

The way from the introduction of an innovation to the long-term use is often referred to as *innovation diffusion*, which denotes “the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system” (Rogers & Scott, 1997). Technology diffusion theory (Rogers, 1995) proposes that technology implementation and use develops in stages from knowledge (becoming aware of its existence and understanding its functions), persuasion (forming a favorable attitude), decision (committing to the adoption) to implementation (putting it to use) and confirmation (reinforcement based on positive outcomes).

Before the actual implementation, information by the organization or vendors create **expectations** in prospective users, which determine whether users develop positive or negative attitudes and through this their usage intentions (Bhattacherjee & Premkumar, 2004; Karahanna et al., 1999). In the early phases after implementation, the focus generally is on **satisfaction and initial acceptance** or rejection decisions (Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). **Adoption** at the individual level denotes users’ decisions to accept and integrate innovations into their work routines, which is an important element of long-term use (i.e., *technology continuance*; Bhattacherjee, Perols, & Sanford, 2008; Liao, Palvia, & Chen, 2009). **Appropriation** describes the processes involved in the integration of new technologies into existing work practices, whereas **technology adaptation** finally looks at the mutual influence of technology and users over time (Dennis et al., 2001; Majchrzak, Rice, Malhotra, & King, 2000).

The **implementation process** itself can be defined as “the transition period during which the targeted organizational members ideally become increasingly skillful, consistent, and committed in their use of an innovation” (Klein & Sorra, 1996, p. 1057). Implementation success links two aspects: the effectiveness of the implementation and the effectiveness of the innovation. **Implementation effectiveness** can be defined as “the consistency and quality of targeted organizational members’ use of the specific innovation”, while **innovation effectiveness** refers to “the benefits an organization receives as a result of its implementation of a given innovation” (Klein & Sorra, 1996, p. 1058). Innovation in this context does not mean that a technology is completely new; rather that it has not been used within the organization before (cf. Nord & Tucker, 1987). The implementation of a new technology is thus only successful, if members within the organization accept and adopt it, and if individuals, as well as the organization see a benefit from the innovation. Accordingly, technology implementations in organizations can have three potential outcomes: (1) the imple-
Chapter 2. Literature review and research questions

Implementation is effective and use of the implementation enhances the organization’s performance, (2) implementation is effective, but use does not enhance the organization’s performance; and (3) implementation fails, because users do not accept and adopt the innovation (Klein & Sorra, 1996).

Many technology implementations fail to deliver all or any of the envisioned benefits. This not only results in considerable financial losses for organizations, but also in disruptions of processes and frustrations for its members. Past studies have identified various factors that determine the success of technology implementation and the degree of user adoption. In a recent review of quantitative and qualitative literature Jeyaraj, Rottman, and Lacity (2006) summarized the most important predictors for adoption decisions. According to this review, adoption of individual users was driven by user characteristics such as computer experience and behavioral intentions, characteristics of the technology mainly in terms of its perceived usefulness, and organizational factors such as top management support and user support. A study comparing implementation projects in the USA, Australia, and Hong Kong further suggests that also the broader context of national cultures may play a role in the diffusion and collective adoption of new technologies (Bajwa, Lewis, Pervan, & Lai, 2005).

A number of theories try to explain the processes underlying technology acceptance and adoption. The most prominent theories for individual adoption decisions are Innovation Adoption and Diffusion Theory (ADT) (Rogers, 1995), the Technology Acceptance Model (TAM) (Davis, 1989), the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003), Adaptive Structuration Theory (DeSanctis & Poole, 1994), and the Theory of Planned Behavior (Ajzen, 1991). The underlying assumption in all these approaches is that users hold specific beliefs about the technology, which affect users’ initial attitudes towards the innovation. These attitudes impact intentions to use or reject the innovation and ultimately result in its adoption or refusal. Differences between these theories are centered around the type and number of variables they consider as influences on users’ beliefs and attitudes. Influencing variables include characteristics of the individual such as demographics, values, cognitive ability, or personality (Bhattacherjee et al., 2008; Czaja et al., 2006; Ilie, Slyke, Green, & Lou, 2005; Kim, Chan, & Chan, 2007; Kim, Chan, & Gupta, 2007), characteristics of the innovation such as interface layout, social richness, or relative advantage (e.g., Hasan & Ahmed, 2007; Venkatesh & Johnson, 2002), or characteristics of the organization such as facilitating conditions, organizational culture, or management support (Klein, Conn, & Sorra, 2001;
2.2. Implementation and adoption of CEs in LADTs


Interestingly, prevalent theories on technology implementation and adoption tend to concentrate on the individual or organizational level (e.g., Frambach & Schillewaert, 2002; Jeyaraj et al., 2006). Given the prevalence of team work in today’s organizations, this seems an unfortunate restriction. The lack of team-based models was recently pointed out by Lapointe and Rivard (2007), who argue that technology implementation in organizations must be considered as a multilevel process – involving the individual and organizational, as well as the group level. Empirical studies support the notion that group-level processes are important in adoption processes demonstrating effects for team characteristics such as national cultures or team-level processes such as team learning, team stability, and psychological safety (Bajwa et al., 2005; Edmondson et al., 2001; Griffith, 1998). Political processes within or between groups can further shape perceptions and use of new technologies (Hayes, 2008; Spicer, 2005). Yet, models and theories, which specifically describe implementation and adoption for a team context are still missing. It is therefore difficult to predict, how a team context may impact the adoption of group-based technologies such as CEs.

So far, the literature on technology diffusion and adoption has also mostly ignored the problem of distributed implementations, even though technology and with it technological changes and innovations are the backbone of distributed work processes (Mark & Poltrock, 2004). The problem of asymmetry in potential users likewise has not received much attention. But why should technology implementation be different or more problematic in an asymmetric distributed context?

A possible answer can be found in the technology-in-practice perspective (Orlikowski, 2000), which emphasizes the mutual influences of technology and social system. As proponents of this approach argue, information technologies are not a mere passive element of the organizational environment, but provide social structures that shape interpretations and expectations of users towards their work and the management of processes. The perception and use of technologies always depend on users’ own subjective experiences, values, and needs; or in short his or her social context. Technology implementation is thus not an objective, clear-cut event. Instead actors perceive the process through their own personal lens and create their own personal narratives and explanations on what is happening and how to evaluate the process. The same implementation will so create multiple versions of the event, which exist parallel to the often streamlined ‘official’ version (Dawson & Buchanan, 2005).
Chapter 2. Literature review and research questions

In a team-setting, success of technology implementations requires that all user groups accept and adopt the same technology finding a mutually agreed way to use it. Yet, if there are no ‘objective features’ of a technology, finding a common ground on how to interpret and use the same technology can become difficult, especially if user groups have disparate views and requirements.

CE implementations in LADTs take place in a distributed team-setting in which subgroups share a common team goal, but are characterized by systematic differences in surface- and deep-level attributes. As stated above, existing models and theories on technology implementation and adoption are generally either focused on the individual user or the organization. It is thus not clear, in how far they can provide guidance in a team context. Further, existing theories do not discuss the challenges of asymmetric distributed teams, which are the focus in this thesis. Although it is well established that organizational and team contexts influence implementation experiences and adoption decisions, it is not clear, which factors are of relevance for technology implementations in LADTs. So far, we also know little about the factors and processes that may be responsible for changes in belief, attitudes, and behaviors over time (Bhattacherjee & Premkumar, 2004).

The rationale of Study 2 was to obtain a better understanding of the process of CE implementations in LADTs and the impact of distribution and asymmetry on technology adoption over time. Its two main objectives were the identification of group-level and context factors that impact adoption decisions over time, and the development of a theoretical model for team-based adoptions in asymmetric distributed settings.

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<td>(1) Identification of group-level and context factors that influence acceptance and adoption in asymmetric distributed teams</td>
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<td>(2) Development of a theoretical model for team-based technology adoption in asymmetric distributed teams</td>
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Main research questions:

(1) How do subgroup asymmetry and distribution affect the technology adoption process?
(2) What are the emergent factors that affect acceptance and adoption in various phases of the process?
(3) To what extent do attitudes and technology usage stabilize over time?

2.3. Short- and long-term effects of CE implementations

Information and communication technologies enable and constrain interactions, support coordination among people, and provide procedures for interpersonal exchange. In this way, technology not only influences how individuals interact with and within their environment, but also how they perceive and make sense of it. **Adaptive Structuration Theory** (AST; DeSanctis & Poole, 1994) provides a theoretical framework to describe the interplay between organizational structures, human interaction, and information technologies. In the words of AST, technology “presents an array of social structures for possible use in interpersonal interaction, including rules (e.g., voting procedures) and resources (e.g., stored data, public display screens)” (DeSanctis & Poole, 1994, p. 125). These social structures provide the templates for the planning and accomplishment of tasks, as well as social interactions within a given organizational context.

According to AST, information technologies are characterized by two aspects: structural features and spirit. **Structural features** refer to the design of the technology in terms of rules, resources and capabilities of the system, such as the ability to store or replay information, visualize data, or send messages to multiple recipients.
Spirit in contrast describes the “general intent with regard to values and goals underlying a given set of structural features” (DeSanctis & Poole, 1994, p. 126). It is the ‘official line’ of how designers and the organization implementing these technologies expect the technology to be used. In reality, users often deviate from this official line – choosing to ignore features the organization deems important, to modify them according to their own preferences, or to use them in unintended ways, which often leads to consequences unexpected by the implementing organization (McAulay, 2007; Peters, 2006).

Structural features of information technologies are thus not objective properties, but obtain their meaning through their recurrent application and the development of usage rules and procedures over time (Orlikowski, 2000). Through the appropriation of new technologies new social practices are developed that, as they become routinized, influence how users perform tasks or what they consider good practice in their organization. In this way technologies can shape users’ perceptions and expectations and in the long run influence organizational properties such as norms, climate, or cultures (cf. Orlikowski, 1992). Information technology in this view becomes a ‘medium of human actions’, that “facilitates and constrains human actions through the provision of interpretative schemes, facilities and norms” (Orlikowski, 1992, p. 410). Technology can thus support the strategic direction of organizational change processes (Pinsonneault & Rivard, 1998) or even itself act as an independent agent for organizational change (Volkoff, Strong, & Elmes, 2007).

2.3.1. Media capabilities and team processes

Information and communication technologies possess built-in features that circumscribe their ability to transmit information. Emails, for instance, can transmit written information, but not modulations in the voice of a speaker or variations in body posture that may alter the interpretation of a message. Phone conversations allow the transfer of voice, but are transient and cannot be reviewed or replayed (unless recorded by an additional device). There are many schemes to categorize media capabilities in a systematic manner. A common scheme is the one developed by Clark and Brennan (1991) comparing the eight aspects visibility, audibility, sequentiality, or reviewability (see Table 2.1). A number of similar schemes exist (e.g. Maruping & Agarwal, 2004; Priest et al., 2006), which differ mostly in details.

Media capabilities can either restrict or support the transmission of certain types of information. Visibility in video-chat programs, for instance, provides non-verbal
Table 2.1.: Dimensions for the description of communication media according to Clark and Brennan (1991)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copresence</td>
<td>group members occupy the same physical location</td>
<td>shared office space</td>
</tr>
<tr>
<td>Visibility</td>
<td>group members can see one another</td>
<td>video-chat</td>
</tr>
<tr>
<td>Audibility</td>
<td>group members can hear one another</td>
<td>phone, audio-conferencing</td>
</tr>
<tr>
<td>Cotemporality</td>
<td>communication is received at the approximate time it is sent</td>
<td>phone, video-conferencing</td>
</tr>
<tr>
<td>Simultaneity</td>
<td>group members can send and receive messages simultaneously</td>
<td>video-conferencing</td>
</tr>
<tr>
<td>Sequentiality</td>
<td>group members’ speaking turns stay in sequence</td>
<td>email, phone</td>
</tr>
<tr>
<td>Reviewability</td>
<td>messages can be revised before being sent</td>
<td>email</td>
</tr>
<tr>
<td>Revisability</td>
<td>messages do not fade over time</td>
<td>paper documents, email</td>
</tr>
</tbody>
</table>

and para-verbal cues, which are unavailable in audio-only or text-only media. In this way, the type of media available to distributed teams influences how team members can interact and therefore affect team processes, as well as team efficacy and the development of social relationships.

The two features most often discussed when considering effects of communication media on team work are **media synchronicity** (Dennis & Valacich, 1999) and **media richness** (Daft & Lengel, 1986). In synchronous communication, individuals interact without conceivable time delays (i.e., in ‘real-time’; for instance, when speaking on the phone or through a video-link); the counterpart – asynchronous communication – describes exchanges with larger time laps between turns or the potential for turns that appear out of their ‘natural’ sequence (e.g., email).

**Media synchronicity theory** (Dennis & Valacich, 1999) posits that synchronous media offer a more consistent flow of communication and are thus more natural and supportive for regular interactions. **Media richness theory** (Daft & Lengel, 1984, 1986) is based on the assumption that each medium has a specific capacity to convey information. Media richness constitutes a continuum from low to high with face-to-face (synchronous communication with presence of verbal and non-verbal cues) at the highest and text messages (asynchronous, written cues only) at the lowest end (cf. Burke et al., 2001). Rich media allow for immediate feedback, use visual and audio channels, and use natural language communication. Leaner media have none or
only a subset of these capabilities. According to media richness theory, richer media should thus lead to clearer, less ambiguous messages. Socially richer media can also convey a wider range of non-verbal cues by transmitting facial expressions, body posture, or gaze direction (Rice, 1993). Such media thus feel generally ‘warmer’ and more ‘personable’ (Short, Williams, & Christi, 1976). In general, media higher in social richness are considered more user-friendly and have been shown to increase media use (Venkatesh & Johnson, 2002). Based on media richness theory, it has been suggested that for meaningful interactions the richness of a medium must be adapted to the complexity of the transmitted information, as otherwise communication will become inefficient and liable to misinterpretations (e.g. Trevino, Lengel, Bodensteiner, Gerloff, & Muir, 1990).

Media richness theory has received fierce theoretical critique and only mixed support for new media like email or voice mail (D’Ambra, Rice, & O’Connor, 1998; Lengel & Daft, 1988; Trevino, Lengel, & Daft, 1987). Problematic with “media bandwidth approaches” (Burke et al., 2001) such as synchronicity or media richness is the assumption that media possess stable, unchangeable characteristics that determine the impact on mediated communications independent of context or situation. As newer literature on technology adaptation demonstrates, this deterministic view might be an artifact of the short-term focus adopted in most studies. **Technology adaptation** refers to modifications in technology use over time and according to the specific usage context. Adaptation effects have been found in experimental as well as field settings. Burke et al. (2001), for instance, compared effects of media richness on group cohesion and process satisfaction over a four week period in two experimental studies with business students. They found that initially cohesion and satisfaction was higher for richer media, thus supporting media richness theory. Over the course of the four weeks, however, differences between media types disappeared indicating an adaptation effect. Kleij, Paashuis, and Schraagen (2005) similarly showed that performance differences in face-to-face and video-mediated small groups disappeared over only four consecutive sessions of a paper-folding task. Interestingly, media conditions showed no differences in satisfaction and cohesion, but mental effort was actually higher in face-to-face teams and remained higher throughout the experiment. In a qualitative study on the long-term use of an audio-visual communication environment in a group of geographically distributed researchers Dourish, Adler, Bellotti, and Henderson (1996) describe personal experiences and communication practices that emerged over several years. Concrete examples on the individual and group level clearly show that behaviors and interac-
2.3. Short- and long-term effects of CE implementations

tion routines changed through the long-term use of audio-visual media.

Channel expansion theory (Carlson & Zmud, 1999) provides a possible theoretical framework for these findings. It assumes that users’ experiences with the channel (or medium), the message topic, organizational context, and communication partners shape their perception and use of a medium. Over time users will develop a medium-specific knowledge base, which allows users to adapt their behaviors and perceptions to the features of the medium.

Technology adaptation effects question the general assumption that the more ‘realistic’ a communication medium, i.e., the closer to face-to-face interactions, the easier and more effective the cooperation between remote participants should become (Daly-Jones et al., 1998). The empirical findings also support the stance of AST and theory-in-practice approaches, which refute the notion of objective technology features. As Griffith and Northcraft (1994) comment, “communication media themselves do not have organizational effects; these effects result from the use of features (acknowledged or unacknowledged) which comprise the medium” (p. 273; emphasis added).

Adaptation effects explain how distributed teams are able to fulfill complex tasks even under suboptimal communication conditions. Before the invention of radio and telephone, military campaigns, for instance, were coordinated using runners carrying verbal messages or paper slips transported by aids on horseback. In WWII, some commanders drove with open vehicles into tank battles to steer their troops, because communication devices were still unreliable over distances. Today digital radio, mobile satellite terminals, and portable radars have inherited these tasks.

If we must concede that media do not have fixed effects, but develop their specific impact through the use of their features and the interaction of these features with the social context of their use, it is hard to predict, what effects the implementation of richer media in the context of CEs may have on ongoing distributed teams. Extant literature can only partly guide us, as empirical data on distributed teams and computer-mediated communication is usually gathered on student populations and ad-hoc groups with a short-term focus of one session to a number of weeks. As Van der Kleij and Schraagen (2006) point out, the temporal aspects of long-term technology use and adaptation are under-investigated and thus not yet well understood. Further, studies are often restricted to the measurement of individual media or the comparison of two distinct media types, which does not mirror today’s business realities. CEs in particular provide a multitude of information and communication technologies – from traditional media such as phone, fax and email.
to more advanced options such as video-conferencing, multi-party manipulation of data, or data simulations. Studies addressing combined effects and usage patterns are still rare. Problematic is also the fact that most research is done in highly controlled and technically ‘flawless’ environments. This again, does not reflect reality in organization, where communication often suffers from bad to mediocre transmission quality with lags, delays, disruptions, or even complete losses of communication.

Another gap in the current literature on computer-mediated communication and distributed teams is its preoccupation with communication media. While communication media are undoubtedly vital for distributed coordination, most teams in organizations also require a way to exchange data and information. This may be as simple as sending a spreadsheet with sales forecasts attached to an email or as complicated as a three-dimensional simulation of a product prototype for collaborative design teams. Collaborative information sources can provide external representations of team states or situations, which provide a common reference for coordination. In this way they reduce the burden to short-term memory and create a common understanding of a situation and domain (Jenkins, Salmon, Stanton, & Walker, 2010). Visualization support can also improve plan accuracy and planning time in teams especially for ill-structured problems (Ntuen, Park, & Gwang-Myung, 2010).

The main challenge of information technologies is the mismatch between the potential of technologies to display data and the potential of humans to process and interpret it – a notion that has been captured in the concept of ‘information overload’. Information overload refers to the fact of receiving more information than a person is able to process leading to sensory overload (Libowski, 1975), knowledge overload (Hunt & Newman, 1997), or even information anxiety (Wurman, 2000). Information overload can lead to cognitive strain, confusion, and stress, as well as difficulties in identifying relevant information (Jacoby, 1984; Malhotra, 1982). This in turn can lead to misinterpretations, a greater tolerance for errors, and high selectivity or omission of information or even to a paralysis in decision making (e.g., Edmunds & Morris, 2000; Schick, Gordon, & Haka, 1990; Sparrow, 1999). In consequence, considerations on information technologies are frequently concerned with the design of displays or the scalability of information to the context (e.g., Erickson & Kellogg, 2000; McGeer, Raab, Reed, Smith, & Kay, 2006; Stefani, Sharples, Hoffmann, Karaseitanidis, & Amditis, 2005). The appropriate display of data is vital for the support of decision processes, as flawed designs can lead to serious failure in safety critical applications, and even fatalities (Thimbleby, 2010).

Distributed team coordination is further complicated by the lacking awareness of
activities of remote members. For instance, working with documents in an asynchronous fashion, distributed teams have the problem to track changes made by members – how do members know when changes were made, what changes, and by whom (change awareness; Tam & Greenberg, 2006). As a consequence subgroups can easily work with out-dated information. These problems are even greater, if no common repository for documents or other information exists, so that several parallel versions need to be maintained.

While the sharing of detailed information may help collaborative work across multiple communities (Landry, Levin, Rowe, & Nickelson, 2010), asymmetric distributed teams have the problem that users frequently have very different information requirements. Police and medics in emergency rescue teams may react to the same incident, but while the former will probably focus primarily on threats to public safety, the latter will rather require information on the number and type of injuries to individuals. Moreover, the ability to interpretation information correctly depends on the respective knowledge of users. Drilling engineers will be easily able to spot unusual patterns in equipment readouts during drilling operations (see picture above); chemists or well engineers, in contrast, in general lack the knowledge how to read them. In asymmetric distributed settings, in which local knowledge repositories are highly diverse, simply making the same information available to all might thus rather confuse than help users.

Another question is the integration of information and communication technologies in the same team context. Information and communication technologies target different aspects of coordination. It can therefore be expected that they also exhibit differential effects on coordination processes and mechanisms. Yet, while we are
in a fair way to a basic understanding of how communication media shape team processes, other types of technologies are less well understood. More critically, it is unclear how combinations of information and communication technologies impact coordination in distributed teams. The study of CEs, which combine both types of technologies, is here a first step towards a better understanding of their interdependencies and mutual influences.

Changes in the technological setup of the organizational environment will therefore have important ramifications not only for immediate team processes, but also for social relationships, team functioning, and performance longer-term. Studies 3 to 6 investigated the short- and long-term impact of technological changes in the context of CE implementations. Study 3 focused on changes in the coordination between remote subgroups, while Study 5 used a cross-sectional design to investigated media effects on groups norms and expectations towards the organization of team processes. In a longitudinal approach, Study 6 examined the development of team identification, intra-team conflicts, and team outcomes over time. Although CEs are conceptualized as primarily technological solutions, alternative approaches are possible. Study 4 compared the effects of three CE designs on team cooperation and relations.

**2.3.2. Effects of technology change on distributed team coordination**

Goal attainment in distributed teams requires the coordination of processes and tasks across geographic distances and subgroups. Team coordination calls for the alignment of “actions, knowledge, and objectives of interdependent members, with a view to attaining common goals” (Rico et al., 2008, p. 163). According to Okhuysen and Bechky (2009) this alignment is driven by five mechanisms that ‘encapsulate’ practices of team coordination: plans and rules, objects and representations, roles, routines, and proximity. These practices lead to three conditions necessary for the success of ongoing coordination: accountability (knowing who is responsible for specific elements of a task), predictability (ability to anticipate tasks by knowing what elements a task has and when they happen), and common understanding (possessing a shared perspective on the team task and individuals’ roles in it).

In mature teams, rules, role, and routines are well established, which provides the necessary predictability for ongoing coordination. In distributed teams established practices of coordination necessarily include agreements on technology use; for instance, how to format complex information, when to use email instead of phone, or
2.3. Short- and long-term effects of CE implementations

how to handle access to shared documents. Such agreements are based on technology frames (Orlikowski & Gash, 1994). Technology frames refer to users’ assumptions, expectations, and knowledge about the nature and role of technology in organizations including “the specific conditions, applications, and consequences of that technology in particular contexts of use” (Orlikowski & Gash, 1994, p. 178). Technology frames thus guide technology use, but also help in the understanding and interpretation of others’ actions. Not surprisingly, lacking agreement can lead to communication problems, conflicts, or even a refusal to cooperate (cf. Davidson, 2006; Davidson & Pai, 2004).

The implementation of new technologies disrupts existing routines and requires the development of new agreements on how to coordinate. The concept of technology frames does not provide indications, however, in what way coordination practices will change, if teams are confronted with modifications in the technological infrastructure. Likely, the type of media capabilities before and after implementation will play a role in this.

The focus of Study 3 was on team coordination. Literature on team coordination has so far concentrated largely on activities within individual teams (Marks et al., 2005). LADTs, however, resemble multi-team systems, i.e., “two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals” (Mathieu et al., 2001, p. 290). Apart from the coordination of within-team activities to accomplish the individual proximal goals, members in multi-team systems also need to align their activities and objectives across groups to ensure that the whole team functions as an efficient unit. In asymmetric distributed teams this cross-team coordination can be particularly challenging, as remote subgroups often possess their own location-specific routines, as well as group-specific norms and expectations on acceptable behaviors, interaction patterns, or the ‘correct’ organization of team processes (e.g., Sole & Edmondson, 2002). If these routines and expectations are not in line with those of their cooperation partners, conflicts and misunderstandings can occur, and efficient cooperation becomes difficult (cf. DeSanctis & Monge, 1999).

Coordination in distributed teams is guided as much by a mutual knowledge of roles and responsibilities, as by a shared understanding of how information and communication technologies should be used for the coordination of tasks and processes. Technology changes alter conditions for team coordination, and existing technology frames can become disputable or even obsolete (Eriksson-Zetterquist, Lindberg, & Styhre, 2009). Study 3 investigated the impact of technology change in the con-
text of CE implementations on coordination within LADTs. The focus was here not so much on exceptional situations, but the routine and every-day coordination processes the teams engage in on a continuous basis. The main objective was to develop generic guidelines for the choice of media capabilities for LADTs.

<table>
<thead>
<tr>
<th>Study 3: Media capabilities and team coordination in LADTs</th>
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<tbody>
<tr>
<td><strong>Objectives:</strong></td>
</tr>
<tr>
<td>(1) Exploring the effect of technology changes on subgroup coordination in LADTs</td>
</tr>
<tr>
<td>(2) Development of generic guidelines for the choice of media capabilities</td>
</tr>
<tr>
<td><strong>Main research question:</strong></td>
</tr>
<tr>
<td>(1) How do changes in media capabilities alter coordination between subgroups?</td>
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</table>

2.3.3. Alternatives to technology as support mechanism: CE design variations

Technology is the essential link for the communication and cooperation across distances, and accordingly technical features dominate discussions on how to support remote working. These discussions frequently center around the design of systems and interfaces, or specific features of applications (e.g., Dennis et al., 2001; Fox et al., 2000; Huang, Wei, Watson, & Tan, 2002; Roussev & Dewan, 2005), but more often focus on specific media capabilities such as *social presence* (Rice, 1993) or *media richness* (Daft & Lengel, 1984, 1986). Advocates of the use of richer media argue that they should lead to more efficient team processes and better relationships. CEs, with their combination of advanced information and communication technologies, are based on the same reasoning.

While findings in temporary or short-term settings seem to confirm the superiority of richer media, long-term studies find that initial differences among media conditions tend to disappear over time. Empirical results on team cohesion, for instance, indicate that cohesion in teams using computer-mediated communication may be lower initially (Jarvenpaa & Leidner, 1999; Warkentin et al., 1997), but with continued use can approach levels comparable to face-to-face conditions (e.g. Burke & Chidambram, 1995). Similarly, Burke et al. (2001) found that cohesion and satisfaction was initially highest in face-to-face groups, but that differences dis-
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appeared regardless whether groups worked face-to-face or through synchronous or asynchronous media. Effects of technology adaptation have also been demonstrated for aspects such as team performance (e.g., Kleij et al., 2005), satisfaction (Chidambaram, 1996), or interaction routines and communication patterns (Dourish et al., 1996; Van der Kleij, Schraagen, & Werkhoven, 2009).

These findings suggest that remote cooperation could be as or at least nearly as effective as face-to-face cooperation, provided teams are given enough time to adapt to available media. With the correct choice of media and collective experiences and learning, ongoing distributed teams should thus be able to establish secure social relations and adequate team performance. Yet, as discussed earlier reports of mature distributed teams in the field indicate that continuous cooperation may not automatically lead to better team knowledge or easier coordination (e.g., Cramton & Webber, 2005; Gibson & Gibbs, 2006; Sole & Edmondson, 2002). Over time, ongoing distributed teams can actually experience a divergence of team mental models due to the increasing differentiation of roles and a subsequent decrease in interactions (Levesque et al., 2001). Especially if members rarely or never meet face-to-face team familiarity, as well as team learning might be difficult to maintain (Baba et al., 2004). This raises the question, whether the sole reliance on technology – of whichever type – is the best option to support distributed teams on a continuous basis.

Alternatives discussed for the support of distributed team work are interventions in the social system, primarily in terms of team learning and management practices. Team learning leads to the development of transactive memory systems and shared mental models, which are an important condition for team performance (Rico et al., 2008; Van der Vegt & Bunderson, 2005; Yeh & Chou, 2005). However, in computer-mediated settings restrictions in media capabilities tend to reduce information sharing between team members (Alge, Wiethoff, & Klein, 2003). Distributed teams therefore often have difficulties to develop a common ground or a shared understanding of situation and processes (e.g., Cramton, 2002; Sole & Edmondson, 2002), especially when face-to-face contact is impossible (Lewis, 2004). Strategies proposed to support team learning are initial face-to-face meetings (Lewis, 2004; Suchan & Hayzak, 2001), and trainings for better group interaction and communication (Priest et al., 2006; Warkentin & Beranek, 1999). Such strategies clearly target the early stages of a team’s development with the aim to develop trust and to provide the basis for successful cooperation in later stages. Yet, they are limited in scope and time scale. Given the continuous nature of LADTs and the problems
of ongoing teams to retain knowledge and their vulnerability to changes in membership (McGrath & Tschan, 2004a), it is questionable, whether such interventions can guarantee the success of continuous cooperation.

Another stream of literature focuses on the role of team leaders. Solutions often suggest the decentralization of traditional leadership functions from leaders to team members (Bell & Kozlowski, 2002; Carte, Chidambaram, & Becker, 2006; Kirkman, Rosen, & Tesluk, 2004). The empowerment of team members should enable a more flexible organization of team processes and thus remove hurdles for coordination. In cases where a more centralized structure has to be retained, team leaders are advised to set clear standards for appropriate behaviors (Bell & Kozlowski, 2002), to develop positive habitual routines early on in the team life cycle (Gersick & Hackman, 1990), or to enhance cohesion by linking individual goals, creating team task strategies, and developing a compatible network of role expectations across team members (Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1998). These general strategies do not clarify, however, how coordination should be supported and regulated on a daily basis, or how empowerment translates into the continuous functioning in ongoing distributed teams. Moreover, not all areas in which distributed working is the rule might lend themselves to a similar degree of empowerment (e.g., academic collaboration versus rescue or military operations).

The existing discussions on how to support distributed team work thus seem not to apply well to the setting of teams with a longer term focus such as LADTs. Yet, alternatives remain under-developed and under-researched. Interestingly, approaches for the support of distributed teams tend to consider dispersion of members as an unchangeable fact. An exception to this is an experimental study by Rockmann, Pratt, and Northcraft (2007), which investigated the effect of structural integration of members into a remote subgroup in another organization. Structural integration referred here to “the combination of formerly distinct organizational units into the same organizational unit” (Puranam, Singh, & Chaudhuri, 2009, p. 313). Structural integration thus offers an alternative to purely technological solutions, as physical proximity facilitates knowledge sharing, increases effectiveness of communication, and assist the development of personal bonding between members (Kerr & Kaufmann-Gilliland, 1994; Kiesler & Cummings, 2002).

So far, it is unclear what the effect of structural integration on the long-term coordination in distributed teams may be. Moreover, the respective merits of technological support and structural integration are untested. Extending on the study by Rockmann et al. (2007), Study 4 compared three different CE concepts – a purely
technological solution, one using only structural integration, and a hybrid design that combined both approaches. The main rationale guiding this study was to explore the differential effects of CE setups on team processes and relations, and to investigate the respective merits of technological and structural integration. Such knowledge can provide important indications on the effect of design variations on team processes and outcomes and thus guide design and implementation decisions.

**Study 4: Differential effects of CE design variations**

**Objectives:**

1. Comparing the effects of CE design variations on team processes and relations
2. Separating the effects of technological support and structural integration

**Main research question:**

1. How do CE variations affect processes and relations between asymmetric subgroups?

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**2.3.4. Effects of media capabilities on cooperation expectations**

With the advances in information and communication technologies cooperation across geographical distances have become a common theme in many industries. From multi-national top management teams to industrial product development, military operations, the mining industry, or academic research people dispersed over various locations work towards a common goal often without ever meeting face-to-face. Such collaborations often take place between dispersed, but interdependent subgroups, either from within the same organization or across different organizations; a form Marks et al. (2005) refer to as **multi-team systems**. Multi-team systems (MTS) can be defined as “two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals. MTS boundaries are defined by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in so doing exhibit input, process, and outcome interdependence with at least one other team in the system” (Mathieu et al., 2001, p. 290).

A major challenge in such collaborations is the coordination of activities among dispersed subgroups or **component teams** (Marks et al., 2005). Apart from within-
team activities to accomplish the individual proximal goals, members also need to align their activities and objectives across teams to ensure that the whole team functions as an efficient unit (Marks et al., 2005; Rico et al., 2008). Accordingly, unhindered communication and a shared understanding of each others’ tasks and roles are essential.

Yet, coordination is not only influenced by the knowledge on how teams operate, but also by expectations on how team work should be organized. Team members possess subjective opinions about what should be done, by whom, and how creating expectations on how colleagues should behave or react. Expectations towards the regulation of team processes can be understood as standards against which existing structures and processes are compared. If these expectations are consistent amongst team members they create group or cooperative norms (Birenbaum & Sagarin, 1976). Group norms help to interpret messages and behaviors, but also influence members’ behaviors as well their reactions to actions of others (Chatman & Flynn, 2001). Incompatible norms among team members can lead to misunderstandings and conflicts, and thus hamper the achievement of common goals (cf. DeSanctis & Monge, 1999). This problem is particularly prevalent in distributed team coordination, as component teams often enter into cooperation with their own location-specific norms and expectations on acceptable behaviors, interaction patterns, or the ‘correct’ organization of team processes. The existence of conflicting expectations is here even more likely than in collocated collaborations.

The alignment of expectations and attitudes in teams generally occurs through negotiations and common experiences in the same context, i.e., the opportunity to work with each other, to observe other members, and share the same social space (Birenbaum & Sagarin, 1976; Edmondson, Dillon, & Roloff, 2007; Langan-Fox, Anglim, & Wilson, 2004). Partners in distributed collaborations usually don’t have this opportunity; instead, they depend on technologies like email, phone, or video-links to exchange information, negotiate processes and priorities, and establish relationships. This reliance on media restricts the opportunity for shared experiences and can thus impede the development of common norms. One way to facilitate the convergence of expectations in distributed team coordination is the implementation of richer media that support more direct and personal interactions between remote team members. The richer media are, and the more they support continuous contacts between members, the easier it should be to reach a common understanding of how team tasks and processes should be organized.

The alignment of expectations in distributed team coordination and the impact of
media on the development of common expectations is an important aspect that has not yet received much attention. The impact of media capabilities on team member and manager expectations was studied in Study 5. The main objectives of this study were to investigate, whether media capabilities impact cooperation expectations between asymmetric subgroups, as well as between team members and managers. Based on its results indications for the role of technology change for the effectiveness of leadership styles and behaviors may be deduced.

Study 5: Media effects on cooperation expectations

Objectives:

(1) Investigate, whether media capabilities impact cooperation expectations between subgroups of asymmetric distributed teams
(2) Obtain indications on the role of media capabilities for the effectiveness of leadership styles and behaviors

Main research question:

(1) How does the implementation of richer media in the context of CEs affect cooperation norms and expectations in team members and managers?

2.3.5. The longitudinal impact of CEs on identification, conflicts, and team outcomes

Team and social identification

One of the pre-requisites for teams to work efficiently is a ‘collective orientation’ of team members, i. e., the tendency to perceive themselves as part of the same group working towards a common goal (Driskell & Salas, 1992; Salas & Cannon-Bowers, 2000). Team members thus need to develop an awareness of their membership in a group, which – together with the emotional bond to this group – becomes part of their social identity. The “emotional significance that members of a given group attach to their membership in that group” is referred to as social identification (Van der Vegt & Bunderson, 2005, p. 533). Especially in distributed settings identification with the own team can provide the ‘glue’, which bonds geographically dispersed members to work towards a shared goal (Wiesenfeld, Raghuram, & Garud, 2001).

However, the lack of direct physical contact and interaction can make it harder to establish a sense of belonging or common identity between dispersed members.
Distributed settings reduce the opportunity to observe others’ behaviors and ascertained shared values. Distributed working further decreases the visible, tangible dimensions, such as a shared work space or collective work practice, that define a group. Team members thus need to develop a sense of togetherness despite the lack of physical contact (Pratt, 2001).

**Social identification** is based on the distinctiveness and salience of the own group compared to other groups (Ashforth & Mael, 1989), for instance, in terms of its practices and values (Oakes & Tuner, 1986). The **distinctiveness** of a group can be based on a variety of features from visible demographic characteristics to more immaterial aspects like attitudes, values, cultural background, or social or organizational affiliation. In distributed teams location can be become yet another distinctive feature. Particularly in distributed teams that consist of two or more subgroups, the physical proximity of collocated members may lead to a lower identification with the whole group in preference to the more intimate subgroup. Distinctiveness of team-internal subgroups is even higher, if members’ demographic attributes or other affiliations align with geographic location, as is the case in asymmetric teams. This alignment intensifies the perception of remote subgroups as different from each other, and thus reduces the perception of subgroups as part of one overall team (Cramton & Hinds, 2005). Yet, the identification based on specific attributes also requires that they are salient to team members. The **salience** of attributes can change depending on situation or immediate context. Employees in a company may define themselves as members of the organization while at work; outside their work place they may refer to themselves as parent, member of a specific sports club, or musician.

This variability in attribute salience means that social identification can be affected by the visibility of specific attributes. In distributed setting, salience of attributes can change with the type of media capabilities available to the team members. The role of media on identification has been captured in the Social Identity Model of Deindividuation Effects (SIDE model; Reicher, Spears, & Postmes, 1995). It argues that “visual anonymity obscures personal features and interpersonal differences and thereby diminishes the relative importance of interpersonal concerns in favor of a focus on the known or emergent characteristics of the group as a whole. Provided a common identity is available, anonymity thus increases the salience of group identity and group identification, thereby enhancing the group’s influence.” (Postmes, Spears, Sakhel, & de Groot, 2002, p. 1244). In other words, if information about individuals are scarce, identification is based on group membership. Low
visibility should thus increase the likelihood of identification with the whole team. Experiments with students confirmed that under depersonalized conditions team members rely stronger on stereotypes to predict and judge others’ actions, which speaks for a stronger influence of the group (Postmes, Spears, & Lea, 2002).

The difficulty with applying the SIDE model to the context of LADTs is the existence of several focuses for identification, namely the own (collocated) subgroup, one or more remote subgroups, and the whole team of which subgroups form a part. While according to the SIDE model the anonymity of the remote subgroup should increase the likelihood for team identification, in LADTs the salience of the own subgroup increase the likelihood for identification with the own subgroup, while decreasing the relevance of the superordinate unit. The local subgroup thus distracts from identification with the whole team (Fiol & O’Connor, 2005).

This trend should be the more pronounced the more differences between subgroups become visible. For this reason Fiol and O’Connor (2005) argue that rich media should increase the tendency to identify with the own subgroup, as “richer media facilitate the transmission of cues that highlight visible diversity fault lines, thereby promoting identification with the subgroup based on those fault lines” (p. 26). This argument is based on visible attributes, i.e., surface-level diversity attributes such as age and gender.

Generally it is argued that the relative obscurity of computer-mediated communication should make easily observable surface attributes such as age, gender, or race less important in distributed settings (cf. DeSanctis & Monge, 1999). Bhappu et al. (1997), for instance, found that individuals in distributed teams paid less attention to gender in-group/out-group differences than individuals in face-to-face groups. Implementing richer media can change this situation. With the use of richer media such as video-conferencing surface-level differences like age or gender become more obvious and can thus develop into a new starting point for subgroup differentiation. Especially in LADTs, where several demographic and deep-level attributes are aligned along the geographic divide, a change in media could activate formerly unobserved differences.

Yet, the importance of surface-level attributes seems to decrease over time (Harrison et al., 1998; Harrison, Price, Gavin, & Florey, 2002). With increasing personal knowledge, judgments based on age and gender stereotypes decrease and team functioning becomes influenced more strongly by differences in expertise, knowledge, or values (i.e., deep-level diversity attributes). This would suggest that in distributed teams with demographic asymmetries identification with the own subgroup would
increase shortly after implementation, but decrease over time. It could thus be argued that under conditions of demographic diversity the re-individualization in the short term will lead to the higher polarization predicted by Fiol and O’Connor (2005), while in later stages identification could shift to other, less visible attributes. Yet, whether such shifts take place, in what way, and what this means for identification with subgroups versus the wider team remains unclear.

Existing models of team identification frequently assume that collective identification is focused on one primary group with consequent reductions in the identification with other groups. Members in LADTs should thus either identify with their own subgroup or with the whole team. Observations in the context of mergers and acquisitions has called this view into question and demonstrated the possibility of ‘dual identities’ with a local subgroup, as well as a superordinate group (e.g., Gaertner, Bachman, Dovidio, & Banker, 2001; Hornsey & Hogg, 2000b, 2000a). It is unclear, however, in what ways or in which circumstances the subgroup identity influences identification with a higher order unit and how media affect this relationship (Rockmann et al., 2007). Extant literature further lacks a developmental or process view on team identification. The first objective of Study 6 was to investigate the relative changes in identification with the subordinate group (subgroup) and superordinate group (whole team) due to the implementation of richer media over time.

2.3.6. Conflicts and team outcomes

Distribution increases the likelihood for intra-team conflicts (e.g., Hinds & Bailey, 2003). Conflicts also tend to become more likely, if teams are diverse, and especially if teams are split into internally homogeneous subgroups (Molleman, 2005; Polzer et al., 2006; Thatcher et al., 2003). In LADTs all three conditions coincide. It can therefore be assumed that LADTs experience a higher degree of intra-team conflict.

In general, three types of intra-team conflicts are differentiated: task conflicts, which describe differences in strategies and the delegation of duties and resources, process conflicts, which refer to disagreements about how the work is done, and relationship conflicts, which involve disagreements on a personal or social level unrelated to work (Jehn, 1995; Jehn & Chatman, 2000). Although some authors argue that conflict may not always be negative (e.g., for non-routine tasks Jehn, 1995), a meta-analysis by De Dreu and Weingart (2003) clearly linked relationship and task conflict to decreased team performance and lower member satisfaction.

Intra-team conflicts seem to be more prevalent and also more disruptive in dis-
tributed than in collocated teams (e.g., Hinds & Mortensen, 2005; Mortensen & Hinds, 2001). This is seen as a direct reflection of media restrictions for the exchange of social information (‘cues-filtered-out’ hypothesis; Culnan & Markus, 1987; Wilson et al., 2006). Richer information and communication technologies should therefore lead to a reduction in intra-team conflicts. Intra-team conflict is further moderated by team cohesion and team identity, or a common sense of “groupness” (McGrath, 1984). A strong shared identity and identification with the team – in contrast to identification with the own geographic location or functional group – reduces the likelihood of task and relationship conflicts (Molleman, 2005; Mortensen & Hinds, 2001). Groupness is given, when team members share common goals, recognize one another as members of the same group, share collective outcomes and for this purpose coordinate the use of shared tools, resources, and knowledge (cf. Meneses, Ortega, Navarro, & de Quijano, 2008). The main condition for the lack of groupness in distributed teams is a lack of the immediate work context due to team opacity (Fiore et al., 2003). The implementation of richer communication media should thus be able to support the development of a shared identity, and subsequently reduce team conflicts.

Media capabilities have also been linked with team performance and satisfaction. In a meta-analysis on team decision making mediated communication led to decreased group effectiveness, increases in the time required to complete a task, and lower overall satisfaction compared to face-to-face teams (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). One moderator to this relationship was the degree of anonymity in the group processes associating visibility in communication media with team outcomes. This link was supported in a study by Baker (2002), which compared four different media types (text-only, audio-only, text-video combined, and audio-video combined) in their impact on decision quality. Decision quality did not differ in teams using text-only and audio-only media; adding video to the audio-only condition, however, resulted in a significant improvement of decision quality. Further, team performance is also influenced by the degree of symmetry and quality of intra-team communication (e.g., Aubert & Kelsey, 2003). Media capabilities, and here specifically visibility, thus seems to be one of the main moderators for outcomes in distributed teams. Past research suggests that the implementation of richer media in the context of CEs should therefore be connected to higher team performance.

Yet, technology change also leads to disruptions in established routines and team relations. Short-term effects of CE implementations may thus well be negative, until new routines are established. Moreover, Lau and Murnighan (2005) found that
Chapter 2. Literature review and research questions

more cross-subgroup communication was only connected to performance in teams with weak faultlines, while teams with strong faultlines did not profit from a higher degree of cross-subgroup communication. A higher degree of communication may thus not have the hoped for positive impact on outcomes in LADTs. Also, due to differences in tasks and support requirements, subgroups may profit differently from the implementations of CEs. Overall, predictions for the possible short- and long-term effects of richer media on social identification, intra-team conflicts and outcomes remain conflicting and unclear. In a longitudinal qualitative investigation, Study 6 examined the long-term impact of CE implementations on these three aspects.

<table>
<thead>
<tr>
<th>Study 6: CE effects on identification, intra-team conflicts, and team outcomes</th>
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</table>

**Objective:** Investigating changes in identification, conflicts and outcomes over time

**Main research questions:**

1. How does CE implementation affect subgroup identification and identification with the whole team over time?
2. What short- and long-term impact has CE implementation on intra-team conflicts?
3. How does the implementation of CEs affect team performance and member satisfaction over time?
RESEARCH CONTEXT: COLLABORATIVE ENVIRONMENTS in the OFFSHORE OIL PRODUCTION

My PhD project was located in one of the major global operating companies in the oil and gas industry today; more particularly in its North Sea performance unit in the United Kingdom (UK PU). The industrial context, as well as the specific local constraints of the UK PU’s production operation in the North Sea did not only provide the atmospheric background for this PhD project, but also the immediate rationale for the implementation of CEs. This chapter provides a short description of the industrial context and the specifics of the CE implementation project, in which I conducted my research.
3.1. Industrial context

3.1.1. Present day challenges for hydrocarbon production in the North Sea sector

The exploration and production of hydrocarbons from offshore platforms is a relatively new activity that began in the 1940s in the Gulf of Mexico. Europe's first viable oil find in the North Sea took until the late 1960s, and the first oil did not reach the shore until 1975. Since then over 130 fields have been discovered and the North Sea became a major contributor for the oil industry. Now, after 35 years of production, the North Sea fields are maturing. Present projections estimate that between 33% to 100% of already produced reserves are still available (Sawaryn, Farley, Gay, & Banks, 2007), leaving another 10 to 35 years of production at present rates.

Yet, while demands for hydrocarbons worldwide are expected to rise by 23% in the next ten years (3i, 2006), with maturing fields and an aging infrastructure the costs of hydrocarbon production increase. The question therefore arises, how to sustain longterm production in a cost effective way.

The industry has two basic choices to react to this challenge. The first is to tap into new fields. The North Sea sector, however, is a mature area and the likelihood for large new discoveries in easy reach of existing infrastructure is in decline. More promising would be the move to newer areas such as the Arctic regions. Still, new explorations not only encounter increasing resistance due to environmental concerns, they are also extremely costly and take a long time to produce returns. For the short- and medium-term, the second option therefore is to increase recovery rates and prolong the life of existing fields by optimizing production processes. This thesis is concerned with this second process, in which Collaborative Environments have a major role to play (Murray et al., 2006).

3.1.2. Hydrocarbon production from offshore fields: A team effort

The exploitation of hydrocarbons is bound to the location of oil and gas fields, and people therefore need to go, wherever these fields are located – often hundreds of miles off the coast. The actual production of hydrocarbons thus takes place on installations offshore – frequently described as small villages in the middle of the sea.

The primary responsibility of personnel offshore is to achieve the daily production goals in barrels of oil and/or cubic feet of gas set by the company. Operations offshore are thus usually focused on the immediate problems of sustained produc-
3.1. Industrial context

tion. This also includes related tasks such as the maintenance of equipment and plant, short-term decision making for production optimization, and the reaction to critical incidents such as well failures or equipment problems. The offshore focus is mostly on the next 48 hours, and the planning of tasks generally restricted to a six week window before the beginning of a job. The offshore team consists primarily of technicians to operate and maintain the complex mix of electrical and mechanical systems, pipes, valves, rotating equipment, etc. Control room technicians monitor and control the wells and alarm systems, while offshore managers are responsible for the planning and distribution of tasks. Managers are also responsible for the contact with the onshore part of the operation.

Hydrocarbon production is a continuous process that needs to be monitored and controlled consistently all day, every day. Offshore work is thus organized in a rotating shift system of 12 hour day and night shifts all year around without break. The continuous task of keeping production up and running does not allow the offshore team much time for longer-term planning. The longer-term planning with a more strategic outlook is located with the onshore part of the operation. Onshore management sets the production goals for the year or quarter, which is then broken down into monthly and weekly production goals for offshore. Onshore engineers are responsible for the direct support of offshore production. This involves the scheduling of activities, the preparation of work packages, and engineering support in case of equipment failures, production losses, or critical incidents.

Work processes in the oil and gas industry are thus characterized by a clear divide in responsibilities between the office (‘onshore’) and the rig (‘offshore’). Still, tasks at both sides are highly interlinked, and for efficient production onshore and offshore personnel have to work closely together. When I started the project in the UK PU, onshore engineers were assigned to support a specific platform. Production was thus a team-based process with onshore and offshore personnel as subparts of the same team. Table 3.1 provides an overview of the main roles involved in the oil and gas production as found in the UK PU in the time of this project, as well a their main responsibilities.
### Main Roles Involved in Daily Activities of Production Operations in the UK Pu

<table>
<thead>
<tr>
<th>Job Function</th>
<th>Main Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore Group</td>
<td>Managers</td>
</tr>
<tr>
<td></td>
<td>Line managers</td>
</tr>
<tr>
<td></td>
<td>Strategic decisions, personnel responsibility</td>
</tr>
<tr>
<td></td>
<td>Technical authorities</td>
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<tr>
<td></td>
<td>Personnel</td>
</tr>
<tr>
<td></td>
<td>Discipline</td>
</tr>
<tr>
<td></td>
<td>Technicians</td>
</tr>
<tr>
<td></td>
<td>Production chemist</td>
</tr>
<tr>
<td></td>
<td>Production manager</td>
</tr>
<tr>
<td></td>
<td>Personnel</td>
</tr>
<tr>
<td></td>
<td>Discipline</td>
</tr>
<tr>
<td></td>
<td>Technicians</td>
</tr>
<tr>
<td></td>
<td>Production</td>
</tr>
<tr>
<td></td>
<td>Line managers</td>
</tr>
<tr>
<td></td>
<td>Engineers</td>
</tr>
<tr>
<td></td>
<td>Control room engineers (CRT)</td>
</tr>
<tr>
<td></td>
<td>Offshore team leaders (OTL)</td>
</tr>
<tr>
<td></td>
<td>Offshore operations engineers (OEE)</td>
</tr>
<tr>
<td></td>
<td>Offshore installation manager (OIM)</td>
</tr>
</tbody>
</table>

Table 3.1: Main roles involved in daily activities of production operations in the UK Pu
3.2. Collaborative Environments in the UK PU

3.2.1. Implementation rationale

Despite the close inter-linkages and interdependencies between onshore and offshore tasks, the communication between these two groups had traditionally been comparatively scarce and cumbersome.

Before the implementation of CEs, the use of mail, email, phone, or audio-conferencing were the norm. Contacts between onshore and offshore personnel tended to be restricted to daily morning calls and function-specific meetings for managers and discipline engineers. These meetings were traditionally held as audio-conferences between the onshore and offshore groups. Besides these regular meetings interactions normally took place only in case of disruptions or unforeseen events.

Face-to-face meetings took place from time to time, usually when onshore engineers were flown offshore to investigate equipment failures directly on the rig or when offshore managers had to attend meetings in the onshore office. Yet, such personal contacts remained infrequent and were generally restricted to crisis situations or specific groups.

The comparatively scarce interaction between subgroups and the inability to get immediate access to plant and production data, resulted in a low transparency of work processes, delayed response times between locations, delays in decision making and problem solving, and difficulties in providing technical expertise to offshore. Information on changes in the status of wells or equipment or the occurrence of critical events, for instance, could reach the onshore office only, if offshore personnel contacted them through email or phone. Coordination was not made easier by the asymmetries in subgroup characteristics with respect to work schedules (24/7 operations in 12 hours shifts offshore versus office hours Monday to Friday onshore), demographics (e.g., educational background), or priorities.

The CE program in the UK PU was a direct reaction to this situation. Its two main objectives were the better support of collaboration between onshore and offshore personnel and the improvement of decision making processes. The specific goals of the program were the optimization of production processes, support for remote collaboration and performance monitoring, a shared sense of responsibility, improved safety, and a better focus on priorities. Through the implementation of CEs the company also expected overall production improvements and a reduction of operation costs.
Chapter 3. Research Context: CEs in the offshore oil production

3.2.2. The general CE concept in the UK PU

Collaborative Environments in the UK PU were envisioned as onshore support centers with the aim to facilitate and support work processes offshore. The CEs were team-based, in that each offshore installation was supported by a group of onshore engineers dedicated to this specific platform. The main tasks for CEs were the day-to-day support for production optimization and the planning and support of maintenance activities for this platform. CEs formed part of a layered support model for offshore. Onshore personnel in the CEs were considered the primary contact point for offshore into the office and constituted the ‘first tier support’ for all issues that required immediate attention (see Figure 3.1). The CE teams onshore operated during normal office hours (Monday to Friday, usually between 7am-5pm), although CEs were also available out of office hours in case of unexpected events.

For the onshore part of the CEs, a cross-functional team of six to eight engineers was created to form the primary contact point for offshore personnel into the onshore office and the surrounding asset team. These teams were placed in dedicated CE ar-
3.2. Collaborative Environments in the UK PU

Figure 3.2.: Schematic layout of the onshore part of the Collaborative Environments

These areas were physically separated from the rest of the office to reduce noise and disruptions for the personnel surrounding the CEs. Internally, the CE area was split into three parts: one accommodating personnel responsible for production optimization, one for personnel responsible for the maintenance and integrity of the platform, and a third area, which served as a break-out or meeting room. Figure 3.2 shows the generic layout of the onshore CE environment. This layout was the same across all CE teams in the UK PU.

Acting as direct support for offshore staff, onshore CE personnel needed not only better means of communication with offshore, but also better access to offshore information and improved awareness of offshore activities and plant and production status. CEs were thus equipped with two types of technologies: communication technologies to support interaction and communication, and subject matter technologies to improve the data access and information exchange between office and rig. Communication technologies included the existing media, i.e., mail, email, phone, fax, and audio-conferencing, with the addition of desktop-sharing and continuous video-links into the offshore control room, offshore meeting rooms and offices. Subject matter technologies were software applications that allowed the real-time display, analysis, and mining of operations data, as well as the rapid access to historical
data for comparison with current activities. For better access to this information, a continuously updated stream of plant and process data was displayed on big screens in the two main CE areas onshore. These screens could also be used to display plans or presentations and be shared with offshore. Table 3.2 provides a comparison of the main pre- and post-implementation technologies.

Compared to the modifications in the onshore team and environment, changes in the offshore environment were rather slight. The only change introduced with the CE program was the installation of video cameras for continuous video-links and the access to desktop-sharing applications. The video-cameras were installed in the control room, meeting rooms and in some management offices. In contrast to onshore teams, offshore teams thus retained the same structure and physical environment. Examples of CEs in the onshore office and on offshore platforms are shown in Figure 3.3.

### Table 3.2: Main technologies before and after CE implementation

<table>
<thead>
<tr>
<th>Before CE implementation</th>
<th>After CE implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mail, fax</td>
<td>Mail, fax</td>
</tr>
<tr>
<td>Email</td>
<td>Email</td>
</tr>
<tr>
<td>Phone</td>
<td>Phone</td>
</tr>
<tr>
<td>Audio-conferencing</td>
<td>Audio-conferencing</td>
</tr>
<tr>
<td>Planning system</td>
<td>Planning system (upgraded)</td>
</tr>
<tr>
<td>Databases for production data</td>
<td>Databases for production data</td>
</tr>
<tr>
<td>Documents, drawings</td>
<td>Documents, drawings</td>
</tr>
<tr>
<td></td>
<td>Desktop sharing</td>
</tr>
<tr>
<td></td>
<td>Video-conferencing</td>
</tr>
<tr>
<td></td>
<td>Monitors with real-time process and equipment data</td>
</tr>
</tbody>
</table>

#### 3.2.3. Implementation process

The implementation of CEs started in 2006 and targeted eight of the production teams in the UK PU. The implementation project was coordinated by an external consultant team, which was responsible for the information and engagement of onshore and offshore teams and managers, as well as the design of the CEs. The implementation of CEs took place in two stages: a pilot phase and the main implementation. The aim of the pilot phase was to test a range of possible CE variations with respect to physical layout and technological capabilities.
3.2. Collaborative Environments in the UK PU

**Onshore office**

**Offshore platform**

**Figure 3.3.** Collaborative Environments onshore and offshore. *Onshore office:* The picture at the left shows the real-time data screens, the other two VC-links into offshore control rooms; *Offshore platform:* The top picture shows the view from offshore into the onshore office, the bottom row the setup and use of the VC screens in offshore offices.
The pilots were conducted between November 2006 and October 2007, involving approximately 50 people from five of the eight teams targeted for CE implementation. The five pilots differed mostly in the physical layout, whereas communication and subject matter technologies showed only minor variations.

The initial information and engagement phase during the pilot phase was very intense – ranging from information workshops for managers and staff to individual consultations, multiple visits to offshore installations, exhibitions of potential furniture and technology solutions, and the creation of newsletters and intranet websites. Interviews, surveys, and evaluation workshop collected feedback from personnel involved in the pilots, which was used to create and fine-tune the standardized CE concept described above.

The start of the main implementation phase was marked by the move of the onshore staff from the old office building to a new office location. With the relocation into the new office, the pilot phase stopped and all teams moved into their final CE environments. The main implementation encompassing all eight teams started in January 2008 and was completed by April/May 2008.

Parallel to the main CE implementation also a major organizational change process began. In this process, the organization moved from a team-based structure, in which engineers of diverse functions were assigned to one platform and worked together in physical proximity, to a functionally-based structure. Engineers were now grouped together according to functions supporting multiple platforms at the same time. The CEs were retained in this new organization and their general intent and function did not change, although the onshore personnel within CEs changed from early career engineers to experienced engineers. CEs thus remained the only part of the organization that still operated in a team-based structure supporting one offshore installation each. Figure 3.4 shows a timeline of events and activities in relation to the CE implementation project, as well as important events in the organizational environment with effects on the CE project. Data collection for the PhD project started in November 2006 shortly before the start of the pilot phase and ended in May 2009, approximately one year after completion of the main implementation. I was located directly within the company for the first two years of this period (November 2006 to December 2008).
3.2. Collaborative Environments in the UK PU

**Figure 3.4.:** Timeline of events during the CE implementation
This chapter describes the general methodological framework of this project. The specific procedures for data collection and analysis used in the empirical studies are described in the respective chapters.

4.1. Choice of a longitudinal, exploratory approach

As discussed in Chapter 2, existing theories on technology implementation or technology change and distributed teams miss vital elements to help us predict the effects of CE implementations in an asymmetric distributed team context. In consequence, an exploratory approach was taken, which – although informed by existing theory – aimed at the generation of new or the extension of existing models, as well as the creation of applicable knowledge for practitioners. An exploratory approach allows to document phenomena as completely as possible, without being restricted to topics that have been documented in earlier studies. In the following I detail the main elements of the approach in this project.
Chapter 4. General methodological approach

Process view and longitudinal investigation. Technology implementation and adoption is a process that unfolds over time. For a full understanding of the phenomenon of CE implementations in distributed team settings, it was therefore imperative to capture the temporal nature of this process (cf. Boudreau & Robey, 2005). Also, implementation and adoption processes in organizations generally do not progress along a neat timeline of events. Affective, cognitive, and behavioral changes may occur at different times or change at different rates. Burke, Chidambaram, and Aytes (2002), for instance, found that after the implementation of a group-support system members’ perceptions on social aspects adapted faster than perceptions of the technology. To capture such time-shifted reactions (McGrath & Tschan, 2004b), it is important to observe technology implementation and use on a continuous basis and over a longer time. This project was thus conducted as a longitudinal investigation lasting over a period of 2.5 years. This longitudinal approach allowed me to observe processes as they unfolded, “in whatever time frame is natural for the system under study” (McGrath & Tschan, 2004b, p. 151).

Presence in the field. Human behavior is situated, i.e., depends on the context within which it occurs (e.g. McGuire, 1989). This ‘situatedness’ of human (re)actions makes it necessary to obtain an in-depth understanding of the community, in which the phenomenon under investigation takes place. This is also an important element of the ‘enactment perspective’ of technology. Technology in this view is always ‘technology-in-practice’ and thus enacted in and influenced by social contexts (Orlikowski, 2000). This project was consequently conducted as a field study. The main benefit of field studies is that the researcher can investigate phenomena in their natural setting and gain rich and detailed descriptions of these in a real-life context (McGrath, 1981). This is useful particularly for the investigation of complex phenomena such as CEs, which are not yet well described or studied. Field studies can here lead to new insights and hypotheses, which would not be possible using a more structured approach.

Studying a complex phenomenon in its natural setting, however, requires a thorough understanding of the context itself, its members, language, culture, and norms. Entering an unfamiliar field, the researcher runs the risks of applying his or her own cultural norms and interpretations, which may lead to mis-understandings, mis-interpretations, and faulty conclusions. The offshore oil industry was such an unfamiliar field for me. To thoroughly understand the effects of CE implementations on oil production teams, I had to make myself familiar not only with the processes
4.1. Choice of a longitudinal, exploratory approach

and the jargon, but also with the way of thinking, behavioral norms, and relationships among their members. This is why a field study with continuous presence in the field seemed the most appropriate approach for this project.

For two of the two and a half years of the empirical phase, I became a member of the UK PU. During these two years, I had an official status as contractor, an assigned desk and phone number, a company laptop, and internal email-address. My role within the company was that of a member in the CE implementation team, although I had no official role in this group and worked largely independent. My continued presence gave me the opportunity for close and sustained contacts to the members in the UK PU and to establish relationships into the community. I further visited industry conferences, followed a training on basic oil field technology to get familiar with the processes and jargon, and underwent the same medical and safety training all personnel within the company had to undergo before allowed offshore. These personal experiences helped me not only to better understand the working conditions, but it also created an additional degree of trust and acceptance. The development of relationships over time helped me to gain access also to the more critical opinions and reports to negative experiences, which might otherwise not have been accessible.

**Multi-method approach and sequential design.** One important element of exploratory field research is to obtain a ‘thick description’ of the phenomenon of interest (Geertz, 1973). The primary focus was therefore on qualitative data, which I collected from various sources such as documents, interviews, observations, drawings, and photographs, as well as multiple groups of participants.

Based on early findings from this qualitative data, I conducted a number of subsequent quantitative studies into specific topics, namely cooperation expectations (Study 5), team identification and intra-team conflicts (Study 6), and changes in communication patterns (not included in this thesis). The quantitative data was used to help in the interpretation of the findings in the qualitative phase. This **sequential exploratory approach** (Creswell, 2003) allowed me to obtain a more systematic understanding of phenomena that had emerged as important topics during the CE implementations.

This project thus used a multi-method approach with a combination of qualitative and quantitative methods. Qualitative methods were semi-structured and unstructured interviews, observations, document analysis. Quantitative methods were questionnaires and Q methodology. The main rationale for the combination of qual-
Chapter 4. General methodological approach

Iterative and quantitative methods was to extend the range of inquiry by using different methods for different topics (expansion purpose; Greene, Caracelli, & Graham, 1989). In the sequential exploratory approach it was further to elaborate and clarify results from one method with results of another (complementarity purpose; Greene et al., 1989).

The overall data collection was not based on a strict course determined before the project start, but followed a more flexible strategy of partly pre-determined and partly emergent topics. While some topics were of interest from the start (e.g., subgroup coordination, intra-team conflicts, or team performance), others only emerged after a first phase of data collection and analysis (e.g., coordination expectations). This more open strategy thus allowed extending the research towards topics that became apparent only after familiarization with the field and project. This strategy moreover provided the necessary flexibility to react to unexpected changes in the organizational environment (see Section 4.5 below).

**Combination of cross-sectional and longitudinal investigations.** In this project I used a combination of cross-sectional and longitudinal studies. The pilot phase at the beginning of the project made it possible to compare different CE designs (Study 4), as well as processes and outcomes in CE- and non-CE teams (Study 5). Study 1 also included teams before implementation and retrospective reports from teams after implementation. Longitudinal studies investigated either the changes in team processes and relations before and after CE implementation (Studies 3 and 6) or a certain aspect over a longer time (Study 2). The time period considered in the longitudinal investigation ranged from twelve months (Studies 2, 3) to two and a half years (Study 6, see Figure 4.1).

**Choice of participants.** Different people will tell different stories about the same event. Hence, a broad view and multiple narratives about the implementation of CEs and their effects were needed to capture as many of the different perspectives as possible. My sample included all personnel, who were either directly affected by the CE implementation (i.e., first-tier and second-tier personnel in the onshore and offshore subgroups; cf. Figure 3.1 in Chapter 3), personnel involved in decisions about the implementation (onshore and offshore managers and members of the implementation group), or individuals involved in the deployment and support of CEs (IT support, trainers, and coaches).
4.1. Choice of a longitudinal, exploratory approach

<table>
<thead>
<tr>
<th>Pilot-phase</th>
<th>Main implementation phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 1: Description</td>
<td>1.5 years</td>
</tr>
<tr>
<td>Pilot-teams: post-implementation</td>
<td>2.5 years</td>
</tr>
<tr>
<td>Cross-sectional comparison pre-</td>
<td></td>
</tr>
<tr>
<td>and post-implementation (Study 4,</td>
<td></td>
</tr>
<tr>
<td>Study 5)</td>
<td></td>
</tr>
<tr>
<td>Non-pilot teams: pre-implementation</td>
<td></td>
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<tr>
<td>Longitudinal comparison pre-</td>
<td></td>
</tr>
<tr>
<td>and post-implementation (Study 3,</td>
<td></td>
</tr>
<tr>
<td>Study 6)</td>
<td></td>
</tr>
<tr>
<td>Longitudinal investigation (Study 2)</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.1.:** Cross-sectional and longitudinal investigations in the empirical studies

**Data triangulation and validation.** As McGrath (1981) – rather provocatively – points out, there is no such thing as ‘flawless research’. Multiple methods thus “not only serve the purposes of replication and convergence; they serve the further, crucial purpose of compensating for inherent limitations that any one method, strategy, or design would have if used alone” (McGrath, 1981, p. 209). The triangulation of methods was one form of validation in this project. Although a multi-method approach, I used the different methods as parallel ways of investigating different aspects of CE implementations. I did therefore not attempt an integration of the methods at the time of data analysis. Instead integration of methods took place at a later stage, using the findings of individual studies at the point of interpretation or theorizing (interpretative integration; Moran-Ellis et al., 2006). The validation of the qualitative data and their interpretation was based on prolonged engagement, triangulation of narratives and methods, and member checks (i.e., confirmation of results with participants).

**Summary of the methodological approach.** The general methodological approach in this PhD project can be summarized as follows:

- **Exploratory field study with continuous presence in the field**
- **Longitudinal investigation over a period of 2.5 years combining cross-sectional and longitudinal studies**
- **Mixed-method approach employing qualitative and quantitative methods**
Chapter 4. General methodological approach

- Primarily parallel combination of method during data collection
- Interpretative integration of methods, i.e., triangulation at the theory level

4.2. Sample characteristics and levels of analysis

The six studies in this thesis were based on the eight production teams located in the UK PU. Only Study 4 included teams from a different geographic location in the same company (see Chapter 8). The overall team task was identical for all teams, as was the general team structure (see Chapter 3, Section 3.1.2). Onshore and offshore personnel belonged to only one team that was dedicated to one specific offshore platform, i.e., all teams were independent units with only minimal contact to each other. Line managers onshore and line to middle managers offshore likewise belonged to only one team.

Oil production teams in the UK PU were comprised of several disparate, but interdependent groups. Functionally, they were split along the divide between production versus maintenance and integrity (cf. Chapter 3). Geographically, teams were divided according to primary work location, i.e., onshore or offshore. Although parts of the same wider team, these disparate subgroups differed in their inputs and processes. Oil production teams in this project thus combined highly heterogeneous subgroups within a superordinate unit (frog pond model; Klein, Dansereau, & Hall, 1994).

The objective of the CE implementation was to facilitate coordination among these diverse groups and integrate them into one bigger unit or CE team. In the offshore subgroup, CE membership was mostly based on function within the subgroup – control room technicians and managers being the primary target groups. In the onshore group, CE membership was based on assignment to the CE team by the organization. The assignment of engineers to CE teams divided existing teams into members and non-members; a separation that was visually emphasized by the physical environment. CEs thus shifted existing team boundaries creating a ‘secondary team’ within the original team (see Figure 4.2).

The CE implementation affected multiple levels within the organization: individual team members, the onshore and offshore subgroups within a team, as well as the wider asset teams, of which CE personnel were members. Effects thus cut across multiple levels within the organization creating a complex interplay of cross-level effects. My focus in this thesis was on the effect of CEs on team processes and intra-team relations. The primary levels of analysis were therefore the teams (group
4.3. The role of CEs for team functioning

Team functioning can be described by an input-mediator-output-input (IMOI) model (cf. Ilgen, Hollenbeck, Johnson, & Jundt, 2005, Figure 4.3). Individual and team characteristics (inputs) affect how teams operate. Ways of working and team processes in turn act as mediators for desired or undesired affective, cognitive, or behavioral outcomes. The final input in the model refers to the longitudinal nature of developmental processes, when outputs from earlier stages become inputs for follow-

**Figure 4.2.:** CEs as ‘secondary team’ within original team boundaries

level) and the sub-units within the teams (meso-level), including their cross-level interactions. On the meso-level I decided to ignore the functional separation between production and maintenance, as qualitative analyses showed that the differences between these two groups were not of major impact for the questions at hand. On the meso-level I therefore only differentiated according to locations, i.e., between onshore and offshore subgroups. Effects on the individual level were considered only in so far as they affected subgroup or team level processes or outcomes (e.g., team identification in Study 6).

The main focus was on first-tier, i.e., CE personnel and their managers, as the primary targets of the CE implementations. Some studies also included second-tier personnel and other groups such as IT support or external consultants involved in organizing the implementation. The specific composition of the sample in each study is described in the respective chapter.
Figure 4.3: CEs as moderators on team functioning in the IMOI-model

The implementation of CEs impacts this model at two points. Firstly, CEs separate parts of the onshore subgroup into a new, smaller team. With the implementation of CEs, team boundaries and composition changed, also modifying the characteristics of the original team (see Chapter 3). CE implementation thus modified the characteristics of the onshore team, i.e., affects the input part of the model. CE implementation did not affect team characteristics in the offshore subgroup. Secondly, the change in information and communication technologies modified established team processes and coordination routines. Technology can thus be seen as a moderator on team processes. As discussed in Chapter 2, information and communication technologies are hypothesized to affect different processes. The role of CEs for team functioning assumed in this thesis is shown in Figure 4.3.

4.4. Summary of methods and data in the six empirical studies

Table 4.1 provides an overview of the approach, sample and data analysis methods for the six empirical studies reported in this thesis. An overview of all data collected as part of these six studies can be found in Appendix A.
### Table 4.1: Overview of methodological approaches for the empirical studies

<table>
<thead>
<tr>
<th>Study/Topic</th>
<th>Level of analysis</th>
<th>Approach and design</th>
<th>Data</th>
<th>Analysis method</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1: Asymmetry</td>
<td>Group, subgroup</td>
<td>Qualitative, cross-sectional</td>
<td>59 interviews</td>
<td>Thematic coding</td>
</tr>
<tr>
<td>S2: Implementation</td>
<td>Group, subgroup</td>
<td>Qualitative, longitudinal</td>
<td>Three cases represented by: 58 interviews (partly overlapping with S1); 191 documents; observation of 30 meeting, 26 hours onshore, 7 days offshore</td>
<td>Comparative thematic coding</td>
</tr>
<tr>
<td>S3: Coordination</td>
<td>Group, subgroup</td>
<td>Qualitative, pre-post comparison</td>
<td>78 interviews (59 from S1, plus 19 additional); observations onshore and offshore (partly overlapping with S2)</td>
<td>Thematic coding</td>
</tr>
<tr>
<td>S4: CE design</td>
<td>Group, subgroup</td>
<td>Qualitative, cross-sectional</td>
<td>Three cases represented by: 58 interviews (25 overlapping with S1)</td>
<td>Comparative thematic coding</td>
</tr>
<tr>
<td>variations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5: Cooperation</td>
<td>Individual, subgroup</td>
<td>Quantitative, cross-sectional</td>
<td>72 Q sorts and accompanying interviews</td>
<td>Q-factor analysis</td>
</tr>
<tr>
<td>expectations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6: Functioning</td>
<td>Group, subgroup, individual</td>
<td>Quantitative, pre-post comparison</td>
<td>325 questionnaires</td>
<td>General linear modeling</td>
</tr>
<tr>
<td>and outcomes</td>
<td></td>
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</tbody>
</table>
4.5. Anticipated and unanticipated challenges encountered in the field

Field studies are seldom free from challenges to the rigor demanded for academic work and this project was no exception. A number of challenges had been anticipated at the beginning, such as the restricted access to offshore locations and personnel. Visits to offshore installations depend on the availability of helicopter and bed space and precedence is given to operation critical personnel. Academic researchers are clearly not part of this category. Anticipated was also a certain degree of turnover in the sample over the two and a half years of the project.

Yet, this project also encountered a number of unanticipated challenges. One of them was the presence of an external consultant team, which had been tasked with the implementation of the CE program throughout the performance unit.

Although this team was mostly supportive, unfortunately the interests and requirements of academic research and consultancy not always align. Some conflicts of interests therefore were inevitable, which resulted in some restrictions for data collection and limitations in access to personnel, particularly offshore – with calamitous consequences especially for response rates of offshore surveys.

Unanticipated was also the scope of the pilot phase, which in the end included over half of the teams in my sample. The original plan of the company had been to conduct one or at most two pilots. The pilots proved so successful, however, that more teams requested to participate. This staged implementation approach limited the possibility for clear pre-post-implementation, as well as longitudinal comparisons. Not only reduced this strategy the sample size for a pre-implementation comparison, but over half of the teams had already acquired experience with some form of CEs before the main implementation. This left doubts in how far teams with or without pilot experience were still comparable in the main phase. Moreover, pilots differed in layout and technological setup not only from the final solution chosen for the main implementation, but also among each other. Due to the differences in CE setup and staffing between pilot and main phase, data collected during the pilot phase could not be directly compared with data in the main phase. On the positive side, however, the extension of the pilot phase gave me the opportunity to study different CE designs (Study 4) and to conduct cross-sectional studies between pilot and non-pilot teams during the first year (Study 5). Although my project did not proceed as originally envisioned, this change thus still provided fascinating alternatives.

More problematic was the onset of the re-structuration process in the onshore or-
4.5. Challenges encountered in the field

organization starting middle of 2007. In this context about 20% of the onshore personnel left, the organizational structure changed from team to function-based, and job functions and responsibilities throughout the organization were redefined. This also led to a redesign of the CE concept, which now included different core functions compared to the concept developed in the pilot phase. In consequence, only a minority of the participant in the CE pilots were still part of the CEs after the full-scale implementation. The planned quantitative investigation with repeated measurements of team processes became therefore impossible.
The universe is asymmetric and I am persuaded that life, as it is known to us, is a direct result of the asymmetry of the universe or of its indirect consequences.

The universe is asymmetric.

Louis Pasteur (French Chemist and Microbiologist, 1822-1895)

5

STUDY ONE: THE IMPACT of ASYMMETRY on TEAM FUNCTIONING\(^\text{1}\)

To obtain a better understanding of the combined impact of asymmetry and distribution in teams, the first study in this thesis took an exploratory approach to examine coordination processes and relationships in existing asymmetric distributed teams. This first study thus provided the background to understand the consequences of CE implementations in distributed asymmetric team settings. Based on semi-structured interviews, I identified three types of asymmetries in the production teams studies in this thesis: task-related, demographic, and cultural asymmetry. These asymmetries affected two aspects of team functioning: intra-team coordination and subgroup relationships. The most problematic for intra-team coordination were the lacking access to information and people, low awareness of activities in the other subgroups, as well as disparate priorities of subgroups. Subgroup relationships were negatively affected by the lacking team familiarity due to the low

visibility of remote team members. Based on these findings, the disparate roles of information and communication technology for the support of distributed team functioning are discussed.

5.1. Introduction

Remote working is and has been a common practice in a number of industries such as air traffic control, construction, mining, or the offshore oil and gas industry for many years. Distributed working in these industries is often driven less by efficiency considerations then by the organizational task itself. Coordination between controllers and pilots in air traffic control, for instance, is by necessity distributed. This type of ‘task-inherent’ distribution is frequently accompanied by considerable asymmetry in tasks, roles, priorities, and demographics in the remote subgroups. Further, due to the clear distribution of tasks across subgroups, the rotation of members between locations is usually not feasible and direct contacts often remain scarce. What exists in terms of contacts between remote members is mostly mediated by media with more or less distinct capabilities for information exchange and communication. At the same time, members are generally highly dependent on the information, work, or products of their remote colleagues, for instance, onshore and offshore subgroups in oil production teams.

High task and goal interdependence requires close and efficient coordination between team members. Yet, as discussed in Chapter 2, both high levels of diversity and geographical distribution render coordination between dispersed members difficult. In the same context, I illustrated that longstanding cooperation does not necessarily lead to easier or more efficient cooperation (Cramton & Webber, 2005; Gibson & Gibbs, 2006; Levesque et al., 2001). So far, it is unclear how extreme forms of diversity such as asymmetry impact functioning of mature distributed teams. The objective of Study 1 was to investigate the effects of subgroup asymmetry and to identify coordination barriers asymmetric teams face during their every-day work. The focus in this study was thus not on critical events or exceptions, but on challenges of asymmetries in standard work processes. Study 1 was conducted as the first exploratory step into the context in which the further empirical investigations took place.
5.2. Methods

5.2.1. Sample and procedure

Study 1 was based on 59 semi-structured interviews from the pre-implementation and pilot phase including three pilot and one non-pilot team. These interviews were chosen for relevance from 104 interviews conducted during the first year of the project (November 2006 to December 2007). The overall task and work conditions of the four teams were identical, so that comparability could be assumed. Also, there was no overlap in members between teams.

The aim of this first study was obtain insight into the work processes, working conditions, and perspectives in production teams, and – based on these descriptions – to detail the asymmetries between subgroups and their effects on team functioning. In the interviews, I therefore asked participants to describe their role and responsibilities in the team, every-day work processes and activities, their collaboration with the other subgroup, relations with the other subgroup, and difficulties in the coordination between office and rig (see interview guideline in Appendix B). To obtain perspectives from both subgroups and disparate functional perspectives I interviewed 33 onshore personnel and 26 offshore personnel from different hierarchical levels (for an overview see Table 5.1). The interviews lasted between 20-90 minutes. All interviews were tape-recorded and transcribed verbatim prior to analysis.

Table 5.1: Overview of job functions and number of interviews included in Study 1

<table>
<thead>
<tr>
<th></th>
<th>Onshore personnel</th>
<th>Offshore personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEAM MEMBERS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support engineers</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Petroleum engineers</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MANAGERS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical authorities</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Team leaders</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Field operations managers</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total onshore</strong></td>
<td>33</td>
<td><strong>Total offshore</strong></td>
</tr>
</tbody>
</table>
5.2.2. Data analysis

The analysis of the interviews was based on thematic coding in Atlas-ti. To identify asymmetries between subgroups I started by marking statements in the interviews with the general topic discussed. These fell into three categories: (1) characteristics of the subgroup, (2) organization of work processes in the team, and (3) characteristics of the individual. Characteristics of the subgroup included the aspects subgroup tasks and priorities, hierarchical structure, and social relationships between members. Organization of work processes included information on work schedules and the organization of work processes (e.g., planning, decision-making, information exchange, or meeting structure), whereas characteristics of the individual contained information on demographics (age, tenure in team, education), type of knowledge and expertise needed for a job function, work situation including the physical environment, and work attitudes. The themes in these first codes were thus closely related to the interview questions. I further marked all reports of challenges and problems including the reasons for these problems as reported by the participants.

In a second step, I compared the content of the individual codes (e.g., work schedules, type of education, task and priorities) between onshore and offshore participants. Based on this step I created an overview of the systematic differences between subgroups in each of the eight aspects coded in the first step.

In the final step I reviewed the statements on problems and challenges in team functioning coding which aspect of team functioning participants discussed. Two main areas for problems between subgroups emerged from this step: intra-team coordination and relationships. Most participants also gave reasons for problems in intra-team coordination and subgroup relationships. Based on these reports I linked specific challenges in subgroup coordination and relationships with the asymmetries identified in the second step.

5.3. Findings

5.3.1. Differences between subgroups and type of asymmetries

Onshore and offshore personnel typically described their overall team task as “to keep the plant running, exporting [oil and] gas at a maximum rate”. Participants made it very clear, however, that the respective roles of office and rig within this task differed considerably. In stark simplification, most participants considered onshore the planning part, which then “hands over to offshore for execution”. This division
was accepted and expected by both sides, as the following comment by an offshore technician shows:

“In an ideal world the guys offshore would love to be given a bag with all their tools, all their equipment, all their spares, and be taken aside and said, ‘Right, there you go, that is yours; for the next two days, don’t come back and see us ever again until it is finished’.”

**Subgroup roles:** Offshore personnel thus saw their role optimally as “purely execution” including the monitoring and control of production equipment, and the maintenance of equipment and plant. The main role of the onshore organization was to support offshore in the execution of these tasks:

**Offshore operations engineer:** “The flow of support and requests should be predominately offshore to onshore. We shouldn’t be dealing with all their stuff. My understanding of their role is that they are there to support us.”

**Onshore engineer:** “Generally, the guys offshore are extremely busy keeping the plant up and running, hence you need an onshore organization to take this away from them, to solve the problem, and give them the solution, so all they do is executing. That’s generally how it works. Because they don’t have the time out there to be going and doing failure analysis and that type of stuff.”

Onshore engineers thus saw their main tasks in the translation of business or strategic decisions into manageable work packages for offshore, the prioritization of work packages, the control of work with respect to technical and legal standards, vendor management, and engineering support in case of operational problems. The onshore subgroup further set the boundary conditions, in which offshore operated:

**Onshore manager:** “Offshore are there to operate the plant from according to a set of boundary conditions. So we set them well guidelines and say, ‘Alright you can operate the wells within these guidelines’. … They are free to do what they feel is the best thing to do to optimize the output. In this case it’s production. So that’s how very much I see it, that onshore tends to provide the boundaries, offshore will then optimize and work within those boundaries to deliver their promise. And we’re there to support them when they either want to challenge those boundaries or something unexpected happens.”

As a rough generalization, most tasks offshore could be characterized as primarily mechanical/technical (at least at the lower levels of the offshore organization), whereas tasks onshore were consistently of an intellectual/analytic nature (Driskell, Hogan, & Salas, 1987).
Chapter 5. Study one: The impact of asymmetry on team functioning

**Time spans:** Due to the more ad-hoc nature of the execution task, onshore and offshore personnel also worked towards different time spans. As one onshore engineer pointed out “[offshore] they are obviously looking at day-to-day stuff, and we’re looking at much larger, much larger issues.” This also had implications for the priorities in both subgroups, as either strategic or tactical:

*Onshore manager:* “The onshore guys need to be more strategic than tactical. That’s how it’s supposed to work. The guys offshore deliver and execute and the guys onshore come up with the strategies.”

**Knowledge:** The disparate subgroup roles required different types of knowledge. While the planning and engineering support required technical knowledge, execution work was based primarily on practical, hands-on knowledge. Expertise was thus split between the technical know-how and the practical know-how with little overlap between the two – or as one offshore engineer phrased it “offshore has got a brilliant experience, but no real technical knowledge, and onshore is exactly the opposite.”

The divide in the type of knowledge and expertise was well established, and seen as part of the natural split in roles between subgroups. Offshore expertise was highly valued by onshore engineers, because it provided information about the specific characteristics of a platform such as the location of pipes and valves, knowledge about the operation and present status of equipment, space limitations, experiences with the behavior and reactions of specific wells, or a realistic appreciation of how much time and resources a certain task would require. Onshore engineers did not possess this practical expertise, but instead possessed the theoretical background knowledge to understand the bigger picture:

*Onshore manager:* “Offshore tend to have knowledge and understanding, but in a different way. So they know if they turn valve A, B happens, but they don’t always know why. Whereas onshore, you tend to know what should happen and what might happen. If you do A then B will happen, but also C, D and E. And what you need to do is get both parties talking to each other and understanding that one group doesn’t have all the knowledge. You actually need to marry both of them together to make the right decision.”

**Access to plant and information:** Offshore personnel were also the only part of the team that could directly intervene in critical events or physically change the status of plant, equipment, or production. Because of the physical distance from the actual production site, onshore personnel were left in a position, in which they
could direct but not act. In a sense, offshore personnel thus served as the ‘ears, eyes, and hands’ of onshore personnel. In the same regard, it was offshore staff, who bore the physical risks in case of accidents or unexpected events. The simple fact that subgroups worked in different locations further meant that members had access to very different sets of information. Offshore personnel were ‘at the sharp end’ with direct access to information on equipment, plant, and production. In the traditional (pre-implementation) situation, onshore personnel had only very restricted access to such information. On the other hand, offshore personnel had only very restricted access to strategic or longer-term decisions and their rationales.

Demographics: The divide in roles and responsibilities was also reflected in the demographics and work patterns of the two groups. Demographically onshore personnel tended to be younger with a high number of university-trained individuals and more female staff. Offshore personnel in contrast were predominantly male and comprised mostly skilled workers, some unskilled, and only a small number of university-trained staff. Management offshore likewise consisted of highly experienced individuals, rather than engineers:

*Offshore Operations Engineer:* “I was a process technician, you know, years ago. But the reason I’m in the position I am is because I’ve got 25, 30 years experience. And that stands for a lot, you know? But at the end of the day we’re not engineers.”

Work schedules: The need for continuous 24/7 production offshore led to the development of disparate work schedules. Onshore kept normal office hours, i.e., Monday to Friday for eight hours during the day, while offshore staff operated on twelve-hour day and night shifts for seven days a week; each individual intermittently spending two weeks on the installation and two weeks ‘off’. Offshore personnel repeatedly stressed this difference, arguing that work conditions offshore were much harder than onshore. Being offshore not only meant working outside on the platform in winter or in harsh weather, it also meant higher risks, a higher unpredictability of work, and the expectation of constant availability even when off shift:

*Interviewer:* If you’re stuck offshore for a longer period of time, do you continue to work?
*Offshore Technician:* Yes, yes, yes, oh yes.
*Interviewer:* So if it is twenty days, it is simply a longer spell?
*Offshore Technician:* A very long spell, yes. So if it is not the sea state that keeps you offshore it can be fog, it could be the helicopter’s broken down. There are
Chapter 5. Study one: The impact of asymmetry on team functioning

*all sorts of variations of why the helicopters can’t come.*

**Offshore Team Leader:** “If you sleep at night and your arm goes up you’re going to be available. . . . You’re here. You’re off shift, but you’re here, so you can’t get away from it, so you are available 24/7.”

**Subgroup structure:** Subgroups further differed in their team structure, in that the offshore subgroup was much more hierarchically organized than its onshore counterpart. Managers offshore had a much stronger position and closer control on processes than team leaders onshore. Offshore managers attributed this stronger control to the more hands-on nature and different work attitudes of offshore technicians:

**Offshore Operations Engineer:** “I think you’ve got to bear in mind that onshore are predominately engineers with professional backgrounds . . . So, they can be expected to work without supervision, work on their own, solve problems. . . . Not sure, whether that is the right word, but they are at a higher level of ability and experience, or whatever, and the technicians [offshore] are not. At least some of them.”

Team leaders’ positions in the onshore subgroup can be illustrated by the following quote, as a typical example for most onshore engineers:

“The team leaders offshore, they are a lot closer to the job and they go out and do a lot more RSA’s and things like that, whereas my team leader never comes and audits me. . . . He doesn’t really set my priorities. I set my own priorities.”

Communication in the offshore subgroup, for instance, went strictly along hierarchical levels. As one offshore operations engineer explained, “most of my communications would be through the OTLs offshore, which is the way it should go, it should go through the line, it shouldn’t bypass and go direct to the technicians”. Similarly, before CE implementations communication between subgroups was conducted primarily between onshore engineers and offshore managers, usually offshore operations engineers (OOEs) and offshore installation managers (OIMs).

**Subgroup attitudes and cultures:** A consequence of the differences in roles, tasks, work schedules, and demographics were clearly disparate work attitudes and subgroup cultures. Offshore staff generally preferred the more hands-on, practical work on the installations compared to the ‘continuous desk work and meetings’ in the onshore office. They generally perceived their own work as more interesting and varied and found little to appeal in “work in an office to be sat there, going in meetings, in
and out of meetings all day long.” At the same time, the focus on hands-on work and the short time span for offshore tasks could also be problematic, as it led to a constant pressure ‘to be seen to be doing something’:

**Offshore technician:** “You can’t be offshore and not be in a boiler suit and not working. You know, what I mean? It’s not allowed; it’s against the law. That’s the mentality.”

Offshore personnel consistently emphasized that offshore “is a totally different world”. Descriptions of work offshore regularly contained images of what Miller (2004) described as the “romanticized cowboy hero” or “frontier masculinity” image:

**Control room technician:** “You have to be quite a character to work offshore, because you have to leave your family, you have to fly by helicopter, it’s in the middle of the sea. You’re working with other men and you got all this alpha male - Hundreds of thousands, I don’t know, testosterone flying high above the place.”

Offshore life was seen as difficult, demanding, and dangerous. These negative aspects were counterbalanced, however, by the very close-knit community between the inhabitants of this ‘small village’ in the middle of the sea. As one offshore technician remarked, “you spend more time with the guys offshore than at home with your family.” Offshore personnel thus experienced much closer relationships than personnel in the onshore office. This was probably also influenced by the much higher turnover and change in personnel onshore:

**Offshore engineer:** “I think probably one of the big differences is that people offshore have been working in [this team] for 25 years. People onshore just change asset every two years, on average.”

Onshore personnel did not necessarily agree with the assumption of the ‘hard offshore life’:

**Onshore manager:** “It’s just part of the culture. These guys are out there. They’re grossly overpaid for what they actually do, but they are at a location that is not desirable. So taking the pay thing aside, because they are kind of long-term guys, this is how I see it, they’ve been out there for years and years, but although they’ve made their choice to be there, they feel hard done by. And you just have to accept that.”

The different cultures also found their expression in disparate behavioral norms on the offshore platforms and in the onshore office. Banter, curses, and bawdy jokes, for instance, were a normal part of everyday offshore interactions, which, in the onshore environment, were not acceptable – or at least not to the same degree. Cultural differences also extended to disparate dress codes. While engineers in the onshore office regularly wore suits, dress pants, or business casual clothing, offshore
staff and managers wore either coveralls or jeans and T-shirts if off-shift or in the accommodation. For an illustration of the differences, Figure 5.2 shows examples of the work environments and people in the two subgroups.

**Summary of subgroup differences and asymmetries**

Overall, I identified eight aspects in which onshore and offshore subgroups differed systematically: subgroup tasks and priorities, working conditions, type of knowledge and expertise required to fulfill the subgroup role, work organization and subgroup structures, type of information available to subgroups members, ability to intervene in processes, demographics, and disparate subgroup attitudes and cultures. These eight aspects were partly consequences of the geographical distribution of the subgroups, partly of the disparate roles of subgroups in the overall team task. Differences in working conditions, the ability to intervene in processes, as well as the type of information available to subgroups were a direct result of the disparate work locations. Subgroup tasks and priorities, the type of knowledge and expertise of subgroup members, work organization and subgroup structure, and demographics were a reflection of the disparate subgroups roles, while the differences in subgroup attitudes and cultures described above can be seen as a result of these differences. A summary of the differences between subgroups is shown in Figure 5.1.

The eight aspects identified in the interviews fell into three higher-order categories: task-related aspects, demographics, and cultural differences. Team were characterized by three types of asymmetries: task-related, demographic, and cultural. Table 5.2 provides an overview of the subgroup differences identified in the data. The subsequent section describes the challenges for intra-team coordination and subgroup relationships linked to subgroup asymmetry.
Figure 5.1.: Summary of the differences between subgroups identified in the data
Figure 5.2.: Work environment and people in the two subgroups
Table 5.2.: Differences between subgroups identified in the data

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Onshore subgroup</th>
<th>Offshore subgroup</th>
<th>Example quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TASK-RELATED ASYMMETRY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgroup tasks and priorities</td>
<td>planning, longer-term strategic outlook, engineering support</td>
<td>execution, shorter-term tactical outlook</td>
<td>Onshore engineer: “The system is designed to where offshore should be execution. We can consult with them, but ultimately I think the steer should come from onshore”</td>
</tr>
<tr>
<td>Knowledge and expertise</td>
<td>engineering, theoretical knowledge</td>
<td>hands-on, practical and local know-how</td>
<td>Onshore engineer: “They [offshore] may say, ‘yeah, you may take that off’ or ‘that will impair two or three other things’, and you think, ‘I haven’t thought about that or haven’t been aware’.”</td>
</tr>
<tr>
<td>Work organization: work schedule</td>
<td>eight hours Monday to Friday</td>
<td>12 hour shifts, seven days a week</td>
<td>CRT: “There will still us going through him. [indicates on a drawing] Him going to him. Him going to him.” – PSB: “So control room to OTL, OTL to OOE, OOE to onshore? That’s a long way to solve a problem.” – CRT: “Exactly, yes. Exactly.”</td>
</tr>
<tr>
<td>Work organization: shift system</td>
<td>no shift system</td>
<td>rotation of day and night shifts, two week shifts on installation, two weeks off</td>
<td></td>
</tr>
<tr>
<td>Subgroup structure</td>
<td>low involvement by managers</td>
<td>strongly hierarchically organized</td>
<td></td>
</tr>
<tr>
<td>Available information</td>
<td>longer-term plans, strategic decisions</td>
<td>status of plant, production, equipment</td>
<td>Onshore engineer: “I could get a phone call right now, where there is a problem with a valve, for example. Now, the [offshore] guy over the phone, he’s seeing the specific problems right in front of him, so he knows roughly what it is or what it might be.”</td>
</tr>
<tr>
<td>Ability to intervene in processes</td>
<td>no direct ability to intervene</td>
<td>ability to intervene due to direct access to plant and equipment</td>
<td>CRT: “A piece of equipment is vibrating, something’s not nice, something sounds off. What we’ll do it is, we will call up [onshore], say, ‘right, there’s a problem with this pump, what is it you want us to do with it?”</td>
</tr>
</tbody>
</table>

CRT: control room technician; OTL: Offshore team leader; OOE: Offshore operations engineer

Continued on next page
Table 5.2: Differences between subgroups identified in the data – continued from last page

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Onshore subgroup</th>
<th>Offshore subgroup</th>
<th>Example quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work attitudes: media preferences</td>
<td>preferred phone</td>
<td>emails, written confirmation</td>
<td>Onshore engineer: “I don’t know why we’re in this state, but a lot of the information that we tell the guys offshore, they’ll ask for written backup.”</td>
</tr>
<tr>
<td>Working conditions</td>
<td>office environment</td>
<td>work in office and outside on the platform, risk in case of unexpected events</td>
<td>OOE: “Because when the weather is so bad, you can’t get materials on and off, you can’t get food on and off, you can’t get helicopters on and off. It’s a very, very difficult environment to work in.”</td>
</tr>
</tbody>
</table>

DEMOGRAPHIC ASYMMETRY

| Gender                          | higher percentage of female personnel | predominantly male personnel |
| Age                             | higher percentage of younger personnel | predominantly middle aged personnel |
| Education                       | mostly university trained personnel | mostly skilled, few unskilled, few university trained personnel |
| Tenure                          | frequent changes between teams | long tenure within same team |

CULTURAL ASYMMETRY

| Work attitudes: Subgroup relations | close involvement in offshore | self-reliance, independence |
| Social relationships              | mostly loose, work-related    | very tight, personal         |
| Dress code                        | business casual               | informal, T-shirts and jeans, work coverall and work boots |

CRT: control room technician; OTL: Offshore team leader; OOE: Offshore operations engineer
5.3.2. Consequences of asymmetries for team functioning

The second objective of Study 1 was to detail the consequences of subgroup asymmetry on the functioning of production teams. Generally, participants considered the differences between subgroups as a normal part of their every-day work, and teams had developed routines and work patterns that integrated asymmetries in the organization of team processes. Still, the interviews revealed some systematic problems these asymmetries had on the functioning of either one of the subgroups or the team as a whole. The two aspects most affected by asymmetries were intra-team coordination and subgroup relationships. The following sections describe the findings on asymmetry effects for these two aspects.

Effects on intra-team coordination

Given the close links between onshore and offshore tasks, the work environment posed several problems for efficient coordination between the subgroups. Coordination in teams requires the integration and linking of activities among interdependent members or subgroups to accomplish a common task. The integration of activities is only possible, however, if team members are aware of the status of activities of others and the general situation of the team. Mutual awareness provides the context for individual activities (Dourish & Bellotti, 1992) and helps to predict developments in the near future (Endsley, 1995).

In the traditional setting, comprehensive awareness of activities or situations in the other subgroup was severely hampered by the dual problem of physical separation and restrictions in information and communication technologies. As one onshore engineer recounted, “before we had that CE system, the only way we could find out if a piece of plant was online, was to call the control room on the phone and ask them.” This lack of visibility and the resulting asymmetry in information was one of the most serious challenges for the efficient coordination of tasks and processes between subgroups. The following account is an example of how long-winded access to information could be:

ONSHORE ENGINEER: “I used to ring the control room to say, ‘Can you tell me, which wells are online?’ And it would just be, ‘it’s A1, B1’. And it would be, ‘ah, that is fine’, and that would be the end of the conversation. And then I would go away and think about it and call them back to say, ‘Okay, I thought about it now. Why?’”

Teams in the pre-implementation setting operated in an environment that pro-
vided little information in terms of ‘what is happening’ (action awareness), ‘who is there’ (social awareness), or ‘how are things going’ (activity awareness; cf. Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). Not surprisingly, access to information and access to people were the most frequent complaints from participants in this study, e. g.,

**Onshore Technical Authority:** “It’s that kind of thing, where you say, ‘well, this piece of equipment, if you take that off, we can’t produce oil’, and we [onshore] don’t always have visibility of that.”

Reliance on media, which were either asynchronous such as emails, or low in richness or context such as phone and audio-conferencing, was one of the major barriers to speedy and comprehensive access to information and people. Yet, various asymmetries identified in the first part of the study further aggravated the situation. Different work schedules, for instance, restricted the time that onshore personnel were available for requests from offshore:

**Offshore Engineer:** “It’s Saturday and it’s one o’clock in the morning. What do you do? Do you just sit down and wait until Monday morning, eight o’clock?”

Although the onshore subgroup acted as support for offshore operations, the differences between normal office hours onshore and a 24/7 operation offshore meant that during three quarters of offshore operations, onshore personnel were not readily available. For serious cases it was therefore accepted practice that offshore personnel could call specific engineers or team leaders also during nights and weekends. Several technical authorities and team leaders reported that they had had phone meetings at home or had spend time in the office over the weekend to work on a problem. At times, offshore personnel even lost track of the fact that their colleagues onshore were not on duty around the clock:

**Offshore Installation Manager:** “If I’m working, sometimes I just pick up the phone and phone somebody, even though it’s 3:00 o’clock on a Saturday afternoon, I’ll just phone them, and I’ll go, ‘I was wondering about this, can you tell me?’ – ‘No, I’m on [x-Street] in [z-town].’ – ‘Oh, sorry, sorry, okay, sorry, speak to you on Monday.’”

A frequent complaint from offshore personnel were the seemingly endless series of meetings, which kept onshore engineers away from their desks. Because of the lacking visibility into who was present or absent in the office, calls from offshore frequently went unanswered, which left the impression that onshore engineers were too rarely available for what should be their main task, namely supporting offshore.
5.3. Findings

While the lacking cover during nights and weekends were problematic for the offshore subgroups in case of unexpected, serious events, the shift system offshore threatened the consistency of longer-term processes and plans, which were the focus of the onshore subgroup. The offshore shift pattern meant that personnel on the installation changed every two weeks. During handovers, information often got lost from one shift to the next and agreements reached during one shift had to be renegotiated. To a minor degree, also different styles and priorities of individuals in changing offshore shifts could affect coordination in a distinctly negative or positive way:

Onshore engineer: “You have spoken to one set of individuals, then when you speak to the new ones that come on, they don’t know anything about it. . . . Or they have a different perception and then you have to go back through the whole process again.”

The most potential for task-related conflicts was probably introduced by the disparate priorities of subgroups. The onshore view was longer term with the primary goal of maximum production, whereas the aim of offshore personnel was to guarantee smooth processes with as little disruptions as possible:

Offshore operations engineer: “Fundamentally it’s getting the balance between driving for production and risking tripping the plant and causing chaos. So onshore wants us to optimize production, drive production up. Offshore left to their own devices – if you would leave the CRT to his own devices, would run the plant at 80% of capacity – and run nice and steady and would loose out on that 20% opportunity. And it’s getting that balance right, which can be a little confrontational. If you tell offshore, ‘ah, I want that on’, and the CRTs are going, ‘if I do that I could loose the whole plant and then you have no production’.”

Asymmetries in priorities thus led to a “division in attitude”, which created frustrations on both sides. Offshore personnel, and here specifically control room technicians, seemed to resent the constant push for higher production as an interference by onshore. Many argued that the plant would run better, if offshore would be left alone:

Control room technician: “You got to let the control room boys do what they do best. It’s not the platform that’s on the platform anymore. It’s either the commercial department that runs it or –. It’s like they always want to forever mess around with the plant; they always want that little bit more out of it. When you get that little bit more, it breaks.”

While the overall team goal was maximum production under safe conditions, the ideas within the two subgroups on how to achieve these goals were clearly not al-
ways in alignment. This last comment also suggests that demands from onshore may at times be considered unreasonable, because they increased the workload for offshore technicians one-sidedly. Due to the necessary delegation of execution activities to offshore, the offshore subgroups carried the consequences of decisions made by onshore staff. Moreover, onshore personnel did not always explain the rationale for their decisions or the reasons for deferring activities offshore deemed important. The missing awareness about what the other subgroup was presently working on (action awareness) together with an incomplete understanding of processes thus increased the negative impact of asymmetric priorities:

**Onshore Technical Authority:** “I can sympathize with the guys out there, because they maybe have frustrations with going to the same equipment, dealing with the same fault year after year. And in the planning process, we rank our jobs and say, ‘this goes the highest, we must do that piece of work; that might be pretty low’. And it probably is, because we have looked at it onshore and went, ‘well, there are bigger problems.’”

Another challenge for subgroup coordination was the fact that onshore engineers had no possibility to directly access plant or equipment or intervene in processes. Offshore in the words of one offshore team leader was the “first line of attack and first line of defense”. While in other production industries such as oil refineries and chemical plants or on land rigs, engineers are able to visit the production site on short notice and with comparatively little hassle, visits to offshore installations are much more problematic. Not only do engineers need up-front legal and medical clearance, they also require safety trainings before getting the permission to fly offshore. Limited seats in helicopters as well as bed space offshore further restrict ad-hoc visits. The reliance on precise and timely information from offshore is therefore even greater than in other industries, in which first-hand knowledge can be obtained on a more regular and short-term basis.

Exchange of information was also influenced by subgroup-specific work attitudes, which, for instance, impacted on the willingness of offshore personnel to inform onshore support of unexpected events. Offshore personnel were generally highly experienced technicians, and as one offshore operations engineer pointed out, “We are pretty self-sufficient in quite a lot of things. If we have a problem here, than we try to solve it ourselves first, do what we need to do out here.” Smaller issues were thus solved directly offshore and reported in the next team meeting. Onshore support became involved, if problems exceeded the expertise of the offshore subgroup. Not unnaturally, there was some ambiguity, which decisions should be made by offshore
and which required onshore input. While offshore personnel complained that onshore engineers were hard to reach when needed, a number of onshore engineers saw this mainly as an excuse to avoid involving them in decisions:

**Onshore Engineer:** “You go in on a Wednesday morning and you find out that something happened on Tuesday morning and they never told you. They say, ‘Well we rang and you weren’t there. We tried to call such and such’. And you don’t really know if they have or not or if they just kind of said, ‘oh, we’ll just make a decision ourselves’.

These problems were not made easier by the fact that onshore and offshore personnel had different habits or standards of communication. Onshore personnel, for instance, frequently sent emails with requests for information or with commissions for tasks on Friday afternoons shortly before leaving the office, probably to get things ‘off their desk’. This meant, however, that the offshore subgroup was unable to check back to get clarification on unclear requests. Offshore personnel, on the other hand, had the tendency to ignore emails sent from onshore. Onshore engineers therefore preferred phone calls to get in touch with specific technicians or team leaders. Many of these phone calls went first to the control room, which – as one control room technician somewhat acidly remarked – acted as the “telecom exchange” of the platform:

“This is the telecom exchange as well for all the calls from the beach. If they don’t know the direct dial number, they come straight in here, ‘oh, I need to speak with such and such.’ … It’s pretty distracting.”

The more hierarchical structure offshore further directed most conversations to the upper two management levels, i.e. OOEIs and OIMs. In the pre-implementation setting, meetings between the two subgroups were primarily restricted to onshore engineers and managers, and managers offshore. In this way, offshore managers were able to retain oversight of processes and planned activities, which they then delegated to OTLs and technicians. While this system ensured that managers stayed informed of all developments and current activities, a number of technicians found this practice unsatisfying:

**Offshore Technician:** “Because technicians are very much kind of left in the dark, you know. More times than often they are told on the day what they are going to be doing. That could be a massive job, and it shouldn’t be like that. The guys should be told weeks in advance, so they can prepare for it. They should highlight issues. More than often they are diving into a job and it’s like, ‘ah, we never though of that, we never thought of this, we don’t have this to carry it out’. So it gets delayed and delayed and delayed and delayed.”
Chapter 5. Study one: The impact of asymmetry on team functioning

The necessary delegation of the physical aspects of the job to the offshore subgroup went hand in hand with the asymmetry in knowledge – hands-on technical knowledge on the one side and more theoretical engineering knowledge on the other. In a simplification of an earlier comment, offshore personnel knew how to do things, whereas onshore personnel knew why. For onshore engineer, the lack of direct experience and the restricted access to information and expertise led at times to unrealistic or faulty assumptions about work processes, work loads, or possible consequences of plans. Onshore engineers generally lacked the hands-on experience with the jobs they planned. This extended as much to the knowledge on how much time and resources these jobs required as to the specifics of the plant:

**Offshore Engineer:** “[Onshore], they are just like, ‘they know how to do it’. They think it’s going to be done like (snaps fingers twice) like that. And to do it takes ages.”

**Onshore Engineer:** “A lot of times, you do a plan and then you send it offshore and they are usually the first ones to say, ‘yeah, well, there’s a backdrain or there’s other work’ we can’t see onshore. … If I think, it’s gonna take eight hours, then they say, ‘that’s a three day job; two men for three days, not one guy for one day’.”

It is easy to envision, that asymmetry in knowledge and expertise may result in misunderstandings and conflicts. Here, however, the ongoing nature of subgroup coordination seemed to help. Although not a precise picture of the immediate situation, ongoing coordination between subgroups appeared to provide at least a general knowledge of individuals, subgroup-specific processes, and an appreciation of differences in expertise and priorities. This generic knowledge thus seemed to alleviate some of the challenges due to lacking visibility and asymmetries.

Occasionally, coordination was also impacted by external circumstances due to the differences in work environments such as weather, reliability of vendors, or transports to the platforms. Work in the onshore office can go ahead in nearly any weather, while most activities on offshore installations rely on favorable conditions – not only for the execution of the work, but also for the transport of equipment and personnel to and from the platforms. Spells of bad weather delayed transports and execution of planned tasks. Delays also occurred, if vendors were unable to deliver equipment or provide necessary experts on time. These factors were clearly located outside the influence of the teams, yet disrupted or complicated cooperation between subgroups. The greater vulnerability of activities in the offshore subgroup to external factors such as weather illustrates that not only team characteristics but also differences in the physical environment impacted intra-team coordination.
5.3. Findings

Effects on subgroup relationships

Interviews and observations further showed that geographical distribution and the low visibility not only of processes, but also of the individuals on either side of the team meant that most members had very little personal contact to each other. Onshore engineers and technical authorities went offshore on occasions, and at times offshore managers came into the office for meetings, workshops, or after the end of a trip, but these occasions were not very frequent. Accordingly, it took time to get acquainted with members from the other subgroup, and team familiarity was relatively low. Especially new personnel found it challenging to get acquainted with their colleagues on the other side:

**Onshore engineer:** “I’ve only been off once, when I started in January, so most of them I couldn’t tell you what they look like. I could walk past them and –. I’ve spoken to quite a few on the phone, no idea what they look like. So the OTLs, spoken to all of those, the OIM, most of the electrical guys, so that’s about it, not many others, because there’s always the problem, you got the different shift patterns. So you can go offshore and you can make three trips and if you have the same crew at the same time, you see the same guy three times, you haven’t seen his back-to-back. It’s sometimes strange, because in our meetings, we got the box and they started to do introductions, ‘ah, it’s [lists names]’, phh, who’s who? So I sit there with the organigram to find out who they are. But then when they start talking, I don’t know who it is that is talking. Is that the OTL, is that the OIM? That’s sometimes quite hard. … I mean there are some people you can identify quite easily, because of their voices, if you speak to them quite often. But others, especially when they provide input or comment on something, you think, ‘who is it? What is their role or are they involved in the job or is that somebody I need to speak to?’”

Most participants generally identified more with their own subgroup than with the whole team. ‘Their team’ was the colleagues around them, rather than the team as the combination of onshore and offshore group. Hence, identification with the own subgroup was stronger then overall team identification, although the trend seemed more pronounced for offshore than onshore personnel:

**Control room technician:** “I know we are all one big team, but because, I suppose, personally I don’t interact with them on a daily basis. Well, I suppose in the meetings, but I don’t have a great deal of influence over what they’re doing or whatever. I don’t know, I suppose my team is my team out here.”

In some teams the ongoing physical separation and the lacking visibility of processes did lead to a ‘them-and-us’ attitude. One onshore manager even referred to it as a “war” between onshore and offshore. Although this comment was not meant
entirely seriously, a certain degree of distrust and frustration was evident in many interviews. At the same time, most participants were of the opinion that this divide was inevitable:

**Offshore operations engineer:** “There is a barrier between onshore and offshore. There always will be. And, you know, no matter what team you go in, there’s always, ‘they onshore, they don’t know what they’re doing’ or ‘they offshore, they don’t know what they’re doing’. You’ll always get that.”

Despite the low team familiarity and the stronger identification with the own subgroup, relationships between subgroups appeared generally good, although not close. A frequent complaint was that the other side had no appreciation of the work and problems of their own subgroup:

**Offshore technician:** “The onshore team and the offshore team are – very far apart. I can’t even find a word to kind of describe it. But some of these guys that are onshore have never been offshore or have been offshore only for a few days, which I find quite ironic, because if you are supporting an offshore team, it makes life so much easier if you have been there.”

**Offshore operations engineer:** “There’s a lack of appreciation onshore of how long some things take to do offshore. What I see is that when you’re offshore, you have ten balls that you’re juggling all the time. When you’re in the office you’ve probably got two or three.”

Not surprisingly the feeling of closeness was influenced by the size of the team, its maturity, and the amount of turnover in personnel. I found this effect most markedly in one of the non-pilot teams in this sample. This team was small, when compared to most other teams, and most team members had worked in this team for many years. Over the years, through repeated visits of onshore engineers to the offshore installation, this team had achieved a trusted and close relationship. As one of the onshore engineers remarked, “it’s family; for the lack of a better term it’s family.”

**Summary of challenges**

Table 5.3 provides a summary of the challenges and conflicts in intra-team coordination and relationship linking them with the asymmetries identified in the previous section.
<table>
<thead>
<tr>
<th>Asymmetry aspect</th>
<th>Main challenge/conflicts</th>
<th>Example quote</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access to information</strong> (20.99% of total problems*, 22.45% onshore ±, 18.75% offshore ‡)</td>
<td>onshore personnel: lacking knowledge about status of equipment and production</td>
<td>Onshore engineer: “We don’t have a huge amount of information coming in from the platform to help us to optimize. So a lot of it is based on rules of thumb and a little bit – it is probably observation.”</td>
</tr>
<tr>
<td></td>
<td>onshore personnel: dependence on information provided by offshore</td>
<td>OOE: “You have your own ideas about what direction you think should be taken. So, you know, you influence the onshore team to look at certain things because in some cases, they’re relying on you, telling them what the problem is. They can’t see it.”</td>
</tr>
<tr>
<td></td>
<td>offshore personnel: little knowledge about long-term strategies or rationale for decisions</td>
<td>CRT: You sometimes get an email from one of the technical authorities and it’ll say, ‘we were looking into this; we discovered this isn’t working correctly, we now need to do this’. As if you could just say ‘ok, I’ll do that right now’. … It might be something that they have deemed not to be safe anymore, they want immediate resolvement of it, which, you know, we got a plan things a bit more.”</td>
</tr>
<tr>
<td><strong>Access to people</strong> (7.41% total problems, 8.16% onshore, 6.25% offshore)</td>
<td>lacking knowledge about status of activities</td>
<td>Onshore planner: “I don’t think, people are as trusting as they could be.”</td>
</tr>
<tr>
<td></td>
<td>low team familiarity (6.17% total problems, 8.16% onshore, 3.13% offshore)</td>
<td>Onshore engineer: “Because I find when the vendors are offshore, I have no contact with them. … us and them organize a plan and then next time you hear from them is when they send the report in to me, so I don’t actually know what they are doing offshore.”</td>
</tr>
<tr>
<td></td>
<td>lacking trust (8.64% total problems, 14.29% onshore, 0% offshore)</td>
<td>Onshore engineer: “Offshore are never quite sure who to contact.”</td>
</tr>
</tbody>
</table>

CRT: control room technician; OTL: Offshore team leader; OOE: Offshore operations engineer

* % of total problems mentioned; ± % of problems mentioned only by onshore personnel; ‡ % of problems mentioned only by offshore personnel

Continued on next page
Table 5.3.: Challenges and conflicts due to asymmetries identified in the data – continued from last page

<table>
<thead>
<tr>
<th>Asymmetry aspect</th>
<th>Main challenge/conflicts</th>
<th>Example quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>high subgroup identification (3.70% total problems, 2.04% onshore, 6.25% offshore)</td>
<td>lacking appreciation of work situation/work load in other work group (6.17% total problems, 4.08% onshore, 9.38% offshore)</td>
<td>Onshore engineers: “I think from that point of view I know what they are doing, but in terms of ‘are their issues my issues’, I don’t know.”</td>
</tr>
<tr>
<td>CRT: control room technician; OTL: Offshore team leader; OOE: Offshore operations engineer</td>
<td></td>
<td>CRT: “We sometime don’t appreciate how much effort and time people on the beach are putting into that, as well as doing their day to day job. But I think it’s the same, you know, they don’t appreciate sometimes how busy it is or can be out here.”</td>
</tr>
<tr>
<td></td>
<td>conflicts between different priorities</td>
<td>Onshore engineers: “It means we haven’t got a team basically, because you got a conflict, you got a division, as well as the division in distance, you got a division in attitude and the attitude is because you have a theoretical view onshore and a practical view offshore.”</td>
</tr>
<tr>
<td></td>
<td>resentment due to perceived infringement into offshore autonomy</td>
<td>OTL: “Sometimes it feels like our hands are tied, when the beach wants involvement. But as I said, we are the first line of defense.”</td>
</tr>
<tr>
<td>Tasks and priorities (19.75% total problems*, 18.37% onshore±, 21.88% offshore†)</td>
<td>lacking expertise to make decisions</td>
<td>OOE: “Onshore engineers quite like to be involved in an area. . . . If I make a decision on behalf of the mechanical engineer on something that I think I know, but I don’t have that skill or competence, then they’re not best pleased, because they are having to deal with an issue if it’s not right.”</td>
</tr>
<tr>
<td>Knowledge and expertise (4.94% total problems*, 2.04% onshore±, 9.38% offshore†)</td>
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</tbody>
</table>

* % of total problems mentioned; ± % of problems mentioned only by onshore personnel; † % of problems mentioned only by offshore personnel

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<tr>
<th>Asymmetry aspect</th>
<th>Main challenge/conflicts</th>
<th>Example quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work organization/work schedules (4.94% total problems, 4.08% onshore, 6.25% offshore)</td>
<td>lacking continuity, loss of information because of shift-handovers offshore</td>
<td>Onshore engineer: “You have spoken to one set of individuals, then when you speak to the new ones that come on, they don’t know anything about it… or they have a different perception and then you have to go back through the whole process again.”</td>
</tr>
<tr>
<td></td>
<td>lacking support for offshore out of office hours</td>
<td>Offshore engineer: “Onshore is never available as often as we would like them to be available…. and you kind of like, figure things out, when you can.”</td>
</tr>
<tr>
<td></td>
<td>unexpected plan changes for onshore due to offshore decisions out of office hours</td>
<td>Offshore engineer: “The thing is, when [onshore engineers] plan something and when it goes wrong, at night, at the weekend, offshore just changes the plan. And then it’s kind of getting back on track or trying to integrate the changes into the plan.”</td>
</tr>
<tr>
<td>Subgroup structures (2.47% total problems, 2.04% onshore, 3.13% offshore)</td>
<td>hierarchical structures lead to friction in communication or lacking clarity who to include</td>
<td>CRT: “If something is going on and the team leader needs to know that. Especially if there is a problem and it goes back to the onshore and it than goes by the team leader, they feel a bit stupid that’s something has been going on and they’re not aware of it.”</td>
</tr>
<tr>
<td>Working conditions (2.47% total problems*, 0% onshore±, 6.25% offshore†)</td>
<td>weather, space restrictions on platform</td>
<td>OOE: “It’s not that we have work that fills up 125 beds. We have enough work to fill a 150 beds and hence, we’re having to continually push work out by three months, six months, nine months.”</td>
</tr>
</tbody>
</table>

CRT: control room technician; OTL: Offshore team leader; OOE: Offshore operations engineer

* % of total problems mentioned; ± % of problems mentioned only by onshore personnel; † % of problems mentioned only by offshore personnel
5.4. Discussion

Study 1 set out to detail the internal structure of production teams and the difficulties these teams were confronted with on a daily basis. Its objective was to obtain a better understanding of the impact of asymmetries in distributed teams; but also to provide the background for the investigation of the type and scope of effects of the CE implementations.

Overall, I identified three types of asymmetries:

1. **Task-related aspects** referring to differences between onshore and offshore subgroups in terms of subgroup-tasks, priorities, time focus, work schedules, work environment, type of experience, access to plant and information, ability to intervene, and degree of personal risks

2. **Demographics** based primarily on differences in education, age, and gender

3. **Work attitudes and cultures**, which found their expression in the disparate relevance of social relationships, behavioral norms, and cultural artifacts such as language and dress codes

Asymmetries in this study were the result of the geographic distribution of subgroups, made necessary by the overall team task, as well as the different subgroup roles in the achievement of the overall team task.

Although the situation in production teams seemed to contain a considerable potential for conflicts, for instance, about disparate priorities, lacking appreciation of working conditions, or imprecision in planning, the existence of established routines and the experience and familiarity with these asymmetries appeared to reduce the actual occurrence of conflicts. It thus seems that ongoing distributed teams may have an advantage over teams operating within a shorter time frame, in that mutual experiences and routines moderate negative asymmetry effects. Participants moreover rarely voiced concerns about team familiarity or team identification, except where they hindered the ease of communication and coordination, for instance, when new team members had difficulties identifying members of the other subgroup in a meeting held over audio-conferencing. These observations illustrate that ongoing distributed teams can develop a comfortable state, in which potentially adverse effects are mitigated by the development of work patterns or routines.

Asymmetries were generally perceived as a normal part of the team work, and ongoing experiences with distributed working had led to routines and interaction patterns, which integrated asymmetries into the organization of team processes. The
comparatively rare contact and the low mutual visibility of subgroups in the traditional (pre-implementation) setting further meant that different behavioral norms or differences in cultures were hidden and had no immediate bearing on intra-team coordination. The differences were well known, but seemed not immediately salient in the daily interactions. Meetings over audio-conferencing, for example, masked disparate dress codes, and as contacts between subgroups were largely restricted to meetings or one-on-one phone calls, differences in language and interaction styles existed in parallel without causing much concern. Team members generally accepted the situation as they found it, and adapted their expectations on how to organize team processes to the constraints of their work environment.

Still, interview reports highlighted the existence of systematic challenges for team functioning. These centered around two aspects: intra-team coordination and subgroup relationships. Chief amongst the challenges for efficient subgroup cooperation was the lacking visibility of processes and the reduced situation awareness, which left team members in doubt of the actions of team members in the remote subgroup. Production teams in the traditional setting thus lacked the ability to easily observe changes in the status of the other subgroup or their actions to modify and adjust their behaviors without prior communication. Comments by participants further highlighted that subgroups often operated under inaccurate assumptions and a lacking appreciation of the working reality at the remote location. Low team familiarity, i.e., a lacking personal acquaintance with the styles and preferences of others, and the higher turnover in the onshore subgroup further reduced the potential for effective implicit coordination.

Implicit coordination occurs, “when team members anticipate the actions and needs of their colleagues and task demands and dynamically adjust their own behavior accordingly, without having to communicate directly with each other or plan the activity” (Rico et al., 2008, p. 164). Implicit coordination is made possible by an intimate knowledge of other teams members’ tasks, the consequences of own actions on the results of others’ work, but also routines and agreed work patterns. Experience within a team leads to the development of routines, as well as a shared understanding of tasks, preferred methods, acceptable behaviors, or areas of expertise for specific members. Implicit coordination thus relies on the development of shared mental models (Cannon-Bowers et al., 2003; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000) and transactive memory systems (Austin, 2003; Wegner, 19987) that guide team members in their activities without the need for explicit coordination. The fact that problems of intra-team coordination persisted despite
the ongoing nature of cooperation between subgroups demonstrates that the simple fact of continuous interactions were not enough to overcome the challenges of distribution and task-related asymmetries. This was one reason, why the reliance on established roles, routines, and the detailed planning of activities was so important to production teams.

Challenges in production teams were due to a combination of geographical distribution – and with it team opacity – and subgroups asymmetries. The teams lacked the visibility of activities in the other subgroup for easy intra-team coordination, as well as the proximity to other members to develop personal relationships. Proximity and visibility are important moderators for the success of coordination (Okhuysen & Bechky, 2009). In distributed teams physical proximity and visibility have to be ‘re-created’ by technological means, i.e. information and communication technologies. Information and communication technologies can thus be seen as moderators for team opacity and thus the relationship between team opacity and team functioning (cf. Figure 5.3).

Information and communication technologies will likely play different roles for asymmetric teams by targeting different challenges. Information technologies influence the type, wealth, and speed of data available to team members. They can thus provide the framework for adjusting own activities and prepare reactions to developments without the need for direct interactions between subgroups. This role
can only be effective, however, if interpretations of data align across remote members. The challenges of disparate priorities and knowledge areas found in this study suggest that it is difficult to reach such an alignment in asymmetric teams. Teams thus need a means to clarify and negotiate common interpretations. This is the role of communication media. Communication media also influence the development of relationships and trust between remote members, which are conditions for the willingness to share critical information or ask for help. Longer term, the frequency of interactions also impacts the accuracy of transactive memory systems and team mental models (Lewis, 2004; Yoo & Kanawattanachai, 2001) – a prerequisite for implicit coordination (e.g., Salas, Cannon-Bowers, & Honston, 1997). Overall, the role of information and communication technologies for the processes in asymmetric distributed teams is likely to be complex. The further empirical studies set out to clarify their individual and combined effects on disparate aspects of the functioning of asymmetric distributed teams.
Two boys arrived yesterday with a pebble, they said was the head of a dog, until I pointed out that it was really a typewriter.

Pablo Picasso (Artist, 1881-1973)

6

STUDY TWO: CE IMPLEMENTATION in ASYMMETRIC DISTRIBUTED TEAMS: A LONGITUDINAL MULTI-CASE INVESTIGATION INTO CE ADOPTION

Study 2 investigated the implementation and subsequent adoption of CEs over a period of two and half years. The objective of Study 2 was to re-conceptualize the technology adoption process for the team level. Using a multi-case design I developed a theoretical model of team-based technology adoption. Differentiating between the two dimensions valence (general direction of attitudes) and alignment (congruence of attitudes across team members). I further identified group-level, subgroup-level, and context factors responsible for changes in CE acceptance and adoption in pre-usage, early-usage, and later-usage phases. Study 2 provides a theoretical extension of the current literature to implementation and adoption processes on the team level. It further provides organizations with practical knowledge on challenges and relevant factors during distributed team implementations.

1This chapter is based on Bayerl, P. S. & Axtell, C. M. (2010). Technology implementation at the team-level: An elaboration for distributed settings. Academy of Management Conference, Montreal, Canada.
6.1. Theoretical background

The adoption of new technology is essential to maintain competitiveness of organizations (Edmondson et al., 2001). Yet, many of these implementations fail to deliver all or any of the envisioned benefits (Standish Group, 2009). Such failures are in part due to technological reasons, but most often they are a result of human and organizational issues – or the failure to take such issues into account (Clegg et al., 1997).

A multitude of models exist to describe the process of technology implementation and adoption, and to detail the factors influencing implementation success. The majority of these models focus either on the individual level (e.g., Innovation Diffusion Theory, Social Cognitive Theory, Technology Acceptance Model, Unified Theory of Acceptance and Use of Technology; Rogers, 1995; Bandura, 1986; Davis, 1989; Venkatesh et al., 2003) or the organization as a whole (e.g., Diffusion- Implementation Model, Tri-Core Model; Kwon & Zmud, 1987; Swanson, 1994).

Yet, organizational processes have become increasingly team-based, and accordingly information and communication technologies are being used more and more in a team context. Email and video-conferencing, for instance, frequently support coordination of tasks among group members, while other technologies such as group support systems have been explicitly designed to facilitate processes within teams. Surprisingly, the increasing prevalence of teams in organizations has not yet found its reflection in theoretical considerations for technology implementation and adoption on the group level.

The aim of this study was to extend the discussion of technology adoption to this intermediate level between individual and organizational implementations – focusing more specifically on distributed team settings. Distributed working is a still growing trend, recent estimates suggesting that at least 60% of professional employees are part of distributed teams (Kanawattanachai & Yoo, 2002). Technology implementations in organizations will thus increasingly affect users working in distributed team settings. By definition distributed teams depend on various forms of information and communication technologies for the interactions between members, the coordination of processes, and the management of tasks and relationships. Information and communication technologies form an indispensable part of their work environment, and technology changes can therefore have a major impact on the functioning and viability of such teams. Yet, despite the increasing importance of distributed working and its sensitivity to technology changes, the specific chal-
6.1. Theoretical background

Challenges of distributed settings have not yet received much attention in the technology implementation literature (Mark & Poltrock, 2004). Theoretical propositions or models in this area are even scarcer. In this chapter I propose a model for technology implementation and adoption in distributed team settings. My main interest lay here in the identification of team-level and context factors that influence acceptance and adoption over time.

6.1.1. Challenges of technology implementation in distributed teams

Technology use in teams relies on common social norms and agreed usage patterns on how and when to use specific media; e.g., when to use email instead of phone or how to handle editing in common documents (Orlikowski & Gash, 1994; Simon & Paper, 2007). Lacking overlap or agreement between members can thus lead to communication problems, conflicts, or even refusal to cooperate (cf. Davidson, 2006; Davidson & Pai, 2004). Given the dependence of distributed teams on technology, the existence of such shared technology frames is thus crucial for their functioning (Gibson & Cohen, 2003).

Changes in the technological infrastructure of distribute teams disrupt existing norms of technology use. The adoption of new technology thus necessitates the renegotiation of agreements and a new alignment of expectations and behaviors (Mark & Poltrock, 2004). The alignment of expectations, attitudes, and usage patterns in teams generally occurs through negotiations and common experiences in the same context, i.e., the opportunity to work with each other, to observe other members, and share the same social space (Edmondson et al., 2007; Langan-Fox et al., 2004).

Members in distributed teams are here faced with a double disadvantage. Firstly, computer-mediated communication is generally less conducive to providing the necessary rich interaction that forms the background for common experiences and thus norm development. Secondly, distributed teams frequently include members with different roles, and functional, organizational, or cultural backgrounds (Griffith & Neale, 2001), which shape expectations for technology use, as well as perceptions of technologies. Heterogeneity of users can thus introduce disparate expectations towards new technologies (e.g., Bajwa et al., 2005). Given the lack of common context, different expectations and understandings between distant subgroups of a distributed team can be difficult to reconcile (Crampton, 2001; Mark & Poltrock, 2004). In consequence, the potential for conflicts and the probability of adoption failure in distributed teams can be expected to be high. Past research has identified
various factors that influence degree of technology adoption – among them characteristics of the individual user such as demographics, values, cognitive ability, or personality (Bhattacherjee et al., 2008; Czaja et al., 2006; Ilie et al., 2005; Kim et al., 2007, 2007), characteristics of the innovation such as interface layout, social richness, or relative advantage (e.g., Hasan & Ahmed, 2007; Venkatesh & Johnson, 2002), or characteristics of the organization such as facilitating conditions, organizational culture, or management support (Klein et al., 2001; Ngai et al., 2007; Park et al., 2004; Zammuto & O’Connor, 1992). The problem of disparate expectations in user collectives on technology adoption has not yet received much attention, so it is unclear how they impact adoption within distributed teams.

The role of expectations in technology implementations has been captured in a recent extension of the expectation–disconfirmation model by Bhattacherjee and Premkumar (2004), which has its roots in cognitive dissonance theory (Festinger, 1957). Bhattacherjee and Premkumar’s model emphasizes the importance of confirmation or disconfirmation of expectations for the development of long-term satisfaction and usage intentions. The model differentiates between two phases, a pre-usage and a usage phase. In the pre-use phase, prospective users develop initial expectations based on second-hand information (e.g., from vendors or their organization) – which may be more or less exaggerated or realistic. Gaining first-hand experiences in the usage phase, users evaluate the extent to which their initial cognitions are consistent or dissonant with their actual experience. Disconfirmation may be positive or negative depending on whether actual experiences with the technology exceeds or falls short of expectations. The model links perceived usefulness and attitudes in the pre-usage stage with beliefs and attitudes in the usage stage and posits that disconfirmation and satisfaction are emergent constructs that influences post-usage attitudes and perceived usefulness of the technology.

In relation to technology implementations in distributed teams, the expectation-disconfirmation model is limited, however, as it concentrates on the individual user and individual technologies rather than team-based technologies or usage contexts. Moreover, the model pays only scant attention to the external or contextual factors that influence the development of expectations or confirmation/disconfirmation experiences over time, while ample experiences from field research demonstrate that context factors play a vital role for acceptance and adoption of new technologies (e.g., Klein et al., 2001; Ngai et al., 2007; Zammuto & O’Connor, 1992). In a team context, individual perceptions and cognitions are shaped by the team context, inter-individual processes, and intra-team dynamics. I therefore argue that these aspects
have to be part of any investigation of team-level adoption. Yet, which factors influence team-based adoption remains unclear. The first objective of this study was therefore to identify group-level and context factors that affect adoption of new technologies in distributed teams. This knowledge is important, when trying to predict different outcomes in terms of user intentions and behaviors.

6.1.2. Technology adoption as a temporal process

By its very nature, technology adoption is a temporal process. Empirical findings suggest that acceptance and adoption are affected by disparate factors at various stages throughout this process. For instance, ease of use has been found to be a significant predictor of technology usage in early, but not in later usage stages, whereas perceived usefulness remains a strong predictor at both time points (Davis, Bagozzi, & Warshaw, 1989; Szajna, 1996). Similarly, normative influences from top management affect the intention to adopt new technology in the pre-adopter phase, whereas continued use is affected stronger by attitudes on perceived usefulness (Karahanna et al., 1999). One possible explanation for this change is that pre-adopter beliefs are primarily based on indirect experiences such as word of mouth, in which social influences obtain a greater importance. In contrast, post-adopter beliefs are based on actual experiences with the technology. Certainly, attitudes based on direct experience predict behavior better than attitudes based on indirect experience (Fazio & Zanna, 1981).

Previous literature has not focused on why or how these factors might change over time (Bhattacherjee & Premkumar, 2004). Yet, differentiating between phases and the factors that impact on attitudes and adoption decisions can help organizations to see where and when they might need to intervene in order to implement the technology as smoothly as possible and to ensure its continued use in the long term. In distributed teams, in which remote subgroups operate in disparate organizational or work environments, adoption processes are likely to differ according to the specific implementation and usage contexts. As such, there is a need for more longitudinal research to consider changes across these phases.

The expectation-confirmation model proposes that over time, users’ cognitions stabilize as they become more realistic and rooted in actual behaviors and experiences with the technology. Bhattacherjee and Premkumar (2004) provide some evidence for this effect, contrasting three time points up to twelve weeks after the introduction of the technology. Even within this short time frame users’ beliefs started to
stabilize. But as their study was based on student samples in a relatively stable en-
vironment, it is unclear whether this rapid stabilization would also be observable in
an organizational context. In a longitudinal field study of three manufacturing and
service organizations Tyre and Orlikowski (1994), for instance, found that adapta-
tion activities tended to decrease rapidly after three to four months after implemen-
tation. Yet, they also observed renewed adaptation activities at later stages, which
were the result of disruptive events and changes in the organization such as the ar-
rival of new managers, new organizational procedures, or additional modifications
in technologies. Stabilization of attitudes and expectations may thus be less likely in
organizational compared to more controlled settings. Disruptive events seem even
more likely in distributed teams, which tend to include multiple contexts and envi-
ronments; and contextual events that alter attitudes and technology usage in one
subgroup may also have ramifications for connected subgroups. Given further the
conflict and lack of agreement that can arise from diversity of contexts and attitudes
in dispersed teams (Hinds & Bailey, 2003), stabilization across distributed teams as
a whole might be particularly difficult. The second objective of this study was there-
fore to examine the factors underlying changes in team-level adoption over time.
The two research questions guiding this study were: What emergent factors lead
to changes in expectations and attitudes in various phases of the process? and To
what extent do attitudes and technology adoption in distributed teams stabilize over
time?

This study adds to the existing body of literature in theoretical, methodological, as
well as practical terms. Theoretically, it extends existing theory to distributed team
settings and aims to put a stronger focus on contextual factors and group-dynamics
in the implementation and adoption process. Methodologically, it contributes to the
literature by conducting a longitudinal field study that follows the implementation
of the same technology across three different organizational units over a two and
a half year period. Longitudinal studies of this nature are rare in the literature,
but are indispensable for expanding our understanding of the process of technology
implementation. On a practical level, a better understanding of the impact of context
factors in various stages of the process can help organizational decision makers in
the planning and long-term support of technology implementations in distributed
team settings.
6.2. Methods

6.2.1. Research design and setting

This study spans two and a half years, beginning six months before the CE implementations and accompanying teams for another two years after the implementation. My presence in the company allowed nearly unrestricted access to personnel in the onshore office, including IT-support personnel, consultants in the implementation group, and management, and mediated contact to the offshore teams. A final visit for data collection took place six months after leaving the company. This setting was attractive for the study for implementation processes for multiple reasons: (1) the implementation was a large-scale project encompassing all production teams in this location, which allowed to gather data from multiple teams at the same time; (2) teams in this company were independent units with their own individual characteristics, cultures, and histories, which enabled me to treat teams as individual cases; and (3) each production team consisted of two highly interdependent but distinct subgroups – one in the onshore office and one on the offshore platform – which allowed to study the challenges specific to distributed implementations.

For the present study I chose three of the eight production teams as basis for the analysis. The selection was made on theoretical grounds, based on the observation that the three teams showed very different developments from pre-implementation to later-usage stage – Team 1 starting well, dipping, and recovering, Team 2 as initial success, but later failure, and Team 3, which started with high resistance, but very quickly switched to complete acceptance. As the aim of this study was to identify factors influencing changes in acceptance and adoption over time, a systematic comparison of disparate developments seemed the most promising strategy.

The comparison of multiple cases supports the identification of common patterns by using other cases to confirm or disconfirm observations in single cases (Yin, 1994). Using within and cross-case comparisons, this design is thus particularly well suited for the development and elaboration of theory (Eisenhardt, 1989; Eisenhardt & Graebner, 2007).

6.2.2. Data sources

Throughout the implementation process, I collected data from three sources: semi-structured interviews, observations, and archival documents.
Interviews

The semi-structured interviews were conducted with all team members and line managers in the onshore subgroup directly affected by the technology implementation, i.e., 6-8 members and 1-2 managers per team. Due to the restricted access to offshore platforms and the size of the offshore subgroup, which could be up to 180 people per team, only part of the offshore personnel were interviewed. The number ranged from four to twelve members, depending on access. All interviews with onshore personnel were conducted face-to-face, while interviews with offshore personnel were conducted by phone or when they came into the onshore office. Further interviews with offshore personnel were conducted during two offshore visits to Team 1 and Team 3. For background information on the implementation strategy, I also interviewed members of the implementation group that was responsible for the planning and execution of the implementation, as well as personnel responsible for deployment and support of the new technologies.

Interviews were conducted before and at multiple time points after the implementation. Interviews before the implementation focused on expectations and initial acceptance of the concept, and the engagement process (e.g., “How did you first hear about the technology implementation?”; “What do you think will be positive or negative effects of the CE implementation?”). Interviews after the implementation focused on evaluations of the concept, disconfirmation of initial expectations, as well as experiences with the concept and the implementation process (e.g., “When you first heard about the CE what did you expect? Where your expectations met? Do you have any comments on how the CE was introduced?”; see Appendix B for the guidelines). Of the 86 interviews conducted in the three teams 58 were chosen for analysis based on relevance for this study. All interviews were tape-recorded and transcribed verbatim prior to analysis. Apart from formal interviews, I also conducted numerous informal conversations, which added snapshots of recent developments and moods throughout the process. These conversations were recorded as written notes as soon as possible after the event.
6.2. Methods

Observations

A second source of information was the direct observation of work processes and technology use within the teams. The observations were conducted in the onshore office and during two visits to the offshore installations of Team 1 (two days) and Team 3 (five days). Further observations included meetings, which aimed to collect feedback from the teams or their managers on the implementation and potential problems with the new technology, as well as weekly update meetings of the implementation group, in which the present status, next steps and problems with individual teams were discussed. At total of seven days of observations on offshore installations, 36.5 hours of systematic observations in the onshore office, and notes from forty meetings were included in the analysis.

Archival documents

My presence on-site further enabled me to collect internal documents the company published throughout the implementation process. Over the 2.5 years of the study I collected a total of 1034 documents. These documents included emails, fliers, brochures, information on the company intranet, and slide packs for the engagement and information of teams. I also collected minutes, reports, notes, and slide packs from workshops and meetings the implementation group held with the teams either for the initial information on the implementation or to collect feedback on the process. Other documents included internal project reports created by the implementation group on strategic alternatives and decisions, technical requirements and physical layouts, architectural drawings, and minutes of the weekly update meetings. Together the archival documents provided a detailed picture of the overall strategy, as well as documentation on individual decisions, developments, and problems during the implementation and later usage phases. They also provided a second source of information on how the teams perceived the implementation and the challenges they encountered. Of the total sample, 191 documents were chosen for analysis, based on relevance for the research questions. A summary of the data analyzed for this study is shown in Table 6.1.

6.2.3. Data analysis

The first step in the analysis was the sighting of the material for each individual case. Based on observations and documents I created detailed timelines on activities and events in each team (e.g., first engagement, installation of technology onshore
Table 6.1.: Type and amount of data analyzed for Study 2

<table>
<thead>
<tr>
<th></th>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEMI-STRUCTURED INTERVIEWS (chosen for relevance from a total of 86 interviews)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within teams (49)</td>
<td>5 onshore</td>
<td>15 onshore</td>
<td>9 onshore</td>
</tr>
<tr>
<td></td>
<td>9 offshore</td>
<td>4 offshore</td>
<td>7 offshore</td>
</tr>
<tr>
<td>Implementation group and IT support (9)</td>
<td>5 implementation group</td>
<td>4 IT support</td>
<td></td>
</tr>
<tr>
<td>OBSERVATIONS (excluding unsystematic/unscheduled observations)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within teams (work processes, meetings)</td>
<td>5 h onshore</td>
<td>14.5 hours onshore</td>
<td>17 hours onshore</td>
</tr>
<tr>
<td>Feedback meetings</td>
<td>2 days offshore</td>
<td></td>
<td>5 days offshore</td>
</tr>
<tr>
<td>Weekly meetings in the implementation group</td>
<td>10 meetings with one or several teams</td>
<td>30 meetings</td>
<td></td>
</tr>
<tr>
<td>ARCHIVAL DOCUMENTS (chosen for relevance from a total of 1034 documents)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minutes of weekly meetings, feedback meetings and reports</td>
<td>129 documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategic and technical documents detailing implementation decisions</td>
<td>38 documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal company communications for information and engagement</td>
<td>24 documents</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

and offshore, start of training workshops). Using self-reports from interviews and informal conversations, external reports by the implementation group, archival documents, and own observations I then overlaid these timelines with information on the general expectations towards the technology, the degree of acceptance, as well as usage of the new technologies. This was done separately for onshore and offshore personnel within each team to capture disparate reactions across subgroups. These summaries provided a general impression of the developments and times of changes in acceptance and adoption over the duration of this study in each team.

The main focus in this study was the identification of factors that impacted initial expectations and acceptance, and those that led to changes in acceptance and adoption within teams over time. To identify these factors I used iterative phases of open and axial thematic coding in interviews and documents (Strauss & Corbin, 1990). In the first step, I marked all statements that indicated positive or negative attitudes, expectations, and instances of use/non-use of the new technology. At the same time, I also coded reasons participants stated for their attitudes and decisions for use or non-use. For each initial code, I further marked, whether participants reported them as barriers or supporting aspects for their acceptance and adoption of
6.2. Methods

the new technologies. Following this first thematic coding, I then grouped the initial codes into common themes to gather higher-order factors that influence acceptance and adoption in a positive (supporting aspects) or negative way (barriers).

Three themes emerged from this step: (1) features of the implementation process (i.e., strategies and behaviors on the part of the implementation group and organization), (2) characteristics of the technology (i.e., features, capabilities, and handling of the new technologies), and (3) characteristics of the implementation context, referring to features of the team or subgroup, individual, task, and organizational environment. In the end, each statement carried three codes: general factor (i.e., process, technology, or context), specific aspect (e.g., knowledge, benefits, ease of use), and type of effect (supporting aspect or barrier). To link changes in expectations, attitudes, and technology usage to influencing factors derived from the coding I separated the data into three phases: (1) pre-usage phase, which focused on information and engagement before technology implementation, (2) early-usage phase, which covered the time period of the implementation and first usage experiences, and (3) later-usage phase, which focused on sustaining and maintaining the concept, once new usage patterns had established themselves. The rationale for splitting the usage phase into two separate stages was to allow a more fine-grained description of short-term versus long-term effects. In the cross-case analysis (Eisenhardt & Graebner, 2007), I compared the factors identified in each phase across the three cases to identify patterns and themes that led to the disparate developments in the three teams. I did this comparison for each of the three phases separately, listing similarities and differences in the type of factors (main themes and specific aspects), as well as their supporting or hampering effects on acceptance and adoption. To identify differences in subgroups within one team, the summary was done for onshore and offshore personnel in each team separately. The final result of the data analysis was one table for each phase, listing supporting aspects and barriers across the three teams showing overlaps and differences in themes and specific factors linked to changes in acceptance and adoption for onshore and offshore personnel.
6.3. Results

This study set out to answer two research questions: Which factors are responsible for changes in expectations and attitudes in various phases of the process? and To what extent do attitudes and technology adoption in distributed teams stabilize over time? In the following, I present the results of the comparative case-analyses for the three implementation phases.

6.3.1. Factors influencing acceptance and adoption across the three phases

Pre-usage phase

The main focus of the pre-usage phase is the information and engagement of prospective users with the aim to create positive attitudes and expectations towards the new technology. In the three teams observed for Study 2, this process was only partly successful. While reactions of onshore personnel in Teams 1 and 2 ranged from cautiously optimistic to near enthusiastic, onshore personnel in Team 3 rejected the technology. In the offshore subgroups, reactions were split along functional groups: middle managers were mostly positive, while offshore staff (technicians) and their immediate line managers (offshore team leaders) voiced misgivings. I thus found a split in initial expectations depending on work location and job function, but also across teams (see Figure 6.1).

In this early phase, initial attitudes and expectations depend on second-hand knowledge provided by the company or vendors. Communication is thus one of the most important factors linked to pre-usage attitudes (Bhattacherjee & Premkumar, 2004). Yet, communication was a consistent problem in all three cases. While onshore personnel were located in easy reach for the implementation group to allow frequent face-to-face conversations or information meetings, communication with the offshore subgroup relied to a large extent on asynchronous, text-based media (emails, intranet, and electronic versions of slides, fliers, and newspaper or printed versions sent by helicopter). Due to the remoteness of offshore platforms visits had to be planned weeks in advance to secure helicopter and bed space, and on several occasions arranged visits were canceled at the last minute, because more vital personnel were needed to fix a sudden problem on the plant. Moreover, offshore personnel worked in continuously rotating two-week shifts, so even if a visit offshore was possible, only parts of the offshore personnel could be informed at any one time. En-
6.3. Results

![Diagram showing attitudes of teams in the pre-usage phase](image)

**Figure 6.1:** Attitudes of teams in the pre-usage phase

Engagement was consequently very intensive in the onshore subgroup, while offshore personnel consistently complained about the lacking transparency of the implementation process. The more negative perception in the offshore subgroups can thus be attributed at least partly to the lack of information about the project.

But the unequal emphasis between onshore and offshore subgroups also created the impression that the initiative was essentially driven by onshore managers and primarily targeted at the onshore subgroup. Although the official rationale of the implementation was to create better support for offshore processes, the uneven treatment strengthened the traditional perception of onshore as the more ‘dominant’ or ‘important’ group compared to offshore interests. As one offshore technician in Team
1 remarked, “It will be more an advantage for the beach, because they can fire more stuff to .eps. . . . Maybe that’s the whole idea of it.” None of the participants offshore made allowance for the difficulty of distributing information or organizing visits to offshore platforms. Instead they perceived the apparent imbalance as part of the implementation strategy. Unequal communication thus emphasized existing stereotypes about onshore and offshore relationships.

Although unequal communication can explain general attitudes in subgroups, it cannot explain the specific concerns or expectations of people, or how groups of people in the same team come to share or disagree in their expectations. The data suggests that the disparate attitudes between onshore and offshore personnel, as well as between offshore staff and offshore managers were primarily due to role-specific perceptions of usefulness and expected task-technology fit. Onshore engineers and managers in Teams 1 and 2, for instance, hoped that the new technology would improve the access to offshore information and facilitate coordination between subgroups. The two higher management levels offshore hope for better support from the onshore office, as well as in improvement in subgroup relationships. Offshore staff and their immediate supervisors, in contrast, feared that the technology implementation – and here particularly the video-conferencing technology – would lead to a higher work load, disruptions for their work, and intrusions into their work space.

Onshore and offshore subgroups, although highly interdependent, had very different roles in the overall team task. In the most basic way, the differentiation was described as ‘planning’ versus ‘doing’ – or as one onshore engineer in Team 2 phrased it, “Onshore we plan the work, we engineer the work, we provide the solution, and we hand over to offshore for execution.” A similar differentiation was also observable within the offshore subgroup, in which technicians and their direct supervisors were responsible for the execution of work packages, while the management levels above were responsible for scheduling and overseeing processes, as well as the coordination with onshore plans. The different task requirements, and specifically the need to communicate with the onshore subgroup, thus influenced the perceived usefulness of the new technology. While onshore engineers required continuous updates and information from offshore personnel, offshore technicians and their line managers saw these requests as distraction from their primary work roles:

Onshore Engineer, Team 2: “For example, if we get a phone call from offshore right now, and we were [having the new technology], if it would be possible that I or offshore we could take a drawing, put it up on the screen and we both see the same thing at the same day; and perhaps use the interoffice so you will be able to draw
6.3. Results

arrows and they see it at the same time. So they see it and we see it. That would be leaps and bounds ahead from where we are just now.” Offshore Engineer, Team 1: “When the plant is going well, and when nothing is moving, [control room technicians] have got a nice, quiet job. But when something is going wrong, it’s just madness. You’ve got about, I don’t know, five doors probably coming to the control room. And you’ve got people coming from everywhere. Coming with a silly question, big questions, silly comments, anything. So if, in addition to that, you’ve got a big screen with onshore and people coming from onshore as well, I think that would kill them, really.”

Onshore and offshore personnel thus differed in their dependence on information from the other subgroup to fulfill their primary task, which affected perceived usefulness. I therefore suggest that the degree of task- and goal-interdependence between subgroups may be an important team-level factor to shape the type of attitudes during team implementation, while similarity of tasks and requirements across remote user groups impacts the agreement of attitudes. More similar tasks and higher interdependence between remote user groups could thus facilitate a stronger alignment in expectations.

The data further suggests that disparity in views between onshore and offshore personnel was also influenced by subgroup-specific cultures. Throughout the interviews, offshore personnel tended to emphasize their status as independent and self-reliant, and “just totally different” from onshore. Coarse language, cussing, or bawdy jokes, for instance, were frequent and tolerated behaviors, and – as one offshore technician in Team 1 somewhat jokingly commented – clearly set the offshore group apart from their onshore colleagues:

Offshore Technician: I mean, we’re all disgusting men out here, that’s why. We’re just horrible; swearing, picking my nose.
PSB: And you think the beach is better?
Offshore Technician: Yes, they don’t.

The idea of a continuous video-link with the onshore office seemed to threaten this independence and raised the fear that the special offshore life style would have to be adapted to the more formal norms of the onshore office. In consequence, offshore technicians were regularly concerned about an invasion of privacy and the extent to which the onshore subgroup would be able to control their every move – the new technology was indeed often referred to as ‘big brother’. Onshore engineers, in contrast, – belonging to the ‘dominant’ subgroup within the team – rarely mentioned privacy concerns. These observations indicate that team-level acceptance of technologies can be impacted by subgroup-specific cultures and attitudes (e.g., the
importance to assert self-reliance and independence), as well as by the existence of considerable disparities between cultures of user groups.

Interestingly, the concerns about an invasion of privacy and a possible loss of the own culture was not found in Team 3. Comments by offshore technicians suggest that this was mainly due to the considerable familiarity between onshore and off-shore personnel. Most of the onshore members had worked in the same team for many years and made regular visits to the offshore platform. Team 3 was also relatively small compared to the other two, which made the development of personal relationships easier. As one onshore engineer remarked:

“We've always been a tight knit team. We've always had good relationships. We've always had really good communication right down to the technician level. . . . It's like family. In fault of a better term, it's family.”

Despite the same disparity in subgroup-cultures, Team 3 did not experience the same level of concerns and resistance from offshore personnel observed in Teams 1 and 2. This suggests that pre-existing relationships between dispersed user groups impact reactions in team-based implementations – especially in the less dominant subgroup. Particularly, familiarity between dispersed user groups seemed to remove some of the conflicts and concerns about later technology use. This suggests that high team familiarity may be able to lower resistance in distributed team implementations. Based on these observations I would expect that the more unproblematic pre-existing relationships and the more similar subgroup cultures, the less conflict or resistance should be experienced during team-based technology implementations in distributed settings.

In contrast to Teams 1 and 2, in which I observed a clear split along locations and functional groups, subgroups in Team 3 were equally skeptical about the value of the new technology. These initial attitudes were based on the belief that the new technology would bring no major advantage to the team. These arguments were based on the maturity of the field, which may force the cessation of the production in only a few years time, as well as a new perfect production record. The overall team context in terms of field maturity and already high efficiency thus reduced the perceived usefulness of the new technology for the team. Comparing the interview statements, I further found that members in Team 3 tended to base their arguments on concerns about the team as a whole, i.e., in how far the technology could benefit the whole team and its overall performance, whereas in Team 1 and Team 2 the focus of members was largely on their own subgroup, i.e., whether the new technology would benefit themselves and their direct colleagues, e.g.:
ONSHORE MANAGER, TEAM 3: “So for [Team 3], shall we say just the costs of the [implementation] program is a million dollar. . . . Why would we spend a million dollars on it? I’d rather spend the million dollars painting the place, or I’d rather spend the million dollars, taking the million dollar worth of costs and change its life from 2011 of cessation in production to 2013.”

ONSHORE ENGINEER, TEAM 2: “We do see things where we can actually see the guys offshore and they can see .eps and we can relay information quicker and more efficiently. Going on from there, it’s going to be great, if these guys can do down to their job site and show .eps the actual problem on a video-camera or immediately relay photographs back, instead for .eps to wait for them to come through.”

Team members thus seemed to differ in their focus of identification, which was either on their own subgroup or the whole team. This hints to team versus subgroup identification as an important group-level factor for the convergence of attitudes and beliefs in asymmetric distributed teams. Identification with the whole team may here lead to a closer alignment between attitudes and expectations, while strong identification with the own subgroup may facilitate the development of more divergent attitudes between diverse subgroups.

Overall, the data indicated several process, subgroup, and team-level factors, which influenced the general direction and the alignment of attitudes between dispersed user groups in the pre-usage phase. While communication seemed an important element for the general perception of the process, other antecedents in the context, namely subgroup and team characteristics, as well as intra-team dynamics proved more important to determine the type of initial attitudes and the degree of alignment among team members.

Early-Usage Phase

The early-usage phase brought considerable changes in attitudes in two of the three cases. Team 3 changed from its critical pre-usage attitude to whole-hearted acceptance, while the onshore subgroup in Team 1 saw a rapid deterioration. In the early-usage phase attitudes between subgroups in Team 1 and Team 3 were now in alignment, although in opposite directions. In Team 2 attitudes of offshore staff became more positive, although not as positive as in Team 3 (see Figure 6.2).

The change towards negative attitudes in onshore personnel in Team 1 was primarily due to mistakes in the process. One of them was the considerable gap in technology deployment between onshore and offshore. Access to offshore platforms was a logistic challenge – starting with the transport of the equipment and trained personnel for their installation. Because of the easier access, the equipment was
installed in the onshore office first. Offshore it took two additional months, and even then the initial installation amounted to not more than “a video-conferencing camera kind of balanced on a bookcase.” From there it took another two months to install the final equipment. This time lag between onshore and offshore installation meant that it took four months for the realization of first benefits. Similar to the unequal communication in the pre-usage phase, the emphasis on the onshore end further strengthened the perception that the concept was focused on onshore benefits. Especially frustrating for the onshore subgroups was the subsequent degree of attention, once the team had started to use the technology. As one of the first teams to work with the new technology, Team 1 received repeated visits and
a continuous stream of requests for feedback, interviews, and evaluations. Instead of the six to eight people normally participating in meetings, now often up to fifteen or twenty people were present; many of them unknown to onshore and offshore personnel alike. Onshore team members perceived this as a severe invasion into their workspace and a distraction from their tasks, which drastically reduced their acceptance of the project:

**Onshore Engineer, Team 1:** “I often feel that we are expected to spend a lot of our time filling in questionnaires, being interviewed for press releases, chairing feedback meetings, and hosting every visitor in the company who wants to see how the technology is used. If I had known that so much of our time would be expected to be given for, what sometimes feels, like it is a PR exercise for the IT consultants, I would have had serious reservations about being included in the team.”

The disconfirmation of the initial positive expectations was here due to a mishandling of the process by the implementation group, not based on negative experiences with the technology itself. Personnel in the offshore subgroup were less disturbed by this problem, although they too considered the participation of unrelated onshore personnel as a distraction. More relevant for the offshore subgroup were still concerns about invasion of privacy and distractions from the primary tasks:

**Offshore Engineer, Team 1:** “The guys hate it. They are very worried about onshore spying on them and checking what they’re doing and everything; so to check how much time they spend on eBay and how much football they watch. . . . These guys kind of turn it down or put a box above it or all kind of systems to be sure that nobody is spying on them.”

In Team 1 negative attitudes in the two subgroups thus coincided, although for different reasons. In consequence, usage of the new technology in Team 1 remained restricted to few formal meetings. This example illustrates that in teams non-adoption of technologies may have disparate reasons across dispersed user groups, although the overall result still is non-adoption in the whole team. It also emphasizes again the relevance of subgroups-specific cultures or concerns as an important factor for (non-)adoption decisions in distributed user groups, already discussed in the pre-usage phase.

The data also suggests that the impact of the implementation differed for the two subgroups, particularly with respect to the extent of changes required to processes and team structures. The implementation of VC-links between onshore engineers and offshore technicians led to a migration of communication from managers to the lower levels of the organization. This change in communication patterns affected
the role and self-concept of offshore managers as planners and controllers of work. The technology implementation thus led to modifications in team structures and processes in the much more hierarchically organized offshore subgroup that was not required in the onshore subgroup. In consequence, offshore managers in Team 2 voiced concerns about a change in their role and the impact of the implementation on established safety procedures. While these managers were positive about the technology implementation for their own role, they were critical about its value for offshore technicians. These negative attitudes may well have increased the cautious attitudes in offshore staff and repressed the actual VC use.

Team 3 experienced a palpable and rapid move from an overall critical to a highly positive attitude. The main driver for this change was the realization of unexpected benefits for the team:

**Onshore engineer, Team 3:** "[Before the implementation] nine times out of ten the [offshore] guys would phone you first thing in the morning, and you would have a chat what they would do offshore, what support they were needing, etc., and that would be it. . . . Now, they'll have a chat with you in the morning, and then lunchtime they would come in with some of the vendors that may have a question. And rather than them being the conduit where the vendor has asked them the question, they've posed me the question, I reply to them and them going back to the vendor, the vendor is there already. . . . Even now, when we're having a meeting, or the guys are in the conference room having a meeting, these guys would be busting in wanting to ask a question."

These positive perceptions and the extent of observed and reported use stand in direct contrast to the pre-implementation attitudes of Team 3. A possible explanation is a change towards more realistic expectations about possible benefits. In the pre-usage phase, the technology had been introduced as a means to improve overall production and team efficiency. Given the context of a mature oilfield and near 100% production efficiency, this was considered highly unrealistic. After the first experiences, the team discovered, however, that the technology did much to improve communication. Onshore and offshore personnel could now contact each other quicker and more comfortably. While Team 3 did not accept the promised ‘big gains’ of better productivity, they were very satisfied with the ‘smaller gains’ of improved communication. The positive shift in attitudes in Team 3 thus seemed to be based on a combination of disconfirmation and re-interpretation of the situation. The disconfirmation was primarily due to unexpected positive experiences and thus an increase in the perceived usefulness of the technology. The re-interpretation concerned the type of benefits acceptable to the team. These findings suggest that – to the degree
that team and subgroup characteristics influence the perception of possible benefits of a new technology – information and engagement in the pre-usage phase had failed to take these characteristics into account, resulting in the initial rejection in the pre-usage phase. In this case, the failures in the process in pre-usage phase, however, were overwritten by the experienced usefulness of the technology.

Team 3 was also the most consequent in its use of the new technology. As the above quote demonstrates, the main drive for adoption came actually from offshore personnel – in strong contrast to Teams 1 and 2 in which offshore personnel were the more negative user group. This difference seemed mainly due to the pre-existing positive relationships between subgroups in Team 3, which had already allied fears of the invasion of privacy fears in the pre-usage phase. As seen in the pre-usage phase, team familiarity in this team was high, and offshore staff consequently felt very comfortable contacting their colleagues onshore. Team familiarity thus seemed to create a climate of psychological safety, which removed concerns that led to non- or reduced adoption in the two other teams. The implementation group, in contrast, attributed the difference to a more consistent knowledge of how to use the technology in both subgroups. Managers in Team 3 had made a conscious decision to train all personnel independent of subgroup on how to use the technology – despite the logistical challenges of freeing up subsequent offshore shifts for trainings sessions in the onshore office. As one member of implementation commented on Team 3, “one shining light team, the one that is head and shoulders above everybody else, sent more people to the training then any of the other teams together. … 33% of the offshore people, who were trained, were [Team 3] people.” Personnel in Team 1 and Team 2, in contrast, consistently complaint about their lacking knowledge of how to use the new technology, which prevented them from its use:

Onshore engineer, Team 1: “We didn’t really have it set up efficiently to work. I guess that was the problem. If we had it set up, if someone would have actually come in and programmed it for what we want it, then we probably would have use it, but there wasn’t any education on how to use it.”

Apart from providing both subgroups with equal knowledge, the commitment to train all personnel independent of subgroups can also be seen as a sign to the team that both subgroups were considered of equal importance in this implementation effort. This again points to the importance of a balanced implementation and engagement strategy across dispersed subgroups. It is further an indication that in this team management was overall supportive of and highly committed to the implementation project.
In Team 2 the degree of adoption depended largely on which shift worked offshore. Some shifts were very positive towards the use new technology and used VCs extensively, whereas others remained critical for the same reasons as offshore technicians in Team 1. The most consistent usage was by offshore managers, as they experienced concrete benefits from its use (e.g., more efficient decision making, less travels onshore for meetings). Accordingly, adoption of the new technology in the offshore subgroup in Team 2 was largely restricted to the two subgroups with positive attitudes, i.e., onshore engineers and offshore managers, but also varied with shift rotations.

Overall, my findings suggest that in the early-usage phase activities and decisions in the process (e.g., timing of the technology implementation across dispersed user groups, consistent technology training, or handling of evaluations or publicity) impact initial attitudes. More relevant for the actual adoption across user groups seemed, however, intra-team dynamics and pre-existing relationships for overall team adoption. The comprehensive adoption by the whole required the alignment of positive attitudes between dispersed subgroups. The non-adoption or restricted adoption was either be due to negative attitudes by one subgroup, which blocks usage by other users (e.g., specific offshore shifts in Team 2), or based on rejection by all user groups (cf. Team 1). Comparing rejection decisions in Team 1 in the early-usage phase with rejection in Team 3 in the pre-usage phase, the data further indicates that non-adoption in teams comes in two different forms. In Team 3 reasons for rejection were shared between subgroups, while in Team 1 each subgroup had disparate reasons for their rejection. My argument therefore is that non-conflicting technology adoption in teams seems to require two types of alignment in attitudes: alignment in the general direction of attitudes (positive versus negative), and alignment in the reasons for acceptance or rejection across dispersed user groups. I further suggest that the team-level, subgroup, and process factors identified so far determine not only the reasons for acceptance or rejection, but also the degree of both types of alignment.
Later-usage phase

The expectation-disconfirmation model predicts that attitudes and beliefs should stabilize over time and that the usage of new technologies should achieve a stable level and consistent patterns. While Bhattacharjee and Premkumar (2004) found support for this claim in relation to individual adoption amongst a student sample, data in this study suggests that team members’ attitudes in organizations, and especially distributed teams, may not be as conducive to stabilization. The data indicated three types of factors, which led to destabilizations in the later-usage phase: team-internal changes, changes in the organizational environment and to a lesser extent decisions in the implementation process (see Figure 6.3 for a summary of adoption in the later usage phase).

A good example for the effect of team-internal changes in the later-usage phase was Team 2. The early phase in this team went very well and the team was hailed as a success within the company figuring in internal newsletters and brochures and being invited to special book clubs and nights-out. After the first year, however, the offshore subgroup experienced considerable turnover in staff and management. The new management team offshore was very critical, partly even hostile to the use of the new technology. Due to the resistance from offshore, video-conferencing was now restricted to formal meetings and either shut-off or pointed towards windows, ceilings, or mascots at other times. This situation remained unchanged until the end of this study. In Team 2, turnover in one subgroup thus resulted in the misalignment of attitudes towards the usage of the new technology, and led to a reduced usage and blocked adoption for the whole team. This observation tallies with findings from Edmondson et al. (2001), who identified team stability as a crucial factor for later disruptions in technology adoption. This observation also demonstrates that events in one subgroup can influence behaviors in the whole team. This supports the assumption that stabilization in distributed team settings may be more fragile than in collocated teams or individual adoption.

In the course of this study, considerable changes occurred also in the organizational environment. Approximately one year after the first implementations, a major re-organization was announced that moved the organization from a team-based to a function-based structure. This re-organization was conducted in parallel with (and independently from) the technology implementation and was completed about three months before the start of the last round of implementations. The re-organization proved problematic for the perception of the new technology, which had been de-
developed around a team-based structure and now sat uncomfortable within the new functionally-oriented structure. This change was most problematic for the onshore personnel, which now found themselves in isolated ‘team islands’ without a clear knowledge of their function and interface into the new organization. The offshore subgroups were not involved in this re-organization, and were thus only slightly affected by this change. While the re-organization change did not directly impact the usage of the technology, it dramatically reduced the satisfaction and perceived usefulness of the concept for onshore personnel, especially because long-term perspectives on how to progress or adjust the concept for the new organization were missing. This is a clear example that changes in the organizational environment

Figure 6.3.: Attitudes of teams in the later-usage phase (black) compared to earlier stages (grey)
can affect technology implementations also in later stages. It further demonstrates that the effect of some changes can be restricted to one locale subgroup without major ramifications for other subgroups.

Decisions of the implementation group on the process had a further, albeit lesser impact on attitudes in the later-usage phase. In order to prove the value of the concept to the organization, they asked teams to sign off concrete financial benefits of the new technology in terms of team performance. As this comment by one onshore manager in Team 3 demonstrates, this decision led to a decided drop in the credibility of the implementation project:

**Onshore manager, Team 3:** “Kind of right from the word go, you might remember, right from the word go [I said], ‘I will not get involved in trying to put a monetary gain against this program. I’m not doing it’. I’m still to this day, I’m not doing it, I’m not playing, because the decision has been made. . . . So why are we wasting any energy going back to revisit a decision, a one off decision, that we don’t need to go back to? It’s bizarre, totally bizarre.”

Just before the official end of the project the implementation group further decided on an ‘always-on’ policy for the video-links and to monitor the compliance using automated logging of usage. This move was widely perceived as “policing” of the teams and as such resented. In an informal conversation, one of the onshore engineers in Team 2 commented that this policy had driven the team to switch the VC on in the morning, and switch it off again, as soon as the timer showed that the expected eight hours had elapsed. The new policy in the later-usage phase thus resulted in compliance and decreased volitional use. The impact was less severe in Team 3, in which continuous usage had been established and the technology had been accepted whole-heatedly by both subgroups. Team 1, which had developed stable, although less frequent usage patterns, also was not strongly affected. In the more problematic Team 2, however, it did further decrease acceptance and usage intentions. It thus appears that in more ‘fragile’ teams such as Team 2 missteps in the process may strengthen existing negative attitudes, while in more ‘secure’ teams such events may not impact the evaluation and usage in a like manner. Together, these examples suggest that internal and external factors can influence team acceptance and adoption even in later stages. These impacts can either affect all subgroups or be restricted to one specific subgroup. Especially ‘fragile’ teams that did not come to an alignment of attitudes or teams in a phase of internal change may be more prone to destabilization.
6.3.2. Unlinking process and technology satisfaction

Consistently throughout the three phases, the handling of the process – i.e., actions and decisions of the implementation group and the organization – influenced users’ acceptance and satisfaction with the CE concept. Not surprisingly, this influence was strongest at the beginning of the process, namely the pre-usage and the start of the early-usage phase. Because knowledge and perceptions were mostly based on external, second-hand information, in these early stages participants often did not differentiate between the features of the concept and problems in the implementation process. A typical example for the lacking separation of concept and process was the following comment by an onshore support engineer in Team 2, who found the concept “a bit elitist, even though the individuals aren’t.” This perception was raised through the special treatment, the CE personnel in this team received by the implementation group such as nights-out, evenings at pubs, or book clubs, and in which other personnel were not included.

Process satisfaction and technology satisfaction in the pre-usage and early-usage phases were thus closely interlinked. Because knowledge about the concept relied on second-hand information, satisfaction with CEs was influenced by how this information was provided, i.e., how much and what information was given, who was included or excluded, or how communication was conducted. Over time, satisfaction with the process and the concept became less and less interdependent. The same onshore manager, who had complained about the request to justify the financial costs of the implementation, nonetheless perceived clear benefits of the concept itself:

ONSHORE MANAGER, TEAM 3: “I was always a ‘lets give it a go and see how it works, I kind of believe it when I see it, but –’. I kind of said it was ok, and now I’ve seen it, I’m kind of absolutely sold on it as a sort of benefit. Whether it’s big enough benefit to offset the costs that we ploughed into it, I don’t know and I don’t want to measure it; because you can’t and everybody knows that.”

These observations suggest an ‘un-linking’ of users’ satisfaction with the process and their satisfaction with the concept over the three phases. The more familiar the teams became with the new environment and technology and the more first-hand experiences they collected, the less did the evaluation of the concept rely on information or actions of the implementation group. With increasing familiarity and first-hand experience, team members started to differentiate between satisfaction with the process and satisfaction with the concept (cf. Figure 6.4). This close connection between process and concept satisfaction at early stages suggests that mistakes or errors in the process early on may have a greater impact on the overall perception.
of an innovation than mistakes at later stages. The unlinking further makes clear that it is important when satisfaction is measured, as early measurements may be confounded with favorable or unfavorable perceptions of the process.

![Figure 6.4: Development of process and technology satisfaction over time](image)

**6.4. Towards a model for CE adoption in asymmetric distributed teams**

In the previous sections, I described the reactions to the implementation of CEs in three teams and the factors that influenced attitudes, acceptance, and adoption from pre-usage to later-usage phase. Based on these findings, I put forward four propositions to extend existing models of technology implementation to asymmetric distributed team settings.

**Proposition 1: Adoption in teams must be conceptualized as a team-level construct.** As this study indicates, the adoption of new technology in a team setting is not only an individual decision, but depends on the adoption by all or at least the majority of team members. Team-level adoption requires the development of shared usage patterns and an agreement on the rationale for technology use within the team. I therefore argue that adoption in team-based settings must also be conceptualized as a team-level construct. Tokens of team-based adoption are, for instance, a shared understanding and appreciation of the new technology, similar levels of satisfaction across team members, and common or agreed usage patterns. Accordingly,
Proposition 2: Team-level adoption is characterized by the two dimensions valence and alignment. The perception and use of technologies depends on users’ subjective experiences, values, and needs, but also on their social context. In distributed settings this can lead to conflicts, if the contexts of team members in dispersed subgroups diverge or are incompatible. Conflicts on the usage frequency and purpose demonstrated that in team-based implementations positive attitudes or usage intentions in one part of the team are not sufficient. I therefore propose that technology adoption in a team setting consists of two separate aspects: valence and alignment. Valence refers to the general direction of attitudes from positive to negative. Alignment refers to the degree of congruence among individuals’ attitudes, either in terms of their direction or their content.

In a team-based setting, the success of technology implementations requires that all user groups accept and adopt the same technology, as well as find a mutually agreed way to use it. Adoption in distributed teams is as much a question of the willingness to actively use a new technology as the willingness to make oneself available for others, who use the technology. In consequence, team-based adoption will only be reached, if teams develop positive attitudes, as well as an alignment in their expectations and usage patterns. Alignment can relate to the agreement in the valence of attitudes and expectations (members’ attitudes or expectations are similarly positive or negative) or to agreement in the type or content of attitudes and expectations (team members have similar reasons for acceptance or rejection). I propose that alignment in valence will lead to either adoption (for positive attitudes) or non-adoption (negative attitudes), while non-alignment will result in compliance or blocked adoption depending on strength of attitudes and comparative subgroup dominance. Alignment or non-alignment with respect to type of attitudes can lead to the four states of congruent adoption, conflicting use, congruent non-adoption, and disparate non-adoption (cf. Figure 6.5).

Congruent adoption refers to teams in which team members agree on the type and degree of usage. Congruent adoption should lead to stable levels of use, and in such teams the likelihood of conflicts about how, when, and why to use a new technology should be low. If team members share the same negative attitudes, a stable state of congruent non-adoption will be reached. In such teams members agree in their
rejection of the new technology and the reasons why not to adopt the technology, and conflicts about the extent and type of technology use should likewise be low. Since non-adoption is based on shared beliefs, attempts by the organization to change attitudes towards the new technology need to identify these shared assumptions. Attempts to alter beliefs also need to target the team as a whole. A good example for these two states was Team 3, which moved from a state of congruent non-adoption (intentions) in the pre-usage phase to a state of congruent adoption in the early- and later-usage phases. In none of these phases did the team experience a marked degree of conflict about the (intended) technology use.

More problematic will be situations, in which type alignment is lacking. Even if subgroups are generally positive about the new technology, lacking alignment of
expectations in terms of how, when, and why to use the technology can lead to disagreements and conflicts among members. I therefore refer to this situation as a state of conflicting use. Examples for conflicting use were early-usage experiences in Teams 1 and 2, in which parts of the onshore engineers tried to use the new video-conferencing as a replacement for phone calls to the platform. This type of usage, however, was rejected by control room technicians as overly disruptive for their work. The main focus in situations of conflicting use needs to be the development of agreed usage patterns early on in the process to prevent that conflicts erode the positive perception of the new technology in later stages.

With disparate non-adoption I refer to situations, in which team members may share their negative attitude towards the innovation, but expectations and reasons for the rejections differ. In the offshore subgroup in Team 1, for instance, control room technicians feared that the implementation of video-links would increase their workload due to increasing request by onshore engineers. They further saw the VC as a means to monitor their work and thus an intrusion into their work space. Offshore managers, in contrast, feared that the technology would take away their control of processes, as communication patterns moved from managers down to the technician level. Thus, although both groups voiced concerns about the implementation, these concerns were clearly focused on different aspects. In this state of disparate non-adoption organizations aiming to change attitudes within teams are faced with multiple underlying reasons for negative attitudes. In contrast to a situation of congruent non-adoption in which universal beliefs of the team as a whole must be addressed, in situations of disparate non-adoption very specific concerns of parts of the team need to be targeted and reconciled. As the example in Team 1 above illustrates, alignment as proposed here is not restricted to attitudes and expectation of remote subgroups as a whole. Differences in attitudes may also occur within subgroups based on attributes such as organizational membership, age, gender, culture, job function, or status.

Team 2 in the later-usage phase highlights another type of non-alignment between subgroups, here as opposition in the type of valence – mainly positive attitudes in the onshore subgroup versus primarily negative attitudes in the offshore subgroup. In Team 2, the full adoption of the new technology was thus blocked by the rejection by offshore personnel. The effect of opposing attitudes on behaviors is likely to be influenced by the strength of respective attitudes in subgroups. For instance, if strongly positive attitudes in one subgroup are coupled with weak negative attitudes in the other, it is probably that the subgroup with the stronger attitudes may exert more
influence on overall team adoption. Also, relative dominance of subgroups may play a role in determining team adoption. More dominant subgroups, e.g., managers, could ‘force’ compliance of members with lesser status, or block adoption by team members of lower status. I therefore propose that non-alignment in the valence of attitudes may thus either lead to compliance or blocked adoption depending on the attitude strength and comparative subgroup status.

**Proposition 3: Adoption at the team-level needs to consider team characteristics and intra-team dynamics.** This study identified a number of group- and subgroup-level variables that served as moderators for group-level acceptance and adoption in the three cases. Overall team characteristics such as size and maturity, level of team familiarity, and team versus subgroup identification were three of the factors that influenced degree of acceptance and adoption in the three teams. I do not propose that these factors are generalizable across all contexts or teams. Yet, so far theories and models of technology implementation and adoption failed to systematically consider team characteristics and intra-team dynamics. This study indicates that their inclusion may be an important step for a better understanding of reactions to implementations in distributed team contexts. Models should therefore include team characteristics and intra-team dynamics.

**Proposition 4: Distributed team adoption is liable to destabilization in the later-usage phase.** Models of technology adoption frequently assume that attitudes and usage patterns stabilize shortly after implementation. Observations across the three cases suggest that stabilization in a team context may be more difficult to achieve than may be assumed from an individual context. Teams and organizational environments are prone to changes such as modifications in team tasks or membership, turnover, or changes in the strategic direction of the organization. The overall dynamic of the team, as well as the organizational environment (e.g., general rate of innovations or turnover) are thus important considerations for the likelihood of disruptions to parts of the whole team. These events can have an impact on the team context or the work organization within teams, which may influence attitudes within a team as whole. As the effect of turnover in Team 2 demonstrated, events and changes in attitudes in one subgroup can have knock-on effects in other subgroups and influence the pattern and degree of use in the whole team. The degree of interdependence between parts of a team thus surely plays a role in how sensitive technology adoption is to team-internal or external disturbances. Overall, stabi-
lization in distributed team settings appears more vulnerable, as team adoption is influenced by multiple levels – from individual, subgroup-, team to organizational factors. Especially ‘fragile’ teams, which lack an alignment of attitudes, may be more prone to destabilization.

A summary of the findings and propositions in this study is given in Figure 6.6.

6.5. Discussion and extensions

In this chapter I proposed a model detailing group- and subgroup-level factors impacting on acceptance and adoption of new technologies in asymmetric distributed team settings. The main propositions are the consideration of acceptance and adoption as a group concept or aggregate of multiple users, as well as the differentiation between valence of attitudes and alignment of attitudes. The model adds team-level, subgroup-level, as well as context factors as important aspect of team-based implementations. It thus populates the gap between individual and organizational implementation and adoption models. The study can also contribute to the investigation of factors such as task-technology fit and perceived usefulness, which are two of the most important predictors for individual technology acceptance and adoption (Jeyaraj et al., 2006; Pollard, 2003). Results in this study pointed to several factors with impacts on the (perceived) task-technology fit specific to distributed team settings, namely differences in subgroup-specific tasks, degree of interdependence between dispersed subgroups, and a shared understanding of the task that require support by the technology. Subgroup-specific tasks and team contexts were also relevant for the perceived usefulness of the technology. These factors are in addition to the ones identified in individual and organizational adoption.

This study also provides practical knowledge for organizations attempting technology changes in distributed team settings. It identified a number of specific challenges for technology implementations in asymmetric distributed teams. The successful negotiation of usage patterns is one major factor in determining the degree of use of new technologies (Griffith, Tansik, & Benson III, 2002). This negotiation, however, is complicated in completely computer-mediated environments, and especially between subgroups with disparate tasks and demographics. Observations in this chapter show that such negotiations may profit from prior relationships and familiarity within teams.
6.5. Discussion and extensions

Figure 6.6: Summary of the findings and propositions from this study
One of the main challenges for the process of distributed team implementations is the balancing of attention, efforts, and actions across all affected subgroups. This is especially difficult if some subgroups are traditionally perceived as the ‘stronger’ or more ‘dominant’ ones, or if geographic restrictions limit access to some parts of a team. This problem may be even more severe, if distributed teams involve partners within other organizations (Mark & Poltrock, 2004).

Members in distributed teams are influenced on multiple levels starting with their own subgroup, the whole team to the organization. In distributed teams, the settings in which technology is implemented can differ considerably across locations, and as attitudes and user intentions are shaped by their environment, the alignment of expectations is not an easy task.

Distributed team implementations seem very sensitive to mistakes in the process and intra-group dynamics need to be taken into account. This study provides insights into the complex dynamics of team-based distributed implementations, and the factors that influence acceptance and adoption of users in such settings. It also highlighted specific vulnerabilities and challenges in team-based distributed implementations throughout the process. A better understanding of these challenges can help organizations and team leaders in the planning and long-term support of distributed technology implementations.

A further aspect affecting acceptance and adoption decisions is the implementation process itself. The style of implementations, for instance, affects the level of stress experiences by targeted users (Korunka, Weiss, & Karetta, 1993). In a meta-analysis of group decision support system implementation Dennis et al. (2001) further found that the implementation process in terms of time required and process satisfaction was primarily influenced by the degree of support, whereas outcome effectiveness was mostly influenced by task-technology fit. Findings also suggested a process of unlinking between process and technology satisfaction. The slow unlinking of technology satisfaction and process satisfaction has several implications for theory and practice. User satisfaction is one of the most important outcome variables in technology implementation and appropriation models (e.g., Dennis et al., 2001). Although a number of empirical studies differentiate between outcome satisfaction and process satisfaction, quantitative studies rarely take a process view of satisfaction and the relationships between different aspects of satisfaction. A meta-analysis by Dennis et al. (2001) indicates that different factors influence process and outcome satisfaction, but little is known, which factors impact concept satisfaction over time. Further research is also needed to clarify the relationships between
the various types of satisfaction (concept, process, outcome).

The close relationship between process and concept satisfaction suggested in this study also emphasizes the practical importance of the implementation process early on. Especially in distributed settings mistakes in the process may prejudice parts of a team against a new technology and hence reduce innovation effectiveness for the whole team. It further highlights the problem of possible confounding influences of process on outcome satisfaction, when measured early in the process. A longer-term perspective may be needed, when trying to accurately capture user satisfaction with a new technology.

This study took place in a very specific organizational context, namely the offshore oil industry. Consequently, some of the challenges throughout the implementation were due to the specifics of this setting. For instance, the remoteness of oil platforms and the strict divide in ‘planning’ and ‘execution’ functions, which were major complicating factors in the three cases, are features that will not apply to many other distributed settings – or at least not to the same extent. The generalizability of the model should thus be tested in other types of distributed team settings. Further, systematic, quantitative investigations of the group- and subgroup-level constructs identified in this study are needed to ascertain their impact on group-level acceptance and adoption.

There were a number of additional factors I could not study in the given context, due to a lack of variation in the three cases such as the extent of heterogeneity or asymmetry within teams, the degree of subgroup interdependence, or the number of dispersed subgroups. Further, all three cases were from the same company. I was therefore not able to investigate the impact of different organizational structures, cultures, and environments. These factors will very likely have an additional impact on the perception of implementation processes and the subsequent acceptance and adoption of CE technologies. Likewise, aspects of the role, position, or personality of individual team members will play a role in the overall team adoption. Mutual influences between different levels (individual, team, organization) are a constant in organizations. The systematic study of these cross-level effects, e.g., between individuals and team, subparts of teams, or team and organization, could clearly add to our knowledge of technology implementation and adoption.

Lastly this study investigated a process in which technology implementation at the team-level was tied to the additional challenge of geographical distribution. It was therefore not possible to differentiate between team-level implementation and distributed implementation. It is plausible to assume, however, that both aspects
have distinctive, although partly overlapping, features and challenges. Future investigations should thus aim to differentiate between the two aspects, as well as look more closely into their interdependencies.
Technology . . . is a queer thing. It brings you great gifts with one hand, and it stabs you in the back with the other.

Carrie P. Snow (American Comedian)

STUDY THREE: EFFECTS of TECHNOLOGY CHANGE ON DISTRIBUTED COORDINATION

Study 3 detailed the changes, CEs implementation made in every-day work processes in production teams. The focus was thus on routine activities and the role of media capabilities for the coordination of these activities between onshore and offshore subgroups. Overall, richer media led to a closer integration of processes between the two subgroups and a shift from routine to non-routine interactions at lower levels of the organization. This led to increased awareness of activities, easier access to information, and faster reactions to unexpected events. Yet, the result also suggested three potential challenges for continuous coordination with richer media: (1) the blurring of traditional subgroup roles, (2) the loss of the longer-term, strategic focus for the team, and (3) the potential weakening of existing control systems. Based on these findings, considerations to guide the choice of information and communication technologies for asymmetric distributed teams are discussed.

7.1. Theoretical background

Work processes in teams require the continuous coordination of resources to accomplish common goals and react to changing organizational priorities. The use of computer integrated production management has helped to support ever more complex processes and increase their flexibility. When computer aided or computer integrated manufacturing (CAM/CIM) was first hailed as the solution to the challenges awaiting businesses in the Western world in the 1980s/90s, the concept was largely technology driven. However, many of the seminal studies on computer-supported collaborative working found that the use of technology alters the practices of coordination and may create problems, if the social organization of cooperative work is disregarded (e.g., Harper, Hughes, & Shapiro, 1989; Heath & Luff, 1992; Zuboff, 1988). Similarly, researchers in work psychology have pointed out that CIM needs to be accompanied by an appropriate work organization such as semi-autonomous teams, if the promises of reduced process losses and increased flexibility are to be realized (Kirsch, Strohm, & Ulich, 1994; Pardo, Leder, & Ulich, 1994). Although the reality did not always live up to the rhetoric of these management concepts, many firms successfully changed how they manage their production.

With some delay, this change of work practices to more computer integrated monitoring and concurrent planning has also reached the less stationary industries such as construction or the exploration and production of hydrocarbons. While some transient industries such as aviation have been studied extensively (e.g., Fields, Amaldi, & Tassi, 2005; Harper et al., 1989), those traditionally considered ‘low tech’ are still under-researched. On construction sites or drilling rigs simple things like a regular update of current production figures on a central server were only worth considering, once remote sites had reliable and fast access to the central infrastructure of their companies. Prior to the advancement of the technological infrastructure and cheap bandwidth, the planners and engineers in the headquarter would prepare drawings, work programs and schedules up to a certain degree of detail and leave the actual implementation and troubleshooting to those on the remote site. The Tayloristic division of labor that assigned ‘thinking’ and ‘doing’ to distinct groups therefore was not only rooted in historical power differences, but had rather practical reasons, as physical access to the remote site is by necessity restricted and the exchange of information between remote partners remains cumbersome. Now that the advancement of media and improved bandwidth have theoretically enabled real-time data transmission to pretty much any remote site around the globe, planners and on-site
mechanics can in fact communicate in ‘real-time’ and update their process models on a continuous basis.

Assuming that the integration of computerized process monitoring is, in principle, a similar undertaking in the construction industry or semi-automated process industries such as oil and gas exploration and production, there should be lessons learned from the earlier studies of CAM/CIM that would be worth considering. The work on collective action regulation in teams showed that teams that were given a higher degree of autonomy in coordinating their internal resources, carrying out detailed planning and cross-training, were not only more flexible and efficient, but also better at knowledge sharing and cohesion (Weber, 1997). The general design principle from this earlier work has been to delegate responsibility as far as possible to the sharp end (Clegg, 2000). Another important aspect identified in the manufacturing industry is that of boundary regulation between semi-autonomous teams: While sub-teams can function well based on their internal coordination, some form of boundary spanning is required between teams whose actions can impact on one another (Zölch, 1999). The higher the interdependency between tasks, the more important coordination becomes. For unmanned space exploration, research teams with relative low task interdependency were found to benefit from simultaneous access to real-time data, as more people could participate in the collaboration and scientists could adapt their models based on real-time data (Olson & Olson, 2000). Manned space exploration involves more task interdependency in the dynamic interaction between astronauts and flight controllers. Thus more scripted roles were required for who should listen in and who may issue requests were found necessary (Patterson, Watts-Perotti, & Woods, 1999; Patterson & Woods, 2001).

The introduction of advanced information and communication technologies into traditional ‘low tech’ industries is likely to progress and become more pronounced as improvements of infrastructure reach increasingly remoter locations. But the question remains, whether better access is a positive development in all cases and for all involved. The safety-critical nature of many tasks in these areas makes it crucial that technology changes do not lead to additional disruptions of established routines and processes. It is important therefore to obtain a better understanding of how different technologies may affect cooperation and coordination in such teams. In Study 3, I investigated changes in the ongoing coordination in distributed production teams due to the implementation of more advanced technologies. Based on its findings generic guidelines for the choice of media capabilities for such settings are discussed.
Chapter 7. Study three: Effects of technology change on distributed coordination

7.2. Methods

7.2.1. Sample and procedure

Study 3 took place in the first twelve months of the PhD project and included pilot, as well as non-pilot teams. Its first objectives were to obtain a thorough understanding of every-day work processes in operation teams and the role of information and communication technologies in the coordination between subgroups. In a second step, I was interested in the effect of the technology change in the context of CE implementations on established coordination processes and routines. Over twelve months, I conducted 104 semi-structured interviews with personnel from various functions onshore and offshore. Of these I selected 78 interviews based on relevance for this study (see Table 7.1 for an overview). Of these 59 interviews were also part of Study 1, in addition to 19 interviews by onshore personnel.

Interviews questions in Study 3 covered the type and frequency of onshore–offshore contacts, communication partners and rationales, the technology used for these contacts, as well as individual tasks and responsibilities within the teams. During the interviews I also asked specifically for experiences with the new media capabilities and how CE implementation had changed team processes and relations between the two subgroups (see interview guidelines in Appendix B). The interviews lasted between 20 and 90 minutes (avg. about 60 minutes). All interviews were recorded on tape and transcribed verbatim prior to analysis. Over the course of the twelve months I also conducted regular workplace observations of onshore meetings and normal work situations, as well as episodes of critical incidents. In addition, I conducted observations of offshore processes during 2-5 day visits to two offshore installations, one prior, one after CE implementation. Information on media use, frequencies, and rationales for media choices were based on self-reports in the interviews, as well as observations.

7.2.2. Data analysis

Interviews were content analyzed using thematic coding in Atlas-ti. The main focus of the analysis lay on descriptions of how subgroups coordinated individual tasks and the role diverse media played in their support. In a first step I identified specific onshore and offshore roles, tasks, and functions as well as coordination requirements between the two subgroups. Based on these descriptions I identified primary activities in which coordination between onshore and offshore personnel was needed.
7.2. Methods

Table 7.1.: Type and number of interviewed personnel included in Study 3

<table>
<thead>
<tr>
<th></th>
<th>Onshore functions</th>
<th></th>
<th>Offshore functions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEAM MEMBERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support engineers</td>
<td>39</td>
<td></td>
<td>Technicians</td>
<td>7</td>
</tr>
<tr>
<td>Petroleum engineers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MANAGERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team leaders</td>
<td>6</td>
<td></td>
<td>Team leaders</td>
<td>5</td>
</tr>
<tr>
<td>Technical authorities</td>
<td>4</td>
<td></td>
<td>Operations engineers</td>
<td>6</td>
</tr>
<tr>
<td>Field operations managers</td>
<td>3</td>
<td></td>
<td>Installation managers</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total onshore</strong></td>
<td>52</td>
<td></td>
<td><strong>Total offshore</strong></td>
<td>26</td>
</tr>
</tbody>
</table>

did not have a-priori assumptions on how media use would change coordination, but instead aimed to find new emerging patterns (Glaser, 1992). I therefore started with an open coding technique (Walsham, 1995), using high-level codes to categorize statements with respect to the primary activities. For each primary activity I then coded the type of medium used, usage patterns such as frequencies or preferences, and comments on the positive or negative aspects of a medium for this task (e.g., ability to document requests in emails versus inability to check for comprehension). I also marked specific examples and episodes that illustrated positive or negative aspects of media, as well as statements that illustrated modifications in the coordination between subgroups due to the changes in technology. As I was interested in the impact of technology changes in a distributed setting, I used the initial coding to contrast statements and experiences from onshore and offshore participants. The longitudinal nature of the study further allowed to sketch changes in coordination over time comparing statements of participants before, shortly after, and several months after the implementation. I used the team observations to obtain a first hand impression of team coordination and media use, but also to validate interview statements by participants.
7.3. Results

7.3.1. Primary team activities

I found three areas in which coordination between onshore and offshore subgroups was required on a regular basis:

1. well and plant configuration for optimized production,
2. planned and unplanned maintenance of the offshore installation, and
3. upset response, i.e., reactions to unexpected events.

Across these three areas, I identified nine primary activities members had to engage in on an ongoing basis to accomplish these tasks. These were planning, executing, monitoring, reporting/informing, trouble-shooting, negotiating, coordination across team boundaries, documenting, and networking/maintenance of social relationships. Not all of these tasks were of equal relevance or criticality; only the first five of these activities, namely planning, executing, monitoring, reporting/informing, and trouble-shooting, can be considered as critical, in the sense that without them the overall team task could not be achieved. Criticality for other activities could be considered either as medium (e.g., negotiating, documenting) or low (e.g., networking).

Activities also differed in the degree of ‘scriptedness’ or reliance on existing rules and regulations. Planning, for example, followed a stringent procedure, which determined, for instance, who was to be involved at what stage or which clearance had to be achieved before a task could pass through consecutive planning gates. Similarly, execution of tasks offshore relied on a detailed planning and reporting system for every single activity to guarantee that jobs could be executed on time and to prevent overlaps between several hazardous jobs at the same location. Planning and execution can thus be considered highly scripted activities, in contrast to activities such as negotiating or monitoring.

Activities further differed in their duration or cyclical nature. Monitoring, for instance, required continuous 24/7 attention, while trouble-shooting activities only became relevant, if critical events occurred. Monitoring can thus be considered an ongoing task, trouble-shooting a sporadic activity. Reporting/informing and planning lay somewhere in between, as they occurred on regular basis, but were not required in the same ongoing manner as monitoring activities.
Due to the distribution of responsibilities between office (planning and support) and rig (execution and maintenance) and the different degree of physical access to plant and equipment, the responsibilities for primary tasks and the degree of involvement of onshore and offshore personnel in these activities varied considerably. Tasks such as planning and coordination across team boundaries were clearly driven and guided by onshore, while others such as execution and monitoring were by necessity located offshore. Table 7.2 provides a summary of the nine activities with respect to responsible group, task criticality, its cyclic nature (ongoing, cyclic, sporadic), and degree of scriptedness (high, medium, or low reliance on standardized procedures).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Criticality</th>
<th>Responsible group</th>
<th>Cyclic nature</th>
<th>Scriptedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning</td>
<td>high</td>
<td>primarily onshore</td>
<td>cyclic</td>
<td>high</td>
</tr>
<tr>
<td>2. Monitoring</td>
<td>high</td>
<td>primarily offshore</td>
<td>ongoing</td>
<td>low</td>
</tr>
<tr>
<td>3. Execution</td>
<td>high</td>
<td>primarily offshore</td>
<td>ongoing</td>
<td>high</td>
</tr>
<tr>
<td>4. Reporting/informing</td>
<td>high</td>
<td>both</td>
<td>cyclic</td>
<td>medium</td>
</tr>
<tr>
<td>5. Trouble-shooting</td>
<td>high</td>
<td>both</td>
<td>sporadic</td>
<td>low</td>
</tr>
<tr>
<td>6. Negotiating</td>
<td>medium</td>
<td>both</td>
<td>sporadic</td>
<td>low</td>
</tr>
<tr>
<td>7. Documenting</td>
<td>medium</td>
<td>both</td>
<td>cyclic</td>
<td>medium</td>
</tr>
<tr>
<td>8. Coordination across</td>
<td>medium</td>
<td>primarily onshore</td>
<td>sporadic</td>
<td>low</td>
</tr>
<tr>
<td>team boundaries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Networking</td>
<td>low</td>
<td>both</td>
<td>ongoing</td>
<td>none</td>
</tr>
</tbody>
</table>

### 7.3.2. Communication and information exchange

**Reasons and frequency of subgroup contacts**

Direction and frequency of contacts between the two subgroups differed according to the three major areas for coordination, i.e., well and plant configuration for optimized production primarily from onshore to offshore, planned and unplanned maintenance of the offshore installation primarily onshore to offshore, and upset response first contact from offshore to onshore, further contacts bi-directional (see detailed discussion of activities below). The main reasons for onshore personnel to contact offshore were the need for input in planning decisions, the need for up-to-date information on the status of the plant or equipment, requests for actions such as chem-
ical sampling or well tests, and suggestions for changes in the plant configuration to optimize or re-establish normal production. Contacts from offshore were driven primarily by requests for help and technical assistance during unexpected events, as well as routine status reports on conditions and production in the context of planned meetings.

The self-reported communication frequencies between subgroups varied considerably across participants – ranging from 1 to 300 times per week ($m = 37.5; sd = 47.7$). At first sight the large range in communication frequencies may surprise. One explanation may be that these numbers are self-reports and must therefore be taken with caution. On the other hand, participants in this study represented various functions such as planners, production engineers, offshore installation managers, or control room technicians. These functions differed considerably in how closely they needed to coordinate with the other subgroup, and the range in self-reports could therefore reflect these requirements. My observations substantiated considerable variation in communication frequencies across functions in a team. Control room technicians (CRTs), for instance, received a large number of calls from onshore, not all of them directly related to their own work. As one CRT remarked:

> “[The central control room] is the telecom exchange as well for all the calls from the beach. If they don’t know the direct dial number, they come straight in here, ‘oh, I need to speak to such and such’.”

Onshore planners and most onshore managers, on the other hand, very rarely contacted offshore, unless unexpected situations occurred:

> **Onshore technical authority:** “It can be a high frequency of interaction with the offshore guys. It just depends what the issue is. You know, I’ve probably had half a dozen emails a day in the last two days from the offshore team leader on a particular issue. So there is a fair bit of communication there. Then it might dry up and there’ll be nothing for a week or so, and then there might be a lot again.”

**Changes in media capabilities due to CE implementation**

As described in Chapter 3, production teams had access to two sets of technologies to support the cooperation between remote subgroups on a daily basis: communication technologies and subject matter technology (i.e., tools for data exchange). In the ‘traditional’ setting, i.e., before the CE implementation, communication technologies consisted of phone, fax, mail, email, and audio-conferencing. Planning software was available for the planning and scheduling of tasks, in which the order of jobs, their interdependence, and logistic requirements such as personnel, tools, materials, or
men hours were specified. This planning software was accessible only to a restricted number of people involved in the planning of jobs, i.e., planners and schedulers onshore, as well as managers offshore. For information on plant and equipment status, as well as production numbers, onshore engineers could log into data bases, which provided a regularly updated overview of the most important offshore systems. The degree of detail in these databases differed, however, from information available offshore. As the following report demonstrates, these differences could at times result in conflicting decisions between subgroups:

**Offshore installation manager:** “You can actually make two different decisions on the same data. The sample time is different, because [onshore] it only scans it 10 times a minute and here offshore it’s 60 times a minute . . . the average can end up different. . . . A good example is, we took some data and I made a decision that one of our systems doesn’t blow down, doesn’t get rid of the gas quick enough. If you look at the pie data [onshore], we were told, ‘you have to open, keep this valve always open’. We looked at the data of the [offshore system] and said, ‘no, that’s nuts’. So you got these two bits of data, and we’re trying to convince the guy onshore, who’s not got the real-time data, that it’s true.”

This situation changed with the installation of the large data screens in the team areas onshore, which presented continuously updated information on production numbers and well status. This information was driven by the same systems that displayed information in the offshore control room panels and provided thus a ‘real-time’ picture of processes offshore. (Bandwidth restrictions reduced the sample rate from some platforms, but the general refresh rate was still higher than before.) For the better exchange of information, desktop-sharing capabilities were added to allow simultaneous screen and system manipulations by multiple members onshore and offshore. The implementation of the new media also added continuous videoconferencing (VC) links and at times cameras for individual use for communication between subgroups. The video-links connected the onshore team areas with the central control room offshore and at a later stage also with offshore offices and meeting rooms. The cameras were directed so that the picture showed most of the onshore team area and large parts of the control or meeting rooms. Figure 7.1 shows the video-links between the onshore office and the control room offshore; Figure 7.2 gives an example for the data screens in the team areas onshore. Part of the organizational implementation strategy was the standardization of the onshore office environment across all teams in terms of technology, as well as physical layout. The arrangements shown in Figures 7.1 and 7.2 were therefore typical for all eight production teams.
Figure 7.1.: Use of the video-link in the onshore office during a meeting with offshore (left) and video-screens from the central control room into the office (right)

Figure 7.2.: Screen in the onshore office for the display of real-time offshore data
According to Clark and Brennan (1991), media can be described according to eight characteristics that determine the nature of communication: **copresence** (group members occupy the same physical location), **visibility** (group members can see one another), **audibility** (group members can hear one another), **cotemporality** (communication is received at the approximate time it is sent), **simultaneity** (group members can send and receive messages simultaneously), **sequentiality** (group members’ speaking turns stay in sequence), **revisability** (messages can be revised before being sent), and **reviewability** (messages do not fade over time). Usually, these aspects are considered in terms of interactions between human actors. For the purpose of this study I extended this framework to the exchange and availability of data and information. This differentiation seemed important to capture the full complexity of the media mix available to teams and to better understand the effects of the newly implemented media. Table 7.3 gives an overview of traditional and new media capabilities based on the eight dimensions described by Clark and Brennan (1991). Features underlined with gray mark additional characteristics of the new media. As can be seen, the new media added visibility for personal interactions, augmenting phone and email, and replacing audio-conferencing with video-links. The data screens added visibility, cotemporality, simultaneity, and sequentiality to processes on the plant. Desktop sharing tools further added cotemporality, simultaneity, and sequentiality for data exchange. A summary of the primary reasons for media choices based on reports by participants and observations, and the average usage frequencies as reported in the interviews is shown in Table 7.4.

**Changes in media use**

Prior to the implementation of the new media, the majority of interactions between office and rig were carried out by phone or email. Onshore engineers generally seemed to prefer the use of phones for quick updates on information. One of the reasons given for this preference was the habit of offshore staff to ignore emails. Offshore seemed to prefer the use of emails, partly because onshore engineers were often not at their desks, but also to document requests and agreements:

**Offshore manager:** “We do use emails all the time because I kind of like to confirm what we discussed, so if we have a meeting and take some actions, then we file an email with the actions, so they are written down, kind of black and white. Similarly, if we set up like a program to do some tests, again we discuss and then someone would send an email with all of the steps to make sure we captured everything and there isn’t any room for interpretation.”
### Table 7.3: Capabilities of traditional and new media (dimensions based on Clark & Brennan, 1991)

<table>
<thead>
<tr>
<th>Traditional media</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>New media</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mail/</td>
<td>Email</td>
<td>Phone</td>
<td>AC</td>
<td>PS</td>
</tr>
<tr>
<td></td>
<td>email</td>
<td>attachmt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMUNICATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audibility</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotemporality</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simultaneity</td>
<td>x</td>
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<td>Sequentiality</td>
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<td>Reviewability</td>
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<tr>
<td>Revisability</td>
<td>x</td>
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<tr>
<td><strong>DATA/INFORMATION</strong></td>
<td></td>
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<tr>
<td>Visibility</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Audibility</td>
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<td>Cotemporality</td>
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<td>Simultaneity</td>
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</tbody>
</table>

AC – audio-conferencing; VC – Video-conferencing; PS – Planning system; features in gray mark additional characteristics of new media; (x) verbal information only, no data.
### Table 7.4: Media use in the sample

<table>
<thead>
<tr>
<th>Medium</th>
<th>Observed and reported reasons for use</th>
<th>Reported frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASYNCHRONOUS MEDIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reports</td>
<td>documentation of activities and status; common ground for group meetings</td>
<td>≥ 1/day</td>
</tr>
<tr>
<td>Email</td>
<td>follow-up on phone calls or if not available by phone; documentation of results; more complex requests; contact to unfamiliar people</td>
<td>1-250/week (depending on job function and situation) depending on the situation</td>
</tr>
<tr>
<td>Email attachments</td>
<td>preparation for group meetings; documentation; common ground for troubleshooting (e.g., pictures of failed equipment); exchange of information such as plans, data dumps of offshore real-time data, drawings</td>
<td></td>
</tr>
<tr>
<td>Planning software</td>
<td>detailing and scheduling of offshore activities</td>
<td>continuous for planners</td>
</tr>
<tr>
<td>Standard mail</td>
<td>exchange of documents that need signing; internal company communications</td>
<td>[not reported]</td>
</tr>
<tr>
<td><strong>SYNCHRONOUS MEDIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone</td>
<td>if information is needed fast or information is of low complexity; quick updates; short requests</td>
<td>1-100/week (depending on job function and situation) approx. 6/week in most teams continuous use through ‘always-on’ VC-links; in few teams only on an as-needed basis for meetings and one-on-one conversations depending on situation</td>
</tr>
<tr>
<td>Audio-conferencing</td>
<td>group meetings (usually replaced by VC where available)</td>
<td>approx. 6/week</td>
</tr>
<tr>
<td>Video-conferencing</td>
<td>group meetings; replacement for phone, mail, and AC</td>
<td>continuous use through ‘always-on’ VC-links; in most teams continuous use through ‘always-on’ VC-links; in few teams only on an as-needed basis for meetings and one-on-one conversations depending on situation</td>
</tr>
<tr>
<td>Desktop-sharing</td>
<td>access to the same information at the same time in both locations during meetings for easier reference (e.g., use of mouse pointers to details, pacing of slides); manipulation of information ‘on-line’ for faster decisions and documentation</td>
<td>depending on situation</td>
</tr>
<tr>
<td>Plant data and trends</td>
<td>monitoring (offshore); basis for planning decisions (onshore); early warning of potential problems offshore (onshore)</td>
<td>offshore constant; onshore depending on availability and job function</td>
</tr>
</tbody>
</table>
Before CE implementation, information was frequently distributed in form of pictures, spreadsheets, or presentation slides attached to emails. Although both sides perceived this as highly inefficient, the lack of alternatives made this a common practice. The implementation of VC and desktop-sharing opened new ways to distribute information. For example, instead of sending photos, offshore now showed small pieces of faulty equipment or oil samples directly over the video-link.

The use of spreadsheet attachments also decreased due to the easier access to process and plant data in the onshore office, as the new data screens in the team areas conveniently showed the same information in a continuously updated way. The screens dramatically improved the accessibility of this type of information and allowed all team members, independent of their job function, to monitor trends and status information. Initially, the new data screens received somewhat mixed reactions. While most production engineers quickly perceived benefits, others such as this maintenance engineer were more skeptical, “There’s no real-time data that we in the maintenance group would require”. Based on my observations, onshore engineers used the data screens most often for a quick glance to get a general impression of the plant and production status; yet, as the following comment from a control room technician suggests, not always as consequently as could be wished:

CONTROL ROOM TECHNICIAN: “We still get bizarre requests where somebody [from onshore] will phone up and say, ‘what’s the pressure, what’s the temperature of components?’ Why phone the control room? . . . Start looking at the data, which they can get on the screen.”

Over time, the new media replaced some of the traditional media and changed interaction patterns. Most markedly, video-links replaced a considerable number of phone calls and nearly all interactions via audio-conferencing. At the beginning, offshore staff was reluctant to use or allow the use of the continuous video-conferencing links. As described in Study 2, video-connections into the control room were frequently seen as intrusive and a threat to the independence of their offshore life-style. CRTs further experienced it as added pressure from onshore, “I just don’t like it. I mean, maybe it’s a bit of added pressure if somebody is watching you”. Especially in the early stages, offshore technicians reacted by placing coffee cups and hardhats over cameras or by pointing the cameras to ceilings, room corners, or at offshore mascots.

After some months acceptance increased and in most teams video-links were used almost routinely instead of phones. On several occasions I could also observe purely social contacts between onshore engineers and technicians or offshore managers, for
instance, when CRTs presented their newest T-shirts to the onshore office, offshore managers placed playful orders for chocolate cookies, or onshore engineers relayed recent travel experiences abroad. This type of personal relationships had not existed before the implementation of VC. As one onshore engineer remarked, “some of the guys that I’ve hardly ever spoken to before, I’m now chatting away like we’re best of friends”. Generally, acceptance of the video-links seemed to remain higher for onshore than offshore personnel, although, as this comment shows, was by no means universal:

ONSHORE ENGINEER: “Obviously there’s a feeling of invasion of your privacy. And I know, sitting there at this end, when the camera is on at the side, you hear the ring; you know somebody is ringing up. You brace, you watch the camera coming round on you. It’s a bit spooky. You know, you think, ‘oh my god, I have to be on my best behavior now, you know, stop picking my nose –‘.”

As illustrated in the previous study on CE implementation, some teams remained (or became) resistant towards the new technologies – and here specifically the VC-links. While the majority of teams used the VC-links to the control and meeting rooms offshore as a replacement for phone, email, and audio-conferencing, two teams used VC only for formally scheduled meetings due to low acceptance by both onshore and offshore staff. On several occasions teams discontinued the use of the VC-links for the duration of a shift, because the new shift “did not like the camera”. In these teams, offshore technicians still frequently requested that information or instructions for activities like tests, chemical sampling, or changes to plant configurations were send by email. These emails seemed to act as safeguards against their supervisors, so that in case of conflicts the technicians would be able to demonstrate that they had acted on the explicit instruction of onshore engineers. The strong offshore hierarchy here seemed to counteract the opportunity for closer contacts offered by the new technologies.

VC or phone conversations were frequently accompanied by desktop-sharing software with the capability to display and manipulate the same data on screens onshore and offshore. Before, discussions of presentations were either done with separate paper versions or on independent computers, each side flipping through the slides at their own pace. Using desktop-sharing, slides were now available in the office and on the rig simultaneously. Not surprisingly, this practice made it easier for both subgroups to follow the flow of the presentation and reduced the number of misunderstandings as to what slide, picture, table, etc. the presenter was referring to.
On one occasion the combination of VC and net-meeting was also used to conduct training sessions for offshore staff. Previously trainers either had to travel offshore or offshore staff had to come into the office to receive the training. Moreover, using the VC-connections, offshore staff now also had the opportunity to directly participate in company town hall meetings for the first time.

Standard mail between onshore and offshore was used primarily for documents that needed signing or company communications such as internal newsletters. This way of communication was comparatively slow, as all mail had to be sent by helicopter, which usually happened on shift change days once a week. My data does not give indications on how frequently standard mail was used, but as neither onshore nor offshore staff mentioned standard mail, when asked for ways of communicating or exchanging information, I can assume that it was not a prominent medium.

7.3.3. Coordination requirements and technology effects – Illustration for critical activities

Coordination of processes and tasks between office and rig had to be managed on a continuous basis to achieve the overall team goal: maximum production under safe conditions. As all interactions were of necessity mediated by media, their capabilities influenced the ability of team members to coordinate. Production teams were able to use a complex mix of media, which either complemented (e.g., VC in combination with desktop-sharing) or competed with each other (e.g., AC versus VC or phone).

In the following sections, I describe my findings on the effects of the technology change in the context of CE implementations for the five critical team activities: planning, monitoring, trouble-shooting, informing/reporting, and executing. These activities were chosen, because they represent a range of tasks from primarily onshore to primarily offshore responsibilities, as well as instances of cyclical, ongoing, and sporadic coordination.

Planning

Planning can be considered one of the most critical activities for production teams. Planning encompassed everything from the forecast of production numbers, the long-term preparation of equipment and plant maintenance to the logistical steps of getting people and equipment on and off the platform. Because of the remoteness of offshore platforms and the restricted space to house people and store equipment,
every transfer of personnel and goods had to be planned minutely down to the number of available seats in a helicopter and the number of free beds on the rig. The main planning responsibility lay with onshore, and the process was optimally seen as a one-way process from the office to the rig:

Offshore Engineer: “Onshore is really the decision part. It's like planning the strategy, what are we going to do, and how are we going to do it. Offshore, theoretically, is pure execution. It's just, 'do what onshore says’.”

Onshore engineers were responsible for the planning of individual activities and the preparation of work packs. The grouping and scheduling of activities was then done by specialized onshore planners. Planning progressed from a first high-level plan, which indicated the main activities in the coming eight quarters to ever more detailed plans looking ahead for twelve, six, and finally two weeks. Each of the activities in these consecutive plans needed to comply with so-called gate criteria, before it could progress into the next planning stage. Planners had to make sure, for instance, that materials were ordered and available twelve weeks ahead of execution. Six weeks before execution the materials needed to be available for transport to the platform, and two weeks before execution they needed to be either on the platform or arriving shortly. Similar gate criteria existed also for all other aspects of a task, such as financial approval or the availability of personnel or special tools. An activity was only moved to the next planning phase, if all requirements were fulfilled at that gate, otherwise the activity had to be rescheduled to a later date. The final plan listed every type of material, equipment, number and type of personnel, duration of the job, as well as related activities such as local isolations or scaffolding required for its execution. This six-week plan was prepared by the onshore planner, sent offshore for review and, if accepted, finalized and send back to offshore for execution. These plans were generally sent as documents attached to emails, in which offshore managers “red-lined” problematic activities. The reviewed document was then sent per email back to the planner.

The observed teams further conducted regular planning meetings, usually once a week, in which the six week plan was discussed between managers and engineers onshore, and managers offshore. In these discussions offshore provided input on possible constraints (e.g., availability of required technicians for the scheduled shift), as well as suggestions on the clustering of related tasks. Yet, while the planning and scheduling was driven by onshore, onshore did not “micromanage” offshore jobs:

Onshore Planner: “Offshore is only responsible for the six week window, but there are processes to take place for any activity in there that needs to be scheduled.
Now, if they are talking about a piece of work that needs a guy or a couple of guys offshore that needs to be scheduled, that has implications for POB [personnel on board], the chopper seats, the materials, or the equipment when it’s going to be shipped. That has implications, so there have to be conversations on that. But if we’re talking about a one hour job for a tech to go out and do something, that’s completely on them. I’m not micro-managing right down to the tech, one-hour jobs. I’m sort of doing the higher level process and lining up the actual work with a block of time that somebody should be there.”

Plans frequently had to be changed on short notice due to unplanned events like sudden breakdowns of equipment or spells of bad weather that made the execution of outside work impossible. In an extreme case, bad winter weather prevented helicopters from landing on a production ship to bring in new staff and take people off; even boats were not able to dock, so that instead of the usual fourteen days, offshore personnel were forced to stay on-board for over three weeks. In that time, not only food became sparse, but also electricity and materials. Moreover, tools, materials, and specialist vendors could not be brought offshore. Most planned activities had thus to be put on hold and rescheduled for when the weather had cleared. The complexity of plan changes can be illustrated with this account of an onshore planner:

“You look at when that activity may have to happen, what’s in there. Does anything need to move, has anything got to be rescheduled to allow that piece of work to happen? Then the discussions start, ‘right, we can do that job; we need three mechanics to work on the process or the gas turbines. For this job here, we need mechanics, then we can’t do this job and we need to reschedule that one to later. So maybe reschedule that a week back’. And then we got the whole process of telling the vendor, who was meant to come out at that point, ‘sorry, that got put back for a week’. They may not have that guy for that week. . . . It’s not something that’s hard and fast, thank you very much, and walk away. It’s continuous, every day, every day.”

Although planning was such a critical activity, onshore as well as offshore personnel often questioned the efficiency of the process. The task-related asymmetry detailed in Chapter 5 were main hurdles for the planning process, particularly the lacking knowledge of local constraints or disparate priorities. Sometimes even wounded sensibilities played a role:

**Offshore Engineer:** “How are you, this young one, who’s been online for three months, telling me how to change this part, when I’ve done it twenty times?”

Using input from offshore to keep plans up-to-date with recent developments or to prevent possible conflicts between tasks and resources required a considerable
degree of interaction and information exchanges between subgroups. Traditional media like phone, email, reports, or audio-conferencing often were not able to provide sufficient support, mostly because information lacked the necessary detail (e.g., audio-conferencing) or timeliness (e.g., reports, email). The implementation of new media allowed a more inclusive approach to planning. Observations of teams showed that onshore engineers used the video-link to request input from CRTs and offshore managers on a spontaneous basis to clarify details in a plan.

VC was also used in the planning meetings together with desktop-sharing tools. In these meetings, onshore and offshore subgroups viewed, discussed, and revised plans directly during the meeting. In this way, checks and fine-tuning were achieved in one session instead of a series of mails or calls, which tied down fewer resources for a shorter period of time. Moreover, since the VC-connections were located in the control room, planning meetings now also included technicians and control room operators. Prior to the CE implementation, such meetings had been restricted to management levels. For offshore personnel this was a clear benefit, because their point of view was now integrated into the plans early on:

Offshore Engineer: “Because from the onshore point of view, if you think of it, they take more the project, long-term point of view and that sort of stuff, ‘so what do we need to do to fit into that?’ But as from the offshore point of view, we take more day-to-day, what we need to do today to get it going. And then the CRT’s, the operator point of view, they think about how practical it is to execute those plans. So it’s nice when we have everybody’s input.”

Overall, my observations indicated that offshore personnel became more closely involved in the planning process, bridging the strict divide of planning and execution roles. This resulted generally in faster planning, higher accuracy of plans, and less re-planning.

Monitoring

Hydrocarbon production is a continuous process with potential risks for personnel, equipment, and environment. One of the most critical job functions offshore was thus the control room technician (CRT). CRTs were located in the control room as the ‘heart and brain’ of the platform, from where they controlled the electronic and mechanical systems such as valves, pumps, flow rates, fluid pressures and temperatures, or fire alarm systems. Their main tasks were to monitor and control the status of the plant, to react to any changes or system alarms, and to implement production strategies negotiated with onshore. CRTs were ultimately responsible for the first
response to problems, which required an in-depth understanding of the system and quick decisions. Monitoring was the sole responsibility of CRTs; other offshore personnel or onshore engineers were not involved in the immediate monitoring process. Participants thus considered monitoring primarily as an offshore task.

Observations showed, however, that onshore personnel also had a monitoring role, although with a different function and criticality. Where CRTs focused on second-by-second data to control the live system, onshore engineers focused on trends and longer-term developments to forestall negative developments (e.g., equipment breakdowns) or to chart possible improvements to the plant. Offshore monitoring can thus be seen as part of a ‘fast feedback loop’ (seconds to minutes) to catch immediate events, while onshore monitoring represented an outer, slower feedback loop of hours to days or months.

Due to the strict role separation of ‘planning’ and ‘execution’, onshore engineers in the traditional setting had no direct access to real-time process data. If requested, offshore staff sent snapshots of real-time data as spreadsheets:

**Offshore Installation Manager:** “Real real-time data they can [get], but that’s our decision. But what we do, we print off a graph or we do a data dump and send it to them, so they can look at it.”

Data-bases with some parameters had been available prior to CE implementation, but were seldom used because onshore engineers perceived the access as cumbersome and of little relevance for most jobs. With the installation of the large data screens in the onshore team areas, real-time data became readily available. Onshore engineers appreciated these screens for the better awareness of the present production and plant status:

**Onshore Engineer:** “You can see what the state of the plant is; and the moment in time you see it go down, you think ‘oh, what’s happening?’ . . . So in terms of being aware of how the plant is running and the impact, I think, it’s great.”

This was clearly a welcome changed for CRTs, because it decreased distractions from phone calls or emails requesting information.

The different speed in the two feedback loops was an integral part of the predetermined roles of onshore and offshore staff in the operation process. Yet, the availability of real-time data in the CEs increased the possible speed of reactions by onshore personnel to actual or potential problems on the platforms. With the installation of the data screens, onshore engineers thus slipped into a kind of secondary monitoring role scanning the information for unusual patterns and signs for poten-
tial problems. The immediate accessibility of offshore data effectively drew onshore closer into the fast feedback loop:

**Onshore manager:** “We already had a portion of real time data that was coming into the office. We probably weren’t using it. The difference with having the CE was, the data was there in the past, but we didn’t have the screens around us to project the data up, which would provoke a conversation; now we do. So the data is now there. We’ll try to have a monitor, which will have the minute by minute production from the field and minute by minute injection rates, and so having that, took away having to pull any other type of data up. And having it right in front of you, that allows us to—’wait!’ It just raises questions, ‘oh, why did that happen?’, and, ‘well, lets look into it.’”

Onshore managers, as well as engineers were generally positive about the increased possibility to monitor plant processes from the office, “It provokes an investigation rather than not noticing until weeks time when it comes up in a summarized report or we’re even missing it.” Yet, the above quotes also suggested a more problematic aspect of this development, namely the blurring of the original division of onshore and offshore roles. As one onshore manager explained, “the primary focus is strategic for onshore”. With the availability of real-time data and the easier access to the control room, onshore engineers were now drawn closer into the day-to-day issues on the platform with the danger of loosing their longer-term, strategic focus:

**Onshore manager:** “[Onshore] you’re supporting the front-line for sure, but that’s a longer time frame. I mean, the guys offshore, the mechies and techies and stuff offshore don’t need any help changing transmitters. They don’t even want to talk about it. That’s their job. But I just see it. They [onshore] get sucked –, they have just been sucked into that.”

The new media capabilities in the context of the CE implementation thus seemed to be a two-edged sword for onshore staff. While on the one hand it provided onshore engineers with a better awareness of processes and the ability to spot potential problems earlier, it also seemed to invite a move into a more tactical, short-term role. Based on my observations most teams seemed able to retain the separation between a longer- and short-term focus, although several onshore engineers voiced concerns that the increased demands by offshore left insufficient time for the longer-term aspects of their jobs. Yet, high workloads or unexpected events clearly increased the pressure on onshore staff to drift into a short-term role. This blurring of roles could leave a gap with respect to longer-term, more strategic decisions, moving team activities from a pro-active process driven by onshore strategy to a more reactive stance driven by demands and requirements offshore.
Trouble-shooting

The two main issues requiring onshore–offshore coordination were production losses and safety-critical events with the potential to endanger plant, personnel, or environment. Offshore participants often described themselves as “the first line of defense and the first line of attack”. They not only carried the personal risks in case of major incidents, but were also the only ones, who could actively intervene, as direct interventions and access to first-hand information on incidents are possible only on the rig itself. The majority of problems were handled directly by offshore staff and then reported at the next regular team meeting. As the following comments suggest, both subgroups accepted this as an efficient way to deal with most minor problems:

**OFFSHORE MANAGER**: “We are pretty self-sufficient in quite a lot of things. If we have a problem here, then we try to solve it ourselves first, do what we need to do out here. . . . [Our technicians] can telephone various vendors, if we need any spare parts. They can purchase material. They can order those sort of stuff themselves.

**ONSHORE ENGINEER**: “One of the machines shut down, one of the compressors. . . . And they found out it was a pressure control valve that had failed. And they [offshore] then made the decision by themselves to take the one from a machine that was down, and they would scavenge it and just put it in. They didn’t have to wait and say, ‘it’s gone down, can you get a spare for us?’ They took that by themselves, and therefore they came back faster, then they would otherwise have done.”

Onshore involvement became necessary, when offshore staff was not able to diagnose the problem or when solutions had to be checked for compliance with technical standards or industry procedures.

The first problem for the effective cooperation in trouble-shooting was for onshore staff to obtain timely information that a problem had occurred. With traditional media like phone or email, onshore personnel could only wait for contact by their offshore colleagues, as this was the only way to know an unexpected event had happened. As already illustrated in Chapter 5, onshore and offshore personnel did not always agree, when onshore involvement was necessary; and at times it came to a conflict between the self-proclaimed “self-sufficiency” of offshore and the desire of onshore engineers to be informed of events or involved in problem solutions:

**ONSHORE ENGINEER**: “You go in on a Wednesday morning and you find out that something happened on Tuesday morning and they never told you. They say, ‘well, we rang and you weren’t there. We tried to call such and such’. And you don’t really know if they have or not or if they just kind of said, ‘oh, we’ll just make a decision ourselves.’”

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Another problem was to obtain accurate and detailed information on the event to create a common understanding of the problem, as well as a shared understanding of possible solutions. In the traditional setting, verbal descriptions over phone and photos, drawings, or test results attached to emails were the usual means to create a common understanding:

**Onshore Engineer:** “I could get a phone call right now, where there is a problem with a valve, for example. Now, the guy over the phone, he’s seeing the specific problems right in front of him, so he knows roughly what it is or what it might be. So he then picks up the phone –. There are three choices. He drops an email, trying to describe the problem or he can pick up the phone and try to explain the problem. More often than not, from his initial phone call, I will have two, three, four more phone calls between us. And maybe I have specific questions, ‘is it this or really this?’ To the point where, email is more advanced these days, so the guy can take a drawing and scan it, or make comments on the drawing and send it. And then again, that will involve more phone calls to discuss this drawing. And that is in general how it works.”

As this description suggests, this process could lead to drawn out discussions and carried considerable potential for misunderstandings – problematic especially in time- and safety-critical situations. The CE implementation supported troubleshooting in two ways. The data-screens in the team areas onshore showed dips in production or unusual patterns in equipment parameters. Instead of having to wait for a phone call or email from offshore, onshore engineers could thus register unusual events as they happened. While not of immediate use for the analysis of the problem, the data screens alerted onshore faster of potential problems and in this way reduced the likelihood of problems going unnoticed. The introduction of video-conferencing further improved the speed and accuracy of problem-solving by supporting visual information like hand gestures or presentation of objects, as well as increasing the access to onshore expertise:

**Offshore Manager:** “You try to explain locations of things … ‘It comes down from the deck like that and it comes across like this and it’s supported under there like that.’ [moves hands to demonstrate]. You can do that kind of thing [on VC] and it makes it a lot easier.”

**Onshore Engineer:** “The guys in the control room can walk around and see the folk sat there and say, ‘We just had an alarm on such and such and what should we do?’ And they’re able to deal with it instantly. So they’ve suddenly got a room full of experts, they can call in for help.”

The following report is an example for the potential benefit this new technology could have for the speed of trouble-shooting:
Onshore Engineer: “The classic example ... was when the guys offshore used to do some oil sampling of the main generation turbines, and the sample when it is supposed to be a nice light, like a lager color, it came out like Guinness black. So they immediately ran down the stairs, pointed it up the screen and said, ‘look, that’s the sample’ and we said, ‘shut the turbine down’. Now, and that was a decision made there and then. It wasn’t a case of, you know, ‘oh, is it that bad? Send it in for analysis. When the analysis is done, we’re going to worry about it’. So where it could have been three or four days delay, could have been a train wreck in the equipment ... it was right up at the screen, ‘this is how it should look like, this is what it does look like’ – ‘Ah, we got a problem. Shut it down.’”

Despite such clear advantages, offshore technicians and managers felt that the greater visibility of problems and the presence of onshore engineers through video-links also had its negative aspects, primarily an increased pressure for CRTs:

Offshore Installation Manager: “The last thing [the CRTs] want is somebody standing over their shoulder. And basically that screen at that period would be somebody looking over their shoulder or wondering what’s going on; or they [onshore] would ... say, ‘there’s been a trip on [the platform]’. Somebody would phone me.”

Similar to monitoring, the added visibility between subgroups had thus positive, as well as negative aspects. On the one hand, increased visibility of problems improved the efficiency of coordination in trouble-shooting activities. On the other hand, the lacking visibility had provided an effective safe-guard against ‘over-involvement’ by onshore. Usually, smaller problems were handled directly by offshore staff often without onshore staff knowing that a problem had occurred. Due to the implementation of real-time data screens and continuous video-links, onshore engineers now were also aware of smaller problems. The new media thus changed the traditional escalation strategy from offshore to onshore, with the consequence that onshore engineers were more often drawn into resolving minor issues and took part in reactive fire-fighting. Again, similar to monitoring, the new media encouraged a blurring of the traditional onshore and offshore roles and a loss of the more strategic focus for onshore personnel.

Informing/Reporting

The geographical distance and low visibility of processes made the task of informing and reporting probably the most important activity for subgroup coordination in production teams. Without proper information on the present production, type and dates of planned shipments, weather developments, equipment failures, upcoming
maintenance work, or available personnel on board, coordination would necessarily operate in the void.

The main topics, on which onshore staff needed information and reports from offshore were updates on production numbers, tasks executed in the last 24 hours, planned tasks for the coming days, information on health and safety, weather, logistics, as well as sudden changes in the operation of the plant, breakdowns of equipment, and changes in the plan due to unexpected events. Information from onshore to offshore was needed on topics like production forecasts, planning decisions, or modifications in agreed plans.

Traditionally the most important activity for the exchange of information and updates on developments offshore over the last 24 hours were morning meetings. Before the implementation of VC these meetings were conducted over audio-conferencing between onshore engineers and management on the one side and offshore management on the other. The frequency of these morning meetings varied across teams from every day (Monday to Friday) to three times a week. In the traditional setting, these morning reports were often the only regular contacts between onshore and offshore subgroups. Over the week additional meetings took place for specific topics like maintenance planning, production planning, logistics, health and safety, or environmental issues involving specific onshore and offshore functions.

Outside of meetings, information requests by either onshore or offshore staff were sent by email or discussed over phone. The difficulty of relaying information in a fast and efficient way between onshore and offshore using traditional media may be judged by this report of an onshore engineer:

“It can be as bad as having to walk several hundred yards to a noisy telephone booth, ring onshore, they get the support engineer’s voice mail because he is away in a meeting. He then leaves a message, goes back to the work site, the engineer comes back, calls the platform, can’t get the person, they put a pager out for him. Now, the guy on-site probably won’t hear that pager because it is noisy and if he does hear the pager, he has to go and find a phone to call back. At this point, [the onshore engineer] has gone to another meeting. It is like ships passing in the night.”

As seen in Study 1, the difficulty of getting hold of onshore engineers was one of the most frequent complaints by offshore managers and technicians. The continuous video-links improved this situation dramatically, because now offshore personnel could easily oversee the team area to check, whether a person was available. Video-conferencing also allowed more direct conversations between subgroups, which both sides perceived as a welcome time saver:
OFFSHORE ENGINEER: “It’s stopped a lot of the three-way communication. So it’s stopped [the onshore engineer] calling me, me going to the CRT, the CRT telling me, they can’t do it and then me going back to [the onshore engineer], ‘they say they can’t do it’. So now we have the meetings, where we have basically all three of us to make the decisions, and everybody puts in.”

Since the continuous video-links allowed easier interactions during the rest of the day, many of the formal meetings became shorter and more focused. Several teams reduced the total amount of meetings, since both sides tended to be informed of activities and developments on an ongoing basis. Because the VC-facilities were located in the control room, discussion more often included technicians and CRTs, which increased the spread and flow of information between subgroups. At the same time, onshore managers saw less need to be present in meeting between subgroups:

ONSHORE MANAGER: “As a team leader you would be tied up in meeting after meeting after meeting, and a lot of it was repetitive to be honest. So now that the meetings are running well, team leaders tend not to go to a lot of the meetings. . . . And it’s not because of lack of interest. It’s there’s no need. . . . It’s freed up a bit more time for team leaders to do some thinking time.”

The new media capabilities added visibility and cotemporality for personal communications, as well as data. Over time this achieved a better awareness between members of onshore and offshore on multiple levels: in the short-term on present activities and work load; in the mid and long-term a better understanding and appreciation of roles, responsibilities, and systems. Most problematic in the traditional setting in the eyes of onshore engineers had been the lacking awareness of production and plant status and the low transparency of processes offshore. Onshore engineers therefore greeted the implementation of the data screens as a way to increase their general awareness of the plant status. As discussed above, onshore engineers generally did not use the screens for in-depth insights into the running of the plant, but to obtain quick updates on the plant and process status. In this way, the availability of real-time data further reduced the need to call the control room offshore for routine information, which reduced the amount of disruptions for CRTs throughout the day.

As discussed in Study 1, interactions between the subgroups traditionally tended to follow a relatively strict hierarchy, in which coordination of processes was mostly the responsibility of line managers. Technicians offshore and engineers onshore provided information and opinions to their respective supervisors, but were often not directly involved in the decision making process. With the continuous video-links, engineers and technicians were now able to interact directly. As a result,
involvement of technicians in meetings increased and a number of processes moved
to lower levels of the organization decreasing the involvement of line managers in
day-to-day operations:

**Onshore engineer:** “Previously, a lot of people, especially technician-wise wouldn’t
be invited to these meetings. It would be only management. You know, management
would only speak to the management here . . . But now you’re speaking to the guys
direct.”

**Onshore manager:** “I would probably be involved in the gathering of informa-
tion and on appraising the problem that would take a longer time, whereas now,
because of the CE, I can do that very quickly and I can step out at an earlier time.”

Overall, the implementation of the additional media seemed to have made re-
porting and informing between subgroups easier and more efficient. Participants
saw the main benefits in the better access to expertise in either subgroup, less time
wasted in trying to get hold of people, and more focused, shorter interactions. Gen-
erally, informing and reporting became less sporadic and less formal. Instead of
formally scheduled meetings, contacts between subgroups were spread throughout
the day instigated more by immediate needs for information:

**Onshore engineer:** “Nine times out of ten the guys would phone you first thing
in the morning, and you would have a chat what they would do offshore, what
support they were needing, etc. And that would be it; you would only speak to
one mechy or maybe two mechies, depending who’s on shift. Now, they’ll come in,
they’ll have a chat with you in the morning, and then lunchtime they would come
in with some of the vendors that may have a question. And rather than them
being the conduit where the vendor has asked them the question, they’ve posed me
the question, I reply to them and them going back to the vendor, the vendor is there
already. And the guys offshore regularly take in the vendors, ‘we’ve got this problem
or we just want a bit of clarification on certain things.’ So the guys are on the VT,
oh, I would say, three, four, maybe five time a day, while before you might only have
that one phone call in the morning.”

**Executing**

The direct execution in terms of daily oil production and maintenance of the instal-
lation was by necessity an offshore task, and in general offshore personnel tended to
prefer as little involvement by onshore personnel as possible:

**Offshore technician:** “We’re always working towards a plan. We know on
a day-to-day basis what work is coming up, and you mainly only get personally
involved with the beach, if something goes wrong.”
Execution of tasks encompassed maintenance work by technicians, monitoring and controlling of the platform, as well as changes to the well configuration by CRTs to optimize or restore production. Execution was considered a pure offshore task, and in the traditional setting the onshore subgroup had therefore only restricted access to detailed information on these activities.

As already discussed in the context of other activities, the implementation of the additional media increased awareness of plant status and improved access to offshore personnel. This meant that onshore engineers and managers were better informed about activities at the remote site and over time obtained a better understanding of equipment and well behaviors. Due to the direct video-link into the control room production engineers were more frequently and directly involved in the fine-tuning of equipment for the optimization of production. Where before engineers would have sent a document with details on the requested changes by email, often followed up by phone calls or other emails to clarify and revise procedures, procedures were now discussed directly with the control room operator on the board.

Besides this more active role of onshore staff in influencing well settings, improved relationships and trust between subgroups also led to a tendency to relax control:

ONSHORE ENGINEER: “I just flag up this job saying ‘needs to be done some time in the next three months’. Whether it is then today or in two and a half months time doesn’t matter . . . so they can have the freedom to manage some of the tasks offshore. We don’t need to have that control as well.”

Observations on execution highlighted another potentially problematic aspect of CE implementations. Work processes offshore were highly scripted and proceduralized, in that every activity had to be checked and signed-off by supervisors and entered into a planning system to prevent potentially dangerous overlaps between tasks. For this reason all requests were usually first sent to offshore managers, who then relayed these requests to the appropriate technicians for execution. Especially offshore managers feared that the easier access to lower levels of the organization could lead to a slipping of control on activities offshore:

OFFSHORE MANAGER: “The ‘always on’ thing is great. I wouldn’t take anything away from that, but there needs to be clear boundaries as to what decision can be made. . . . My worry is that if you don’t set that boundary up, we could just sit up here, unless we’ve got a three-way CE, we could just sit up here, go downstairs [to the control room] and the whole world has changed.”
If not managed correctly, the increasing involvement of onshore in requesting and guiding activities at the technician level could thus be a potential danger for the integrity of the existing control system offshore.

7.4. Discussion

The aim of Study 3 was to investigate the effect of technology change in the context of CE implementations on every-day work processes in asymmetric distributed teams. In a first step, I identified the primary activities involved in the overall team task and the changes in communication and information exchange between subgroups. In a second step, I reviewed five critical activities and compared coordination in the traditional setting with coordination in CEs to detail effects of the technology change.

The analysis demonstrated that tasks of onshore and offshore subgroups in operations teams were closely interlinked and that both groups relied on tight coordination to accomplish their common goal. Although type and degree of interdependencies varied across the primary activities, the performance of one subgroup depended very much on the performance of the other indicating high task interdependency (Thompson, 1967; Van der Vegt & Janssen, 2003). Due to the inherent geographical separation between subgroups, this interdependence had to be managed with sole reliance on communication and information technologies. Based on a long common history of remote cooperation, the respective roles and division of labor between onshore and offshore were well established and did not require much negotiation. Differences in terms of primary tasks, work schedules, or access to plant and information were well known and integrated into the normal work process. These processes and routines had been developed based on traditional technologies.

Traditionally, subgroups tended to act as “segregated territories” (Clement & Wagner, 1995) in which the combination of homogeneity in local groups and heterogeneity of distanced groups hampered the establishment of common interpretations of information and situations. The implementation of VC and better access to data increased the ability to establish shared interpretations and understanding, which could considerably increase the speed of reactions in sporadic activities like troubleshooting. The better awareness decreased the need for direct contact for routine information, while the VC-links facilitated contacts for non-routine information. Observing teams over twelve months, these media further seemed to help in removing negative effects of remoteness also in less tangible areas, for instance, by increasing
the mutual understanding of each others’ roles and capabilities and a better acceptance of potential conflicts over priorities.

The new tools also helped to increase social interactions, as well as better awareness on ‘who is around’ (social awareness), ‘what is happening’ (action awareness), and ‘how are things going’ (activity awareness; Carroll et al., 2003). With traditional media, this type of information was nearly impossible to obtain, leading to a state of team opacity (Fiore et al., 2003), which has repeatedly been linked to coordination problems and failures (Jones & Endsley, 1996; Sneddon, Mearns, & Flin, 2006). Low awareness of processes at the sharp end is a common fate in many process industries. Similar to the engineers in Study 3, Heyer (2009) found that engineers in oil and gas refineries were very conscious about their lacking familiarity with details on the plant. His participants, however, were very critical about the use of video-links. In their opinion VC could not replace own, first-hand ‘personal impressions’. The onshore engineers in Study 3 felt the same way; but the location of offshore platforms, as well as the logistical hassles involved in sending people offshore makes physical access to offshore production rigs much more difficult than to land-based refineries. Onshore engineers still went offshore to investigate more severe problems, but the implementation of CEs and the subsequent improvement in the access to information reduced the need for these visits. The implementation of CEs thus saved travel time and costs. Also, while visits to the rig may provide onshore engineers with a ‘snap-shot’ of processes offshore, the new media in my sample actually helped both subgroups to develop a more realistic picture of work processes at the other end in the long-term.

The implementation of CEs did not lead to a radical change in team coordination, but rather to the modification and adaptation of existing routines. The additional media did not so much replace, but offer alternatives to existing media for better interaction and task support. On the surface, teams underwent a transformation of capabilities integrating new routines ‘with carryover of existing routines’ (Lavie, 2006, p. 160). The CE implementation was mostly experienced as a positive change from the former situation, because it made interactions smoother and more efficient. Over time, decision making processes involved more lower levels of the organization and reduced the transfer of information via managers, which increased efficiency of processes and decreased the involvement of managers in day-to-day tasks.

However, as highlighted in the sections on execution, monitoring, and troubleshooting, this development also contained problematic aspects. The new technologies shifted the clear boundaries between established responsibilities leading to a
higher involvement of onshore personnel in traditional offshore tasks. Although the main responsibilities did not change, over time the division of ‘planning’ and ‘doing’ between subgroups became less strict. The seemingly small shifts in individual activities and subgroup roles could thus lead to situations in which the existing systems that guarantee oversight of activities or developments loses its effectiveness. For this reason Johnsen, Ask, and Roisli (2007) actually argue that “increased connectivity and human collaboration in remote operations have significantly enhanced the risks to safety and security” (p. 83).

Overall, I identified three main challenges that confronted asymmetric distributed teams after CE implementations: (1) the blurring of traditional subgroup roles, (2) the loss of the longer-term, strategic focus for the team, as onshore became more involved in day-to-day activities offshore, and (3) the loss of oversight for managers. Generally, risks were mitigated by strict rules and guidelines, i.e., a high ‘scripted-ness’ of processes, specifically in the planning and execution of work, but it is not clear whether existing guidelines and procedures will be sufficient to attenuate the potentially negative side-effects of the technology change. The existing rules and procedures had been developed based on the traditional media capabilities. Now, the CE implementation subtly changed the context, on which these rules had been based. For instance, the traditionally strongly hierarchical communication – from onshore engineers to onshore management to offshore management to offshore technicians – was rendered obsolete by the implementation of continuous video-links between onshore engineers and offshore technicians. The implementation of CEs aimed at a ‘re-alignment’ of onshore and offshore subgroups. Yet, it seems that the long-term consequences of closer onshore–offshore coordination on work processes.

7.4.1. Implications for technology choices in CEs

A major challenge in supporting distributed teams in the production of hydrocarbons lies in the disparate requirements for information and data between the two subgroups. Responsibilities for the nine primary tasks were not uniform, and accordingly the type of information needed by onshore and offshore staff varied considerably. At the same time the high task interdependency required continuous awareness of states and activities. During normal operations both subgroups based their work on the same general information, but the depth of information, as well as the time spans considered by offshore and onshore subgroups differed considerably. Only CRTs required second-by-second updates on data during normal operations,
whereas onshore engineers took a longer-term view of hours, days, or even weeks. This changed, when unexpected events occurred that could potentially compromise production or endanger plant, personnel, or environment. Depending on the situation or main activity, the degree of interdependence and extent of coordination between subgroups changed substantially, and given the time- and safety-critical nature of the task these changes could occur very quickly and at any time. In such events, teams move from a status with little need for overlap to a status, in which both subgroups need immediate and complete access to the same in-depth information.

The role of information and communication technologies in this change from normal to abnormal situations was demonstrated in an experimental study on process control operators (Nickel & Nachreiner, 2008). Operators in normal and abnormal control situation used either one or two visual units for the functional dynamic display of information. While in normal situations, two displays brought no added benefit, in abnormal conditions fault management deteriorated significantly, if only one display was available. Thus, information that had been sufficient during normal operations proved inadequate in critical conditions. For coordination in distributed production teams the situation is even more problematic, as here technology has to accommodate changing information requirements of subgroups with very different but highly inter-related tasks and perspectives. I therefore argue that technology must be able to accommodate disparate requirements and quick changes between situations. In other words, for the support of asymmetric distributed teams data presentation needs to be scalable with respect to type of information, amount, degree of detail, or time frames.

This study also draws attention to the conflict between media choices based on the ‘normal’ role of organizational members and requirements in critical, but sporadic situations. For instance, available data for onshore and offshore personnel in the traditional setting varied in detail (i.e., sampling rates), which could lead to different decisions for the same problem. In oil production teams, onshore technical authorities generally made the decision, on whether a procedure was technically sound. While the onshore subgroups thus had the decision authority in terms of technical and legal standards, in some cases they lacked the adequate information to make such decisions in an informed way. The choice of media capabilities in the traditional setting had been based on the primary role understanding of ‘onshore planning’ versus ‘offshore execution’. The above example again demonstrates the need for flexibility and access for detailed data also for functions that not usually re-
quire continuously detailed updates. It further highlights the challenge in asymmetric

team coordination of reconcile location of the richest information and locations at

which decisions are made.

To remove the lacking transparency of processes, information and communication
technologies should further support social, action, and activity awareness, as well

as the development of system knowledge between subgroups, for instance, by en-
abling more direct, real-time interactions. For more efficient sharing of information

and perspectives media should also allow simultaneous operations and decisions by

subgroups, for instance, by offering collective viewing and manipulation of data or

visual information such as pictures or graphs and good quality video-conferencing
to allow body language and physical pointers.

Technology should further be able to accommodate different and changing require-
ments for accessibility and privacy in the two subgroups or of one subgroup over

time. As comments by offshore personnel illustrated, in times of high workload con-
tinuous video-links can be a hindrance for concentrated work and thus add undue
pressure. For this reason most teams in the UK PU developed a protocol that encour-
gaged CRTs to shut cameras off during critical situations. Also decisions on where

cameras are placed, the degree of resolution, or the remote controlling of camera

angles are important aspects for regulating the amount of distraction, personal com-
fort in media environments, and the acceptance of new media – is it, for instance,
really necessary to see “every wart” on the nose of your communication partner? Or

should offshore technicians indeed be able to read emails on the PC screens of their

colleagues onshore?

Another problem for the coordination between remote subgroups is the document-
ation of decisions. In production teams onshore engineers were not as easily avail-
able during nights and weekends, although production still continued on the remote
site. Decisions made during these times and their rationales must be comprehensi-
ble and reviewable by the other subgroup. As demonstrated in Chapter 1, regular

turnover in membership and work systems like rotating shifts offshore similarly
challenges the continuity of processes. Decisions and procedures discussed with one
shift were often not handed over fully to the next, and then had to be re-negotiated
or explained again. While verbal agreements, emails, or slide attachments can be ef-
fective for teams with stable membership, these procedures were often inadequate to
guarantee continuity over rotating shifts. To maintain efficient coordination teams
must thus be able to capture events and decisions taken by one subgroup in the ab-
sence of the other in sufficient detail for review or for other team members to take
over without delay.

A recurring conflict for nearly all critical team activities was the tension between better coordination due to improved access to the remote subgroup, and possible distractions from the main job function (i.e., monitoring and controlling for CRTs, longer-term strategic work for onshore engineers), as well as the potential blurring of subgroup roles. Affordances of the new media clearly supported closer coordination and higher involvement between subgroups, and in many ways the new technologies provided considerable benefits for the coordination of tasks and processes. The potentially more problematic side effects did not become apparent until months after the implementation. At this point, technological changes in distributed team coordination clearly require a re-consideration of subgroup roles and responsibilities and the negotiation of usage rules – or a renewed discussion around the desirable features of media.

7.5. Conclusion

In their seminal article ‘distance matters’ Olson and Olson (2000) argued that remote working should succeed best, if teams were loosely coupled, i.e., have few dependencies and rely mostly on routines, whereas high interdependency tasks should ideally be co-located. For tasks such as offshore oil production co-location clearly is not an option. Accordingly, choosing media that can support highly-interdependent tasks in asymmetric distributed settings is crucial. In Study 3, I investigated the effects of media capabilities on asymmetric distributed coordination. I further identified various challenges for team functions, when moving from one set of technologies to another, such as the blurring the roles between subgroups. Technological change in the context of CE implementations altered existing routines, indicating that the organization of distributed working is very much a question of available media capabilities. My findings also showed that technology changes can modify the coupling within teams by shifting established roles of actors.

The present study used a longitudinal multi-layered approach in following teams for twelve months, observing their work in various situations, and collecting further insights through semi-structured interviews. For security and privacy reasons, I was not able to obtain systematic data on technology use (server statistics, email content, etc.), so my information relies mostly on subjective measures and incidental events during periods of observations. Although I feel that the length and approach of the present study provided a good basis for investigating the intricacies involved in
remotely operating teams with highly interdependent tasks, further studies including more objective data on media type and usage could clearly broaden our understanding of effects of media capabilities on ongoing cooperation in distributed teams. Considering the impact of different media configurations and effects of changes in technology use over time in other industries that use distributed teams, could provide additional insights into the specific needs and challenges of supporting ongoing remote team cooperation.
The rationale for the implementation of CEs was to improve the support for work processes in production teams. CEs are generally conceptualized as technological approaches providing a diverse mix of advanced information and communication technologies. Yet, the support of distributed teams need not be restricted to technological means. In this chapter I report findings from the comparison of three different CE approaches – the purely technological solution discussed in the previous chapters, a structural solution based on the physical integration of members into the remote subgroup, and a hybrid solution, which combined the use of advanced media with the physical integration of members. These three approaches showed systematic differences on the organization of team processes, team performance, team learning, and relationships between subgroups. Based on the comparison of these three approaches I discuss the differential effects of technological and structural aspects for the support of distributed teams, as well as generic situations in which the three approaches might be best suited.

8.1. Introduction

Technology is the essential link for the communication and cooperation across distances, and accordingly technical features dominate discussions on how to support distributed working. These discussions center around the design of systems and interfaces, specific features of applications (e.g., Dennis et al., 2001; Fox et al., 2000; Huang et al., 2002; Roussev & Dewan, 2005), or focus on specific media capabilities such as social presence (Rice, 1993) or media richness (Daft & Lengel, 1984, 1986). The assumption in these discussions is that media capabilities influence the type of interactions and information exchanges between dispersed team members, and thus determine the effectiveness of team work. The implementations of CEs, with their attempt to provide distributed teams with advanced technological capabilities, are based on the same rationale.

Past research has shown that distributed teams adapt to the technological capabilities available in their work environment (e.g., Burke et al., 2001; Kleij et al., 2005). Yet, reports of mature distributed teams in the field also show that longer experience with media and longer cooperation with the same partners do not automatically lead to better team knowledge or easier coordination (e.g., Cramton & Webber, 2005; Gibson & Gibbs, 2006; Sole & Edmondson, 2002). Over time, ongoing distributed teams can actually experience a divergence of team mental models due to the increasing differentiation of roles and a subsequent decrease in interactions (Levesque et al., 2001). Especially if members rarely or never meet face-to-face team familiarity, as well as team learning might be difficult to maintain (Baba et al., 2004).

This opens the question, how best to support ongoing coordination in distributed teams. It also raises the question, whether technology is the only or even the best means to support ongoing distributed team work. Rockmann et al. (2007) investigated an alternative to purely technological solutions – the physical integration of members into the remote subgroup. They found that physical integration strengthens affective ties with the hosting subgroup and leads to stronger identification with the whole team. While structural integration is an interesting possibility, the study was based on an experimental setting and focused primarily on team identification. It did not investigate how structural integration affects team processes between hosting and remote subgroups or in which way technological and structural solutions differ in their effects on team processes and relationships. Extending on the study by Rockmann et al. (2007), the main objectives of Study 4 were to compare
the ramifications of CE design variations for the functioning of LADTs and to clarify the disparate effects of technological support and structural integration.

8.2. Methods

8.2.1. Setting

During the time of my project the company piloted diverse approaches of CEs. In this study I compared three of these approaches, which were implemented at two different geographical locations: a technological and a structural solution trialled during the twelve months of the pilot phase in the UK PU, and a hybrid solution at a second company location in the United States (US PU). At the time of the study, the hybrid approach in the US PU had completed the test phase of over twelve months with a subsample of production teams, and was now moving to full-scale implementation throughout the PU. I visited the US PU for a week in May 2007, which gave me the opportunity to obtain a first-hand impression of the physical environment, conduct interviews with team members, managers, and members of the implementation group, as well as observe everyday work processes. Data on the other two approaches were collected during the twelve months of the pilot phase in the UK PU.

8.2.2. Description of CE designs

Technological approach

The technological approach in this study refers to the standard CE approach chosen in the UK PU and detailed in Chapter 3. This approach only used technological means to improve access to data and personnel, while subgroup roles and responsibilities remained unchanged. Existing media (i.e., phone, mail, email, audio-conferencing) were augmented with constant video-links to the offshore control rooms and offices of offshore management, as well as desktop-sharing and net-meeting applications. For better access to data a continuously updated stream of plant and process data was displayed on big screens in the onshore team areas. The pilot phase comprised in total five teams, four using the technological approach. This study was based on data from three of these teams.
Chapter 8. Study four: Differential effects of CE designs

**Structural approach**

The structural approach was tested by one team as an alternative solution parallel to the other CE pilots in the UK PU. This design was based on modifications in the structure of the team. In the approach studied here, two to three offshore technicians and one offshore supervisor were moved into the onshore office to work alongside onshore engineers. They remained in the office for several months before permanently moving back to offshore. During their time in the office, these individuals changed from their offshore rota (12-hour day and night shifts seven days a week) to the regular office work schedule. Communication and data exchange between onshore and offshore subgroups remained based on the existing, traditional media.

**Hybrid approach**

This third approach employed a combination of technological and structural means to improve cooperation between office and rig. Additional control rooms for each platform were created in the office and manned with one offshore control room operator each. Each of these onshore control rooms assisted one specific platform in form of week-round 12 hour day-time support. The control room operators retained offshore shift patterns (12-hour days, seven days a week) and rotated regularly between office and platform. The onshore control rooms replicated the offshore systems and screens, providing access to the plant and process data in (almost) real-time. In addition to the real-time data, continuous video-links were provided in the onshore control rooms, further on an as-needed basis in the wider team meeting areas.

The three approaches differed primarily in two aspects: type of technological support and the degree of structural integration between subgroups. The technological approach represented one end of the spectrum using only technological means to support team coordination, with the structural approach at the other end relying solely on structural integration. The hybrid approach combined both aspects. Table 8.1 summarizes the main features of the three design variations.
### Table 8.1: Characteristics of the three CE designs

<table>
<thead>
<tr>
<th></th>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEDIA CAPABILITIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capabilities</td>
<td>traditional and advanced</td>
<td>traditional</td>
<td>traditional and advanced*</td>
</tr>
<tr>
<td>Communication</td>
<td>between work areas onshore and control room/management offices offshore</td>
<td>n/a</td>
<td>between onshore and offshore control rooms, from work areas onshore to various locations offshore and outside organization</td>
</tr>
<tr>
<td>Information technologies</td>
<td>screens with continuously updated plant and process data in onshore team areas</td>
<td>n/a</td>
<td>exact replication of offshore data systems in onshore control room with continuous life updates of data</td>
</tr>
</tbody>
</table>

**CHANGES FOR ONSHORE PERSONNEL**

<table>
<thead>
<tr>
<th>Structural changes</th>
<th>none</th>
<th></th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical environment</td>
<td></td>
<td>areas for onshore part physically separated from rest of office</td>
<td>open office plan with multiple assets collocated on one floor; one onshore control room pro team as physically separated area from the office space</td>
</tr>
</tbody>
</table>

**CHANGES FOR OFFSHORE PERSONNEL**

<table>
<thead>
<tr>
<th>Structural changes</th>
<th>none</th>
<th></th>
<th>placement in onshore control room as physically separated area from onshore personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person involved</td>
<td>n/a</td>
<td>2-3 discipline technicians and one supervisor</td>
<td>one control room operator per team per shift</td>
</tr>
<tr>
<td>Duration of stay onshore</td>
<td>n/a</td>
<td>usually six month stay onshore; afterwards permanent move back offshore</td>
<td>continuous rotation between onshore and offshore</td>
</tr>
<tr>
<td>Work schedules</td>
<td>n/a</td>
<td>office work hours</td>
<td>12 hour day shifts Monday to Sunday, rotation between onshore/free/offshore for two weeks each</td>
</tr>
</tbody>
</table>

*Traditional media: phone, mail, email, audio-conferencing, planning systems; advanced media: continuous video-links, desktop-sharing, access to real-time plant and process data*
8.2.3. Participants and procedure

To capture effects of the different designs on team processes and relations I conducted a total of 122 semi-structured interviews over the three concepts. Of these I selected 58 interviews with the most relevance for this study. The interviews included onshore, as well as offshore personnel over multiple hierarchical levels (see Table 8.2 for an overview) and lasted between 30 and 90 minutes (avg. about 60 minutes). All interviews were recorded on tape and transcribed verbatim prior to analysis. The interviews asked for individual tasks (“What is your role in the team? What do you do day-by-day?”), team tasks and subgroup coordination (e.g., “How often and for what do you have to coordinate with on/offshore? Who are your main contacts?”), specific team processes such as decision making and planning, team relationships/climate, media use, and a general evaluation of the changes compared to the traditional setting (the interview guidelines can be found in Appendix B). In addition to the formal interviews, informal conversations with individuals working in or around CEs were gathered as field notes. While these conversations were not formally recorded, they added background information and insights apart from the interview protocol.

Since I was located in the onshore office in the UK PU, where the technological and structural approaches had been implemented, it was possible to further conduct regular workplace observations of meetings, shift handovers, and everyday work situations for these two settings to obtain a direct impression of the cooperation within and between subgroups. Most of these observations took place during formal meetings and as scheduled visits. Apart from these scheduled observations, a number of ad-hoc observations helped to obtain a richer picture of day-to-day coordination. These observations lasted between five minutes and two hours. Data for the hybrid approach was collected during a week-long visit to the US PU.

Due to the restricted access to offshore installations, most observations and interviews took place in the onshore office. Interviews with offshore personnel were usually conducted by phone or video-conferencing, occasionally also during short stays of offshore staff in the onshore office. I conducted further interviews and observations during visits to two offshore installations, which used the technological approach. In addition to face-to-face interviews with offshore personnel, this allowed the direct observation of work processes on the installation and interactions with the office from offshore.
8.2. Methods

Table 8.2: Overview of the sample and data included in Study 4

<table>
<thead>
<tr>
<th>Functions</th>
<th>Approach</th>
<th>Technological</th>
<th>Structural</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onshore personnel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discipline and support engineers</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Offshore personnel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CROs, technicians and engineers</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total interviews</td>
<td>25</td>
<td>17</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Observation period</td>
<td>12 months</td>
<td>8 months</td>
<td>1 week</td>
<td></td>
</tr>
</tbody>
</table>

8.2.4. Data analysis

Study 4 was conceptualized as a multi-case study (Eisenhardt, 1989) considering each of the three CE designs as an individual case. In a first step, I analyzed each CE design separately to obtain an understanding of how teams operated in each of the three settings (within-case analysis). In this step, I created detailed descriptions of processes and relationships based on the statements in the interviews. These descriptions remained as close to the original text as possible, using quotes and direct citations to retain the details of the original descriptions (open coding). My focus during this first part of the analysis was on how participants described individual work processes such as decision making, access to people and information, or information distribution. My main focus was here on how they were conducted, who was involved, and what media were used. I also marked statements that commented on relationships between subgroups and team performance.

After a time, narratives of participants started to repeat the same descriptions and details. After this point, I started the grouping of similar narratives into codes with the same themes (axial coding; Strauss & Corbin, 1990). From this step, four main themes emerged: (1) descriptions of tasks and processes, (2) team performance, (3) team learning, and (4) team relationships/climate (a detailed list of codes created in this step can be found in Appendix D). As the interviews were conducted in the

\[\text{I also coded effects on the individual levels. As the main focus of this thesis is on team processes, these are not discussed here. A short overview on individual effects can be found in Bayerl, Lauche, and Badke-Schaub (2008).}\]
context of the CE implementations, most participants reported effects on team performance and relationships in terms of comparisons from the traditional setting. Apart from the simple coding of the theme, I therefore also marked, whether participants perceived an improvement, deterioration, or no change compared to the traditional situation for each of the detailed codes. This helped me to get an indication on how participants evaluated this specific aspect and to identify main risks and contingencies of each approach.

In the second step, I compared the detailed descriptions for similarities and differences across the three designs (cross-case analysis). The two objectives of the cross-case analysis were to detail the disparate effects of the three approaches and to identify the differential effects of technological support and structural integration. For this purpose I compared the three approaches for each of the four themes found in step one using network views in Atlas.ti. In these views I arranged the detailed codes for the three approaches together with one or two descriptive quotes for onshore and offshore personnel into one picture (cf. Figure 8.1 for an example). During the analysis of the detailed codes I found that CE designs differed with respect to three aspects: (1) organization of team processes, (2) effects on relationships, and (3) location of effects, i.e., who in the onshore and offshore subgroups were involved or affected. Differences with respect to team processes concentrated on four topics: subgroup coordination, communication between subgroups, team learning, and team performance. I thus used seven codes for the final comparison of CE effects: subgroup coordination, communication between subgroups, team learning, team performance, relationships, and location of effects.

In a last step, I aimed to capture how the use of information and communication technologies or alternatively the structural integration of members differed in their effect on team processes, subgroups relationships, and location of effects. For this purpose I compared the same processes (e.g., access to information or decision-making) across approaches detailing, how they were conducted either based on technology use or the integration of remote members.
8.2. Methods

**Figure 8.1.** Example of cross-case comparison for detailed codes

<table>
<thead>
<tr>
<th>All.4 - Access to information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STRUCTURAL</strong></td>
</tr>
<tr>
<td><strong>benefits</strong></td>
</tr>
<tr>
<td>Improved communication</td>
</tr>
<tr>
<td>Reduced time to complete tasks</td>
</tr>
<tr>
<td>Reduced costs</td>
</tr>
<tr>
<td>Increased efficiency</td>
</tr>
<tr>
<td>Improved accessibility</td>
</tr>
<tr>
<td>Enhanced user experience</td>
</tr>
</tbody>
</table>

**All.4 - Access to information**
8.3. Results

8.3.1. Organization of team processes and relationships

Technological approach

The technological approach was the standard approach in the UK PU. The rationale of the technological solution was to improve access to information and personnel in the remote subgroup to increase the speed and accuracy of decisions and planning processes.

Coordination: As shown in Study 3 in the previous chapter, the technological approach did not change the main roles or tasks within the team, although it resulted in a blurring of the traditional division between planning and execution functions. Processes between subgroups were more closely integrated and coordination moved from higher-level, mostly formalized interactions to more spontaneous interactions between lower levels of the organization. The technological solution affected onshore staff, as far as they were part of the CEs or as irregular users in the second-tier personnel. It further included potentially all offshore staff, either as regular users or sporadic users of the technology. The impact of the technological solution thus depended largely on the frequency of contacts between subgroups and the choices of onshore and offshore personnel between available media (e.g., preferences for phone or emails versus video-conferencing).

Communication: Improvements in the communication between subgroups was the aspect most frequently mentioned by participants (60.0% of interviewees in the technological approach). The technological approach allowed the continuous communication through video-links between onshore office and rig, which increased the ability for quick updates on developments and conversations with the remote group. The better access to people and expertise in the remote subgroup was consequently a common theme in the interviews for onshore and offshore personnel alike (48.0% of participants). Information technologies supported team performance by providing faster and more detailed access to raw data from plant and production for onshore engineers. Interestingly, this aspect was mentioned only rarely (20.0% of participants), and then only by onshore personnel.

Team learning: Media capabilities also influenced team learning, although this aspect was mentioned very rarely and again only by onshore personnel (16.0% of
participants). In the traditional setting, team members had a general knowledge about responsibilities of the other subgroups, but often no precise knowledge on processes or local constraints (cf. Study 1 in Chapter 5). Subgroups in the traditional setting also had only very restricted social and activity awareness. Real-time data access and continuous video-links increased situational awareness, and over time led to a more precise appreciation of processes in the other subgroup and local constraints – although the depth of knowledge still depended on the intensity of subgroup-contacts. The technological approach in the UK PU contained a structural aspect, although only for the onshore part of the teams. CEs grouped engineers from multiple functions (electrical, mechanical, process, etc.) into the same area, which provided the opportunity for cross-functional learning for onshore engineers. Conversations over video-links could be overheard by other members adding to the awareness on activities beyond their own scope.

**Relationships:** The technological approach further impacted team familiarity and thus relationships and team climate. Together with positive changes in communication and access to people and expertise, improvements in subgroup relations were the most frequently mentioned aspect in the technological approach (48.0% of participants). The video-conferencing tools provided a ‘personal touch’, which – compared to the traditional setting — reduced frictions and increased team identification:

**Offshore manager:** “With so many new people (offshore) that had never met the beach support guys, you could see as soon as the meeting started, the relationships improved massively. Rather than just talking to a name without a picture – who is talking to people and getting to know people face to face –; and the relationship is totally improved straight away, massively.”

**Onshore manager:** “It actually does bring offshore and onshore closer together and there is a real feel of sort of ‘this is one team here’; combining both, even so they’re hundreds of miles away from each other.”

These relationships continued even after individuals had left the original CE teams:

**Onshore engineer, former CE-member:** “Obviously my involvement with the guys offshore stems back from me being in the CE, so I quite enjoy to communicate with the guys and continue the relationship, which I still do over the phone.”

The continuous coordination between subgroups meant that team members knew each other fairly well based on regular contacts over months and years. The type of media available to teams, influenced, however, as how ‘personal’ these contacts were
perceived and thus the overall team climate. Effects of the technological approach were thus clearly influenced by the media capabilities, but also by the media choices of individual team members.

The latter was also one of the main vulnerabilities of the technological approach. Technology can be used in many different ways and given the combination of various media team members were thus flexible, which medium to use and when. Technologies are easy to ignore, if they fail to offer benefits, and as Study 1 illustrated, different expectations or communication preferences in distributed teams can lead to frictions and less than optimal interactions. The sole reliance on technology further made this approach vulnerable to failures in the internet link. In addition, the quality of media and more generally the technological infrastructure played an additional role in the effectiveness of technology-based solutions. Initially, bandwidth to offshore installations had not always been sufficient to support continuous updates of data or high quality video, and the low quality of voice and pictures or disruptions in transmissions restricted the use of the new technologies in teams. Continuous use and benefits for the teams were only observed, once the infrastructure had been upgraded and the additional technologies could be used to their full potential.

**Structural approach**

**Team performance:** The structural solution aimed to improve access to information and expertise by placing offshore personnel alongside onshore personnel in the office. The main rationale for this solution was to relieve offshore staff from administrative tasks like short-term planning, preparation of work packages, or vendor contacts to free up time for the more manual tasks like repairs and plant maintenance. The technicians in the CEs thus took on tasks that were traditionally done offshore (e.g., preparation of work packages), as well as tasks of onshore engineers (e.g., vendor contacts), thus changing existing tasks and processes within subgroups. Not surprisingly, the improvement in team efficiency through the delegation of tasks was a topic only found in the structural (and hybrid) approach, but not in the technological approach. The same is true for the access to local expertise, which was another CE aspect linked to improvements in team performance.

The presence of the offshore technicians, for instance, eliminated many conversations that would originally have taken place between onshore engineers and offshore managers or the control room. Instead of calling offshore, onshore engineers could walk over and talk with CE technicians face-to-face to draw on their local expertise
on plant layout, processes, or equipment:

**Onshore engineer:** "In a way I could keep phoning offshore, but these are sitting in there. They are my eyes and ears offshore, except they are sitting in the CE, which makes it a lot easier."

For offshore technicians, their colleagues onshore provided a trusted access point into the office. Due to similar backgrounds and expertise, the communication with CE technicians was described as much easier and more efficient. Offshore technicians, for instance, could place requests for equipment directly with technicians in the CE instead of onshore engineers:

**Offshore technician:** "I can talk to a guy who is mechanical in the CE. He knows what I'm talking about. . . . With the purchasing guy, you're trying to explain it and he'll say, 'I know what you want'. Next thing the wrong thing turns up."

The presence of offshore personnel in the office made offshore expertise readily available to the onshore team. The general consensus was that this input allowed for more in-depth discussions and new insights, which improved problem solving and helped to increase the efficiency and accuracy of planning processes. Technicians also supported onshore engineers in tracking down information. Where traditionally the onshore engineer would have contacted the offshore control room to search for a person with the right knowledge, CE technicians could use their familiarity with the offshore team to contact the correct person right away:

**CE technician:** "C. (onshore engineer) was talking to me about instrumentation. Well, I'm not instrumentation, but I wasn't going to say to him, 'I'm not instrumentation, that's not me. I'm electrical, so that is not my discipline'. I just said to him, 'what is it you need?' And it's nothing for me to just do a little email and send it to a person, who I know, who will give me that information, and that is what happened."

Consequently, over half of the participants (53.8%) linked the structural approach to increases in the efficiency of process. The two main mechanism were seen as access to local knowledge in easy reach of onshore engineers and the reduction of administrative work loads offshore (i.e., delegation).

**Team learning:** CE technicians further helped onshore engineers to develop a better understanding of offshore processes and responsibilities. Compared to the technological approach, in which only 20.0% of participants mentioned some form of team learning, 58.8% of participants mentioned one or more aspects of team learning. The most important aspect for personnel in both subgroups was a better knowledge of the respective roles, perspectives, and local constraints. Especially, new
onshore personnel profited from this arrangement to ‘get up to speed’ in their new jobs faster. During their time in the onshore office, CE technicians likewise acquired a fuller understanding of the processes onshore and a greater appreciation of the interdependencies between the two groups. This knowledge, however, presented no direct benefit for CE technicians once they moved back to their former offshore jobs. Long-term benefits of team learning were thus only experienced by onshore personnel.

**Relationships:** The same limited scope of effects existed with respect to the development of relationships and effects on the general team climate. Although 52.9% reported better relationships with members of the other subgroup, these effects were restricted to contacts between people in the onshore office. Because requests by offshore personnel was still either done traditionally over phone, email, or audio-conferencing, or re-routed through the CE technicians, relationships between the larger parts of the subgroups remained unchanged. Changes in team familiarity or the development of personal relationships between subgroups were again restricted to the two to three technicians in the CE.

**Communication:** The role of CE technicians in the structural approach could be described as buffer or mediator between onshore and offshore, in that communication between subgroups are now funneled through the CE. This fact may be one reason, why access to people was considerably less mentioned in the structural design than in the other two approaches (only in 17.5% of interviews). The setup in this particular case was not optimal, however. Although technicians were placed in the office, they officially remained part of the offshore team. As offshore staff, they did not take part in the regular onshore meetings, but at the same time had also no longer the opportunity to participate in the usual meetings offshore. In consequence, CE technicians found it difficult to keep up-to-date with the developments and activities offshore they were supposed to support:

CE TECHNICIAN: “For example your morning check in. I mean, you need that because if you don’t, you’re kind of left on your own to do your own thing. You’re left out of the loop. . . . Because you’re a technician in the office, you’re not carrying out your normal day-to-day work. So if you don’t know what’s happening, it’s very difficult to try and assist people on how to make life easier for them.”

As comments by two of the CE technicians suggest, this approach was also vulnerable to lacking compliance or support by offshore, especially offshore managers:
"I'm not liaising directly with the mechanics (offshore). It's through the supervisor. So if that information is not fed on, the guys I work for along side don't see a benefit from me being in the office."

The strong hierarchical structure in the offshore subgroup moreover could deter technicians from cooperating directly with the CE:

CE TECHNICIAN: “Everything has got to be done through the team leader. So, if I was offshore and I was a technician, I wouldn't just phone the CE on my own work, because you then upset the team leader, because he doesn't know when he's kept out of the loop. It shows you're undermining him.”

In this approach, the integration between office and rig was thus restricted to the few individuals transferred onshore. Overall, the structural approach enhanced efficiency for specific tasks, particularly for administrative tasks offshore; yet, none of the soft benefits – development of a common ground, better understanding of work priorities and processes, or the establishment of personal relationships – went beyond the small group of individuals involved in the scheme. The relationships between onshore and the wider community offshore remained unchanged.

**Hybrid approach**

**Coordination:** The hybrid approach combined advanced information and communication technologies and the structural integration of control room operators (CROs) in the onshore office. Similar to the technicians in the structural approach, the main role of onshore CROs was to relieve their offshore counterparts of administrative tasks. In the same way as CE technicians, onshore CROs shielded offshore staff from repeated information requests by onshore engineers, as they provided onshore engineers with a first contact point for information. Because control rooms were manned continuously for 24 hours every day, onshore engineers used them habitually to get hold of individuals offshore, leave messages, or acquire quick information on the status of equipment or plant. All this added considerably to the work load of CROs and distracted from their main role of monitoring and controlling operations. The presence of onshore CROs took away much of these ‘nuisance calls’, reducing strain and tensions offshore:

ONSHORE CRO: “CROs get phone calls all day long, because everybody knows that somebody's going to be sitting there 24/7... They are getting phone calls and they can't react to what they are doing. Everything is routed to here right now and I can tell them. So it takes away all the miscellaneous phone calls that shouldn't be going on.”
The presence of CROs in the onshore office thus reduced the general amount of interaction between onshore and offshore personnel.

**Team performance:** The combination of direct access to real-time offshore data and offshore operators in the office was also seen as a way to improve team performance, especially the efficiency of processes. One of the main reasons given for the increase in efficiency was the opportunity to delegate tasks to onshore CROs, easier access to information through the onshore control rooms, and reduced need for travel between locations. Access to people and access to information were also one of the main benefits mentioned by the majority of participants (62.5% and 50.0% respectively), although the advantage was clearly seen as one-way profiting onshore engineers. Benefits in these two aspects seemed more prevalent in the hybrid approach than in the technological and particularly the structural approach: only 48.0% of participants in the technological and 17.6% in the structural approach mentioned better access to people and only 20% and 29.4%, respectively, mentioned better access to information.

The combination of technology and easy availability of offshore personnel was generally seen as a trigger to improved team performance, especially in terms of decision making and planning efficiency:

**Onshore engineer:** “When you have to make fast decisions you got the right people really quick to pull together. You don’t have to go tracking everybody down.”

**Onshore manager:** “We’ll have the discussion with offshore input and we’ll decide on the prioritization and what goes first. So we move activities around actually real time in the meeting and decide it there.”

The following are some examples for benefits of the hybrid approach reported by participants in this study:

**Onshore manager:** “We had a meeting this morning … I was sitting there and just looking round the table starting the meeting and then all of a sudden the VC came on and the [offshore manager] VC-ed in. And I didn’t even know he was joining. … He just knew where we were meeting and VC-ed in and joined like he walked in the room.”

**Onshore manager:** “It saved [an onshore manager] from having to travel, loose three days of his valuable time trying to come out here to present something. He can do it in 30 minutes with this technology.”

**Onshore engineer:** “We can make programming changes from here without having to send that automation engineer offshore to take care of it.”
8.3. Results

Access to offshore data provided a better awareness of the plant and production status, and the additional video-links facilitated quicker access to people offshore with first-hand experience, which helped to speed up problem identification and solutions. Onshore CROs moreover provided onshore with a convenient avenue for access to local knowledge and offshore perspectives. They were consequently often pulled into planning meetings, reviews of procedures, or to support troubleshooting – a second task that, although beneficial for the onshore subgroup, could distract onshore CROs from their primary role of supporting their platform.

An aspect unique to the hybrid approach was that onshore CROs added an additional layer of monitoring as a “safety net” for offshore. Being away from the bustle and distractions of the platform, deviations and potential problems were often detected faster by onshore CROs than by their offshore colleagues. In critical situations, onshore CROs could also act as a second pair of eyes or even coach inexperienced operators:

**Onshore CRO:** “Things happen out there and you feel the pressure. When it happens, in here you don’t feel the pressure. So when you go to look at it, you have a completely different perception of what you’re looking at and where to go.”

**Onshore CRO:** “We’ve been short in board operators out there and actually had somebody [inexperienced] going there on the board and there was an experienced operator in here . . . and they just talked him through it. They told him what to do.”

As a considerable advantage, onshore and offshore personnel considered the reduction in the number of travels between office and rig, as physical presence could be replaced by video-conferences. Although one participant voiced concerns that less travels and face-to-face contacts could reduce the mutual awareness and familiarity with new developments or new team members, most participants agreed that the advantages far outweighed the downsides.

As with the technological approach, the benefits of advanced technologies relied on the quality and reliability of the infrastructure. Onshore CROs were unable to fulfill their primary tasks, if the data and communication links to the platforms were lost. For onshore engineers, on the other hand, their presences provided at least access to offshore knowledge, even if communication links were not operating.

**Team learning:** In terms of team learning onshore CROs and onshore personnel reported slightly different effects. For onshore personnel, the primary aspect seemed to be a better knowledge of equipments and technologies offshore. For onshore CROs, their presence in the office helped to obtain a better understanding of the roles and
work processes in the onshore subgroup, as well as a better understanding of the onshore perspective. Remaining offshore personnel did not mention team learning aspects.

**Relationships:** The majority of participants also perceived an improvement of relationships between subgroups (58.8% of participants). For offshore personnel, this effect was mostly based on the physical integration into the onshore team, while onshore engineers attributed this effect primarily to richer technologies:

**Onshore CRO:** “Once [CROs] get (onshore) they notice that the people in the office aren’t bad, they are helpful . . . When they get out here they understand, [people onshore] are on the same side; they are normal people, and they have their bad and their good days too.”

**Onshore Engineer:** “We’ve got the technology capabilities to VC in with the platform, so it’s sort of - you get more of the one team feel”

Yet, as one onshore manager pointed out, improvements in team relations and the development of personal relationships and effects of team learning were largely restricted to onshore engineers, onshore CROs, and individuals managers that tended to use the VC-capabilities on a regular basis:

“In one sense you are not developing relationships with the other people offshore, because you got someone here you can use . . . You are funneling through one individual rather then multiple.”

Similarly to the structural approach, onshore CROs thus acted as a buffer against the wider spread of close relationships between subgroups.

As the only one of the three approaches, the hybrid solution stimulated new relationships beyond the boundaries of the team. Traditionally in all three teams, offshore personnel were bound to one platform and little contact existed between different rigs. Working in the same office, CROs of different assets were able to develop an informal network for support in critical situations, the exchange of experiences, or simply to pass the time. These relationships were also retained during their spells offshore, during which CROs contacted colleagues on other platforms over VC to discuss problems or just for social chats.

In the structural approach a major problem was the social isolation of offshore personnel. In the hybrid solution, the constant video-link between the onshore and offshore control rooms helped to reduce the isolation of the single operators in the unfamiliar office environment, kept social ties alive, and enabled onshore CROs to
stay up to date with developments on the platform. This was further supported by the continuous rotation of personnel between onshore and offshore shifts.

A problematic aspect of the hybrid approach was that onshore CROs replicated an existing position in the offshore team. To fill this position without reducing staff levels offshore, the hybrid approach required additional or ‘superfluous’ CROs. If this additional personnel was not available, onshore control rooms remained unmanned. Together with the replication of offshore systems, financial commitments in the US PU were therefore considerable higher than in either of the other two approaches.

8.3.2. Summary of effects

Despite the fact that the overall team task and the interdependencies between office and rigs were the same across the three teams, the variations in the CE designs led to systematic variations in the functioning of teams and subgroup relations. CE approaches also differed in the location and longevity of effects. Each solution presented a number of (potential) benefits, risks, and contingencies unique to this approach. The following is a short summary of the main findings discussed above. A schematic overview of the main effects on team processes is shown in Table 8.3. Table 8.4 lists the main problems, potential risks, and contingencies.

Technological approach

In the technological approach richer information and communication technologies improved the availability and efficiency of non-routine interactions, replacing emails and phone, and reduced the number of failed or missed calls. Better communication was seen as a trigger for the improvement of team relations and supported the development of task and team mental models. This concept, while being the least disruptive of the three, seemed to affect the biggest number of individuals in both subgroups, i.e., provided the widest spread of effects. Possible risks and contingencies were the vulnerability to lacking reliability of the technological infrastructure. Further, technologies are easy to ignore or circumvent, if alternatives are available. Media preferences of individuals or subgroups determine media choices and thus influence the efficiency of technological solutions. In addition, the interdependence between subgroups impacts the frequency of contacts and thus how technologies affect team processes.
Chapter 8. Study four: Differential effects of CE designs

**Structural approach**

Despite the integration of members of one subgroup into the working environment of the other, the structural approach left the majority of work processes or interactions between subgroups unchanged. Coordination remained largely explicit and relied on traditional media with the usual problems of missed calls, ignored emails, etc. Gains in efficiency could be found for individual tasks, in which offshore personnel could provide fast input and local expertise for onshore or where CE-personnel took over administrative tasks from offshore. The structural solution did thus not affect team performance or functioning on a large scale, but instead focused on a small number of processes and tasks that required close onshore-offshore integration. A better understanding of processes and relationships developed for onshore personnel and the few individuals in the CE, but these effects did not extend to others in the offshore community and became obsolete as soon as the CE-personnel returned permanently to their original offshore roles. In the approach studied here, the integration was only partial, i.e., offshore technicians moving into the office still remained part of the offshore work force and hierarchy. As technicians are low in the ‘offshore food-chain’, this model was vulnerable to lacking commitment or compliance by offshore managers. It is likely that a fuller structural integration between the two subgroups would have yielded different or more wide-ranging effects.

**Hybrid approach**

The biggest benefits of the hybrid approach seemed to be felt by the offshore subgroup, either in form of support for processes like monitoring and administrative tasks or in shielding offshore from requests and calls from onshore. Effects on team learning with respect to team and task mental models seemed largest for onshore CROs, while onshore engineers profited most from access to local expertise and the opportunity for easier access to offshore if needed. Despite the availability of real-time technology, team situation models did not build in the same way as in the technological approach, as the technology was primarily tailored towards onshore CROs. Main risks for the hybrid approach were the reliability of technology and role ambiguity or conflicts for onshore CROs in their double function of offshore support and providers for onshore expertise.
### Table 8.3: Summary of effects for the three approaches as identified in the data

<table>
<thead>
<tr>
<th>SUBGROUP COORDINATION</th>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access to information on plant/production status</strong></td>
<td>high, real-time plant and production data directly available in team areas</td>
<td>low</td>
<td>moderate, replication of offshore systems in onshore control rooms</td>
</tr>
<tr>
<td><strong>Access to people/expertise for onshore personnel</strong></td>
<td>very high, through continuous VC connection in team areas</td>
<td>moderate, direct access only to CE technicians</td>
<td>high, direct access to onshore CROs, continuous VC in onshore control rooms and ad-hoc VC in meeting areas</td>
</tr>
<tr>
<td><strong>Access to people/expertise for offshore personnel</strong></td>
<td>very high, through continuous VC connection in control rooms and meeting rooms</td>
<td>low, only through traditional media</td>
<td>moderate, mostly relayed through onshore CROs</td>
</tr>
<tr>
<td><strong>Action awareness</strong> (’what is happening’)</td>
<td>high</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td><strong>Activity awareness</strong> (’how are things going’)</td>
<td>moderate</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td><strong>Social awareness</strong> (’who is around’)</td>
<td>high for offshore personnel</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td><strong>Delegation of tasks</strong></td>
<td>none</td>
<td>administrative offshore tasks</td>
<td>administrative offshore tasks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMUNICATION BETWEEN SUBGROUPS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Line of communication</strong></td>
<td>primarily between onshore engineers and offshore technicians, reduced involvement of managers</td>
<td>along traditional offshore hierarchy</td>
</tr>
<tr>
<td><strong>Formal conversations</strong></td>
<td>low (compared to traditional setting)</td>
<td>high</td>
</tr>
</tbody>
</table>

Continued on next page
## Table 8.3: Summary of effects for the three approaches as identified in the data – continued from last page

<table>
<thead>
<tr>
<th></th>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Informal/ad-hoc conversations</strong></td>
<td>high, depending on acceptance of continuous VC connections in teams btw. onshore and offshore personnel</td>
<td>low, CE technicians as additional buffer for requests on local expertise</td>
<td>moderate, requests from onshore engineers funneled through onshore CROs, depending also on VC use</td>
</tr>
<tr>
<td><strong>TEAM PERFORMANCE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Decision making</strong></td>
<td>faster through direct access to offshore input and and plant/production data</td>
<td>more precise through availability of offshore expertise in CE technicians</td>
<td>faster through direct access to offshore input and plant/production data</td>
</tr>
<tr>
<td><strong>Identification of problems</strong></td>
<td>faster identification through real-time data and continuous access to other subgroup</td>
<td>no change (compared to traditional setting)</td>
<td>faster identification due to presence of onshore CROs and offshore systems in onshore control room</td>
</tr>
<tr>
<td><strong>Solution of problems</strong></td>
<td>faster solution through direct access to other subgroup and information exchange through VC</td>
<td>slightly faster solution through availability of offshore expertise of CE technicians</td>
<td>faster solution due to direct access to offshore expertise of onshore CROs and through VC</td>
</tr>
<tr>
<td><strong>Onshore planning</strong></td>
<td>increased precision and speed through direct input from offshore early on in the process</td>
<td>slightly increase in precision and speed due to availability of local knowledge in CE technicians</td>
<td>increased precision and speed through direct input from offshore early on in the process</td>
</tr>
<tr>
<td><strong>Efficiency gains offshore through delegation</strong></td>
<td>none</td>
<td>moderate to high (gains depending on type of tasks given to CE technicians)</td>
<td>moderate to high, delegation of administrative tasks, presence in planning meetings, and taking of calls to onshore CROs</td>
</tr>
<tr>
<td><strong>Time savings on travels between locations</strong></td>
<td>high, VC connection partly replaced travels for onshore/offshore managers and onshore engineers</td>
<td>none</td>
<td>high, VC connection partly replaced travels for onshore/offshore managers and onshore engineers</td>
</tr>
</tbody>
</table>
Table 8.3.: Summary of effects for the three approaches as identified in the data – continued from last page

<table>
<thead>
<tr>
<th>TEAM LEARNING</th>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily processes/routines</td>
<td>high, onshore + offshore personnel</td>
<td>high, CE technicians only</td>
<td>high, primarily onshore CROs</td>
</tr>
<tr>
<td>Inter-dependencies between subgroups</td>
<td>high, onshore + offshore personnel</td>
<td>high, CE technicians only</td>
<td>high, primarily onshore CROs</td>
</tr>
<tr>
<td>People’s expertise</td>
<td>very high</td>
<td>low, CE technicians only</td>
<td>moderate, primarily onshore CROs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RELATIONSHIPS</th>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgroup relationships within the same team</td>
<td>potential for closer relationships btw. all onshore and offshore personnel, depending on VC use</td>
<td>potential for closer relationships btw. onshore engineers and CE technicians, not to wider offshore community</td>
<td>potential for closer relationships btw. onshore engineers and onshore CROs, little to wider offshore community</td>
</tr>
<tr>
<td>Identification with the whole team</td>
<td>increased team identification potentially for all onshore and offshore personnel, depending on VC use</td>
<td>increased team identification for CE technicians, but no changes for wider offshore community</td>
<td>increased team identification for onshore CROs, but no changes for wider offshore community</td>
</tr>
<tr>
<td>Relationships between teams</td>
<td>no direct link</td>
<td>no direct link</td>
<td>development of relationships between onshore CROs of different teams</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCATION OF EFFECTS</th>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread of effects</td>
<td>all personnel, depending on technology availability and use</td>
<td>hosting group and people making the move</td>
<td>hosting group and people making the move</td>
</tr>
<tr>
<td>Duration of effects</td>
<td>continuous for onshore and offshore personnel</td>
<td>continuous for onshore personnel, CE technicians only during stay onshore</td>
<td>continuous for onshore personnel and onshore CROs rotating between locations</td>
</tr>
</tbody>
</table>
Table 8.4.: Problematic aspects, risks, and contingencies of the three approaches

<table>
<thead>
<tr>
<th>Technological approach</th>
<th>Structural approach</th>
<th>Hybrid approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROBLEMATIC ASPECTS</strong></td>
<td>potentially more disruptions for offshore, high demands on infrastructure</td>
<td>depletion of offshore skill set, threat to integrity of hierarchical structure offshore</td>
</tr>
<tr>
<td><strong>MAIN RISKS</strong></td>
<td>easy to ignore or circumvent, potential loss of control and oversight by management</td>
<td>easy to ignore, alienation of offshore management</td>
</tr>
<tr>
<td><strong>MAIN CONTINGENCIES</strong></td>
<td>reliability of infrastructure, technology acceptance and adoption, technology training/proficiency</td>
<td>acceptance by offshore, staffing levels</td>
</tr>
</tbody>
</table>

8.4. Discussion

In this study I compared three approaches to overcome geographical distance between interdependent subgroups in ongoing distributed teams – a purely technology-based solution, a structural solution that integrated members into the remote subgroup, and a hybrid solution using both technological and structural modifications. The three designs all aimed to improve team processes and relations, but chose different means to attain this goal. While the technological approach focused on better access to information and expertise through technological means, the remaining two solutions created a layered approach with offshore personnel onshore mediating and buffering between the two subgroups. The findings in this study suggest that technological and structural modifications result in systematic differences in team functioning and outcomes. In the following section I aim to separate the effects of technical versus structural integration.
8.4.1. Prizing apart effects of technology capabilities and structural integration

The technological capabilities in the three cases consisted of two main types: communication technologies for synchronous and asynchronous interactions and information technologies for access to plant and process data. At first sight the introduction of both types of technologies at the same time produced contradictory effects. On the one hand, information technologies reduced the need for direct interactions between office and rig; on the other hand, richer communication media provided easier access and more opportunities for direct and continuous contacts. Observations in this study showed that information technologies eliminated primarily requests for routine information due to equal access to real-time data in both office and rig, while communication technologies increased the efficiency of non-routine information exchanges. The latter was of importance especially for unexpected or critical events. The introduction of continuous video-links in the technological approach increased not only the mutual availability of subgroups, but also enriched and ‘personalized’ interactions. The opportunity for continuous access to colleagues helped increase team familiarity between subgroups, which is an important condition for team performance especially for complex tasks (Espinosa et al., 2007). Comments from participants also pointed towards better team mental models and more accurate transactive memory systems. In combination, advanced information and communication technologies led to increased awareness and knowledge of the present situation (team situation model; Rico et al., 2008), an increased understanding of the overall system, and a change in team relations. The technology thus increased the ability for implicit coordination, i.e., the ability to coordinate “in the absence of overt communication” (Rico et al., 2008, p. 167). Yet, while technology modified team processes and relationships between subgroups, its impact existed only to the extent that team members were willing to use the capabilities, and as long as the technological infrastructure was reliable.

Compared to information and communication technologies, structural integration introduced a second layer between the onshore and offshore team through which interactions between subgroups could be funneled. This funneling function was most pronounced in the hybrid solution, where requests would in most parts go through the onshore control room operators in each team. The integration of offshore personnel in the office rerouted some communications between office and rig and improved decision making onshore through the input of expertise in planning decision. Deci-
The three designs differed considerably in how many people were affected and for how long effects could be retained. In the technology-based solution changes affected nearly all individuals in the onshore group and a great part of the offshore CROs and managers; at least to the degree that they were users of the technology. In the structural and hybrid solutions these effects were confined mostly to the individuals moving from one group to the other. The structural changes thus limited the effects of CE-implementations largely to the ‘hosting’ group and those few individuals making the move.

Overall, structural changes and information and communication technologies affected different aspects of teamwork and functioning. Table 8.5 provides an overview of their impact on eight core teamwork activities. These activities describe general functions and processes underlying team performance (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995).

### 8.4.2. When is which design most appropriate?

Given the systematic differences of effects, and their different breadth and location, technological, structural, and hybrid approached are clearly not interchangeable, when it comes to supporting ongoing distributed teams. Distributed teams are not a uniform concept, and accordingly the approaches discussed in this study will differ in their applicability for specific tasks, situations, or organizational settings. Also the degree of ‘virtualness’ as the percentage of time team members spend apart on a task (Griffith, Sawyer, & Neale, 2003) and the type of dispersion (spatial, temporal, or configurational; cf. O’Leary & Cummings, 2007) may play a role. The results in this study pointed towards a number of factors that might influence the choice of approach, such as degree of continuous or intermittent coordination between subgroups, the degree of task and goal interdependence, percentage of tasks that need coordination, criticality of tasks, number of people in each subgroup required to coordinate with each other, and dynamic of team tasks or work environment (i.e., speed with which situations can change from routine to non-routine). The following is a first attempt to identify possible situations, in which one or the other approach is most suitable.
Table 8.5: Support of technology and structural integration for team process factors (based on Cannon-Bowers et al., 1995)

<table>
<thead>
<tr>
<th>Process factor</th>
<th>Definition</th>
<th>Technology</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared situation</td>
<td>Team members develop shared knowledge of the team’s internal and external environment</td>
<td>x (x) (x)</td>
<td></td>
</tr>
<tr>
<td>awareness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptability</td>
<td>Team members use information from the task environment to adjust strategies through the use of flexibility, compensatory behavior, and reallocation of resources</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Decision making</td>
<td>Team members integrate or pool information, identify alternatives, select solutions, and evaluate consequences</td>
<td>x x (x)</td>
<td></td>
</tr>
<tr>
<td>Team management</td>
<td>Team members direct and coordinate task activities, assign tasks, plan and organize, and motivate other team members</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Coordination</td>
<td>Team members organize team resources, activities, and responses to ensure complete and timely completion of tasks</td>
<td>x x x</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Team members exchange information efficiently</td>
<td>x (x)</td>
<td></td>
</tr>
<tr>
<td>Performance monitoring and feedback</td>
<td>Team members give, seek, and receive task-clarifying feedback</td>
<td>x x x</td>
<td></td>
</tr>
<tr>
<td>Interpersonal relations</td>
<td>Team members optimize interpersonal interactions by resolving conflicts, use of cooperation, and building morale</td>
<td>x (x)</td>
<td></td>
</tr>
</tbody>
</table>

CT – communication technologies, IT – information technologies; SI – structural integration
(x) only applicable for members making the move

Technological approach

In the technological approach remote subgroups remain largely independent; synchronous information and communication technologies, however, can help team members to develop a good mutual knowledge about the team, task and organizational environment, as well as support shared situation and activity awareness. If critical events occur, team, situation and task mental models can help identify and solve problems quickly, while rich communication media can support instant and efficient conversations in a near face-to-face style. This approach thus seems best suited for situations in which subgroups are highly interdependent, but many tasks rely on routine information and repeated processes with few exceptions or critical events.
Chapter 8. Study four: Differential effects of CE designs

**Structural approach**

Due to the very localized effects of the structural solution, this design seems best suited for cases with low overall task-interdependence between subgroups. This approach could thus be an option for more loosely-coupled distributed teams in which subgroups share few very specific interdependent processes and not much in-depth coordination is needed in an ongoing basis. The pilot team in this sample used integration only in a ‘one-way’ fashion and for a restricted time, but this approach could easily be adapted to various tasks and contexts by changing the number and type of personnel exchanged between locations or ‘cross-exchanging’ members across subgroups (cf. Rockmann et al., 2007).

**Hybrid approach**

The combination of technological and structural means in the hybrid approach provides a flexible way to tailor the degree of involvement between remote members according to tasks and functions. Coordination with and access to remote groups can be flexibly handled through the combined gate-keeping functions of either technology or integrated subgroup members. This approach seems thus well suited for situations in which critical, e.g., high hazard, tasks are performed in the remote location and where as much stress and strain should be taken off individuals at the remote location, or in which one side has a primarily supporting function for the other. Yet, in choosing this approach organizations need to be aware of the greater costs and the greater changes and adaptations required of team members compared to the other solutions.

Overall, this study suggests a complex relationship between effects of longterm cooperation and the type of approaches chosen to bridge the gap between remote members of distributed teams. It further shows that alternatives to purely technological solutions in CEs are feasible. Combining differential effects of structural and technological aspects could be a powerful mechanism to tailor CE designs to the specific situations in distributed teams.
There go the people. I must follow them for I am their leader.

Alexandre Ledru-Rollin (French Politician, 1807-1874)

STUDY FIVE: EFFECTS of MEDIA CHANGE on COOPERATION EXPECTATIONS

Study 5 investigated the effect of the CE implementation on cooperation expectations with respect to lateral integration between subgroups (i.e., subgroup integration) and vertical decentralization. Starting point for this study were observations in Study 3 that cooperation moved to lower levels of the organization and managers reduced their involvement in day-to-day processes. This raised the question, how staff and managers perceived these changes; and more specifically, whether the changes in technology were accompanied by according cooperation expectations and whether onshore and offshore subgroups, as well as managers and staff concurred in their expectations. Comparing individuals in pre- and post-implementation teams, Q sorts and semi-structured interviews showed that the type and content of expectations differed across media (i.e., pre- versus post-implementation) conditions. Further, alignment of expectations was higher in the post-implementation, i.e., higher rich-

1This chapter is based on Bayerl, P. S. & Lauche, K. (2009). Technology as enabler for empowerment in distributed teams: A field study on leadership attitudes. Academy of Management Conference (AOM 2009), August 7-11, 2009, Chicago, USA.
Chapter 9. Study five: Effects of media change on cooperation expectations

ness condition. Study 5 thus indicates that media capabilities influence cooperation expectations in teams, as well as the degree of their alignment across distributed subgroups. This suggests that the technological infrastructure in distributed teams may be a contingency for the effectiveness of managers' leadership styles and behaviors.

9.1. Theoretical background

9.1.1. The role of expectations in distributed team coordination

A major challenge of distributed work arrangements is the coordination of processes and tasks across geographic distances. Coordination in teams requires the alignment of "actions, knowledge, and objectives of interdependent members, with a view to attaining common goals" (Rico et al., 2008, p. 163). In an optimal state, teams should be able to coordinate implicitly, and to anticipate and dynamically adjust behaviors (Cannon-Bowers, Salas, & Converse, 1993; Rico et al., 2008). Yet, coordination is not only influenced by the knowledge on how teams operate, but also by expectations on how teamwork should be organized. Expectations towards the regulation of team processes can be understood as standards against which existing structures and processes are compared. If these expectations are consistent amongst team members they create group or cooperative norms (Birenbaum & Sagarin, 1976). Group norms help to interpret messages and behaviors, but also influence members' behaviors as well as their reactions to actions of others (Chatman & Flynn, 2001). Incompatible norms among team members can lead to misunderstandings and conflicts, and thus hamper the achievement of common goals (cf. DeSanctis & Monge, 1999). This problem is particularly prevalent in distributed team coordination, as team members or subgroups often enter into cooperation with their own location-specific norms and expectations on acceptable behaviors, interaction patterns, or the 'correct' organization of team processes. Here, conflicting expectations are even more likely than in collocated collaborations.

The alignment of expectations and attitudes in teams generally occurs through negotiations and common experiences in the same context, i.e., the opportunity to work with each other, to observe other members, and share the same social space (Birenbaum & Sagarin, 1976; Edmondson et al., 2007; Langan-Fox et al., 2004). Partners in distributed cooperation usually do not have this opportunity; instead, they depend on technologies like email, phone, or video-links to exchange informa-
tion, negotiate processes and priorities, and establish relationships. This reliance on media restricts the opportunities for shared experiences and can thus impede the development of common norms. One way to facilitate the convergence of expectations is the implementation of richer media. The richer media are and the more they support continuous contacts between members, the easier it should be to reach a common understanding of how team tasks and processes should be organized.

The two main issues of coordination in distributed teams are the coordination of tasks, processes, and relationships across subgroups, and the role of managers in this process. My investigation, therefore, focused on two aspects: (1) expectations for subgroup integration, i.e. the extent to which processes between subgroups are (expected to be) organized and managed as a whole team (integration) or independently by each subgroup on its own (separation); and (2) expectations for vertical decentralization, in other words the desired degree of involvement of managers in subgroup coordination.

9.1.2. Media effects on subgroup integration and vertical decentralization

Lateral integration between subgroups

Communication and information technology in organizations enables and constrains interactions, supports coordination among people, and provides procedures for interpersonal exchange. In this way, technology not only influences how individuals interact with and within their environment, but also how they perceive and make sense of it. Technology “presents an array of social structures for possible use in interpersonal interaction, including rules (e.g., voting procedures) and resources (e.g., stored data, public display screens)” (DeSanctis & Poole, 1994, p. 125). These social structures provide the templates for the planning and accomplishment of tasks, as well as the social interactions within a given organizational context.

Media characteristics influence the ability as well as the willingness (Venkatesh & Johnson, 2002) of distributed team members to interact, exchange information, and develop personal relationships, trust, and team cohesion (e.g., Burke et al., 2001; Krebs, Hobman, & Bordia, 2006; Roch & Ayman, 2005; Walther & Bunz, 2005). The type of media also influences the flow of communication. As Hinds and Kiesler (1995) found, richer media tended to decrease interactions across hierarchical levels, while increasing interactions at the same organizational level. Richer media thus supported the lateral integration among individuals at the same hierarchical level.
Extending this concept to dispersed subgroups in distributed teams, it can be hypothesized that richer media increase lateral integration between subgroups. The use of richer media can pull together members of distributed teams more closely and serve as the backbone for closer integration of processes. Better information and communication technologies that support the coordination and adjustment of processes should create closer links between remote members. The closer interaction may also lead to the alignment of integration expectations over time.

**Vertical decentralization**

The main role of team leaders is “to do, or get done, whatever is not being adequately handled for group needs” (McGrath, 1962, p. 5). This includes tasks like the diagnosis of problems that could impede group and organizational goal attainment, generating and planning appropriate solutions, and implementing these solutions within the given social context (Fleishman et al., 1991; Zaccaro, Rittman, & Marks, 2001; Zaccaro, 2001). In this sense, team leaders are mainly social problem solvers that facilitate performance and the progress of their team towards a common goal (Fleishman et al., 1991; Hackman & Walton, 1986; Zaccaro et al., 2001). To do this successfully team leaders need to fulfill four basic leadership functions (Fleishman et al., 1991): (1) information search and structuring, (2) information use in problem solving, (3) managing personnel resources, and (4) managing material resources. As this taxonomy illustrates, the handling of information is one of the most important aspects of the management role. Consequently, access to and control of information form the basis for effective leadership interventions, but can also be seen as a management strategy to retain control over team processes and a position of power (Curry & Stancich, 2000).

In consequence, technologies that enable employees to access and exchange information in a more direct manner enable managers to relinquish control, at the same time empowering employees to take over traditional management functions. Technology thus provides the basis for the delegation of responsibilities to lower hierarchical levels giving “employees increased decision-making authority in respect of the execution of their primary work tasks” (Wall, Cordery, & Clegg, 2002, p. 147). This process leads to the vertical decentralization of team processes. **Vertical decentralization** here refers to the delegation of formal power down the hierarchy (Mintzberg, 1984) and thus describes the degree of control by team leaders in the execution of primary work tasks.
In distributed teams, communication is largely impacted by the type of communication media available to team members. It can therefore be argued that richer media can provide a structural framework for the vertical decentralization of processes. An empirical underpinning for this assumption was found in a case study on the development of the B2 stealth bomber (Argyres, 1999). Over the course of this project communication partners distributed across organizations developed a ‘technical grammar’ and common social conventions for communication. These social conventions formed the basis for effective coordination across locations, reducing the need for hierarchical coordination.

These two aspects are not seen as independent. In teams favoring a high degree of subgroup integration, members will likely prefer to contact each other directly rather than expect their team leader to serve as a go-between. If team members prefer a strong separation between remote subgroups, team leaders may be expected to play a more active role in the coordination. Expectations for subgroup integration can thus impact expectations about the role of managers. Mismatches between expectations could lead to considerable frictions between members and their team leaders, but also remote subgroups (Armstrong & Cole, 2002; Bosch-Sijtsema, 2007).

This study investigated the impact of two sets of technologies on leader, as well as follower expectations for the two aspects subgroup integration and vertical decentralization. My main hypothesis was that richer technologies, by allowing more direct access between remote team members, should facilitate the alignment of expectations across subgroups. This study contributes to the literature in theoretical and managerial terms. Theoretically, it adds to the present understanding of how information and communication technology technologies shape organizations proposing the creation of expectations in organizational members as stabilizing factor for newly established organizational processes. For managers, this study highlights the potential of information and communication technologies for shifts in expectations towards the organization of team processes, which can have important implications for the effectiveness of hitherto accepted leadership styles and behaviors.

9.2. Methods

Due to the staged CE implementation process, six of the eight production teams affected by the initiative in the UK PU started the use of the additional technologies a year before the others. This implementation strategy allowed me to compare members in the ‘traditional’ media setting with members in teams that had changed to
the advanced media slightly over twelve months ago. A period of twelve months seemed long enough to allow team members to become familiar with the new capabilities, to integrate them into their daily work processes, and to establish new coordination practices between subgroups. I also assumed that after this time potential changes in expectations should have stabilized. To contrast the two conditions, I refer to the setting before CE implementation as low-richness condition, to the situation after CE implementation as high-richness condition. Each team included about eight team members onshore and six to eight members offshore directly involved in the coordination with the office. Although all teams worked in the same business unit, contacts between teams were minimal, as each team supported only one specific platform, as members only belonged to one team.

The production teams possessed several desirable characteristics for this study: Firstly, the coordination between the onshore and offshore subgroups is by necessity mediated through technology. Variations in media capabilities thus have a considerable impact on the flow of information between subgroups. Secondly, because hydrocarbon production is a continuous and long-range activity, production teams tend to possess a long history of working remotely. Accordingly, members are routinized in distributed working and the use of various technologies to support coordination. Thirdly, they tend to be part of mature teams, in which processes and relationships are well established and show little variation. Expectations about the organization of work processes in production teams should therefore be well-established, stable, and largely shared at least among members within the same subgroup. Finally, onshore and offshore subgroups constitute highly interdependent, but clearly identifiable entities with their own tasks, management structure, and work cultures. This setting allowed to contrast media effects in intact, but disparate subgroups.

9.2.1. Sample and procedure

The sample for Study 5 included all hierarchical levels directly involved in the coordination between the two subgroups from engineers to line management in the office (3 hierarchical levels) and from technicians to middle management on the rigs (4 hierarchical levels). Expectations were assessed using a card sort technique called Q methodology (McKeown & Thomas, 1988). The aim of Q methodology is “to identify groups of participants who make sense of a pool of items … in comparable ways” (Watts & Stenner, 2005, p. 68, emphasis in the original). It compares subjective views of participants with the aim to identify participants with a similar outlook.
9.2. Methods

on a specific topic. In a first step, participants are clustered in groups based on the similarity of their views; the second step details the qualitative differences of these views. Q methodology does not require a-priori assumptions about the possible number of disparate groups or the attributes that differentiate between groups; nor does it make assumptions about the possible direction or type of differences between views.

Expectations about the organization of team processes

Expectations were assessed with respect to the two aspects: degree of subgroup integration and degree of vertical decentralization. *Subgroup integration* referred to the desired degree of integration between onshore and offshore, i.e., whether participants preferred the two subgroups to work and decide as one team (integration) or on their own (separation). Attitudes towards *vertical centralization* contrasted preferences for a high level of top-down management (centralization) versus a high degree of team participation (decentralization).

Development of the Q sort statements and procedure

The items used in the Q sort were created as a naturalistic Q sample (McKeown & Thomas, 1988) based on the interviews and observations in Studies 1 and 3. This procedure ensured that the items captured the core tasks and issues of the teams and were phrased in a language that team members could understand and relate to. The item set covered ten primary activities of production teams in the areas *TASKS* (decision-making, informing/reporting, planning, problem-solving), *PROCESSES* (goal-setting, coordination, control), and *RELATIONSHIPS* (aligning people, supporting/mentoring, handling disturbances). For each of the primary activities, one item for each extreme end of the two aspects subgroup integration and vertical centralization was formulated, resulting in a total of 40 items. The complete list of statements can be found in Appendix E. Item formulations were based either on direct quotes from interviews or variations thereof. Example statements are “Team leaders need to keep close control on how things are done” (*PROCESSES/control*: vertical centralization) or “In order to make better decisions, onshore and offshore personnel have to participate equally in making decisions” (*TASKS/decision-making*: subgroup integration). Two members of the company checked the formulations for relevance and potential problems with the terminology or phrasing. Q sort sessions were conducted individually. Participants were asked to sort the 40 items in a forced
distribution ranging from $-4$ (completely disagree) to $+4$ (completely agree; see Figure 9.1). Since I was interested in attitudes, not the actual degree of integration of centralization in a team participants were instructed to sort according to their ideal state. The formulation of items with “need to/must” was chosen to reinforce this instruction, as well as to ensure strong reactions and opinions for the degree-disagree decisions.

**Figure 9.1.** Illustration of Q sort into a forced distribution

**Recordings and interviews**

Participants were encouraged to provide comments during the sorting to explain why they agreed or disagreed with statements or to comment on dilemmas or ambiguities in the placement of items. In order to capture the additional information and assist in the interpretation of findings, all Q sort sessions were recorded on tape. To capture more systematic feedback on the placement of items, semi-structured interviews were conducted with all participants after the sorting. Participants in the high-richness group were also asked to comment on the way team processes and
leadership behaviors had changed compared to the low-richness environment they had experienced before.

Overall, I collected 74 Q sorts from two teams in the low-richness condition \((n = 32)\) and four teams in the high-richness condition \((n = 42)\) amounting to approx. 40\% of the individuals directly affected by the CE implementation. Three participants refused to use the forced format and instead produced sort with free distribution. I excluded these from analyses to prevent problems due to lacking comparability of the sorting distributions. I excluded another four Q sorts from second-tier personnel to retain only sorts from participants working in the CEs. This left 67 sorts and accompanying interviews, 28 in the low-richness condition and 39 in the high-richness condition (see Table 9.1).

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Team members</th>
<th>Managers</th>
<th>Team members</th>
<th>Managers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore ((n = 39))</td>
<td>11</td>
<td>5</td>
<td>18</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>Offshore ((n = 28))</td>
<td>4</td>
<td>8</td>
<td>9</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>28</strong></td>
<td><strong>10</strong></td>
<td><strong>39</strong></td>
<td><strong>15</strong></td>
<td><strong>67</strong></td>
</tr>
</tbody>
</table>

9.2.2. Data analysis

Data analysis of the Q sorts was carried out using SPSS for Windows, as well as PQMethod (Schmolck, 2002). For the initial analyses principal components analysis and Varimax rotation was used to obtain orthogonal factors ensuring the independence and thus easier interpretation of views (Stainton Rogers, 1995). PQMethod was then employed to identify the defining statements for each factor. Sorts were analyzed separately for onshore and offshore groups, as well as team leaders and team members leading to four groups: team leaders onshore \((n = 10)\), team leaders offshore \((n = 15)\), team members onshore \((n = 29)\), and team members offshore \((n = 13)\).

The relevance of the two aspects subgroup integration and vertical centraliza-
tion was calculated as their percentage in the twenty highest-ranking items (i.e., items with the ten highest and ten lowest Z-scores in the normalized factor rankings) in each factor. In the same way the relative importance of TASK, PROCESS, and RELATIONSHIP statements was assessed, although here only the general direction was considered, i.e., whether the majority of items pointed towards separation/centralization or integration/decentralization. The accompanying interviews were used to validate and qualify results of the Q sort analyses (Flick, von Kardoff, & Steinke, 2004). These interviews were also analyzed for evidence of changes in behaviors or expectations in team members.

9.3. Findings

9.3.1. Results of the factor analyses

The scree-tests in the exploratory factor analysis showed a clear two-factor structure for all groups except offshore team members, where a three-factor solution was chosen. With the exception of onshore managers, the underlying characteristic that differentiated the factors in each of the groups was media condition, i.e., whether participants worked in the high- versus low-richness setting. This is an interesting result, as Q methodology does not make prior assumptions on the grouping of participants, that is the differentiation between factors could have been based on any attribute such as team membership, job function, tenure, age, or gender. In this sample, media condition appeared as the main formative influence in shaping integration-decentralization expectations.

The only group that did not show a clear differentiation in terms of media condition was onshore managers. Here both factors included an equal number of sorts from both settings. Team leaders in factors one and two did not differ systematically in terms of tenure, age, gender, or leadership experience. Instead differences in views seemed to be based on job function and responsibilities in the onshore subgroup. Factor 1 comprised managers, whose job required continuous interaction with the offshore subgroups. Factor 2 comprised managers with little need for ongoing contact to offshore. I thus named the two factors continuous coordination condition and discontinuous coordination condition.

In contrast to other groups, the factor solution for offshore team members showed three factors, one with participants in the high-richness condition, one with participants in the low-richness condition, and one mixed factor. Because two of the four Q
sorts in this mixed factor had been administered by an offshore manager, it cannot be ruled out that this may have influenced the ratings, particularly with respect to vertical centralization expectations. I therefore decided to exclude the mixed factor from further consideration. A summary of the factors identified in the four groups is provided in Table 9.2. The detailed factor analyses results and a summary of the defining statements for the four groups can be found in Appendix E.

Table 9.2.: Q methodology – Summary of the final factor solutions

<table>
<thead>
<tr>
<th>Group</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onshore members</strong></td>
<td>high-richness group</td>
<td>low-richness group</td>
<td></td>
</tr>
<tr>
<td>(56.40%, 29 sorts,</td>
<td>32.61%</td>
<td>23.78%</td>
<td></td>
</tr>
<tr>
<td>6 sorts excluded*)</td>
<td>16 sorts: 13 HR</td>
<td>7 sorts: 5 LR</td>
<td></td>
</tr>
<tr>
<td><strong>Offshore members</strong></td>
<td>low-richness group</td>
<td>mixed (excluded for</td>
<td>high-richness group</td>
</tr>
<tr>
<td>(67.33%, 13 sorts,</td>
<td>28.49%</td>
<td>method. reasons)</td>
<td>19.15%</td>
</tr>
<tr>
<td>2 sorts excluded*)</td>
<td>6 sorts: 6 LR</td>
<td>19.69%, 3 sorts: 2 HR</td>
<td>2 sorts: 2 HR</td>
</tr>
<tr>
<td><strong>Onshore managers</strong></td>
<td>continuous coordi-</td>
<td>discontinuous coordi-</td>
<td></td>
</tr>
<tr>
<td>(65.73%, 10 sorts,</td>
<td>nation, 35.03%</td>
<td>nation, 30.70%</td>
<td></td>
</tr>
<tr>
<td>2 sorts excluded*)</td>
<td>4 sorts: 2 HR</td>
<td>4 sorts: 2 HR</td>
<td></td>
</tr>
<tr>
<td><strong>Offshore managers</strong></td>
<td>low-richness group</td>
<td>high-richness group</td>
<td></td>
</tr>
<tr>
<td>(55.79%, 15 sorts,</td>
<td>29.63%</td>
<td>26.16%</td>
<td></td>
</tr>
<tr>
<td>2 sorts excluded*)</td>
<td>7 sorts: 6 LR</td>
<td>6 sorts: 5 HR</td>
<td></td>
</tr>
</tbody>
</table>

LR – low-richness condition, HR – high-richness condition; * exclusion of sorts loading equally high on more than one factor

9.3.2. Comparison of group expectations

In comparing expectations, I was interested in two aspects: Firstly, in what way the four groups differed in the direction of their expectations, as well as the relative importance of subgroup separation–integration versus vertical centralization–decentralization expectations; secondly, in how far the four groups differed in the relative importance of the three aspects TASKS, PROCESSES, and RELATIONSHIPS. In the following, I detail the findings for both aspects.
Cooperation expectations across groups

The biggest difference between groups was found for the vertical centralization–decentralization dimension, and here most markedly for team leaders (see Figure 9.2). While offshore managers in the high-richness condition and onshore managers in the continuous coordination condition favored a decentralized management style, offshore managers in the low-richness condition and onshore managers in the discontinuous coordination condition preferred a strong top-down leadership style. While the former agreed strongly to statements, such as “The people at the sharp end should be empowered to decide on how to deal with any emerging problems themselves”, the latter preferred statements such “It has to be the team leader who sets the performance standards for the team and monitors whether the team performs accordingly”.

These differences were explained in the accompanying interviews, which clearly highlighted the disparate views on the role of managers, e.g.,

**Onshore manager, continuous coordination factor:** “These engineers are responsible guys. We’re not dealing with people working stocking shelves . . . This is a highly effective team without me telling. I don’t need to check in on these guys and say, ‘right, now what were you planning to do today?’”

**Offshore manager, low-richness condition:** “We need to curb that, ‘this is what we’re going to do’, because if that guy is not technically competent to make up the decision around doing some form of modification or a change. And that’s what my role is, to fix that; to make sure they follow the rules because these guys are doing a lot of things they are not supposed to be doing.”

In contrast to managers, team members favored a decentralized management style – independent of media condition or subgroup. In the low richness conditions, expectations of offshore staff about the position of team leaders were thus in direct contrast with expectations of the team leaders themselves. Offshore managers, for instance, retained for themselves “the right to make decisions and prioritize and make sure that people are doing what you expect them to do”, whereas an offshore technician working in the same team stated:

“It’s not like we need to be told what to do. . . . Without the team leaders, the place would still survive. The work would get done. Maybe not in the order the onshore wanted it done or the manner that onshore wanted it done, but the work would get done.”

In contrast, statements such as “There is no need for the team leaders to get involved in day-to-day operations. Onshore and offshore personnel are more flexible and ef-
9.3. Findings

"Ficient if left alone" (PROCESSES/coordination) found very strong agreement from offshore team members in both conditions.

In the high-richness condition, both offshore members and managers favored a decentralized, more empowering management style. Expectations in the offshore subgroup thus diverged in the low richness conditions, but concurred in the high-richness condition.

![Diagram showing relative importance and direction of subgroup separation–integration and vertical centralization–decentralization expectations in the four groups.](image)

**Figure 9.2.** Relative importance and direction of subgroup separation–integration and vertical centralization–decentralization expectations in the four groups.
The onshore subgroup showed the same pattern. Onshore engineers in both conditions favored vertical decentralization, and onshore managers in the continuous coordination factor concurred with this preference. Managers in the discontinuous coordination factor, however, showed a very clear preference for close involvement in team coordination. This difference in the views of managers was born out by distinguishing statements such as “Team leaders need to keep close control on how things are done” (processes/control; continuous condition: -2, discontinuous condition: +2) or “The people at the sharp end should be empowered to decide on how to deal with any emerging problems themselves” (tasks/decision-making; continuous condition: +4, discontinuous condition: -1).

Onshore members likewise favored an independent role with little involvement of team leaders in the direct, day-to-day work. They perceived themselves as highly skilled individuals that did not need close supervision by managers; although the receptiveness for managers’ input increased with the perceived expertise of the team leader (e.g., “if it’s a good team leader you obviously agree with him having more control, but if he is a poor team leader or he doesn’t know his stuff, then he needs more advice from the team.”; onshore engineer, high-richness condition). Still, too close supervision was actually considered ‘erosive’ to their decision making authority:

**Onshore engineer, high-richness condition**: “It starts to erode your control if team leaders come and make all the decisions and then takes all that control away from the support engineers.”

Groups showed no differences in expectations for **subgroup integration-separation**. All participants – independent of subgroup, hierarchical level, and media condition – favored the close integration between subgroups. Items such as “Onshore and offshore have to have the same goals, objectives, and agendas; otherwise we will never achieve the best results for our asset” (relationships/alignment) ranked high in all profiles. Interview comments suggest that this preference may be based on the awareness that onshore and offshore personnel depended on each other to achieve the common team task, e.g.,

**Onshore engineer, high-richness condition**: “If it’s that sort of things going on day by day effecting production, we need input from offshore and they need input from us.”

**Offshore manager, high-richness condition**: “We need to talk to the [onshore] engineers to get vendors organized. We need to talk with them how to do the task, etc., etc.”

Because subgroup separation–integration and vertical centralization–decentrali-
9.3. Findings

Zation statements were mixed into the same item set, I was able to compare the relative importance of the two dimensions across groups. In the low-richness, respective discontinuous coordination condition, subgroup integration and vertical decentralization tended to be of about equal importance in all groups; between 45 and 60% of the high-ranking statements were on subgroup integration. In the high-richness/continuous coordination condition, this percentage increased to between 65% and 75%. The higher frequency of subgroup integration statements in the high ranking items suggests a greater importance of the subgroup integration aspect and less concern about the role of team leaders. Only offshore members showed the reverse effect, in that the relative importance of subgroup integration was slightly lower in the high-richness condition (55% versus 50%; cf. Figure 9.2).

Relative importance of TASK, PROCESS, and RELATIONSHIP aspects

A graphical summary of the findings for the three team work aspects TASKS, PROCESSES, and RELATIONSHIPS is shown in Figure 9.3. In the low-richness condition, the primary focus of onshore and offshore members was on task coordination (60% of all statements in the highest ranking items). Considerably less emphasis was placed on processes (35% and 20%) and relationships (5% and 20% of the highest ranking statements, respectively). In the high-richness condition, emphasis on relationships was higher (25% and 30%), whereas emphasis on the task aspect decreased (45% and 35%). Overall, team member profiles showed a higher similarity for members in the same media condition than for members in the same subgroup, but different media condition.

Managers in the low-richness/discontinuous coordination condition showed a near equal emphasis for all the three aspects, whereas managers in the high richness/continuous coordination condition focused mostly on the task aspect. Similar to team members, the team leader profiles showed a greater similarity between managers in the same condition than between managers in the same subgroup, but different conditions.

Summary of findings

Overall, results indicate that alignment of expectations across all groups was considerably higher in the high-richness/continuous coordination condition than in the low-richness/discontinuous coordination condition – both in terms of direction of expectations and the relative importance of dimensions and team work aspects. In the
Chapter 9. Study five: Effects of media change on cooperation expectations

### Figure 9.3:

Relative importance of TASKS, PROCESSES, RELATIONSHIPS in the four groups (independent of direction and dimension)

<table>
<thead>
<tr>
<th>Team members</th>
<th>ONSHORE SUBGROUP</th>
<th>OFFSHORE SUBGROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LowR</strong></td>
<td>Tasks (5%)</td>
<td>Processes (25%)</td>
</tr>
<tr>
<td><strong>HighR</strong></td>
<td>Tasks (25%)</td>
<td>Processes (30%)</td>
</tr>
<tr>
<td><strong>LowR</strong></td>
<td>Tasks (60%)</td>
<td>Processes (60%)</td>
</tr>
<tr>
<td><strong>HighR</strong></td>
<td>Tasks (35%)</td>
<td>Processes (45%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Managers</th>
<th>DisC</th>
<th>ConC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LowR</strong></td>
<td>Tasks (40%)</td>
<td>Processes (20%)</td>
</tr>
<tr>
<td><strong>ConC</strong></td>
<td>Tasks (35%)</td>
<td>Processes (45%)</td>
</tr>
</tbody>
</table>

LowR - low-richness condition; HighR - high-richness condition
DisC - discontinuous coordination; ConC - continuous coordination

#### 9.3.3. Linking media capabilities and behavioral and structural changes

As part of the interviews, I asked participants for effects of the technology change on subgroup coordination and leadership involvement. Participants in the high-
richness condition had previously worked under the same technological conditions as those in the low-richness environment, and were thus able to compare the two settings. In line with findings in Study 3 participants in Study 5 reported improvements in onshore-offshore coordination and personal relationships.

In the onshore subgroup, these improvements led to a reduction of involvement by management (vertical decentralization) and more direct interactions between lower levels of the organizations (lateral integration):

ONSHORE ENGINEER: “Management [offshore] would only speak to the management here [onshore] or to technical authorities. [The team leader] needed information from you, so he could relay that offshore. Now that that’s happening at the lower levels, [he] stays well out of it.”

ONSHORE ENGINEER: “Before, if I wanted to contact offshore I would always go through the OOE, whereas now I have no issue with ringing up the OTL or even the control room.”

Team members referred to this reduced involvement of managers as an empowering experience that provided them with more decision space and freedom for action. Interestingly these changes were seen as a conscious decision by team leaders and directly attributed to the changes in technologies:

ONSHORE ENGINEER: “[Our team leader] has given us - can I use the word empowerment? ... He has given us much more freedom to make calls on these jobs ... partly because that flow of information from onshore to offshore is now happening a) quicker and b) to the right people.”

This view was largely affirmed by the onshore managers themselves:

ONSHORE MANAGER: “[Before] I would probably be involved in the gathering of information and on appraising the problem that would take a longer time, whereas now, because of the [new technology], I can do that very quickly and I can step out at an earlier time.”

ONSHORE MANAGER: “Part of the experiment was to see if people would step up to the plate if left to their own devices. In most cases they have. ... It gives them opportunities to be leaders, I guess.”

While according to the self-reports the technology change did not have an impact on managers’ roles, it appeared to have had a direct or indirect impact on leadership behaviors. In the interviews, participants attributed these changes directly to the differences in media capabilities.

Like their onshore colleagues, offshore managers in the high-richness condition agreed on the need for close subgroup coordination and decentralization of control.
This attitude was a considerable change from the low-richness condition. Offshore managers were still more cautious, however, when it came to relinquishing control over processes fearing a fragmentation of existing offshore processes and structures (cp. Study 3). Decentralization in the offshore subgroup was consequently focused on smaller tasks and did not reach the scope of the onshore subgroup. It is likely that this was due to the much more structured and proceduralized nature of processes offshore, which were set in place to control the risks involved in hydrocarbon production on offshore platforms. Offshore tasks need closer oversight to prevent dangerous overlaps, and broad decentralization in an offshore environment may thus increase the risk of incidents. These aspects become of critical interest, when considering the decentralization expectations observed in offshore members.

9.4. Discussion

In this study I investigated the impact of technology change on cooperation expectations. The main objectives of Study 5 was to explore, whether the changes in coordination behaviors observed in Study 3 were accompanied by changes in cooperation expectations, and to identify potential conflicts between the ‘spirit’ of the CE implementation and reactions in teams.

The findings from Q methodology and semi-structured interviews indicated a clear divide of expectations along media conditions in three of the four groups. As Q methodology does not make a priori assumptions on the number of factors or the type of characteristics underlying these factors, these findings suggests that media condition directly or indirectly impacted attitudes towards the organization of team processes. Only the Q sorts for onshore team managers did not fall into clear low- and high-richness groups. For this group the factors instead sorted according to the required degree of onshore–offshore coordination.

Independent of location or condition participants favored the integration between subgroups. Yet, the relative importance of subgroup integration compared to vertical decentralization was higher in the high-richness (respective continuous coordination) condition. The general preference for subgroup integration is likely a recognition of the high interdependence between onshore and offshore groups. The fact that groups using richer media attribute a higher importance to this dimension points towards a better understanding and appreciation of these interdependencies.

The most marked difference between profiles existed for vertical centralization–decentralization expectations. Team members generally favored a decentralized
leadership style. Managers with less direct contact to the other subgroup (either due to leaner media or due to discontinuous coordination needs) preferred a centralized, top-down leadership style, while managers with more consistent or more direct interaction between subgroups (i.e., richer media or continuous coordination needs) clearly favored a decentralized management style. The difference was most marked in offshore managers. While team leaders in the low-richness condition preferred a strong hierarchical work organization, their colleagues in the high-richness condition not only attached less significance to the position of team leaders, but also preferred the participation of team members with respect to tasks and relationships. A possible explanation is that in the traditional setting offshore managers primarily liaised with managers onshore, while in the new environments they developed closer communication links also with onshore team members. Further, offshore managers probably profited most from the new technologies as their role before the implementation consisted to a large extent in the distribution of information from onshore down the offshore hierarchy or to inform onshore of developments on-site. Most of the routine information could now be exchanged directly between technicians and onshore engineers freeing the management for other tasks.

Onshore managers were the only group that did not fall into separate Q-sort factors according to media condition. A possible explanation is that onshore managers were the only group that was not in direct contact with the new technology and was thus not directly impacted by the media change. The interviews suggested that some onshore managers were well aware of the opportunities of the new technologies for greater decision-making freedom and discretion at lower levels and acted accordingly. It is possible that the richer technology now simply supported a management style some of the managers had already preferred, but which had not been possible in the traditional environments. Managers with a more technical focus, but no personnel responsibility were generally highly critical of decentralization and instead preferred a strongly centralized management position. As the function of technical managers was primarily the supervision and decision on technical and engineering standards, it is conceivable that technical managers saw greater decentralization as a threat to their authority. Line managers with their more strategic outlook and additional personnel responsibility possibly perceived this as less problematic. Evidence from interviews suggests that these differences in expectations between onshore team members and technical managers indeed lead to conflicts, as well as resentment after the CE implementation. Shortly after the implementation the organization in fact decided to eliminate the position of technical manager with the
reasoning that it had become obsolete.

Contrary to my assumptions onshore, team members in the high-richness condition attached little importance to the vertical decentralization dimension. Comments by members and team leaders indicate that the technology change had already relocated some of the decision making authority to lower levels and that team members did feel a greater freedom and autonomy in their work. It is therefore possible that the aspect of vertical decentralization had lost its relevance, as the team was already moving in the desired direction.

In another marked difference between conditions, team members in the high-richness condition placed more emphasis on the RELATIONSHIPS aspect, while members in the low-richness concentrated mostly on the TASKS aspect. It is likely that the closer contact between subgroups increased the awareness for the relevance of relationships and their mutual dependence. This suggests that media capabilities influence distributed cooperation also by introducing a more task-based or relationship-based focus.

9.4.1. Theoretical and practical implications

The findings in this study have several theoretical and practical implications. The discussion of technology effects on organizational structures and processes has a long history, and has been confirmed in a number of empirical investigations (e.g., Afuah, 2003; Brews & Tucci, 2004; Leonardi, 2007). From early on empirical studies have shown that the implementation of technologies into organization changes organizational structures and processes, as well as internal norms (cf. Zammuto et al., 2007). Affordances of technologies can bring about new or modified behaviors, which over time lead to modifications in processes and structures. But while these theories state a link between media capabilities, behaviors, and changes in structures, they do not make specific predictions why these changes stabilize or at what point these stop. Based on this study I suggest that changing expectations could account for the stabilization of new organizational processes or structures. Conflicts between technology affordances and expectations of team members towards the organization of work processes may also explain some of the tensions encountered in technology implementations.

The findings also have implications on the study of leadership in distributed teams. The relevance of leadership for the effective functioning and performance of teams has been a major concern for many decades (e.g., Hackman & Walton, 1986; Mc-
Grath, 1962; Zaccaro et al., 2001). While this research provides a reasonable understanding of leadership and follower processes in ‘traditional’ collocated settings, it is widely recognized that distribution increases the challenges for team leaders to fulfill their role effectively (e.g., Bell & Kozlowski, 2002). Especially the dependence of distributed teams on information technology to regulate and coordinate internal processes introduces a number of hurdles not present in more traditional forms of teamwork. Team leaders thus find it often more difficult to supervise member activities or to identify and forestall unproductive developments (Hertel, Geister, & Konradt, 2005). Due to the lack of personal interaction with their colleagues and supervisor, team members can feel socially isolated, which may lead to motivation losses (Belanger, Watson-Manheim, & Jordan, 2002), a lower commitment to team goals, and social loafing (Chidambaram & Tung, 2005; Karau & Williams, 1993). Accordingly, managers have often a more difficult task in motivating members, supporting commitment, and creating conditions that allow members to identify with the team, organization, and their leaders (e.g., Connaughton & Daly, 2004).

Research into distributed leadership has formulated a number of guidelines or suggestions on specific activities or behaviors for managers leading distributed teams. These suggestions are frequently formulated in a general style that implies that the same leadership styles and behaviors would apply to various distributed settings in the same way (e.g., Bell & Kozlowski, 2002; Connaughton & Daly, 2004; Joshi, Lazaro-va, & Liao, 2009). These general guidelines largely ignore the technological context of distributed collaborations. Based on my findings in Study 5 I would caution against this generic view. If members’ as well as managers’ expectations on how team processes should be organized are impacted by media capabilities, the type and availability of media can influence the ‘fit’ of specific leadership styles. I therefore argue that future investigations on the effectiveness of leadership styles and behaviors should consider more closely the technological framework in which distributed working takes place.

Changing expectations or attitudes towards subgroup integration and leadership involvement can have considerable impact on the role of managers. If followers expect more relaxed top-down control, they will be comfortable with fewer interventions from their leader and possibly hostile to leadership behaviors they perceive as micro-management. Changing expectations in team members triggered by technological modifications may thus necessitate a rethinking of leadership roles, styles, and behaviors (Avolio, Kahai, & Dodge, 2000) or team structures.

Expectations towards the organization of team or organizational processes also
play a role in cooperation between remote partners that do not know each other well or come from different organizations with disparate company cultures. Such multi-team systems can, for instance, be found in emergency-response or military operations, which combine multiple functions or sub-teams to accomplish an overarching goal. Apart from within-team activities to accomplish the individual proximal goals, members here also need to align their activities and objectives across teams to ensure that the whole team functions as an efficient unit (Marks et al., 2005; Rico et al., 2008). This study suggests that information and communication technologies may play a role in the speed and extent to which common norms develop among dispersed cooperation partners. Especially richer media may be beneficial for the alignment of expectations.

This study also highlights the importance of careful deliberation by organizational decision makers in choosing technologies. Organizations can control the degree of direct communication on the employee level by policies, but also by the type of technologies they provide. Changing expectations about organizational processes could be one of the ‘unintended consequences’ (McAulay, 2007) of implementing a new technology. The implementation of new media could create expectations that may not be in alignment with organizational strategies or goals. If technology is able to shape expectations on organizational processes, managers might find themselves spending considerable energy to countermand or ‘correct’ expectations that are not aligned with the overall organizational direction or strategy.

9.4.2. Limitations and extensions

This study was of a cross-sectional nature and therefore does not allow to draw causal links between media capabilities and the change of expectations. Clearly, a more systematic longitudinal investigation on technology changes is needed to establish this link. Also, although I found difference in the degree of alignment between team member and manager expectations in the two media conditions, I did not investigate the effects of conflicting or compatible expectations on team functioning, such as task or process conflicts or efficiency of team processes. Considering the importance of group norms on team processes and outcomes, further investigations into this topic are clearly needed.

Also, the focus of this study was on expectations, not on actual leadership or integration behaviors. I focused on subjective views and expectations of individuals rather than traces of technology use and appropriation such as number of messages
sent or observable behaviors. In using Q methodology, my aim was to capture the more transient effects of technology implementation. As intractable as expectations may seem at first sight, they can have a considerable impact on team behaviors and outcomes. Studies on the Pygmalion leadership style (Eden, 1990, 1992) for instance, suggest that leaders’ initial expectations influence subordinates’ motivation and performance. In the same way employees’ own intrinsic expectations can influence subsequent behaviors and motivation (Galatea effect; Eden, 1990, 1992). While participants indicated changes in manager’s behaviors, I did not verify these changes through direct observations. Further investigations into change processes over time should connect developments of attitudes with actual team member and leader behaviors.

The precise role of different media capabilities such as visibility, co-presence, or co-temporality for the alignment of expectations and norms is still unclear. More research is needed to clarify these relationships. Further, more systematic studies would be of value to clarify which capabilities can best support the development of shared expectations.
STUDY SIX: THE LONGITUDINAL IMPACT of TECHNOLOGY CHANGE on IDENTIFICATION, CONFLICTS, and TEAM OUTCOMES

Study 6 investigated the long-term impact of CE implementations on identification, conflicts and team outcomes. Its objects were (1) to detail changes in the social and team identification across subgroups and (2) to explore the impact of CE implementations on team functioning and outcomes (satisfaction and performance). It used four waves of surveys \( n = 249 \) over two and a half years. Generally, identification patterns did not change significantly after implementation. Team identification remained highest for the own subgroup compared to the remote subgroup, although I observed a marginal increase for identification with the whole team. A re-analysis of the data revealed, however, that onshore and offshore personnel discriminated differently between own and remote subgroup, as well as the whole team. Asymmetry in distributed teams thus led to disparate perceptions of team identification. Ratings for conflicts, satisfaction, and CE performance showed significant improvements up to twelve months after implementation, but dropped to pre-implementation levels at
eighteen months. This chapter discusses the theoretical implications for the study of team identification and practical implications for technology choices in distributed teams.

10.1. Introduction

In Study 1 self-reports in the interviews indicated that onshore and offshore personnel identified more with their own subgroup than with either the other subgroup or the whole team. Further, offshore personnel seemed to identify more with their own subgroup than onshore personnel did. The geographical isolation of offshore personnel, their unusual work place and work schedules compared to much of the remaining work force may account for the higher distinctiveness of offshore worker. Strong subgroup cultures and personal ties within the teams further add an affective component to the identification, which seemed to be missing in the onshore environment.

One of the preconditions for strong identification is distinctiveness between groups, which is strengthened through the ‘deindividualization’ of remote subgroups and close contact with members of the own subgroup (Ashforth & Mael, 1989; Coleman, Paternite, & Sherman, 1999; Reicher et al., 1995). The introduction of richer media in the context of CEs altered the degree of anonymity between subgroups. Especially the introduction of video-conferencing led to closer, more personal contacts between onshore and offshore personnel (cp. Studies 3 and 4). Especially mutual visibility, it has been argued, leads to changes in the social categorization of team members affecting overall team identification (e.g., Fiol & O’Connor, 2005).

Team identification, in contrast to subgroup identification, is linked with a reduction in task conflicts, a better management of relationship conflicts, and higher team performance (e.g., Bezrukova et al., 2009; Fiol & O’Connor, 2005; Mortensen & Hinds, 2001). Increasing team identification in distributed teams should thus improve team functioning and outcomes. Yet, effects are by no means clear-cut. Michinov, Michinov, and Toczek-Capelle (2004), for instance, found that the high team identification increases task- and moral-building, if teams use synchronous communication media. The same study did not find an impact of identification on performance. Given the asymmetries and strong subgroup cultures in onshore and offshore personnel it is further questionable, whether the introduction of advanced information and communication media is able to affect team identification. The first objective of Study 6 was therefore to investigate the relative changes in identifica-
tion with the subordinate group (subgroup) and superordinate group (whole team) before and after CE implementation.

Distributed working has frequently been linked to a higher degree of intra-team conflicts (Hinds & Mortensen, 2005; Hobman, Bordia, Irmer, & Chang, 2002), lower satisfaction (e.g., Caballer, Gracia, & Peiro, 2005), and lower team performance (e.g., Baltes et al., 2002). Yet, the discovery of processes such as technology adaption (e.g., Van der Kleij et al., 2009), moderating influences of team characteristics such as faultline strength (e.g., Lau & Murnighan, 2005), or impacts of task interdependence (Rico & Cohen, 2005) have demonstrated that a more dynamic long-term view of the effects of media capabilities is necessary. The link between team identification and team functioning and outcomes further raised the question, whether CE implementation affected conflicts, team member satisfaction, and team performance. This formed the second objective of Study 6.

10.2. Methods

10.2.1. Sample and procedure

This study was based on four waves of questionnaires, one before the implementation of CEs and three after the implementation of the final CE design (i.e., main phase). The three post-measurement points were five, twelve, and eighteen months after implementation. Data collection targeted all onshore and offshore personnel directly affected by the CE implementation. These were personnel working in the new onshore environments, onshore managers, and offshore personnel in regular contact with the CEs from control room technicians to middle managers. The total number of onshore personnel affected was six to eight people in each of the eight teams, i.e., 48-64 people across all teams. Membership or involvement in the offshore subgroup was more fluent and mainly determined by the frequency of CE usage. Considering only the ‘core personnel’, i.e., control room technicians, OTLs, OOEs, and OIMs, the number of affected offshore personnel was around eight people per team (considering one shift at any one time). The total number of directly affected personnel can therefore be estimated as about 16 people per team, resulting in 128 people over all eight teams at each measurement point. The total number of surveys to be expected over the four measurement points was therefore around 512. In total, I collected 249 responses over all four measurement points (total response rate of 48.63%).

I also collected questionnaires throughout the 12 months of the pilot phase. Be-
cause the CE designs and personnel in the pilot phase differed from the main phase, I decided to exclude this data (52 surveys) from the study. I further excluded 23 surveys from onshore personnel, who were not part of the CE teams (second and third tier personnel).

The study had been conceptualized as a longitudinal study with repeated measurements in the same teams. Repeated measurements, however, were only partly possible, as CE teams onshore, and to a lesser extent offshore experienced considerable turnover and changes in personnel. In consequence, only 39 participants did fill out surveys more than once. I decided to retain the repeated surveys, as not to further decrease the sample size. The majority of the data, however, were unique across measurement points, although within the same teams.

A breakdown of the data for time points and subgroup, as well as an overview of sample characteristics is provided in Table 10.1.

### Table 10.1: Sample description and data in Study 6

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Onshore personnel</th>
<th>Offshore personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>87.39% male</td>
<td>96.84% male</td>
</tr>
<tr>
<td>Age</td>
<td>31-40 (median)</td>
<td>41-50 (median)</td>
</tr>
<tr>
<td>Job tenure</td>
<td>5.19 years (std: 6.61)</td>
<td>5.61 years (std: 5.57)</td>
</tr>
<tr>
<td>Years in team</td>
<td>3.12 years (std: 3.47)</td>
<td>6.30 years (std: 3.92)</td>
</tr>
<tr>
<td>Managers in sample</td>
<td>18.37%</td>
<td>60.78%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample size and response rates</th>
<th>Before implementation</th>
<th>After implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>5 months</td>
</tr>
<tr>
<td>Onshore personnel</td>
<td>26</td>
<td>56</td>
</tr>
<tr>
<td>Offshore personnel</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td>Sum</td>
<td>34</td>
<td>95</td>
</tr>
<tr>
<td>Response rate</td>
<td>26.56%</td>
<td>74.22%</td>
</tr>
</tbody>
</table>

### 10.2.2. Variables and instruments

#### Social categorization and team identification

*Social categorization* was assessed for three aspects: gender, age group, and work location (i.e., being an onshore/offshore worker). To focus participants on their own
personal perceptions the instructions were given as “Thinking about your work, how strongly do you identify with the following?” All items were measured on a five-point scale ranging from 1, ‘not at all’ to 5, ‘completely’. The three aspects were considered as independent; I did therefore not calculate an overall score for social categorization.

Team identification in production teams can be focused on either the own subgroup, the remote subgroup, or the whole team. This differentiation makes allowance for the possibility that members can consider their own subgroup as their primary team, in contrast to the whole team including onshore and offshore personnel. Team identification was assessed with four items adapted from Van der Vegt and Bunderson (2005, e.g., “How much do you feel emotionally attached to your team?”). To differentiate between the three aspects of identification (own subgroup, other subgroup, whole team), I reformulated each of the four items to refer once to the onshore subgroup, once to the offshore subgroup, and once to the whole team (e.g., “How much do you feel emotionally attached to a) the onshore part of the team?, b) the offshore part of the team?, c) the team as a whole?”). Items were measured on a five-point scale from 1, ‘not at all’ to 5, ‘completely’. The four items for each group were combined into a separate scale to represent identification with either the onshore subgroup, the offshore subgroup, or the whole team. Internal consistency of the three scales were good with $\alpha = .87$ for identification with onshore, $\alpha = .86$ for identification with offshore, and $\alpha = .87$ for identification with the whole team. Following Henry, Arrow, and Carini (1999), team identification was defined as an individual-level process. The three variables were therefore not aggregated to the team level.

Intra-team conflicts

Intra-team conflicts were assessed using the Intragroup Conflict Scale for task and relationship conflicts (Jehn, 1995). Task conflict refers to conflicts over work issues (4 items; e.g., “There is conflict about the work in the team”, $\alpha = .63$), whereas relationship conflict refers to conflicts over interpersonal issues (4 items; e.g., “There is a lot of friction among team members”, $\alpha = .91$). Exploratory factor analysis confirmed the two-factor structure. Intra-team conflicts generally describe processes on the team level. The test for aggregability to the team level showed, however, that in nearly half of the teams’ perceptions were not in agreement (see Table 10.2). I therefore decided to treat intra-team conflicts on the individual level.
Table 10.2.: Indices for test of aggregability on the team level (Aggregation for values $r_{wg(j)}^{*} \geq .70$; values too low for aggregation in parenthesis)

<table>
<thead>
<tr>
<th></th>
<th>Onshore subgroup</th>
<th>Offshore subgroup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relationship conflicts</td>
<td>Task conflicts (internal)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-implementation (t0)</td>
<td>Team 2</td>
<td>.77</td>
</tr>
<tr>
<td></td>
<td>Team 3</td>
<td>(.60)</td>
</tr>
<tr>
<td></td>
<td>Team 5</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>Team 6</td>
<td>.87</td>
</tr>
<tr>
<td>Post-implementation (t1)</td>
<td>Team 1</td>
<td>(.61)</td>
</tr>
<tr>
<td></td>
<td>Team 2</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>Team 3</td>
<td>(.54)</td>
</tr>
<tr>
<td></td>
<td>Team 4</td>
<td>.98</td>
</tr>
<tr>
<td></td>
<td>Team 5</td>
<td>(.60)</td>
</tr>
<tr>
<td></td>
<td>Team 6</td>
<td>.98</td>
</tr>
<tr>
<td></td>
<td>Team 7</td>
<td>(.64)</td>
</tr>
<tr>
<td></td>
<td>Team 8</td>
<td>(.61)</td>
</tr>
<tr>
<td>Post-implementation (t2)</td>
<td>Team 1</td>
<td>.97</td>
</tr>
<tr>
<td></td>
<td>Team 2</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>Team 5</td>
<td>.94</td>
</tr>
<tr>
<td></td>
<td>Team 6</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Team 7</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Team 8</td>
<td>(.40)</td>
</tr>
<tr>
<td>Post-implementation (t3)</td>
<td>Team 1</td>
<td>(.15)</td>
</tr>
<tr>
<td></td>
<td>Team 2</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>Team 3</td>
<td>(.66)</td>
</tr>
<tr>
<td></td>
<td>Team 5</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>Team 6</td>
<td>(.55)</td>
</tr>
<tr>
<td></td>
<td>Team 8</td>
<td>.77</td>
</tr>
</tbody>
</table>
10.2. Methods

Communication frequency

Past research has demonstrated that communication frequency between subgroups impacts team identification (Brickson, 2000; Cramton & Hinds, 2005). I therefore also captured changes in the communication frequency between subgroups. Communication frequency was measured as average number of weekly interactions with the other subgroup. Because it was not possible to obtain objective measures such as email or phone records, self-reports had to be used. Participants were provided with a list of communication media and asked to mark all media they used, when communicating with the other subgroup (phone, email, audio-conferencing, other; after implementation also: video-conferencing, desktop sharing). They were further asked to provide an estimate of the average usage frequency per week. The total amount of communication per week was then calculated as the sum of all media. Communication frequencies showed fourteen extreme outlier values (based on Z-scores > 1.96), which were excluded from the analyses.

Team outcomes

Outcomes were assessed as individual satisfaction and CE performance. Individual satisfaction was assessed with respect to collaboration with colleagues in the CE onshore (e.g., “How do you feel at the moment about the collaboration with your colleagues in the CE onshore”?), collaboration with colleagues in the CE offshore, and the overall impression of the work. CE performance was assessed with respect to seven aspects: meeting objectives, quality of decision making, speed of decision making, effectiveness of problem solving, effectiveness of collaboration between onshore and offshore, getting access to information, and overall performance. The seven aspects were integrated into an overall performance score. Exploratory factor analysis confirmed a one factor structure (see Table 10.3) with good reliability ($\alpha = .86$).

CE performance was calculated separately for internal and external ratings. Onshore managers were not part of the CE teams. Their ratings thus provided an external measure for CE performance. The internal measure of CE performance consisted of CE members onshore, offshore staff, and offshore managers. In contrast to the onshore subgroup, offshore managers were the main CE users. Ratings of offshore managers were thus included into the internal performance measure. CE performance is a group-level construct, and internal ratings were thus aggregated to the team level (Klein et al., 1994). Aggregation was tested using the $r_{wg(j)}$ in-
Table 10.3.: Factor analysis results for CE performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeting objectives</td>
<td>.65</td>
</tr>
<tr>
<td>Quality of decision making</td>
<td>.80</td>
</tr>
<tr>
<td>Speed of decision making</td>
<td>.80</td>
</tr>
<tr>
<td>Effectiveness of problem solving</td>
<td>.73</td>
</tr>
<tr>
<td>Effectiveness of onshore-offshore collaboration</td>
<td>.77</td>
</tr>
<tr>
<td>Getting access to information</td>
<td>.37</td>
</tr>
<tr>
<td>Overall performance</td>
<td>.85</td>
</tr>
</tbody>
</table>

*Explained variance* 52.90%

dex for multi-item scales developed by Lindell, Brandt, and Whitney (1999). The calculation was done separately for onshore and offshore subgroups in each team for the four measurement points. Aggregation is possible, if \( r_{wg(j)}^* \geq .70 \). Results indicated that aggregation was possible except for three values at time \( t_2 \) in the offshore subgroups (see Table 10.2). These three teams were excluded in the subsequent analyses. External ratings were only represented by one onshore manager per team, so no aggregation was performed.

**Independent variables**

Time and primary work location were the two independent variables in this study. Time consisted of the four measurement points: pre-implementation \((t_0)\), five \((t_1)\), twelve \((t_2)\), and eighteen \((t_3)\) months after implementation. Primary work location was coded as either onshore or offshore.

The full list of items used in Study 6 can be found in Appendix F.

**10.2.3. Data analysis**

Intra-group conflicts, communication frequency, team and social identification, and satisfaction were assessed at the individual level. Individuals were nested within teams, and accordingly linear multilevel analyses were employed to account for the

---

1 Tests by Lindell and Brandt (1997) and Lindell et al. (1999) have revealed irregular behaviors of the original \( r_{wg(j)} \) index for multi-item scales developed by James, Demaree, and Wolf (1984). For this reason, the alternative \( r_{wg(j)}^* \) suggested by Lindell et al. (1999) was used, which provides more stable estimates (Eby, Meade, Parsi, & Douthitt, 1999; Hofman, 2002).
10.3. Results

effects of team membership. Time and primary work place, as well as their interaction were entered as fixed factors, team membership as random factor. Internal ratings of CE performance was a team-level variable, and I thus used univariate ANOVA to test for effects of time and primary work place on team average CE performance. Because the sample consisted of different participants at each of the four measurement points, they were treated as independent. Changes in external ratings of CE performance were analyzed using univariate ANOVA with time as independent variable. Correlations between variables were calculated separately for the two subgroups and each of the measurement points using Spearman’s rho.

10.3. Results

Table 10.4 shows the means, standard deviations, and correlations for the variables in Study 6.

Team identification. Team identification was measured only at five and eighteen months after implementation, so only three measurement points could be compared. I found significant main effects for work place in both analyses for subgroup identification (identification with the onshore subgroup: $F(1, 147.41) = 22.70, p < .001$; identification with the offshore subgroup: $F(1, 149) = 27.59, p < .001$). Participants thus identified significantly more with their own subgroup than did participants of the remote subgroup (both $p < .001$, see also Figure 10.1a and b). There was no difference in subgroup identification across the three time points (identification with the onshore subgroup: $F(2, 133.38) = 2.25, p = .11$; identification with the offshore subgroup: $F(2, 149) = 1.01, p = .37$). Onshore and offshore personnel did not differ in their identification with the whole team ($F(1, 145) = 1.50, p = .22$). There was, however, a marginally significant main effect for time ($F(2, 145) = 2.76, p = .07$), in that identification with the whole team was higher at five and eighteen months after the technology change then before CE implementation (see also Figure 10.1c).

Social categorization. Social categorization was assessed with respect to the three aspects gender, age group, and work location. Gender identification did not differ across the three measurement points ($F(2, 154) = 0.31, p = .74$), but showed a significant main effect for subgroups ($F(1, 154) = 10.17, p < .01$), in that gender identification was significantly higher in offshore than onshore personnel (see Figure 10.1e).
## Table 10.4: Descriptive statistics and Pearson correlation coefficients

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social categories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Age group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Work location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team identification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Onshore subgroup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Offshore subgroup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Whole team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intra-team conflict</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Relationship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. External rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Communication frequency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Variable on the team level; 
† n = 11

\( n = 219 \); \( p < .001 \); \( * p < .01 \); \( * * p < .05 \); \( * * * p < .10 \); \( ' p < .15 \); \( + p < .20 \); \( ± p < .25 \).
Comparable results were found for identification with age group, i.e., a significant main effect for subgroup affiliation ($F(1, 153) = 7.70, p < .01$), but no main effect for time ($F(2, 153) = 0.22, p = .80$). Again, offshore personnel identified stronger with age group than onshore personnel (see Figure 10.1f).

Identification with work location was assessed at all four measurement points, i.e., before and five, twelve, and eighteen months after the technology change. Identification with work location showed a significant main effect for subgroup affiliation ($F(1, 204.96) = 17.71, p < .001$), as well as time ($F(3, 206.96) = 10.80, p < .001$). A Sidak post-hoc test revealed that identification with work location was significantly higher twelve months after implementation compared to all other measurement points. At the same time, offshore personnel identified significantly more with work location than onshore personnel (see Figure 10.1d). None of the interaction effects between time and primary work place were significant.

**Communication frequency.** Communication frequency showed a significant main effect for time ($F(3, 180) = 4.13, p < .01$), but not for subgroup affiliation ($F(1, 180) = 1.66, p = .20$). A Sidak post-hoc test revealed that communication frequency was higher at twelve and eighteen months after implementation compared to pre-implementation levels. In average offshore personnel reported slightly more communications per week ($m = 46.74$ versus $m = 38.99$), but this difference was not significant (see Figure 10.2).

**Intra-team conflicts.** Onshore and offshore personnel did not differ in their ratings of relationship conflicts ($F(1, 216.99) = 0.19, p = .664$) or task conflicts ($F(1, 215.18) = 0.15, p = .70$; see Figures 10.3a and b). Relationship conflict differed, however, across measurement points, $F(3, 213.28) = 5.60, p < .001$, with a significant decrease at twelve months and an increase at eighteen months. For task conflicts the main effect for time was only marginally significant, $F(3, 214.61) = 2.43, p = .07$. A post-hoc comparison found no significant differences across measurement points.

**CE outcomes.** Onshore personnel rated CE performance as significantly better than offshore personnel ($F(1, 170) = 57.17, p < .001$), although the internal performance ratings showed similar changes across time ($F(2, 170) = 66.18, p < .001$). Performance ratings for both subgroups were highest at twelve months after implementation, with a drop to the five month ratings at t3. The same reversed U-shape was found for external ratings by onshore managers ($F(2, 216) = 10.18, p < .001$).
Chapter 10. Study six: Changes in identification, conflicts, and team outcomes

2.5

4.5

pre-implementation

5 months

18 months

a) Identification with ONSHORE SUBGROUP

b) Identification with OFFSHORE SUBGROUP

WORK PLACE

Onshore subgroup

Offshore subgroup

c) Identification with WHOLE TEAM

d) Identification with WORK LOCATION

e) Identification with GENDER

f) Identification with AGE GROUP

Figure 10.1.: Team and social identification over time (estimated means)
Satisfaction revealed a parallel increase and decrease as CE performance with significant main effects for time in all three aspects (collaboration with onshore colleagues: $F(1, 220) = 5.30, p < .01$; collaboration with offshore colleagues: $F(3, 218) = 8.33, p < .001$; overall work satisfaction: $F(3, 218) = 4.02, p < .01$). Onshore personnel were significantly more satisfied in their collaboration with onshore colleagues than were offshore personnel ($F(1, 220) = 10.01, p < .01$). Subgroups showed no difference in their satisfaction with offshore ($F(1, 218) = 0.28, p = .60$) or overall work satisfaction ($F(1, 218) = 0.77, p = .38$). Figure 10.4c-f provides a graphical representation of team outcomes over time.

**Correlations: Team identification.** The correlations between identification and communication frequency showed somewhat inconsistent results (see Table 10.5). The three aspects gender, age, and work location were unrelated to communication frequency, expect for a marginally significant relationship of age in the onshore subgroup. Higher levels of communication were, however, linked to higher subgroup and team identification in the onshore subgroup before and five months after CE implementation. At eighteen months these correlations disappeared. For offshore personnel, communication frequency and identification was completely unrelated, except for identification with the whole team and marginally with the offshore subgroup. The general amount of communication seemed thus relevant for identifica-
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Figure 10.3.: Intra-team conflicts over time (estimated means)

tion only in the onshore subgroup, although not at later stages after implementation.

To test the effect of visibility on identification, I calculated separate correlations for the usage frequency of video-conferencing. For offshore personnel the use of video-based communication was positively related to identification with the onshore subgroup at both post-measurement points. For onshore personnel it was related only to identification with gender at eighteen months after implementation (see Table 10.5).

In previous research, team identification was identified as support for team functioning and outcomes. Such a link was only found for onshore personnel (see Table 10.6). In the onshore subgroup, team identification was negatively related to task conflicts five months after implementation, as well as to relationship conflicts five and eighteen months after implementation. Team and subgroup identification was further positively related to the three aspects of satisfaction at all three measurement points, while correlations with CE performance were only found at eighteen months after implementation.

For offshore personnel, relationships showed no very coherent pattern. The three types of identification were positively related only to overall work satisfaction five months after implementation. Identification with the onshore subgroup was further positively related to satisfaction with onshore collaboration at $t_2$ and internal ratings of CE performance at $t_3$. A relationship between identification and conflicts was only found for onshore identification and relationship conflicts at $t_2$. 

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In contrast to onshore personnel, for which all three aspects of identification were related to conflicts and outcomes, for offshore personnel identification with the onshore subgroup seemed the most relevant aspect. Correlations pre-implementation and eighteen months after implementation, with one exception, were all found to be non-significant. The sample sizes in the offshore subgroup were small, especially at $t_0$. The low number of significant correlations in the offshore subgroup could thus be an expression of the low test power due to the small sample sizes.
Table 10.5.: Correlations between communication frequency and identification (Spearman’s rho)

<table>
<thead>
<tr>
<th>Identification with</th>
<th>All media</th>
<th>Video only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t0</td>
<td>t1</td>
</tr>
<tr>
<td>Onshore subgroup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Gender</td>
<td>-.02</td>
<td>-.18</td>
</tr>
<tr>
<td>2. Age group</td>
<td>-.37†</td>
<td>.09</td>
</tr>
<tr>
<td>3. Work location</td>
<td>-.09</td>
<td>.12</td>
</tr>
<tr>
<td>4. Onshore subgroup</td>
<td>.51*</td>
<td>.45**</td>
</tr>
<tr>
<td>5. Offshore subgroup</td>
<td>.55*</td>
<td>.28†</td>
</tr>
<tr>
<td>6. Whole team</td>
<td>.57**</td>
<td>.34*</td>
</tr>
<tr>
<td>Offshore subgroup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Gender</td>
<td>†</td>
<td>-.07</td>
</tr>
<tr>
<td>2. Age group</td>
<td>†</td>
<td>-.31</td>
</tr>
<tr>
<td>3. Work location</td>
<td>†</td>
<td>.16</td>
</tr>
<tr>
<td>4. Onshore subgroup</td>
<td>†</td>
<td>.21</td>
</tr>
<tr>
<td>5. Offshore subgroup</td>
<td>†</td>
<td>.36†</td>
</tr>
<tr>
<td>6. Whole team</td>
<td>†</td>
<td>.45*</td>
</tr>
</tbody>
</table>

onshore: n = 94; offshore: n = 56; † p < .10; * p < .05; ** p < .01; † too little data for analysis

Correlations: Conflicts and team outcomes. As with social and team identification, correlations between conflicts and team outcomes showed different patterns for onshore and offshore personnel (Table 10.7). In the onshore subgroup, intra-team conflicts and satisfaction were consistently negatively related five and eighteen months after implementation, while intra-team conflicts and internal CE performance were unrelated at any measurement point. For offshore personnel, higher levels of task and relationship conflicts were negatively related to satisfaction with onshore colleagues five and twelve months after implementation. In contrast to the onshore subgroup, data for offshore personnel also showed a negative relationship between conflicts and internal ratings of CE performance at t2 and t3. It thus seems that for onshore personnel conflicts had a stronger impact on satisfaction, while for offshore personnel they had a stronger impact on performance. The negative relationships between conflicts and external ratings of CE performance were only marginally significant at t3. The very high correlations in combination with the small number of onshore managers suggest that these results may be probably spurious and interpretations of these relations should therefore be made with care.
Table 10.6.: Correlations between identification, conflicts, and outcomes (Spearman’s rho)

<table>
<thead>
<tr>
<th></th>
<th>Onshore subgroup</th>
<th>Offshore subgroup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Identification with</td>
<td>Identification with</td>
</tr>
<tr>
<td></td>
<td>onshore subgroup</td>
<td>offshore subgroup</td>
</tr>
<tr>
<td><strong>Pre-implementation (t0)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship conflicts</td>
<td>-.16</td>
<td>-.28</td>
</tr>
<tr>
<td>Task conflicts</td>
<td>.03</td>
<td>-.39</td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>.48*</td>
<td>.26</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>.42*</td>
<td>.56**</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>.45*</td>
<td>.62**</td>
</tr>
<tr>
<td><strong>Post-implementation (t1)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE performance (internal)</td>
<td>.10</td>
<td>.15</td>
</tr>
<tr>
<td>CE performance (external)</td>
<td>.33</td>
<td>.35</td>
</tr>
<tr>
<td>Relationship conflicts</td>
<td>-.21</td>
<td>-.25</td>
</tr>
<tr>
<td>Task conflicts</td>
<td>-.34*</td>
<td>-.47**</td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>.41**</td>
<td>.27*</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>.29*</td>
<td>.27*</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>.43**</td>
<td>.37*</td>
</tr>
<tr>
<td><strong>Post-implementation (t3)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE performance (internal)</td>
<td>.54**</td>
<td>.41*</td>
</tr>
<tr>
<td>CE performance (external)</td>
<td>.73</td>
<td>.92*</td>
</tr>
<tr>
<td>Relationship conflicts</td>
<td>-.44*</td>
<td>-.47*</td>
</tr>
<tr>
<td>Task conflicts</td>
<td>-.55**</td>
<td>-.60**</td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>.73**</td>
<td>.74**</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>.39*</td>
<td>.57**</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>.42*</td>
<td>.38*</td>
</tr>
</tbody>
</table>

Onshore: n = 94; Offshore: n = 56; *p < .10; *p < .05; **p < .01; ***p < .001
Chapter 10. Study six: Changes in identification, conflicts, and team outcomes

Table 10.7.: Correlations between conflicts and outcomes (Spearman’s rho)

<table>
<thead>
<tr>
<th></th>
<th>Onshore subgroup</th>
<th>Offshore subgroup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relationship</td>
<td>Task</td>
</tr>
<tr>
<td></td>
<td>conflicts</td>
<td>conflicts</td>
</tr>
<tr>
<td>Pre-implementation (t0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>-.06</td>
<td>.11</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>-.03</td>
<td>-.10</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>-.10</td>
<td>-.06</td>
</tr>
<tr>
<td>Post-implementation (t1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE performance (internal)†</td>
<td>-.08</td>
<td>-.06</td>
</tr>
<tr>
<td>CE performance (external)</td>
<td>-.43</td>
<td>-.45</td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>-.49**</td>
<td>-.31*</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>-.51**</td>
<td>-.13</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>-.41**</td>
<td>-.39**</td>
</tr>
<tr>
<td>Post-implementation (t2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE performance (internal)†</td>
<td>-.08</td>
<td>-.31</td>
</tr>
<tr>
<td>CE performance (external)</td>
<td>-.61</td>
<td>-.41</td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>.19</td>
<td>.25</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>.01</td>
<td>.06</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>-.12</td>
<td>.00</td>
</tr>
<tr>
<td>Post-implementation (t3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE performance (internal)†</td>
<td>-.25</td>
<td>-.29</td>
</tr>
<tr>
<td>CE performance (external)</td>
<td>-.82†</td>
<td>-1.00</td>
</tr>
<tr>
<td>Satisfaction w/ onshore colleagues</td>
<td>-.46*</td>
<td>-.55**</td>
</tr>
<tr>
<td>Satisfaction w/ offshore colleagues</td>
<td>-.44*</td>
<td>-.40*</td>
</tr>
<tr>
<td>Work satisfaction</td>
<td>-.38*</td>
<td>-.40*</td>
</tr>
</tbody>
</table>

onshore: n = 94; offshore: n = 56; † p < .10; * p < .05; ** p < .01; *** p < .001; † variable on team-level

10.4. Discussion

The objective of Study 6 was to investigate the longterm effects of a change towards richer media on identification with subgroups and the overall team, as well as intra-team conflicts and outcomes. Overall, the findings showed that onshore and offshore personnel identified stronger with their own subgroup than with the remote subgroup. This can be seen as an indication that continued geographical distance and asymmetries also led to a cognitive and emotional distance between subgroups.

One motive for the categorization of people into definable groups is uncertainty reduction. By referring to a group as a complete entity it is possible to ignore the individual differences of members and instead replace them with a generic prototype of how this group as a whole ‘is like’. This reduces the complexity in dealing with its members, because it provides a frame of reference to predict actions of the
10.4. Discussion

other group. Offshore personnel, for instance, tended to refer to onshore personnel summarily as “those guys on the beach” leaving little room for inter-individual differences. This moniker also demonstrates that work location (onshore versus offshore) was one of the most distinctive and salient aspects in differentiating the two groups.

The availability of richer technology after CE implementation did not lead to a change in the identification with the own or remote subgroup, which remained higher for the own compared to the other part of the team. The technology change, however, did lead to a slight and parallel increase in identification with the whole team in onshore and offshore personnel. The fact that identification with the own subgroup remained stable, while identification with the whole team increased speaks for the development of a ‘dual identity’, in which the own subgroup remained the main focal point, but team members also developed a stronger connection to the superordinate group.

At the same time, the technology change did not significantly increase identification with the remote subgroup. The data showed some increase, but these increases were not significant. Media did not alter the existing asymmetries between subgroups in terms of location, role, or subgroup cultures, and the two subgroups apparently had too little overlap in their characteristics for either side to consider themselves as part of the other group. But instead of a further ‘splintering’ or separation as predicted by Fiol and O'Connor (2005), team members latched on to a higher order category, the whole team. The closer interaction and higher visibility with the remote subgroup thus seemed neither to erase, nor increase perceptions of differences.

The dual identification suggests that team members are able to perceive themselves as parts of disparate entities. This speaks for an acceptance of subgroup differences as part of the team task (‘agree to differ’). Research in collocated diverse teams demonstrated that a belief in the value of diversity is positively related to group identification (Knippenberg, Haslam, & Platow, 2007). Such pro-diversity beliefs have a positive impact on team performance in collocated diverse teams (Homan et al., 2007). Although pro-diversity beliefs were not assessed in this study, interview data suggests that the technology change did lead to a better understanding and appreciation of the other subgroup (see also Study 3, Chapter 7). These results suggest that asymmetric distributed teams do not necessarily need to develop a single, shared identity, if they can develop identification with a superordinate unit. Also, subordinate and superordinate identity need not necessarily be in conflict.
This study does not clarify, what aspects the two identities are based on, i.e., what the social categories are that differentiate subgroups, but unite the whole team. Also, this study cannot clarify the cognitive and affective processes underlying the development of dual identification in distributed teams. These aspects clearly require further study.

**Communication frequency versus visual contact.** One ambiguity in the literature on identification in distributed teams is the status of communication between dispersed members. While some authors argue that the degree of communication and the integration of communication networks is important (Brickson, 2000; Crampton & Hinds, 2005), others explicitly refer to the effects of visual contact (Fiol & O’Connor, 2005; Postmes et al., 2002). The question thus is whether changes in identification were due to a general increase in communication or the higher richness in media. The implementation of the CEs led to a significant increase in interactions after the technology change, especially for offshore personnel.

Overall communication frequency was positively related to subgroup, as well as team identification. This again points to a parallel process of subgroup and team identification. Identification is based on distinctiveness and salience of common characteristics. Closer interaction with members of the other subgroup can highlight differences between subgroups and thus increase the distinctiveness of the own subgroup. However, neither onshore nor offshore personnel significantly changed identification with their own or the remote subgroup. Thus, the simple fact of more communication did not have a marked effect on subgroup identification. The parallel increase in identification with the whole team together with the positive correlation with communication frequency suggests, however, that the degree of interaction with the other subgroup may well have an effect on overall team identification. Eighteen months after implementation no relationship between communication frequency and identification was found in either subgroup. This might indicate that after a time the effect of communication ceases to have an impact on identification, i.e., indicate the stabilization in team and subgroup identification after the technology change.

Considering only interactions using video-conferencing, i.e., visual contacts between subgroups, no relationship was found for onshore personnel, expect a lower identification with gender eighteen months after implementation. For offshore personnel, however, visual communication was significantly related to identification with the onshore subgroup. This might be an indication that richer media may have
disparate importance for subgroups. While visual contact seemed to be relevant for the offshore subgroup, it was not related to team identification in the onshore subgroup. This suggests that subgroups may focus on different elements in the social categorization process or that subgroups rely on different attributes for identification. Further research is needed to investigate in what way subgroup characteristics influence categorization processes.

**Location as main factor for shaping identification.** The importance of the demographic characteristics age and gender was significantly higher for offshore compared to onshore personnel, but did not change with the implementation of richer technologies. More specifically, visual communication did not show relationships with either of the demographic categories age or gender. This contradicts suggestions by Fiol and O’Connor (2005) that richer technologies should increase social categorization based on visible features. Yet, as Harrison et al. (1998) demonstrated in collocated teams, surface-level attributes lose their importance over time. It is thus possible that five months after the technology change the relevance of demographic differences had already subsided. Additional studies using shorter intervals between implementation and measurement would be able to confirm or disconfirm these assumptions.

Offshore personnel also identified significantly more with work location. The category work location replicated the split between onshore and offshore groups focusing specifically on the physical separation. The consistently higher relevance of the work location for offshore personnel may be explained by the higher distinctiveness and salience of offshore work. Working on an isolated platform already sets offshore personnel apart and provides even a clear physical demarcation between onshore and offshore personnel. Working offshore is also connected with an image of ‘daring’, as well as confronting adversity (see Study 1, Chapter 5). Based on cognitive dissonance theory it could be argued that the choice to work in an unattractive workplace leads to cognitive dissonance, which needs to be explained. This dissonance may be resolved by increasing the positive sides of the job, either instrumentally (higher salary) or affective (liking, must be better than working onshore).

Identification with the work location increased significantly until twelve months after implementation, after which time it dropped again to the pre-implementation level. The initial raise speaks for an increase in the salience of the physical separation through the implementation of richer media. This could explain why identification with the own subgroup remained high. Identification with work location,
However, did not hinder the increase in identification with the whole team. This indicates that, while work location may be one of the most obvious separating characteristics for subgroup identification, other aspects are relevant for identification with the whole team. Thus, at least in this sample identification with the own subgroup and identification with the team seemed to be driven by a different set of features. Further research is needed to substantiate this claim and to obtain a better understanding of the types of categories that influence identification with sub- and superordinate groups.

Identification was also significantly related to the perception of conflicts and team outcomes, although these relationships were more consistent for onshore personnel than for offshore personnel. For onshore personnel, especially collaboration satisfaction and overall work satisfaction were positively related with subgroup, as well as team identification over all three measurement points. A positive relationship was also found for identification and internal CE performance ratings, albeit only after eighteen months. These results are consistent with results by Cunningham and Chelladurai (2004), who found that a strong in-group identity increases process satisfaction, and is itself linked to positive perceptions of group performance. Likewise, intra-team conflicts were significantly negatively related to all three aspects of identification.

For onshore personnel all three aspects of identification played a near equal role in the perception of satisfaction, conflicts, and team outcomes. Reviewing the mean values for the three aspects of identification, I found that on average onshore personnel rated all three aspects very similarly (e.g., means for pre-implementation ratings: $m_{onshore} = 3.84$, $m_{offshore} = 3.28$, $m_{whole\ team} = 3.55$). Onshore personnel seemed to make less of a distinctions between the own subgroup, remote subgroup, and whole team compared to offshore personnel (e.g., means for pre-implementation ratings: $m_{onshore} = 3.14$, $m_{offshore} = 4.25$, $m_{whole\ team} = 3.79$). The stronger differentiation in the offshore subgroup is in line with the higher identification with the own workplace found for offshore personnel. This points to systematic differences in the perception of these aspects.

To test this assumption I conducted exploratory factor analyses for both subgroups over all twelve identification items and four measurement points (four items each for onshore identification, offshore identification and identification with the whole team). The onshore data showed a clear two-factor solution (see Table 10.8). The first factor contained nine of the twelve items including an equal number of items referring to onshore, offshore, and the whole team. The second factor contained
the three items on “how much do you feel that the team’s problems are your own?” Onshore personnel thus did not differentiate between own and remote subgroup or whole team. The solution for offshore personnel showed three factors (see Table 10.9). The second and the third factor each combined items on identification with the whole team and the offshore subgroup, while the second factor comprised the items referring to the onshore part of the team.

Table 10.8.: Exploratory factor analysis for team identification items: Onshore personnel \((n = 94)\)

<table>
<thead>
<tr>
<th>Item: “How much do you feel”</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Part of a family in the team - whole team</td>
<td>.88</td>
<td>.20</td>
</tr>
<tr>
<td>2. Part of a family in the team - onshore part</td>
<td>.85</td>
<td>.15</td>
</tr>
<tr>
<td>3. Emotionally attached to the team - whole team</td>
<td>.83</td>
<td>.34</td>
</tr>
<tr>
<td>4. Emotionally attached to the team - offshore part</td>
<td>.82</td>
<td>.25</td>
</tr>
<tr>
<td>5. A strong sense of belonging to the team - whole team</td>
<td>.82</td>
<td>.37</td>
</tr>
<tr>
<td>6. A strong sense of belonging to the team - offshore part</td>
<td>.80</td>
<td>.17</td>
</tr>
<tr>
<td>7. Part of a family in the team - offshore part</td>
<td>.79</td>
<td>.20</td>
</tr>
<tr>
<td>8. Emotionally attached to the team - onshore part</td>
<td>.76</td>
<td>.33</td>
</tr>
<tr>
<td>9. A strong sense of belonging to the team - onshore part</td>
<td>.66</td>
<td>.37</td>
</tr>
<tr>
<td>10. That the team’s problems are your own - whole team</td>
<td>.35</td>
<td>.89</td>
</tr>
<tr>
<td>11. That the team’s problems are your own - onshore part</td>
<td>.16</td>
<td>.88</td>
</tr>
<tr>
<td>12. That the team’s problems are your own - offshore part</td>
<td>.27</td>
<td>.86</td>
</tr>
</tbody>
</table>

Explained variance

| Explained variance | 50.20% | 25.00% |

Hence, identification in the two subgroups seemed to experienced very differently. While results showed that team members identified stronger with the own subgroup than did members of the remote subgroup, onshore personnel still seemed to perceive less of a divide between the two subgroups than team members offshore. These findings mirror comments from interviews, in which offshore personnel insisted that offshore “is a world apart”. Interestingly, offshore personnel seemed not to differentiate as strongly between the own subgroup and the whole team as between the own subgroup and the onshore subgroup. This again speaks for a dual identification with both a subordinate and a superordinate group. The separation between the two subgroups in the factor analysis could thus be interpreted as yet another expression that offshore team members do not perceive their onshore colleagues as part of their own group, but still as part of the larger group.²

² Separate factor analyses for each of the three measurement points largely replicated the factor structures
Table 10.9.: Exploratory factor analysis for team identification items: Offshore personnel (n = 56)

<table>
<thead>
<tr>
<th>Item: “How much do you feel”</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. That the team’s problems are your own - whole team?</td>
<td>.88</td>
<td>.13</td>
<td>.11</td>
</tr>
<tr>
<td>2. Emotionally attached to the team - whole team?</td>
<td>.72</td>
<td>.34</td>
<td>.21</td>
</tr>
<tr>
<td>3. That the team’s problems are your own - offshore part?</td>
<td>.70</td>
<td>-.07</td>
<td>.24</td>
</tr>
<tr>
<td>4. Emotionally attached to the team - offshore part?</td>
<td>.70</td>
<td>.06</td>
<td>.22</td>
</tr>
<tr>
<td>5. A strong sense of belonging to the team - whole part?</td>
<td>.68</td>
<td>.31</td>
<td>.47</td>
</tr>
<tr>
<td>6. That the team’s problems are your own - onshore part?</td>
<td>.58</td>
<td>.52</td>
<td>-.28</td>
</tr>
<tr>
<td>7. Like part of a family in the team - onshore part?</td>
<td>-.07</td>
<td>.87</td>
<td>.15</td>
</tr>
<tr>
<td>8. A strong sense of belonging to the team - onshore part?</td>
<td>.17</td>
<td>.81</td>
<td>.06</td>
</tr>
<tr>
<td>9. Emotionally attached to the team - onshore part?</td>
<td>.20</td>
<td>.80</td>
<td>-.09</td>
</tr>
<tr>
<td>10. Like part of a family in the team - offshore part?</td>
<td>.14</td>
<td>-.02</td>
<td>.95</td>
</tr>
<tr>
<td>11. A strong sense of belonging to the team - offshore part?</td>
<td>.41</td>
<td>-.19</td>
<td>.73</td>
</tr>
<tr>
<td>12. Like part of a family in the team - whole team?</td>
<td>.25</td>
<td>.44</td>
<td>.70</td>
</tr>
</tbody>
</table>

**Explained variance**  
28.34%  23.23%  20.18%

**Team conflicts and outcomes.** Considering team functioning over time, relationship conflicts decreased from pre-implementation to twelve months after CE implementation, but increased again to pre-implementation levels at eighteen months. At the same time, satisfaction and performance ratings increased up to twelve months, but decreased at eighteen months. I found these changes in conflicts, satisfaction, and performance for onshore, as well as offshore team members, and apart from collaboration satisfaction with onshore the perception of overall team processes did not differ between subgroups.

The ratings of team functioning and outcomes thus suggest significant improvements up to twelve months after CE implementation. The drop at eighteen months in all measures of team functioning and outcomes in both subgroup is mirrored by a negative change in external ratings of CE performance. Several explanations are possible. In interviews, team members reported numerous benefits of the technology change for coordination and team relations (cf. Studies 3, 5). The positive development in the team ratings could thus be a reflection of these positive changes in team found in both subgroups. This seems to indicate a stable effect that was not impacted by changes in the technology or organizational structure. Yet, as sample sizes at the individual time points are comparatively small, it seems problematic to draw conclusions with any degree of certainty.
functioning. The drop to pre-implementation levels at eighteen months may be an expression that teams have grown used to the new technology and view the changes and new processes as a now normal part of their work. As detailed in Study 3, the implementation of CEs was accompanied by subtle, but far-reaching changes in the roles and work patterns of subgroups. It is therefore also possible that after the initial ‘honeymoon’ period of unexpected positive experiences, teams started to become aware of the more problematic aspects of the technology change.

It could also be argued that the long-term nature of my engagement in the UK PU may have had an impact on ratings. Some teams received the same questionnaire four to five times over the 30 months of Study 6. This may have led to a certain degree of weariness to fill out ‘yet another survey’, which may have contributed to the lower ratings. Yet, as the number of participants that reacted to the same questionnaire more than once was very small, this effect should not have played a major role. More important might have been a certain degree of ‘experimenter effect’. Most of the questionnaires up to twelve months after implementation I handed out in person. Due to my continuous presence in the UK PU I had very good relationships to a large proportion of the participants. Participants were aware of the effects I was looking for, which may have encouraged more positive ratings. Closer relationships and a more positive attitude towards the research may further have led to a self-selection process – in that more critical team members responded less. At $t_3$ I had been gone from the UK PU for six months, which had loosened the contact. On the other hand, my contacts with the offshore community had been rather loose compared to the onshore subgroup. Nonetheless, offshore team members showed the same improvement and drop. If an experimenter effect was to blame, it should have been absent or at least less pronounced in offshore personnel.

More likely are lingering effects of the restructuration of the onshore organization. This organizational change happened shortly before the beginning of the main phase of the CE implementation and was accompanied by high levels of insecurities and concerns, as well as turmoil due to the necessary modifications in existing work processes and organizational structures. The beginning of the main CE implementation fell together with the settling down period after the re-organization. The positive changes in the team ratings could thus also be an expression of the overall improvement of the climate in the onshore organization. The drop in ratings at eighteen months may simply denote a ‘return to normal levels’ after this difficult period. I am not aware of other developments within the organization that might have caused the drastic drop in ratings around $t_3$. 
Chapter 10. Study six: Changes in identification, conflicts, and team outcomes

Overall, it is problematic to conclude that changes in team functioning and outcomes were (solely) due to the implementation of CEs. While interviews surely support a general impression of positive changes in team coordination and relationships, there were numerous modifications in the organizational environment with likely influences on the perception of team processes independent of the technology. Technology after all is only a small part of the organizational environment. The decline in team functioning and performance at eighteen months could indicate three things: either the positive perceptions of the technology change were not retained (adaptation effect), increasing (awareness of) negative effects of the implementation, or other factors worked against or countermanded otherwise positive effects (suppression by context factors).

Study 6 is based on self-reports, not objective data of team functioning and performance, and perceptions of organizational members are swayed by many factors. Interesting in this regard is that all three variables – conflicts, satisfaction, and performance – were perceived by onshore and offshore in a similar way across all measurement points. This suggests that perceptions within teams concurred and were not significantly impacted by subgroup contexts. Although team identification was influenced by membership in one or the other subgroup, perceptions of the more general team processes seemed not influenced by the existing asymmetries. This indicates that even within distributed teams and despite strong heterogeneity, members of ongoing teams can perceive team processes in a comparable way. Study 5 suggested that alignment in expectations is supported by richer media. My data does not allow checking whether the perception of team processes also became more similar between subgroups after the implementation of new media. This would be an interesting topic for further study.

10.4.1. Limitations

The majority of studies on social identification in distributed teams have been conducted in the laboratory under controlled conditions, and thus sacrifice generalizability and realism in favor of control and accuracy (McGrath & Kravitz, 1982). This study, in contrast, was conducted in the field, and thus suffers under the reverse problem – lack of control. The study took place under conditions of considerable turmoil and change within the organization unconnected with the CE implementation. These external events clearly had an impact on the perception of team processes and member satisfaction. But also the implementation of CEs in itself was a stressful
10.4. Discussion

Event for most teams, especially for onshore personnel.

External events can be triggers for the activation of social identity faultlines (Chrobot-Mason, Ruderman, Weber, & Ernst, 2009; Cramton & Hinds, 2005). Chrobot-Mason et al. (2009) identified five such events, among others the unequal treatment of subgroups. As chapter 6 illustrated, onshore and offshore subgroups received very different attention during the implementation, which led to some resentment specifically in the offshore subgroup. Such differential treatments, as well as the differential effects for the two subgroups may have influenced the perception of team processes, as well as the degree of subgroup identification. Given the additional external events in the organization during the time of the CE implementation, it is difficult to argue that the findings in this study are only due to the technology change within teams.

The study had originally been conceptualized as a longitudinal study. Yet, the considerable turnover within the teams meant that there was little consistency within teams and consequently, the sample consisted largely of independent measures. The results therefore cannot be interpreted as true developments over time. They are rather independent snapshots of individual and team states at different times before and after implementation. Moreover, restrictions in access to offshore personnel led to very low response rates, especially for the pre-implementation measure (cp. Chapter 4). More problematic still, pre-implementation surveys from offshore represent only one team. Hence, generalizability across teams is questionable.

On the positive side, in investigating mature teams instead of newly created project or students teams, this study demonstrates the complexity of real team processes and of CE effects in asymmetric distributed teams. Study 6 also highlighted topics for identification research that need further attention. Especially the effects of asymmetry, in isolation or together with distribution, and the question of which features impact simultaneous sub- and superordinate identification would be worth further investigation. The changes in identification after CE implementation point toward an impact of technology features on identification processes. Because of the lacking variation between teams I could not compared different media settings or isolate technology features. Most research so far focused on visibility and thus communication media. The combined effects of information and communication technologies, as found in CEs, or more specifically the impact of information technologies have been largely ignored. Findings from this study and studies reported earlier in this thesis suggest that this is an omission that should be remedied in the future.
The essence of technology is by no means anything technological.

Martin Heidegger (German Philosopher, 1889-1976)

DISCUSSION and IMPLICATIONS

The aim of this PhD project was to clarify the role of technology in distributed team coordination. Distributed teams depend on technology to transmit information and establish communication between dispersed members. The premise in this thesis was that technologies and their features shape internal team processes and outcomes. In other words, technology design influences team processes and through this organizational processes and structures. But this is neither a one-way nor a deterministic process. Study 3 in this thesis demonstrated, how changes towards richer technologies modified long-established roles and routines, Study 5 highlighted the capability of technologies to affect type and alignment of coordination expectations. Other studies demonstrated clearly, how team characteristics, intra-team dynamics, and the organizational environment shape perceptions, adoption, and use of technologies (cf. Study 1 on the impact of asymmetries or Study 2 on the implementation and adoption process).

That technology impacts team processes and that the usage context of technology influences technology perceptions and usage is not a new thought. Most well known in this respect is probably the triangle of technology, institutional properties, and
human agents by Orlikowski (1992), who also introduced the concept of the ‘dual nature’ of technology and more recently the notion of *sociomateriality* (Orlikowski, 2007) – the latter emphasizing the “inherent inseparability between the technical and the social” (Orlikowski & Yates, 2008, p. 434).

The contribution of this thesis lays in the application of this thought to a new context – distributed asymmetric teams. The main theoretical contributions of this thesis are

- the introduction of the concept of asymmetry and its effects on distributed team work,
- reframing IT implementation and adoption as a team-level process,
- the development of a model for IT adoption in distributed teams,
- a delineation of effects of technological versus structural means to bridge geographic distribution, and
- a detailed view on the processes, with which multiple technologies impact on team functioning and more specifically intra-team coordination in mature asymmetric distributed teams.

Findings from this thesis also provide practical contributions. Their main target groups are organizations using distributed teams, managers of distributed teams, and designers of support technologies. While some studies supply concrete suggestions (e.g., Study 3 for technology choices and features, or Study 2 for the ‘do’s and don’ts’ of distributed implementations), I see the primary benefit of the empirical work more generally in highlighting the process nature of technology implementations, and even more the extent of aspects technology changes impact within distributed teams. This thesis also reiterates the often undervalued role of technology designers as organizational designers and the trans-disciplinary nature of technology implementations in organizations.

In the following, I summarize the key findings of the six studies reported in this thesis. The subsequent sections discuss the theoretical and practical implications, followed by a description of limitations and strengths, and possible extensions for further research.

### 11.1. Summary of key findings

The six empirical studies targeted different aspects of technology use and technology change in distributed team coordination; for an overview see Figure 11.1.
11.1. Summary of key findings

Study 5

- subgroup asymmetry
- intra-team coordination
- subgroup relationships
- team opacity

Study 2

- team-level implementation and adoption
- defined by valence alignment
- moderate ICT use and effects

Study 4

- geographic distribution
- structural integration
- ICT change
- reliance on roles, routines, planning (explicit coordination)
- modification of rules, routines
- team opacity
- development
- leadership styles/behaviors
- acceptance and adjustments
- ICT change
- team conflicts and outcomes
- onshore
- offshore
- over time

Study 3

- misalignment of priorities, requirements, preferences
- disparity
- team opacity

Study 6

- acceptance
- and adjustments

Figure 11.1: Aspects investigated in Studies one to six
Study 1 was a qualitative study that examined the systematic differences between onshore and offshore subgroups in production teams. Its aim was to provide a description of the type of asymmetries in production teams and their consequences for team functioning. Past research has shown that team configurations with two or more geographically dispersed subgroups experience more coordination problems, more conflicts, and weaker identification with the overall team than fully dispersed or collocated teams (O’Leary & Mortensen, 2010). More specifically, student teams consisting of two nationally different subgroups showed significantly more conflicts and less trust than more nationally balanced teams (Polzer et al., 2006). These findings suggested that dispersion and asymmetry impact team dynamics. Study 1 examined the combined effects of dispersion and asymmetries for team coordination and relationships. Based on reports in semi-structured interviews I identified three types of subgroup asymmetries that existed simultaneously in the production teams in my sample: task-related asymmetry (e.g., roles, priorities, expertise), demographic asymmetry (e.g., gender, age, education), and cultural asymmetry (attitudes, behaviors, relevance of social relations). The most problematic for effective coordination between subgroups was the combination of geographic distribution and task-related asymmetries. Distribution and disparate work schedules, for instance, led to lacking access to information and people, low transparency of processes, and lacking consistency in task execution. These aspects restricted the ability of teams for implicit coordination between subgroups. Explicit coordination was constrained by disparate priorities and different knowledge and expertise, which led to misunderstandings, faulty assumptions about work processes, and conflicts about the execution of tasks. Disparate aspects of task-related asymmetry thus exhibited differential effects on explicit and implicit coordination mechanism in the teams. The relative anonymity of the other subgroup together with demographic and cultural asymmetries resulted in comparatively loose subgroup relationships, which were characterized by a strong identification with the own subgroup, but a low identification with the other subgroup and the whole team. Based on the findings in Study 1 I argued that the implementation of information and communication technologies should be able to improve conditions for subgroup coordination by increasing mutual awareness and data availability. I further argued that information and communication technologies will play different roles in this process. While information technologies target the short-term problems of low visibility of processes and situation awareness in terms of plant status, communication technologies in the short term will increase social awareness and subsequently subgroup relationships. In the
long-term richer communication media should also lead to a better understanding of each other's knowledge and expertise (transactive memory systems, team learning).

**Study 2** investigated the CE implementation and adoption process from pre-implementation to early-usage and later-usage stages. Current literature considers implementation and adoption of technologies either on the individual or the organizational level, while team processes and group-level constructs are largely ignored (Lapointe & Rivard, 2007). Despite the growing prevalence of distributed working, distribution also has not yet received much attention in empirical or theoretical considerations on technology implementation and adoption. The same is true for team diversity. Individual studies have started to investigate the impact of national cultures (e.g. Bajwa et al., 2005; Griffith, 1998), disparate ‘social worlds’ in inter-organizational teams (Mark & Poltrock, 2004), or social influence in terms of social norms, image, visibility and voluntariness of usage (Yang, Moon, & Rowley, 2009), but heterogeneity in user collectives such as work teams remains a neglected topic. These are not only theoretical gaps, but also leave organizations without guidance on how to plan and conduct implementation processes in heterogeneous distributed settings. The first aim of Study 2 was to identify the practical challenges connected with CE implementations in asymmetric distributed teams, and subsequently to identify the group-level and context factors that influence acceptance and adoption from pre-implementation to long-term use. The study was based on a longitudinal comparison of three teams over pre-usage to early- and later-usage phases. In the pre-usage phase handling of the process was most critical in shaping initial expectations in potential users. Pre-implementation expectations were further shaped by the specific team context, subgroup-specific cultures, team identification in contrast to subgroup identification, and the subgroup-specific task-technology fit. Shortly after implementation, aspects like the degree of interdependence between subgroups, team familiarity, and process factors like equal treatment of onshore and offshore subgroups in the deployment of technologies became more relevant to decide the actual degree of usage in teams. Changes in technology use observed in the later-usage phase were due either to changes in the internal structure of the teams (e.g., high rate of turnover in one subgroup or in key personnel) or changes in the organizational environment (e.g., organizational structure). The probability for changes in the later-usage phase seemed higher, however, for teams in which no stable agreement on technology use had been reached in the early-usage phase. The findings further suggested that user satisfaction consists of two different aspects, namely technology satisfaction and process satisfaction, which are nearly inseparable at the
beginning of the implementation process but show a slow unlinking in the early- and later-usage phases. Based on the comparison of the three cases I developed a theoretical model to describe potential outcomes of technology implementations in distributed team settings. The model suggested two dimensions to describe teams’ attitudes towards new technologies: valence and alignment. Valence refers to the type of users’ attitudes (positive or negative), while alignment refers to the degree of congruence between users’ attitudes. I argue that different combinations of positive/negative valence and alignment/non-alignment can predict user reactions and implementation success in teams. I proposed that alignment in valence will lead to either adoption (for positive attitudes) or non-adoption (negative attitudes), while non-alignment will result in compliance or blocked adoption depending on strength of attitudes and comparative subgroup dominance. Alignment or non-alignment with respect to type of attitudes should lead to the four states of congruent adoption, conflicting use, congruent non-adoption, and disparate non-adoption. Based on the specific combination of valence and alignment I formulated general strategies on how to change users’ attitudes.

With the implementation of CEs organizations aim for the improvement of team processes and relationships in distributed teams. The choice of the right combination of technologies is not trivial, however, and design decisions must be informed by the potential consequences of these choices. In Studies 3 to 6, I examined the effects of CEs on team processes and outcomes. Study 3 focused on the effect of media capabilities on intra-team coordination comparing team processes before and after the implementation of advanced information and communication technologies. The focus was here on routine activities and the role of media capabilities in the coordination of these activities between onshore and offshore subgroups. Based on semi-structured interviews and observations, I found that richer media led to a closer integration of processes between the two subgroups and a shift from routine to non-routine interactions at lower levels of the organization. This led to increased awareness of activities, easier access to information, and faster reactions to unexpected events. Yet, the results also suggested three potential challenges for continuous coordination with richer media: a) the blurring of traditional subgroup roles, b) the loss of the longer-term, strategic focus for the teams, and c) the potential weakening of existing control systems. Based on these findings, considerations for the choice of information and communication technologies for asymmetric distributed teams were discussed.

Collaborative Environments are technological solutions to support distributed teams.
Despite the growing range of technological capabilities and choices, the exchange of knowledge and expertise through media remains problematic, especially if knowledge is site-specific (e.g. Sole & Edmondson, 2002). **Study 4** examined the physical integration of members into the remote subgroup as an alternative approach. In this study three CE designs were compared in their differential consequences for team coordination and outcomes. The three designs varied in the type of technological support and physical integration of subgroups and ranged from a purely technological solution, which relied solely on advanced media to connect remote subgroups, a structural solution based on the physical integration of members into the remote subgroups, to a hybrid solution, which combined the use of advanced media with the physical integration of members. The aim of this study was to examine the differential effects of these three solutions on team processes and relationships, to compare the spread of effects, and to identify the main risks and contingencies. Overall, the technological approach lead to the best availability to information and expertise, high activity and social awareness, faster identification and solution of problems, and allowed detailed mutual input in planning and decision making. It further led to closer, more personal relationships between subgroups. Main risks and contingencies were its vulnerability for failures in the technological infrastructure, its dependence on the willingness of personnel to use specific media, and possible conflicts in the media preferences of individuals or subgroups. Also, the establishment of contacts between job functions was largely determined by the location of communication media, e.g., the placement of video-conferencing in control rooms versus managers’ offices or public meeting areas. Careful consideration must thus be given to the placement of technology, as not to either overload personnel and interrupt critical work processes, or exclude relevant personnel. The structural solution seemed particularly well suited to support a small number of processes that needed detailed input from the remote group, and to move specific tasks such as detailed planning to an environment more appropriate for concentrated working. For these specific tasks the integrated personnel in the hosting group eliminated the need for communication between the remote subgroups, reducing the number of interactions. The main benefits were experienced by the hosting group, primarily in terms of the easy availability of offshore expertise. Main risks were the loss of experienced personnel for the sending group and the isolation of personnel from developments in their home group. The hybrid approach combined the positive effects of the structural solution (easy availability of offshore expertise for onshore personnel and reduction in calls to offshore) with the easier access to information and people. Team learning and
establishment of relationships between subgroups were largely restricted to the offshore personnel in the onshore group. As the only approach, the hybrid solution also created links among the offshore personnel of different teams. Main risks for the hybrid solution were reliability of infrastructure, as well as the depletion of the skill set for the sending group. Based on the comparison of the three approaches generic situations were suggested for which each design variation might be most appropriate. It was argued that the technological approach seems best suited for situations in which subgroups are highly interdependent, but many tasks rely on routine information and repeated processes with few exceptions or critical events. The structural approach was suggested as an option for more loosely-coupled distributed teams in which subgroups share few very specific interdependent processes and not much in-depth coordination is needed on an ongoing basis. The hybrid approach seemed well suited for situations in which critical, e.g., high hazard, tasks are performed in the remote location and where as much stress and strain should be taken off individuals at the remote location, or in which one side has a primarily supporting function for the other.

**Study 5** investigated the effect of media capabilities on expectations of team members and managers towards vertical decentralization and subgroup integration (i.e., lateral integration between subgroups). The study was based on the assumption that the richer media in the CE environments would lead to a greater alignment of expectations between subgroups. Results based on Q methodology and semi-structured interviews largely supported this assumption. Expectations were more similar across media conditions than across geographical groups (onshore/offshore) or functional groups (members/managers). In the high-richness condition member and manager expectations further showed greater alignment than in the low-richness condition. The findings in Study 5 suggest that media capabilities influence type and alignment of cooperation expectations between dispersed members in distributed teams. I thus propose that technological infrastructure in distributed teams may be a contingency for the effectiveness of managers’ leadership styles and behaviors mediated over cooperation expectations.

**Study 6** focused on the long-term effects of technology change on social identification, conflicts, and team outcomes (i.e., performance and member satisfaction). Its objectives were to investigate the relative changes in identification with the subordinate group (subgroup) and superordinate group (whole team), and to investigate the effect of technology change on team identification, conflicts, and outcomes over time. Study 6 was based on four repeated waves of surveys from pre-implementation
11.2. Theoretical considerations for the distributed team literature

to two and a half years after CE implementation. The increase in communication frequency after technology change was related to an increase in identification with the whole team, although members consistently identified more with their own subgroup than the remote subgroup. Results in Study 6 thus suggested that over time richer technologies led to the development of a ‘dual identity’ encompassing the own subgroups, as well as the whole team as superordinate category. At the same time, the perceived separation between subgroups seemed stronger for offshore personnel than onshore personnel. The technology change was further related to less intra-team conflicts and better performance and higher member satisfaction up to twelve months after implementation. Identification was negatively related to the perception of conflicts and positively to team outcomes especially for onshore personnel.

A simplified summary of the main findings for team aspects before and after CE implementations is shown in Figure 11.2. (This comparison is (arguably) oversimplified, but presents the general trends. For a discussion of the issues, caveats and contingencies underlying this graphic I refer back to the respective empirical chapters.)

11.2. Theoretical considerations for the distributed team literature

For the distributed team literature, results from this thesis have their main theoretical implications in three areas: (1) the introduction of asymmetry as extreme form of diversity, (2) the combined role of asymmetry and distribution on intra-team coordination in mature ongoing teams, and (3) the role of combinations of information and communication media and technology change on the functioning of longitudinal asymmetric distributed teams (LADTs).

11.2.1. The role of asymmetry and technology on intra-team coordination

One of the main contributions of this thesis is the introduction of asymmetry as theoretical concept. Findings in this thesis have demonstrated repeatedly its relevance for team processes, technology use, expectations, and preferences, as well as for the implementation and choice of technologies in distributed teams. The notion of asymmetry put forward in this thesis helps to frame work processes and technology use on the subgroup and group level. It addresses the collective properties of a group, not individual characteristics of users, thus highlighting the importance of meso-
level processes for intra-team coordination, as well as technology adoption and use. It thus helps to fill the theoretical and empirical gap that exists for this intermediate level (Klein & Kozlowski, 2000).

The main topic that emerged in this thesis was the role of alignment between dispersed asymmetric subgroups. Coordination in distributed teams requires the alignment of activities, as well as an agreement among users about the meaning and use of technologies, on which coordination between dispersed subgroups depends. The alignment of activities is driven by cooperation mechanisms, which ‘encapsulate’ practices of team coordination such as plans and rules, routines, roles, objects and representations, and proximity (Okhuysen & Bechky, 2009). The alignment on technology use is based on technology frames, which hold users’ assumptions, expectations, and knowledge about the nature and role of technology including “the specific conditions, applications, and consequences of that technology in particular contexts of use” (Orlikowski & Gash, 1994, p. 178). Lacking overlap or agreement of technology frames can lead to communication problems, conflicts, or even refusal to
11.2. Theoretical considerations for the distributed team literature

The reliance on technology in distributed teams makes the agreement in assumptions, expectations, and knowledge about technology even more significant. It is possible that distribution alone might cause misalignment of technology frames over time, but diversity among users does so very certainly and instantaneously. Distribution separates subgroups geographically. My findings demonstrated that asymmetry as extreme form of diversity adds separation in terms of task-related, demographics, and cultures. Misalignments and conflicts are therefore a normal part of asymmetric teams. Their settlement and alignment, however, are made even more challenging by geographic distribution and the accompanying team opacity.

The disparities in roles, preferences, requirements, etc. between asymmetric subgroups need to be cushioned either by shared understanding or by explicit coordination mechanisms. In absence of direct contacts, information and communication technologies must permit both. Media capabilities do not change team characteristics, i.e., distribution and degree of asymmetry, but they modify how teams can cooperate. Adjustments in cooperation mechanisms and expectations were the two main drivers of changes to team processes and relations, I identified in my thesis.

The implementation of CEs targeted two of the five cooperation mechanisms suggested by Okhuysen and Bechky (2009): proximity and the availability of common objects and representations across dispersed subgroups. Yet, while CEs were primarily directed at these two cooperation mechanisms, over time the changes in media capabilities also led to modifications in the remaining mechanisms, such as established rules and routines, the execution of plans, and agreed roles of subgroups (cf. Study 3). Information and communication technologies were thus not only the medium through which coordination was channeled, but also shaped the coordination mechanism themselves (see Figure 11.3).
The role of technology in the asymmetric distributed teams studied in this thesis was foremost that of supporting explicit coordination between dispersed subgroups. To achieve a common team goal, team members need to align their activities and objectives across subgroups to ensure that the whole team functions as an efficient unit (Marks et al., 2005; Rico et al., 2008). In an optimal state, teams should be able to coordinate implicitly, and to anticipate and dynamically adjust behaviors (Cannon-Bowers et al., 2003; Rico et al., 2008). Given the observations in this thesis, for asymmetric distributed teams this seems an unrealistic expectation. Richer media can support team learning and consequently the development of better mental models and transactive memory systems over time. Still, as the findings in this thesis showed, even longstanding, ongoing coordination seems not able to overcome the combined effects of continuous distribution and stark differences in task-related aspects, demographics, and cultures.

**Complementarity and competition of combined technologies**

The implementation of CEs provided a combination of advanced information, as well as communication technologies. Observations in the context of Study 3 showed that technologies concentrating on information or data and technologies providing communication links exhibited differential effects for team coordination. The access to real-time data, for instance, reduced the need for interactions between subgroups on routine information, whereas continuous video-links increased the ease for interactions.

The assumption for the combination in multiple technologies in CEs is that information and communication technologies provide support for different processes and should thus complement each other and lead to synergistic effects. Yet, my observations suggest that the combination of information and communication technologies can have the opposite effect. While in my sample some media indeed complemented each other (e.g., video-conferencing and desktop-sharing), other media either stood in direct competition (e.g., email, phone, video-conferencing) or could lead to ambiguities in the way they affected coordination (e.g., increase or reduction in communication frequencies). Combinations of information and communication technologies can send thus mixed messages.

They also open the field for media preferences. Asymmetries in work schedules and subgroup cultures, for instance, led to different media choices by onshore and offshore personnel – which constraint intra-team coordination and led to conflicts.
between subgroups (cf. Study 1). This observation does not imply the need to restrict technologies to only one or two. I argue however, that it is important to pay closer attention to the notion of complementing and competing technologies, when studying effects of technologies on distributed team processes.

The differential effects observed for information and communication technologies highlight a further gap in the study of technology for distributed team functioning. So far, empirical literature on the impact of computer-mediated communication in distributed teams has focused primarily on communication media. The objective of these studies is to contrast different media conditions such as text-, audio-, or video-based settings. Literature on computer-supported collaborative work, on the other hand, concentrates mostly on data presentation and design issues (e.g., Drews & Westenskow, 2006; Nova, Girardina, & Dillenbourg, 2010; Tory, Staub-French, Po, & Wu, 2008). This may be partly due to the type of tasks these studies investigate, the majority of which are knowledge tasks such idea generation, design, or management (e.g. Campbell & Stasser, 2006; Van der Kleij, Lijkwan, Raskera, & DeDreu, 2009; Lira, Ripoll, Peiro, & Zornoza, 2008). More ‘hands-on’ tasks or continuous processes such as production, in which the access to real-time or process data are important, are rarely studied.

An indication for the dominance of communication media in the computer-mediated communication literature is the lack of descriptive schemes for information media analogous to the ones developed for communication technologies (e.g. Clark & Brennan, 1991; Maruping & Agarwal, 2004; Priest et al., 2006). While concepts like media richness, social richness, or synchronicity abound, comparable schemes for information media are still lacking. This makes the conversation about features and their effects on team processes cumbersome. I therefore argues for a broadening of the focus of computer-mediated communication to include information and communication technologies, to more closely consider consequences of combinations of diverse media including the notion of complementarity and competition, and to develop a vocabulary for the description of information media.

**Linking media and team structures**

For distributed teams not only alignment on technology use is important, but also agreement on how coordination should be organized. In this thesis richer media capabilities led to a better alignment in cooperation expectations between subgroups and hierarchical levels (cf. Study 5). Personnel using richer media preferred close
integration, as well as less involvement of managers in task and processes. These findings provide a link between media capabilities and changes in team or organizational structures. Advances in information technology are often connected with expectations for the ‘disaggregation’ or decentralization of organizations (e.g., Zenger & Hesterley, 1997; Lawler, 1988). Arguments for the flattening effect of information and communication technologies on organizational hierarchies are generally based on transaction-cost economics (Williamson, 1975, 1985) or resource-based explanations (e.g., Afuah, 2003; Kim & Mahoney, 2006). Technologies possess certain features that enable or restrict the flow of information between organizational members (e.g., Zammuto et al., 2007). Richer technologies should reduce the internal costs of coordination and communication through the lateral integration of information (cf. Galbraith, 1977). Information can thus be collected and integrated at lower levels of the organization without involving management.

Yet, the fact that media offer certain features does not explain decentralization. Organizational effects do not result from media themselves, but from the use of these media (cf. Griffith & Northcraft, 1994). Technology circumscribes the range of possible actions (e.g., does an onshore engineer have to phone the control room to obtain information on the status of production or can this same information be obtained at a glance from a screen without the need for interaction) – whether or in what way these options are taken up is influenced by the specific context of individuals, subgroups, and group. The degree of interdependence between subgroups, for instance, impacts how often coordination and corrective actions are necessary, job function and subgroup-specific tasks determine what type of information is required, while team familiarity may influence how willing members are to choose a more personal medium (e.g., video-conferencing) over a less personal one (e.g., email) for interactions. In transaction-cost economics or resource-based approached the link between media capabilities and organizational structures remains unexplained. It is unclear why these changes happen, in what way, and why changes stop or may be more of less stable.

A possible link between media capabilities and team structures explored in this thesis were expectations and cooperation norms (cf. Study 5). Changes in technology alter available options by creating new opportunities of action. These new opportunities affect the values either by making actions possible that were closed off before or by making some values easier to implement than they have been before (Mesthene, 1970). The implementation of richer communication media in production teams, for instance, facilitated a decentralization of decision-making structures
11.2. Theoretical considerations for the distributed team literature

that had not been feasible in the same way before. These new opportunities influence the possible range of behaviors and create new expectations about what can be done or should be done. The role of information and communication technologies for shaping processes and structures seems to lay in their impact on attitudes, values, and expectations of users. Lacking agreement between expectations and media capabilities can also explain rejections of new technologies, as well as conflicts about media usage in user collectives.

Integrating the findings discussed above, it is thus possible to extend the first (naive) picture from Chapter 1 (see Figure 11.4).

**Alternatives to technological solutions**

While technology is undoubtedly an important element of distributed working, this thesis also demonstrated that it is not the only option to support distributed teams. Structural integration, examined in Study 4, can be seen as an alternative approach to bridge the distance between remote subgroups. The structural integration of diverse members into one team is a common approach in areas, in which innovative or complex decisions are necessary (e.g., Polzer, Milton, & Swann, Jr., 2002; Roberge & van Dick, 2010). Cross-functional teams provide a broader span of views and problem solving abilities. The expectation is that availability of multiple perspectives
and diverse areas of expertise in one team result in better and faster work processes, as well as improvements in the quality of team decisions (Miller, 2001; Tony, Pelled, & Smith, 1999; Payne & Frow, 2005). This thesis suggests that the same idea might also be feasible for distributed teams. Structural integration can provide easy access to location-specific knowledge that may be hard to transmit over media, such as situated knowledge or information on physical constraints. Especially in ongoing asymmetric teams, where expertise is based on very different educational backgrounds and long-standing experience in one specific culture with little overlaps between subgroups, the physical integration of members is an alternative to purely technological solutions.

The combination of structural integration and technologies can be a versatile method to integrate specific groups or tasks more closely between subgroups, but also to shield particular processes or job functions from undesirable contacts. Especially in short-term projects in which team learning and the mutual acquisition of knowledge over weeks or even years is not an option, the partial integration of members may be a good way to increase coordination efficiency between remote subgroups. The examples in this thesis suggest that such arrangements are probably not uncommon in organizations. It seems, however, that the empirical and theoretical literature on distributed teams has not yet caught on. The investigation of hybrid forms could tell us much about distributed coordination and the effects of technology, in addition to broadening our view on how to support distributed team work. It thus seems a promising avenue for further research with both theoretical and practical relevance.

11.2.2. Technology implementation and adoption

The notion of asymmetries between user groups also can help to explain different reactions to technology and more particularly technology changes. In the course of continuous coordination and cooperation asymmetric distributed teams establish agreed norms, rules, and practices. The technology change challenged established notions on how subgroups should coordinate these routines. The comfortable equilibrium achieved over years of cooperation was shaken up, and a new way of coordination had to be established and re-negotiated. As observed in Study 2 such a move is seldom without conflicts. One of the main reasons for such conflicts was task-related and cultural asymmetry between subgroups. In this thesis, I conceptualized technology implementation and adoption on the team- and subgroup-level, focusing
11.3. Theoretical and practical implications for designers

specifically on the team and subgroup characteristics and dynamics that impacted acceptance and adoption in user collectives. The role of team and subgroup dynamics have so far been largely ignored or concentrated on political issues (Markus, 1983; Spicer, 2005). The findings in Study 2 add to our theoretical knowledge of technology implementations introducing the concepts of ‘valence’ and ‘alignment’, as well as concrete factors that affect adoption in teams over time.

11.3. Theoretical and practical implications for designers

The main implications for designers lie in practical considerations for the design of technologies for asymmetric distributed teams, but it also offers implications more generally for the investigation and evaluation of products in such settings (i.e., for the field of design methodology). Here, especially Studies 1, 2, and 4 are of interest. The empirical studies showed repeatedly that media capabilities impact processes and relationships in asymmetric distributed teams. Effects were found on all outcomes levels – affects, cognitions, attitudes, and behaviors. This knowledge provides designers with guidelines for the choice of technologies. Study 4 further demonstrated that modifications in the social system may be an alternative to purely technological solutions. While designers generally focus on the tangible product, at times it may be more efficient to target organizational or team structures. Study 4 provided some indications for situations in which one or the other choice seems more appropriate. The different feasibility of approaches reiterate again, how important it is to first understand the usage context, before creating and implementing technologies (or any other product).

The consequences of media capabilities on team processes, member relations, and team structures found in Studies 3, 4, and 5 are moreover a reminder that designers of technology are not only creating products. These products have ramifications for individual users, their teams, as well as the organizations implementing them. These wider ramifications need to be taken into account, and it is therefore important that designers learn to see themselves as organizational change agents (cf. Junginger, 2008).

Studying distributed working in asymmetric settings may also provide designers with an appreciation of what it means to work in distributed teams. The development of a globalized and multi-connected work force affects the design community not only as developers of technology technological products and environments for the support of distributed working. They are themselves increasingly part of de-
sign teams, which incorporate diverse geographical and functional groups (Bürdeck, 2005; Sonnenwald, 1996). Study 1 highlighted the consequences of distribution and asymmetry on team functioning, while Studies 3, 4, and 6 demonstrated some of the short- and long-term problems and consequences of working in distributed teams.

11.3.1. Technology design for asymmetric distributed contexts

Apart from implications for the concrete design of complex support technologies such as CEs, findings in this thesis address challenges of designers as creators of environments for heterogeneous, distributed user groups and thus issues of design methodology. Efforts in this field “are directed toward optimizing the methods, rules, and criteria to be used in order to investigate, evaluate, and even improve design” (Bürdeck, 2005, p. 225).

The study of Collaborative Environments can bring important insights to designers, because they (a) constitute a complex mix of technological components instead of one single product, (b) extend the focus from the single user to a multi-user context, and (c) have to comply simultaneously with different expectations and requirements of diverse users. The interest in studying CEs lays thus in their inherent complexity, as here the ‘product’ technology becomes integral part of a complex socio-technical system combining influences at the individual and the group level with potentially heterogeneous user groups.

Instead of providing concrete design suggestions, I see the main benefit of this project for the design community in sensitizing for the social embeddedness of products and the need for a long-term, multi-level perspective of user reactions. It raises awareness for

- the relevance of social interdependencies and dynamics for product acceptance and use,
- the possibility of disparate or even conflicting user requirements in multi-user contexts, and
- the importance of a stronger process view of user reactions from initial attitudes to long-term use.

It further show-cased the use of several quantitative and qualitative methods to assess different aspects of user reactions (attitudes, expectations, affects, cognitions, behaviors).
11.3. Theoretical and practical implications for designers

Groups as users: Including social interdependencies and higher-order units of analysis

Product characteristics such as form, dimension, or color have to be decoded by users to become meaningful (Boess & Kanis, 2007). The interpretation of such characteristics, however, is influenced by experiences and needs, as well as learned meanings developed through the exposure to cultural conventions and norms (cf. Van Rompay, 2007). User reactions thus always take place in a specific usage context, which influences individuals' reactions (e.g., Suchman, 1987, 2007). Product semantics specifically emphasizes the “study of the symbolic qualities of man-made forms in the cognitive and social contexts of their use and the application of the knowledge gained to objects of industrial design” (Krippendorff, 1989, p. 10). The situatedness of user reactions in design models are in line with theoretical models on technology use such as Adaptive Structuration Theory (DeSanctis & Poole, 1994) or the “technology-in-practice” approach (Orlikowski, 2000, 2007).

Yet, while the relevance of the social context such as national cultures, society values, or reactions by peers are increasingly recognized as important influences on user reactions (e.g. Crilly, Moultrie, & Clarkson, 2004, 2008; Dong & Lee, 2008), design theoretical considerations and models remain focused on the individual user. The recent trend towards (distributed) team work in organizations means that some products are increasingly used in a multi-user or team context. As the results in Study 2 demonstrated, the interdependencies between team members and the social dynamics in teams can have important ramifications for the acceptance and long-term use of new technologies. Group level constructs such as team versus subgroup identification or team familiarity, for instance, changed the willingness to use the newly installed video-links. Study 1 further illustrated how group-level constructs such as subgroup cultures and subgroup-specific tasks impacted media choices in subparts of a team.

In consequence, ignoring social interdependencies and higher-order constructs with respect to the subgroup, group, or the organization/society users belong to, will lead to an incomplete picture of user reactions. I therefore argue that design considerations should take more notice of the social interdependencies and dynamics between (potential) users.

At present social influences from groups or larger units such as societies are primarily modeled as moderating influences on individual reactions. Different levels of influences – from immediate peer-group to larger society groups to national cultures
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– are commonly subsumed under the label of ‘social setting’ (e.g., Crilly et al., 2004). The lacking differentiation of levels leads to loss of detail and a certain ‘fuzziness’ in the modeling of such influences. Making the nesting of different levels explicit can increase the precision, with which effects and influences on user reactions can be described.

My results further demonstrated that not only individual users, but groups as a whole can show similar reactions to a product such as CEs. In my opinion design theory and methodology should thus broaden their focus from individual users to groups as users, including the group as level of analysis.

**Awareness for the challenges of multi-user contexts**

This thesis was concerned with a very specific context, namely asymmetric distributed teams in which remote subgroups were closely interlinked, but also highly heterogeneous. As the empirical studies in this thesis demonstrated, the heterogeneity among subgroups posed considerable challenges for the design and implementation of CEs. Not only were subgroup-specific tasks and cultures responsible for conflicting media preferences (cf. Study 1), but asymmetries in task-related, demographic, and cultural aspects also influenced initial acceptance and short- and long-term adoption of CEs (cf. Study 2).

The notion of heterogeneity has recently entered the discussion on technology design in form of *ubiquitous computing* (Weiser, 1991) or *multi-contextuality*, i.e., “the co-existence of different use contexts” (Henfridsson & Lindgren, 2005, p. 96). But these concepts are generally restricted to single technologies (e.g., Henfridsson & Lindgren, 2005; Lindgren, Andersson, & Henfridsson, 2008) or inter-organizational boundary spanning (Fano & Gershman, 2002; Levina & Vaast, 2005), not complex socio-technical systems such as CEs.

For designers the results from this project highlight the challenges related to heterogeneous user groups, chief amongst them the need to accommodate various, often even detrimental user requirements and preferences without restricting or prescribing potential uses. Products intended for multi-user contexts thus have to find a balance between the effective functioning for specific tasks on the one hand and the flexibility to accommodate heterogeneous user requirements on the other – or as Boztepe (2007) phrased it for multi-cultural contexts, designers need to find a way to achieve both ‘adaptation and standardization’. Based on the findings in this project, the main challenges in these types of user scenarios can be summarized in
the following questions:

- If users represent a heterogeneous group, how can product design accommodate various, and possibly even contradicting interpretations and requirements of users?
- On what level(s) do user experiences differ (e.g., affects, cognitions, behaviors) and which levels are of importance for the design of such products?

Apart from raising these questions, this thesis also attempted to provide at least preliminary answers to these questions. In Study 3, I formulated a number of design considerations, which centered around the need to design for flexibility and choice. The different media preferences and requirements in onshore and offshore subgroups could not be accommodated with one single technology, but required a combination of information and communication technologies. The concept of *technology interdependence* as the mutual interaction and dependence of technologies during work (Bailey, Leonardi, & Chong, 2010) may here be of use.

As demonstrated in Study 2 the danger in designing for multi-user contexts lays in emphasizing the similarities among user groups, while downplaying or ignoring the differences. Treating onshore and offshore subgroups as ultimately identical users, just in different locations, led to sub-optimal designs and a faulty implementation strategy. The initial placement of cameras on offshore installations, for instance, was driven by convenience and onshore requirements. Another sticking point was a tell-and-sell strategy that was targeted primarily at the onshore subgroup ignoring the different interests and preferences of offshore personnel. This study points to the importance of considering multiple user groups, when developing products for multi-user contexts. A further learning from this study is that to guide the design and implementation of such products a thorough knowledge of the relevant asymmetries and the differences in user groups are needed up-front. A generic user model will not work.

**Taking a longterm perspective of user reactions**

Technologies in organizations tend to be purchased by the organization and intended for long-term use. In these cases, short- and long-term acceptance and adoption become important – and with this the question, what aspects lead to consistent and committed use.

In design discussions, user reactions are frequently focused on initial reactions
and purchasing decisions. Where longer-term decisions are considered, it is usually in terms of product attachment, i.e., “the emotional bond a consumer experiences with a durable product” (Schifferstein & Zwartkruis-Pelgrim, 2008, p. 1). Product attachment can thus be compared to the affective concepts of acceptance and liking in the technology implementation and continuance literature.

Results of Study 2 suggest that considerations on the acceptance and adoption of products (i.e., product attachment in designerly terms) may gain from a longer-term, process view. The changes in acceptance and use within teams from pre-usage to early- and later-usage phases indicate that acceptance is not a stable construct, but changes over time. In the early-usage stage these changes were based on experiences with the product itself or experiences with the implementation process, in the later-usage phase events in the group or the organizational environment were most likely to alter acceptance. Results in Study 2 further suggested that in early stages instrumentality considerations may be more important in a group context than affective components. Liking based on personal experiences together with the instrumentality of the technologies become more important in later stages.

These observations speak for a change in factors that impact reactions to CE technologies over time from earlier to later usage stages. This thesis therefore argues for a process view on user reactions from pre-use to later-usage stages. Together with the inclusion of a multi-level approach and the inclusion of group-level and context factors this could add considerably to the precision of design studies and theoretical models.

11.3.2. Broadening the view of ‘the designer’

As stated at the begin of this chapter, the primary benefit of the empirical work for practitioners is in highlighting the process nature of technology implementations, as well as the in drawing attention to the inter-dependencies between technology design, team functioning, and to a certain extent also organizational functioning. Taking these interdependencies seriously requires a broadening of the concept of ‘designer’, which incorporates not only the person creating the actual systems, interfaces, displays, but also organizational decision makers choosing technologies, and users. It moreover requires the inclusion of the specific usage environments that will shape requirements, perceptions, and adoption. This argument is closely linked to the earlier consideration of the three inter-dependent ‘design levels’ of technology, team processes, and organizational functioning.
As findings throughout this thesis have demonstrated, the design and implementation of Collaborative Environments in teams is a complex process—especially when teams consist of geographically dispersed and asymmetric subgroups. This thesis has shown how asymmetry and distribution affect the implementation process and reactions to the technology in teams. It further detailed short- and long-term effects of CE implementations. The implementation of CEs augmented rather than replaced existing technologies, and led thus to an incremental rather than a dramatic change. Still, the empirical studies showed that the modification in technological capabilities over time led to shifts in the functioning of the teams, such as the readjustment of subgroup roles (Study 3), changes in coordination expectations (Study 5), or patterns of identification (Study 6). These alterations developed gradually, were mostly unexpected by the organization, and often went unnoticed at first. Over time, however, these changes led to subtle pressures on the organization to change structures and processes. Overall, this thesis illustrated the close interlinkage between team characteristics, organizational context, and technology design in their effect on team functioning.

In organizational adoptions of technology, this interlinkage is seldom taken into account. Instead the design and implementation of technologies in organization is still mostly done in functional silos and seen as disparate, disconnected steps. Managers and IT departments decide on technological solutions, system designers create applications and interfaces, consultants or team leaders manage the implementation, and users deal with the solutions chosen by their organization. Generally, the communities in each of these steps act largely independent, and the hand-over between the individual steps often remains perfunctory. In consequence, designers are often unaware of the ramifications of their products on organizational processes, while decision makers in organizations are unaccustomed to evaluate systems and interface designs. Even more critically, both groups generally lack the knowledge to predict or systematically evaluate the psychological short- and long-term effects on existing work systems.

Treating technology design and implementation as functionally segregated steps, organizations and designers not only miss the opportunity to learn from each other. They also ignore the role of their decisions for long-term consequences for users and implementing organizations. I therefore argue that organizations and designers should develop a stronger appreciation of their roles as shapers of organizational processes. In this sense, a better understanding of technology design and implementation as an integral process is needed, which requires a longitudinal process view...
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and an inter-disciplinary approach – including designers, organizational decision makers, implementers, organizational psychologists, as well as prospective users. Technology is an integral part of every-day processes in most organizations; and as such not an external entity, but an integral part of their functioning. Technology design should thus be seen not only as the design of support tools, but of the whole socio-technical system. In this view, the design process does not end, when a product is completed and delivered, but extends to its effects on the wider usage context. For this process to be successful, also the specifics of the user context and the social dynamics within this context need to be taken into account.

11.4. Implications for team managers and organizations

This thesis highlighted a number of practical issues for managers and organizations confronted with implementations of Collaborative Environments for asymmetric distributed teams. Through the implementation of Collaborative Environments organizations hope to improve processes and hence the performance of their distributed teams. Yet, the range of available alternatives and the speed with which new information and communication technologies are developed can make the choice difficult. A further challenge is the successful implementation of technologies in asymmetric distributed settings. In the following I discuss practical implications of my findings for team managers and organizations, presenting general guidelines (1) on factors that impact the choice of technologies – or alternative solutions, (2) on the planning and handling of CE implementations, and (3) on consequences of CE implementations and their evaluation.

11.4.1. Considerations for technology choices

The implementation of CEs is based on the assumption that more information and closer interaction should increase the precision of decisions and the efficiency of coordination between remote members. Data displays become increasingly dynamic simulating real-life and real-time processes, and the temptation is understandably high to provide personnel with as much information as possible. Yet, the ability of computers to display information is considerably greater than the ability of humans to integrate and make sense of it (Benbasat & Taylor, 1982). The main challenge is here the translation from the technological possible (e.g., presentation of millions of data points in real-time) to the humanly sensible (i.e., limited capacity for concentration and interpretation of information). As Drews and Westenskow (2006)
remarked “the right picture is worth a thousand numbers”; yet, too much information can rapidly become overwhelming (Jacoby, 1984; Malhotra, 1982) resulting in misinterpretations, selectivity or omission of information or even to a paralysis in decision making (e.g., Edmunds & Morris, 2000; Schick et al., 1990; Sparrow, 1999). It is therefore important to strike the right balance between overwhelming personnel with information, and providing enough information to fulfill their job.

In distributed teams, which cooperate towards a common goal and around the same objects, a common understanding of the situation is vital. Lacking transparency of processes reduces situation awareness, leaving remote members with snapshots of unconnected information, if it is not presented in its context. It is therefore tempting to provide all subgroups with the same amount or depth of information.

Yet, asymmetric subgroups possess very different roles in the overall team task. Accordingly, information and data requirements of one subgroup overlap only partly with those of others. They further operate on very different domain expertise. Asymmetric subgroups thus not only require disparate information to fulfill their tasks, but also differ in their ability to interpret and make sense of the same data, as the correct interpretation of information largely depends on knowledge about the underlying processes (e.g., Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, & Frey, 2006; Stasser, Vaughan, & Stewart, 2000). What might be adequate depth and detail of information for one part of the team, might be too much or too little for the other. Moreover, some team members may require information other team members have no need for. Hence, despite the need for common representations on the main objectives, information requirements between asymmetric subgroups may differ considerably in terms of type of information needed, as well as quantity or level of detail that can be processed. Instead of providing all subgroups with the same detail of information, information must thus be tailored to the specifics of the subgroup tasks.

**Considering the full role set, instead of only primary roles** Team members’ roles are inscribed into technology, but technology also circumscribes what roles team members can fulfill. Technology choices thus require a comprehensive understanding of the mutual roles and responsibilities of users. Technology choices seem often based on what organizations perceive as the ‘primary roles’ of their personnel (e.g., planning for onshore engineers versus monitoring for control room technicians; cf. Study 3). Yet, team members often possess secondary roles or multiple functions,
which become relevant only at specific times or for specific tasks. In my sample, sudden failures of machinery or shutdowns of wells, for instance, required immediate access to detailed information on equipment or well parameters not required during normal operations. In these moments, the primary role of onshore engineers became one of troubleshooters and problem solvers. Technologies must support such sudden changes in responsibilities and the accompanying changes in information and communication requirements. Accordingly, organizational choices of technology need to reflect the full range of primary and secondary roles and responsibilities personnel has to fulfill. Technology choices thus have to be based on a comprehensive analysis of work processes and interdependencies between asymmetric subgroups, including routine and non-routine tasks.

**Preventing information and communication overload** While information overload is primarily discussed in terms of information technologies, i.e., the display of data, communication technologies are not exempt. Richer communication media generally emphasize continuous connectivity. This may be an advantage to one part of a team, but not necessarily for another. What may be an essential call for an onshore engineers to obtain vital information, may be an unwelcome disruption for the control room technician at the other end. A constant flow of emails can disrupt work processes (Burgess, Jackson, & Edwards, 2004; Jackson, Dawson, & Wilson, 2001), just as video-conferencing can induce stress by adding pressure from remote peers and lack of privacy (Boyle & Greenberg, 2005). Disconnecting instead of enriching may thus be the more adequate move for certain functions. I therefore argue that in choosing technologies for asymmetric teams, organizations should consider richness rather as a relative concept. Instead of striving for ‘the best and most informative’ technologies for all, asymmetric teams necessitate a careful choice based on subgroup roles and requirements. As Kim et al. (2007) point out, all technologies come with benefits, as well as sacrifices. Organizations need to make sure that in asymmetric settings benefits and sacrifices are not likewise asymmetrically distributed.

**Preventing conflicting messages and conflicts with organizational/team-internal strategies, values, and norms** CEs provide a combination of information and communication technologies for the support of distributed teams. These media can compete with each other (e.g., video-conferencing and phone) or complement each other (e.g., video-conferencing and desktop-sharing). The technologies offered to teams can thus actually send out conflicting messages – should onshore engineers and off-
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shore technicians communicate more, given continuous video-links, or communicate less, because of real-time data access? Should they keep communicating with team leaders, as suggested by the strong offshore hierarchy, or contact technicians directly? In production teams the documentation of decisions and activities is very important. Should onshore engineers then make decisions ad-hoc over video-links or stick to email to document requests – or do both, adding to the overall work load? While the overall intention of CEs seemed clear, the combination of information and communication technologies provided team members with disparate ways of accomplishing the same task. In combining information and communication technologies organizations should thus be conscious of possible conflicts between media choices. These conflicts may either be with each other or their intended use conflicts with the social context. To prevent conflicting messages, organizations should thus strive for consistency in the ‘spirit’ of their media choices. Organizations further should make sure that media choices do not contradict established processes and organizational or team structures; or that these conflicts are mitigated by the adjustment of existing roles and rules.

Alternatives to technological solutions

Technology is generally the first thing that comes to mind, when faced with the problem of supporting distributed teams in organization. Study 4 examined the structural integration of members into a remote subgroup as an alternative approach – either alone or in combination with technological means. Findings in this study suggested that technological and structural solutions differed, in how they impacted team processes. Technological solutions seemed to encourage the integration of dispersed processes (see also Study 3), while structural solutions tended to create ‘buffers’ between subgroups, in which members of a remote subgroup shielded their colleagues from requests from the hosting group.

Most work in production teams happened outside the range of information and communication technologies, e.g., maintenance work on machines in the outside areas of offshore installations. A detailed knowledge about such processes and the physical layout of the platform can improve decision making onshore. However, such knowledge is acquired through the continuous and direct experience by offshore personnel. Implementations of technologies can here do little for onshore engineers to acquire such knowledge.

In consequence, technological solutions may not be the best approach, if teams pos-
sess asymmetries in task-relevant knowledge and expertise. Structural integration might here be a more promising approach. Study 4 identified a number of practical points, to ensure structural integration yield the expected benefits. The two most important ones, were that exchanged personnel has to be sufficiently knowledgeable, and the people need to retain links to their home group, as otherwise the advantage of local knowledge disappears. Rotations between home and hosting group seemed a good solution to solve this problem.

Integration of remote members into the other subgroup can also provide cross-training for both sides. Cross-training is a common method to improve team-related mental models and thus performance between members of different educational or functional backgrounds. It provides insights into “the tasks, duties and responsibilities of his or her fellow team members. The goal of this type of training is to provide team members with a clear understanding of the entire team function and how one’s particular tasks and responsibilities interrelate with those of the other team members” (Volpe, Cannon-Bowers, Salas, & Spector, 1996, p. 87). It thus allows team members to anticipate information that others might require and consequently improve coordination and reduce the need for communication (Marks, Sabella, Burke, & Zaccaro, 2002; McCann, Baranski, Thompson, & Pigeau, 2000). As Study 4 demonstrated, in case of asymmetric distributed teams, structural integration can provide an efficient means for cross-train and team learning.

With the combination of technological support and structural integration organizations posses a flexible way of supporting distributed teams. Technological solutions can be scaled to encompass the whole or only parts of the team. Structural integration can be adapted with respect to the type and number of team members that move from one subgroup to the other or the length of time they remain there. Based on the results in Study 4 I suggested situations in which one or the other approach might be most suited. Degree of interdependence between subgroups and the type of tasks that need support (e.g., routine or non-routine) were two of the aspect likely to influence the feasibility of approaches. The exploratory nature of this study does preclude exact guidelines, on when to choose which approaches. This is clearly a question for further research. Still, it should encourage team managers and organizations to take account of alternatives to purely technological solutions.
11.4. Implications for team managers and organizations

**Considerations for technology choices in asymmetric distributed teams**

1. **General considerations**
   a) Technologies need to accommodate disparate information and communication requirements in asymmetric subgroups.
   b) Consequently, technology choices need to reflect the full range of roles and interdependencies of team members in routine and non-routine tasks, not only most frequent or most important functions.
   c) Closer integration of information must be accompanied by adequate knowledge (i.e., training) to interpret context-specific data.
   d) Organizations should aim to avoid conflicting messages between multiple technologies, or conflicts of technology choices with established rules, procedures, or team/organizational structures.

2. **Technological integration versus structural integration**
    a) Technological integration seems preferable, if:
       - the majority of task and processes in a team require the direct coordination between dispersed subgroups
       - coordination between subgroups involves a wide spread of different functions and hierarchical levels
       - coordination is ongoing and mostly based on routine activities
       - team members possess a thorough understanding of each others roles and tasks, as well as the interdependencies with the other subgroup(s) (mature teams)
    b) Structural integration seems preferable, if:
       - coordination between distributed subgroups is needed only for a small number of specialized tasks
       - knowledge need for tasks is highly specialized and cannot be obtained through technologies (tacit knowledge)
       - subgroups coordination is needed for short-term projects on complex tasks, which require highly specialized input from subgroups
       - remote subgroup needs to be shielded from too much interaction/requests by other subgroups (structural integration as buffer)
       - teams have many new members or a high-level of turnover (structural integration for cross-training)
11.4.2. The implementation of technology in asymmetric distributed teams

The implementation of new technologies in organizations is seldom an easy task. But as Study 2 illustrated, the task becomes even more complicated when dealing with asymmetric distributed teams. Geographic separation added logistic problems for communication and concurrent deployment of technologies, while the heterogeneity of team members led to conflicting expectations and requirements. Moreover, technology implementations in asymmetric distributed settings seem more sensitive for changes and mistakes early on in the process.

One of the most important findings for managers and organizations from Study 2 is probably the longitudinal nature of the implementation processes. Managers and organizations often consider an implementation completed, once the technology is deployed and running. The results in Study 2 should dispel this comfortable conviction. As the example of Team 2 demonstrated, in asymmetric distributed teams events like turnover in a subgroup can change acceptance and use even months after the actual implementation. Part of the implementation must therefore be to create guidelines and strategies, how to handle turnover in teams, integrate new members, and re-engage existing members.

Further, acceptance and adoption starts long before the actual implementation takes place. An important finding was here that resistance is not necessarily targeted against the technologies itself, but can also arise because of strategies and actions of change agents; that is, change agents themselves can become a source for resistance (cf. Ford, Ford, & D’Amelio, 2008). The close linkage between process and technology satisfaction found early in the process indicate that their impacts can be particularly disruptive early on in the process. This cautions implementers to prepare the pre-implementation phase very carefully. This includes the need to tailor information and implementation to the specifics of individual subgroups and teams. Especially with asymmetric distributed teams a ‘one-size-fits-all’ approach is clearly inappropriate.

Skepticism and resistance are a frequent occurrence during technology implementations. The difficulty is to find a good strategy to deal with such negative reactions. The two concepts of valence and alignment, developed in Chapter 6 provide a theoretical framework, with which to classify different types of reactions. This framework makes it possible to differentiate, for instance, between non-conflicting non-adoption and conflicting non-adoption. Both situations may look the same from
the outside, but the strategies to resolve them are different. The concepts of valence and alignment proposed in this thesis provide managers and organizations with a structured approach to analyze and device strategies to deal with resistance.

Considering implementations as a longitudinal process opens the possibility to anticipate typical problems along the way. In my sample the three phases of pre-, early, and later-usage were characterized by phase-specific challenges. In the pre-usage phase, for instance, the main challenges centered around the choice of ‘tell-and-sell’ strategy versus user participation, over-engagement (for CE personnel) versus lacking information (second and third-tier personnel), and the decision who to include in the engagement process (managers, staff, first-tier, support personnel). In the early-usage phase tensions were mostly centered around the degree of standardization in the concept requested by the organization and acceptable to teams, conflicts in the perceived benefits for organizations and teams, as well as the handling of the evaluation and the subsequent communication of successes. Topics in the later-usage phases were how to link and reconcile the CE concept to modifications in the organizational environment and the handling of turnover in teams. I also observed recurring tensions in the moved from one phase to the other. Transition tensions, for instance, from the pre- to the early-usage phase centered on the consistency in engagement and actual delivery, while the main topic in the move from the early- to the later-usage stage was the challenge to users to become independent from the continuous support of IT personnel and implementation consultants. While the specifics will differ across contexts, I expect that the more general topics of the phase-specific challenges and transition tensions will be applicable to a wider context (e.g., misalignment between announced and chosen implementation strategy, as well as the one preferred or expected by (prospective) users). Taking a process view of technology implementations will allow team managers, organizations, and implementers to be prepared and even proactive about phase-specific challenges and transition tensions also in later stages.

The following box formulates recommendations for the implementation of technologies in asymmetric distributed teams, resulting from observations in my thesis.¹

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Considering and recommendations for the implementation of CEs

1. Communication and engagement
   a) Engagement of dispersed subgroups must be balanced to avoid the appearance of preference or unequal status in the implementation initiative.
   b) Information and engagement needs to include all personnel, not only managers or staff that is directly affected by the implementation (i.e., also second and third-tier personnel).
   c) The information strategy needs to take into account subgroup-specific roles, expectations, fears, and cultures to prevent the impression of one-sided initiatives.
   d) For general communications, the focus, language, layout, type of communication, media chosen for transmission must be generic enough to fit asymmetric subgroups.
   e) Communication of expected benefits must address the specific situations and characteristics of individual teams and subgroups, otherwise it will appear unrealistic across multiple subgroups and teams.

2. Participation of prospective users in the decision making process
   Participation of users should only be sought, if:
   a) equal participation of different user groups (e.g., onshore/offshore) can be guaranteed
   b) implementation and support groups are given sufficient resources to handle the extra demands,
   c) the organizational framework actually allows the necessary leeway to act on user expectations,
   d) organizational restrictions in terms of degree and areas of user participation are clarified beforehand and communicated clearly to users at the beginning of the general engagement process.

3. Technology deployment and training
   To prevent negative perceptions and rejection early in the process:
   a) Parallel deployment or offshore deployment first to reduce impression of onshore/management driven agenda.
   b) Training for new technology is given to onshore and especially offshore personnel directly after deployment and re-training is available for people moving into CEs after the initial deployment.
   c) Clarification of roles and responsibilities of CEs early in the process for all personnel also with respect to other parts of the organization.
   d) Clear communication of reasons for delays/problems to avoid impression of lacking organizational support.
   e) Re-engagement of teams or subgroups after considerable turnover in personnel.
4. Preventing inefficiencies and conflicts between stakeholders
   a) Identify all groups involved and affected by the change and identify, which are the core groups at specific stages of the diffusion process prior to the implementation
   b) Map out and agree on requirements, roles, and interdependencies for each group covering the process from start into routinization, as requirements and interdependencies will change throughout the implementation process.

5. Preventing disillusionment by providing a long-term perspective
   a) Clear communication from the outset whether or what long-term career/developmental benefits are associated with moving into CEs.
   b) Development of a clear long-term perspective for the future use and purpose of CEs within the organization and communicate it to all groups early in the implementation process.

6. Evaluation of implementations
   a) The existence of an evaluation process and the steps and instruments involved need to be communicated before starting the change process.
   b) The number of people conducting evaluations should be kept consistent and minimal and CE personnel should be allowed to judge the appropriateness of the timing of evaluations.
   c) If information gathered in the evaluation goes public it has to be balanced and truthful, i.e., also represent negative or critical voices to indicate the organization is honest about a people-driven change process.
   d) Feedback and suggestions need to be acted on quickly to avoid devaluation of the feedback process.
   e) Evaluations should start early in the implementation process (persuasion and decision stages) and kept as an ongoing cycle with higher frequency at the beginning; after the implementation and an overall positive confirmation has been reached the evaluation process should lead into a permanent option for feedback and suggestions with the normal support groups.
   f) All groups involved in the implementation process also need to take part in the evaluation process.

7. Diagnosing and handling resistance (for an explanation of the three adoption stages see Chapter 6)
   a) Conflicting adoption: identify and reconcile conflicting expectations, remove or reconcile problematic aspects of technology usage specific to individual subgroups, emphasize shared positive beliefs and experiences
   b) Congruent non-adoption: identify and address the shared negative beliefs and experiences held by the team as a whole
   c) Disparate non-adoption: identify and reconcile the specific concerns of subgroups to reach agreement on perception and technology usage
11.4.3. Evaluation of effects and the need for a longer-term focus

Findings in this thesis illustrated that technology change in the context of the CE implementation affect team processes, as well as relationships between subgroups. Consequences of CE implementations can thus be expected at multiple levels – from modifications in behaviors such as communication patterns to adjustments in established routines, defined roles, cooperation expectations, and affective aspects such as identification and work satisfaction. The implementation of CEs thus affects not only single aspects of team work, but the whole set from work-related aspects to social relationships. In other words, even so organizations may target only specific processes such as planning or decision making, it is impossible to change one aspect without affecting others. Consequently, CE implementations are likely to lead to unexpected – and maybe even undesired – effects.

Examples in my data were the blurring of subgroup roles and the move into a more short-term tactical position in teams (cf. Study 3), or adjustments in cooperation expectations, which conflicted with established practices, as well as expectations of parts of the team leaders’ (cf. Study 5). Although these changes in roles and attitudes were relatively subtle, they still had ramifications for the team coordination and the management of teams longer-term.

In evaluating consequences of technology implementations, organizations tend to limit their focus to the specific aspects, the technology was chosen to support, and to hard indicators such as higher production numbers or cost reductions. Moreover, evaluations are seldom systematic, as they are often concentrated on the short term and on positive changes. It is therefore little wonder that organizations often find themselves hard put to predict and react to negative impacts longer-term.

In consequence, organizations need a broader view of effects, as well as a longer-term perspective for a comprehensive understanding and evaluation of CE implementations. For a full picture, organizations thus need to capture also negative effects and aspects not directly linked to the expected benefits. ‘Soft benefits’ such as effects on motivation, satisfaction, or relationships, for instance, are often disregarded or added only as an after-thought, although there exist clear links to satisfaction and performance in distributed teams (e.g., Morris, Marshall, & Jr., 2002; Peters & Karren, 2009; Staples & Webster, 2008). Moreover, change processes are not only ‘messy’ and “characterized by oscillations and reversals” (Amis, Slack, & Hinings, 2004, p. 35), but can also take a long time. Some consequences of the technology change may only become apparent months after the fact (e.g., the shift
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in onshore and offshore roles observed in Study 3). Effects may still unfold, when the organizational focus has already moved to something else, and consequently be missed – either as positive results or problematic developments that call for countermeasures. For example, changes in technology can create potential for conflicts between old structures and emerging structures, such as the predominantly formalized coordination and control structures in the offshore subgroup which conflicted with the move towards increasingly ad-hoc, informal interactions. Moreover, effects make take longer to manifest than organizations expect. It is therefore important to develop awareness for time-shifted reactions, i.e., different pace of changes in behaviors, cognitions, attitudes, etc, assessing effects on multiple outcome levels (see box below).

Organizations are notorious for taking a short-term stance on projects forgetting that personnel will be confronted with the modifications continuously day after day. Too often one change initiative is treated as independent from the other – as was the case in this company, where the CE implementation was succeeded immediately afterwards by a structural re-organization. Frequently, the same organizational members are affected in parallel change initiatives, and multiple changes at the same time each have their distinct potential for discomfort (Bareil, Savoie, & Meunier, 2007). In strategic terms a year between two programs may look like a long time, while for people on the ground it may seem like continuous turmoil leading to demotivation, fatigue, and frustrations. Too little awareness exists of the consequences of such multiple overlapping or parallel change initiatives for personnel ‘on the ground’. The implication for managers and organizations should be the realization that change initiatives need longer-term support strategies, as well as long-term perspectives – presumably beyond what organizations deems necessary. Apart from a long-term process view on change initiatives I also argue that closer attention should be given to the mutual effects of change initiatives.
Recommendations for the Evaluation of Technology Implementations

1. Evaluation of technology implementation
   a) Evaluations need a long-term perspective to judge effects reaching from pre-implementation to at least one year after implementation.
   b) Systematic pre-post comparisons with repeated measurements after implementation to detail changes.
   c) Evaluations need to consider the whole system not only single parts: inclusion of interaction effects and team dynamics.
   d) Measures should include multiple outcome levels (behaviors, cognitions, attitudes, etc. on the individual and group level).
   e) For a full picture of the effects of CE implementation also systematically capture unexpected, negative effects (avoidance of a positive effects bias).
   f) Evaluations need to be aware of time-shifted reactions, i.e., different paces of change in outcome measures.

2. General considerations
   a) Effects may take longer to manifest themselves than organization expect.
   b) Expect the unexpected: Most effects cannot be predicted. Especially, in asymmetric distributed teams, effects may differ depending on job function, group, process.
   c) The evaluation needs to include an option to re-design or undo technology choices.
   d) Parallel or consecutive change initiatives are not separate events. Organizations need an integrated strategy to prevent negative consequences of multiple projects for organizational members.

11.5. Strength and limitations

The major strength of this project was its ability to investigate the process of CE implementations and use over a considerable time span directly as and where it happened. In this project I was thus able to study the phenomenon in its full complexity. Especially empirical research on distributed teams suffers from a bias towards either student samples or management teams. Further, too often studies only look at short-term effects. The project had been planned from the outset as a longitudinal project. It thus had a developmental perspective on technology change and a process view, which is rare in the distributed team literature.

It further investigated processes on the group, as well as subgroup, i.e., meso-level. As Klein and Kozlowski (2000) pointed out, research at the meso-level and its
11.5. Strength and limitations

relation with levels below and above is lacking. This thesis fit into this gap.

While the exploratory field study approach has draw-backs, it also has a number of advantages, which makes it an invaluable approach for under-researched areas such as technology design and implementation in asymmetric distributed teams. Taking an exploratory stance, this thesis broadened knowledge on existing concepts (e.g., diversity, which was investigated here in terms of subgroup asymmetry and its consequences). I also identified new aspects that had not been in the focus before such as media effects on cooperation expectations. Further, the qualitative approach supports the development of new theoretical models resulting in the formulation of the valence-alignment model for team-based implementations in distributed settings.

Yet, the methodological approach and the data collected during this project also have clear limitations. All work in this thesis was done in the field, accompanying the implementation and use of Collaborative Environments in one of the major global companies in the upstream oil and gas industry over a period of two and a half years. Field research trades control and ability for replication of results for the ability to study a complex phenomenon in a real-life setting – accompanied by all the complexities and imponderabilities that are a normal part of organizations. One of the most frequent objections leveled against field research is therefore the lacking generalizability (McGrath, 1981). The offshore oil and gas industry is a very specific setting. For instance, the remoteness of offshore installations and the strict divide between ‘planning’ and ‘execution’ in subgroups are features not found in many other distributed settings. Still, the combination of asymmetries and distribution are not unique to oil production teams. Areas such as air control, space flight, or mining share the problems of distribution, asymmetries, and the safety-critical nature of the task. Some degree of asymmetry is likely to occur, wherever international and inter-organizational subgroups work together. Although individual consequences of asymmetry on team processes and relationships identified in this thesis are likely to be context-specific, the concept itself is applicable to other settings as well. The same applies for the role of technology in asymmetric distributed team settings.

Another limitation is the restriction of data collection to only one company, and with one exception even to one location within this company. This project was concerned with one single, albeit very complex case for which the organizational setting, its structures, established processes, norms and cultures provided the framework for all studies. I had no control over changes within this environment and no way of manipulating conditions in a controlled way. Especially for the quantitative studies this limits the certainty with which effects can be attributed to media capabilities
or more generally the implementation of CEs. Also, the restriction to one setting makes it impossible to differentiate influences from technology and influences of other variables such as organizational structures or culture.

Studying processes in the field is a powerful approach to obtain in-depth insights and understanding of complex phenomena, but it also bears the danger of reduced objectivity and the over-generalization of findings. A concern for the reliability of qualitative findings surely is that all data was collected, analyzed, and interpreted by only one person. A certain degree of control was achieved by member checks, when I relayed back my interpretations from earlier interviews or observations and asked participants to comment on these interpretations. The triangulation of methods provided a second way of validating findings. Also, discussions with supervisors and other researchers about the interpretations and conclusions drawn from data helped to identify possible gaps or biases. On the other hand, my familiarity with the context made it possible to explain developments and findings in a way a more hands-off approach could not. Moreover, my close involvement with the people in this company allowed me to get access to critical voices and to observe events that organizations might not normally divulge to external researchers.

As described in Chapter 4, this project had to deal with a number of unanticipated developments that impacted data collection. The re-structuration of the company at the end of the first year and the larger than expected pilot phase are just two examples. The extremely low response rates for offshore personnel before CE implementation in Study 6 are another. The planned quantitative comparison of team processes before and after implementation became thus impossible. I reacted to these events by changing to primarily qualitative methods and shorter time-frames.

11.6. Open questions and further research

Technology in the production teams studied in this thesis was an integral part of every-day processes. Coordination between teams and the achievement of the team goal would be impossible without some form of technology mediation. In this sense, technology is thus not an external entity, but an integral part of the function of these teams. The theme of this thesis was not to contrast teams using no technology (‘face-to-face teams’) with those using technology (distributed teams), but to study the change in team functioning, when moving from one set of technologies to another. This thesis was thus concerned with changes in the technological framework of distributed coordination. In this thesis I suggested that information and com-
11.6. Open questions and further research

Communication technology affect different coordination mechanisms and in combination change conditions for distributed team coordination. These combinations can be complementary or conflicting. Because this thesis was conducted in only one setting, it was not possible to contrast different combinations of information and communication technologies. Organizational teams are usually confronted with combinations of technologies, so the knowledge about the mutual interdependencies and combined effects of media capabilities is important for technology design and choices. Future research should thus look into the effects of technology combinations and relationships for a more realistic picture of media effects on functioning in distributed teams.

The concept of subgroup asymmetry introduced in this thesis helped in explaining processes and dynamics on the subgroup level within distributed teams. Aspects like subgroup-specific roles, priorities, knowledge repositories, or cultures helped in framing challenges in intra-team coordination and reactions to the implementation of CEs. It therefore seems worthwhile to broaden the examination of asymmetry on team processes at the intermediate level. One open question is here, which types of asymmetries are most problematic over the life-span of a team and how do media capabilities influence their impact on team processes at various stages. Teams in this thesis were all in a continuous work stage and thus not faced with problems of either formation or disbanding. Team members were thus used to the differences in their teams and had integrated them into their work patterns and relationships. The technology change did alter existing routines, but had no major disrupting effects. Less ‘well-seasoned’ asymmetric teams might have more difficulties to adjust to technology changes.

While media capabilities most directly affect individuals, subgroups, and groups, observations on changes in decentralization expectations suggest that technology changes may also have consequences for organizational processes and structures. This thesis concentrated on processes on the group and subgroup levels, neglecting greater organizational ramifications, as well as impacts from and on individual team members. It further took only unsystematic note of effects between individuals and subgroup. Future studies should take a fuller account of these cross-level effects.

In Chapter 6 I proposed a theoretical model for team-based implementations in distributed settings. This model and the propositions for team-based adoption were developed based on three cases in the same company. Clearly, subsequent studies are needed to verify this model in other contexts and to tests its predictions. In the same study I also identified subgroup-level and team-level moderators for team-based adoption, which need to be tested as well.
Alignment between subgroups was one of the main themes that emerged from this thesis – either as alignment in cooperation expectations, as congruent attitudes during the adoption process, or as agreement on technology use and preferences. In this thesis I did not study the process of alignment itself, but rather its context and ramifications. Investigating the process itself could yield important insights into how asymmetric teams manage to coordinate complex processes despite little contact. In teams, and specifically in asymmetric teams, it is likely that the meaning and use of technology overlap only partly. If alignment is an important factor in the adoption of technologies, as well as team functioning, the question arises, how much overlap is necessary and what aspects do have to overlap to allow efficient coordination. A better knowledge about the alignment process and a possible ‘minimal set’ of aspects, distributed teams have to agree on, will also help in the planning of engagement strategies, development of training, and team management.

The structural integration of team members was discussed as an alternative strategy to technological means to support distributed coordination. While I identified systematic differences in effects between technological and structural approaches, these results are based on an exploratory study of three teams with the same overall team task, structure, and industrial context. Moreover, due to the difficulty of offshore access, this thesis also largely ignored effects in the sending group (in this case offshore). Technological and structural integration are very flexible approaches that allow a wide range of design variations. In this thesis I could only study a small range of possible solutions, and these in only one industry and company. Further investigations are needed that take a more systematic look into design variations and ascertain the influence of variables such as team tasks, task interdependence, or organizational structures.

Cooperation expectations and norms are important to guide team coordination. In distributed teams, especially those with considerable heterogeneity in members, expectations and norms are likely to differ. Findings in this thesis suggested that media capabilities can affect the alignment of cooperation expectations. The results were based on a quasi-experimental study, which does not allow causal interpretations. The effect of media capabilities on cooperation expectations and their alignment have potentially important ramifications for team managers and the organization of organizational processes. Further investigations should therefore take a more systematic look into the link between specific media capabilities and cooperation expectations and norm formation. A more precise knowledge about the relevant features (e.g., visibility or synchronicity) could guide technology choices, as well as
prepare team managers for potential role changes. It is further unclear, how technology features lead to the alignment or non-alignment of expectations and norms. Related to this are questions about the impact of media capabilities on the role of team leaders and the effectiveness of leadership styles and behaviors. So far media in distributed teams are primarily considered as a neutral background for team managers. Based on this thesis, media may well be a contingency factor for the effectiveness of leadership styles and behaviors.

The last study was concerned with the relation between subgroup and team identification, as well as its development after technology change. Members of oil production teams are part of their own local subgroup, as well as part of a larger team comprised of onshore and offshore subgroups. Findings throughout the thesis demonstrated that offshore personnel considered themselves a ‘world apart’ from the onshore subgroup suggesting a strong identification with their local subgroup. Social identification in teams reinforces similarity within the team, and differences between teams. As indicated by the consistently low identification with the remote subgroup, richer technology did not increase the perception of similarity between subgroups. It thus seems that in teams with extreme faultlines in demographics, task-related aspects, and culture (i.e., asymmetric teams) too little overlap exists to bridge the divide. Hence, despite the increased mutual contact, a definition as part of the other subgroup did not seem possible. Instead the subgroups were able to develop a stronger superordinate identity without giving up on their own subgroup identification. Unclear remains, how subordinate and superordinate identification are affected by different media. The effects in this thesis could be based simply on the increased frequency of contacts or the added visibility. I further found that onshore and offshore subgroups did not differentiate between subgroups and the whole team in the same way – while offshore personnel made a very clear distinction between the three groups, onshore personnel did not. This suggests that in asymmetric teams perceptions of what constitutes a subgroup may be based on different aspects. It is unclear which characteristics are responsible for these differences, how they affect team functioning, and whether they are stable or influenced by media capabilities. Further investigations are needed to answer these questions.

In this project I necessarily had to make a selection of the phenomena I wanted to study. Many interesting topics emerged during observations or interviews, which could not be studied systematically. Two such topics are power/status relationships between dispersed asymmetric subgroups and team learning. Comments by participants suggested that the richer technologies helped to improve team mental
Chapter 11. Discussion and implications

models, and that information and communication technologies supported different knowledge types. Asymmetric distributed teams are surely a setting in which team learning is at once crucial and extremely difficult. In the production teams studied here, despite lacking transparency in processes team members had developed enough common ground to coordination efficiently. Ongoing coordination thus seems to be able to bridge even extreme asymmetries and unfavorable communication conditions. Yet, most heterogeneous distributed teams don't have the opportunity for prolonged cooperation. The question thus arises, what media capabilities may facilitate team learning in asymmetric teams, replacing the need for long-standing coordination experiences. Also a deeper look into the role of technology and asymmetries on specific processes such as distributed decision-making, distributed planning, or modifications in social networks was not feasible in the context of this thesis. These will be topics for subsequent projects.
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Appendix A: Summary of data collected during the project
Appendix A. Summary of data collected during the project

Table A.1.: Summary of data collected in the context of the six studies

<table>
<thead>
<tr>
<th>Method</th>
<th>Data Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>185 semi-structured interviews informal conversations (not counted)</td>
</tr>
<tr>
<td>Questionnaires</td>
<td>325 surveys over four waves of data collection (23 surveys from second and third tier personnel excluded from analysis)</td>
</tr>
<tr>
<td>Observations</td>
<td>30.5 hours of structured observations of work processes 7 days offshore in two teams 13 feedback meetings with teams or managers 30 weekly meetings in the implementation group unsystematic observations (not counted)</td>
</tr>
<tr>
<td>Q sorts</td>
<td>72 sorts using forced distribution, comprised of 43 sorts by onshore, 28 sorts by offshore personnel (37 sorts using free distribution, excluded from analysis)</td>
</tr>
<tr>
<td>Archival documents</td>
<td>1034 documents (minutes of weekly meetings, feedback meetings and reports, strategic and technical documents detailing implementation steps and decisions, internal company communications, architectural drawings, technical handbooks, etc.)</td>
</tr>
<tr>
<td>Pictures of physical environment</td>
<td>692 photos</td>
</tr>
<tr>
<td>Communication networks</td>
<td>52 communication networks (not included in this thesis)</td>
</tr>
</tbody>
</table>

Note: In this thesis I only reported on data from production teams. Data collected from drilling teams not included in this thesis comprise 29 interviews, 27 surveys, 35.3 hours systematic observations, 6 decision making workshops, 185 documents.
Appendix B: Questions for semi-structured interviews in Studies 1 to 4
Questions for Study 1: Team functioning before CE implementation, types and effects of asymmetries

- What is your job title?
- What is your role in the team?
- What are the tasks and responsibilities of your work group?
- What are your personal tasks and responsibilities in the team?
- With whom do you communicate onshore and offshore? About what? What media do you use?
- For what do you need to cooperate with onshore/offshore? (depending on primary work location)
- Do you know your colleagues onshore/offshore? (depending on primary work location)
- Have you ever worked onshore/offshore? (depending on primary work location)
- How are decisions made that involve both off- and onshore teams? What decisions are these?
- When unexpected situations occur, how are they resolved? How do onshore and offshore cooperate in such situations?
Questions for Study 2: Factors impacting acceptance and use

Note: The following questions are directly related to the implementation process. Further factors were identified from questions on CE use and effects.

Questions before implementation

- How have you first heard about the CE implementation?
- What do you expect the CE will change in the way your team works?
- What do you expect the CE will change how you yourself will do your work? In what way will it change your tasks and responsibilities?
- How will it change in the collaboration between on-/offshore?
- How will it change the communication between on/offshore?
- What do you think will be positive effects about the CE implementation?
- What do you expect are the effects on asset/group performance
- Do you expect any problems? Do you have any misgivings?
- Do you think there could be resistance against the implementation? How and why?

Questions after implementation

- When you first heard about the CE what did you expect? Where your expectations met?
- Did you receive any training for the technology?
- How was the concept introduced to you?
- Do you have any comments on how the CE was introduced?
Appendix B. Questions for semi-structured interviews in Studies 1 to 4

Questions for Study 3 and 4: Effects of CEs on team functioning and relations

- For what tasks do you use the CE?
- How did you do the tasks before the CE was installed?
- Has the CE changed the way you exchange information with other team members? How has it changed?
- How has the collaborating with your colleagues on/off-shore changed? (What is easier, what is more complicated?)
- Have your contacts changed, e.g., do you talk to different or more/less people now?
- Do you think that the CE helped you develop a better understanding of the tasks and responsibilities of your offshore/onshore colleagues?
- Do you think you develop a better personal connection with your colleagues on/offshore?
- Do you think the CE led to better decision making and problem solving?
- Do you think the CE led to better performance of the asset? Why, how and in what respects?
- Do you think the CE supports closer and better collaboration between on/offshore?
- Do you think you develop a better personal connection with your colleagues on/offshore?
- How has the CE changed the way problems are solved?
- Has the CE changed the position of your team leader?
- For managers: Has the CE changes how you lead your team, your role or involvement in daily tasks?
Appendix C: Codes resulting from the thematic coding in Study 2
### Table C.1.: Codes resulting from thematic coding in Study 2

<table>
<thead>
<tr>
<th>Category and subcategory</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONCEPT</strong></td>
<td>features of the CE and technology that influenced acceptance and adoption</td>
</tr>
<tr>
<td><strong>CE</strong></td>
<td>perception of the concept or its rationale</td>
</tr>
<tr>
<td>CE approach</td>
<td>features of the physical environment, e.g., layout, furniture</td>
</tr>
<tr>
<td>Physical setup</td>
<td>number and selection of personnel, consistency of staffing, incentives, consequences for onshore or offshore team, financial concerns</td>
</tr>
<tr>
<td>Resourcing</td>
<td>management of the contact between CE and the rest of the team or organization</td>
</tr>
<tr>
<td>Interfacing</td>
<td>reactions to the use or presence of the CE, e.g., attractiveness, distraction from work</td>
</tr>
<tr>
<td>Usage conditions</td>
<td>degree of fit of the concept with existing or evolving organizational structures and processes</td>
</tr>
<tr>
<td>Fit with organization</td>
<td>expected or experienced benefits due to the implementation of the CE</td>
</tr>
<tr>
<td>Demonstrable benefits</td>
<td>features of the new technology that influenced acceptance and adoption</td>
</tr>
<tr>
<td>TECHNOLOGY [TEC]</td>
<td>specific capabilities of the technology</td>
</tr>
<tr>
<td>Capabilities</td>
<td>reports of positive or negative experiences with the use of the technology</td>
</tr>
<tr>
<td>Experiences</td>
<td>type and availability of alternatives to the new technologies</td>
</tr>
<tr>
<td>Alternatives</td>
<td>strategies, activities, and events in the implementation process</td>
</tr>
<tr>
<td><strong>PROCESS [PRC]</strong></td>
<td>overall implementation strategy, e.g., degree of participation of team members</td>
</tr>
<tr>
<td>Strategy</td>
<td>actions and activities by the implementation group, e.g., information workshops, steps for evaluation</td>
</tr>
<tr>
<td>Actions</td>
<td>onset, phase, or duration of activities or events</td>
</tr>
<tr>
<td>Timing</td>
<td>type and degree of support for the implementation process</td>
</tr>
<tr>
<td>Support</td>
<td>degree of knowledge about the concept, technology, process</td>
</tr>
<tr>
<td>Longterm perspective</td>
<td>long-term plans or prospects for CEs and CE personnel within the organization</td>
</tr>
<tr>
<td>Category and subcategory</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>CONTEXT FACTORS</strong></td>
<td></td>
</tr>
<tr>
<td>GROUP [GRP] characteristics of the team</td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td>size and hierarchical structure</td>
</tr>
<tr>
<td>Nature of asset</td>
<td>characteristics of the asset, e.g., maturity</td>
</tr>
<tr>
<td>Attitudes</td>
<td>Work attitudes and cultural aspects within teams</td>
</tr>
<tr>
<td>On-offshore relations</td>
<td></td>
</tr>
<tr>
<td><strong>INDIVIDUAL [IND]</strong> characteristics of the individual</td>
<td></td>
</tr>
<tr>
<td>Experiences</td>
<td>Personal experiences, including prior experiences with similar implementation programs</td>
</tr>
<tr>
<td>Personaliies</td>
<td>Personality characteristics</td>
</tr>
<tr>
<td><strong>TASK [TSK]</strong> characteristics of the team or individual task</td>
<td></td>
</tr>
<tr>
<td>Task-technology fit</td>
<td>task requirements that influence the need for the technology</td>
</tr>
<tr>
<td><strong>ENVIRONMENT [ENV]</strong> organization and physical environment</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>restrictions of infrastructure, e.g., broadband, office space</td>
</tr>
<tr>
<td>Parallel developments</td>
<td>development and initiatives parallel to the CE implementation that impacted perception or effectiveness of CE implementation or concept</td>
</tr>
<tr>
<td><strong>OUTCOMES</strong> outcomes of the implementation process</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>general positive or negative evaluations on the concept, technology, process, context</td>
</tr>
<tr>
<td>Acceptance</td>
<td>degree of satisfactions or resistance</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>degree of perceived usefulness</td>
</tr>
<tr>
<td>Usage</td>
<td>type and degree of usage of the CE and technology</td>
</tr>
</tbody>
</table>
Appendix D: Themes emerging from the within-case analysis in Study 4
### Table D.1: Detailed codes created during the within-case analysis of the three CE designs in Study 4

<table>
<thead>
<tr>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. TASKS AND PROCESSES</td>
<td></td>
</tr>
<tr>
<td>A1. Type of tasks and roles</td>
<td>Tasks, processes, and work distribution in the team</td>
</tr>
<tr>
<td>A2. Access to information</td>
<td>Access to information and plant and production data</td>
</tr>
<tr>
<td>A3. Access to people/expertise</td>
<td>Access to people in the remote subgroup or outside experts</td>
</tr>
<tr>
<td>A4. Information distribution</td>
<td>Way and ease in distributing information</td>
</tr>
<tr>
<td>A5. Meeting structure</td>
<td>Type and frequency of meetings, number of people or functions attending meetings</td>
</tr>
<tr>
<td>A6. Communication patterns</td>
<td>Type and number of communication partners, communication frequency, and media used</td>
</tr>
<tr>
<td>B. TEAM PERFORMANCE</td>
<td></td>
</tr>
<tr>
<td>B1. Decision-making</td>
<td>Decision-making within the team</td>
</tr>
<tr>
<td>B2. Efficiency/speed</td>
<td>Efficiency of processes and speed with which tasks and processes are completed</td>
</tr>
<tr>
<td>B3. Team performance</td>
<td>Team performance with respect to company-internal indicators (e.g., weekly production, overdue tasks)</td>
</tr>
<tr>
<td>B4. Problem solving</td>
<td>Process and quality of problem solving in case of unexpected events</td>
</tr>
<tr>
<td>B5. Planning</td>
<td>Process and quality of planning procedures involving both subgroups</td>
</tr>
<tr>
<td>C. TEAM LEARNING</td>
<td></td>
</tr>
<tr>
<td>C1. Skills/knowledge</td>
<td>Effects on skills and knowledge (e.g., understanding of roles and responsibilities, technical knowledge)</td>
</tr>
<tr>
<td>C2. Transactive memory</td>
<td>Knowing who knows what and how is responsible for which tasks within the team or the other subgroup</td>
</tr>
<tr>
<td>D. TEAM RELATIONSHIPS/CLIMATE</td>
<td></td>
</tr>
<tr>
<td>D1. Team familiarity</td>
<td>Degree of team familiarity with members of the own and the remote subgroup</td>
</tr>
<tr>
<td>D2. Relationships within team</td>
<td>Quality of relationships within the team, especially between subgroups of the same team</td>
</tr>
<tr>
<td>D3. Relationships outside teams</td>
<td>Quality of relationships to members outside the own team</td>
</tr>
<tr>
<td>D4. Trust</td>
<td>Trust between members of the onshore and offshore subgroup in a team</td>
</tr>
<tr>
<td>D5. Commitment/cohesion</td>
<td>Degree of cohesion and commitment to the whole team or own subgroup</td>
</tr>
<tr>
<td>D6. Common vision/goals</td>
<td>Degree of common vision and goals between the onshore and offshore subgroup in a team</td>
</tr>
</tbody>
</table>
Appendix E: Items, instructions, and Q-factor analysis results in Study 5
Appendix E. Items, instructions, and Q-factor analysis results in Study 5

Explanation of symbols in the table:
VD: vertical decentralization (C: centralized, D: decentralized)
SI: subgroup integration (S: separated, I: integrated)

Table E.1.: Q sort items used in Study 5

<table>
<thead>
<tr>
<th>TASKS</th>
<th>A) DECISION-MAKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD.C:</td>
<td>Team leaders have the most experience and best overview so they should make all important decisions.</td>
</tr>
<tr>
<td>VD.D:</td>
<td>The people at the sharp end should be empowered to decide on how to deal with any emerging problems themselves.</td>
</tr>
<tr>
<td>SI.S:</td>
<td>It is more efficient if offshore make urgent decisions themselves.</td>
</tr>
<tr>
<td>SI.I:</td>
<td>In order to make better decisions, onshore and offshore personnel have to participate equally in making decisions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B) INFORMING/REPORTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD.C:</td>
</tr>
<tr>
<td>VD.D:</td>
</tr>
<tr>
<td>SI.S:</td>
</tr>
<tr>
<td>SI.I:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C) PLANNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD.C:</td>
</tr>
<tr>
<td>VD.D:</td>
</tr>
<tr>
<td>SI.S:</td>
</tr>
<tr>
<td>SI.I:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D) PROBLEM-SOLVING</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD.C:</td>
</tr>
<tr>
<td>VD.D:</td>
</tr>
<tr>
<td>SI.S:</td>
</tr>
<tr>
<td>SI.I:</td>
</tr>
</tbody>
</table>

Continued on next page
Table E.1: Q sort items used in Study 5 – continued from last page

**PROCESSES**

E) GOAL-SETTING

| VD.C | It has to be the team leader who sets the performance standards for the team and monitors whether the team performs accordingly. |
| VD.D | Each team should be in the position to set its own performance goals without major intervention from management. |
| SLS | Onshore and offshore teams should each set their own performance standards. |
| SLI | Performance goals should be negotiated between onshore and offshore. |

F) COORDINATION

| VD.C | Team leaders should give clear instructions about what to do and how to do the work. |
| VD.D | There is no need for the team leaders to get involved in day-to-day operations. Onshore and offshore personnel are more flexible and efficient if left alone. |
| SLS | For most tasks there is no real need to closely coordinate between onshore and offshore. |
| SLI | Onshore and offshore need to closely coordinate their tasks to get things done. |

G) CONTROL

| VD.C | Team leaders need to keep close control on how things are done. |
| VD.D | The team should take control over how work is planned and allocated. |
| SLS | Oversight of processes and tasks clearly has to lay with onshore. |
| SLI | Control of resources must be given to onshore and offshore in equal measure. |

**RELATIONSHIPS**

G) ALIGNING PEOPLE

| VD.C | Ultimately it is the responsibility of team leaders to make sure that everyone is singing from the same hymn sheet. |
| VD.D | It is best left to the team itself to sort out that everybody is working towards the same goal. |
| SLS | You cannot have a common vision onshore and offshore; they are two different worlds. |
| SLI | Onshore and offshore have to have the same goals, objectives, and agendas; otherwise we will never achieve the best results for our asset. |

H) SUPPORT/MENTORING

| VD.C | Team leaders should personally oversee that people have the right knowledge for the job. You cannot simply leave it to themselves or their colleagues. |
| VD.D | The best support and mentoring you can get is not from your boss but from your colleagues within the team. |
| SLS | Onshore and offshore are too far apart to support each other on a personal level. |

Continued on next page
Table E.1.: Q sort items used in Study 5 – continued from last page

<table>
<thead>
<tr>
<th>SL_I:</th>
<th>Onshore and offshore need a close personal relationship, because it is essential that they give each other support and advice.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD_C:</td>
<td>If there is a conflict or personality clash, the team leader should take control to sort out the problem.</td>
</tr>
<tr>
<td>VD_D:</td>
<td>The team leader should only intervene in personal conflicts if the conflicting parties cannot deal with it themselves.</td>
</tr>
<tr>
<td>SL_S:</td>
<td>Onshore and offshore are so far apart they cannot help each other in mediating conflicts.</td>
</tr>
<tr>
<td>SL_I:</td>
<td>If there are any personal conflicts between onshore and offshore, both sides should work together to find a solution.</td>
</tr>
</tbody>
</table>
Dear Participant,

You will be given a pile of 40 statements about different aspects of your work. Your task is to sort them according to how much you agree or disagree with the individual statements on the cards.

For this task use the scale spread out on the table ranging from –4 (strongest disagreement) to +4 (strongest agreement). Please sort only the indicated number of statements into each category.

<table>
<thead>
<tr>
<th>disagree</th>
<th>neutral</th>
<th>agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>0</td>
<td>+4</td>
</tr>
<tr>
<td>-3</td>
<td>+1</td>
<td></td>
</tr>
<tr>
<td>-2</td>
<td>+2</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>+3</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When sorting, there is no “right” or “wrong” decision. The only criterion is how much you personally agree or disagree with the statements.

From experience it is easiest to start by sorting the statements into three piles:

- **Pile A**: Any feeling of disagreement
- **Pile B**: No strong feeling
- **Pile C**: Any feeling of agreement

Do not understand

When you are happy with those three piles, start placing the cards under the scale on the table. Most people find it easiest to start with one pile e.g. pile A and find the 3 statements they most disagree with and place them on the extreme end. Then work your way towards the middle in the same manner until you have finished this pile and continue with pile C on the other end of the scale. The last pile should be pile B to be sorted into the fields that are still free.

If you are unsure about the procedure or have questions at any time in the process, please don’t hesitate to ask.

Thank you for your participation!

**Figure E.1.**: Q sort instructions given to participants
### Table E.2.: Factor solution for onshore team members

<table>
<thead>
<tr>
<th>Subject</th>
<th>F1</th>
<th>F2</th>
<th>Media Condition</th>
<th>Team</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.79</td>
<td>0.24</td>
<td>HR</td>
<td>1</td>
<td>f</td>
</tr>
<tr>
<td>7</td>
<td>0.75</td>
<td>0.33</td>
<td>HR</td>
<td>1</td>
<td>m</td>
</tr>
<tr>
<td>18</td>
<td>0.71</td>
<td>0.35</td>
<td>HR</td>
<td>4</td>
<td>f</td>
</tr>
<tr>
<td>16</td>
<td>0.70</td>
<td>0.40</td>
<td>HR</td>
<td>1</td>
<td>f</td>
</tr>
<tr>
<td>11</td>
<td>0.67</td>
<td>0.37</td>
<td>HR</td>
<td>4</td>
<td>m</td>
</tr>
<tr>
<td>22</td>
<td>0.67</td>
<td>0.28</td>
<td>HR</td>
<td>5</td>
<td>f</td>
</tr>
<tr>
<td>15</td>
<td>0.65</td>
<td>0.25</td>
<td>HR</td>
<td>4</td>
<td>m</td>
</tr>
<tr>
<td>2</td>
<td>0.64</td>
<td>0.44</td>
<td>HR</td>
<td>1</td>
<td>m</td>
</tr>
<tr>
<td>3</td>
<td>0.62</td>
<td>0.47</td>
<td>HR</td>
<td>1</td>
<td>m</td>
</tr>
<tr>
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<td>0.60</td>
<td>0.39</td>
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<td>1</td>
<td>m</td>
</tr>
<tr>
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<td>0.51</td>
<td>HR</td>
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<td>m</td>
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<td>m</td>
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<td>m</td>
</tr>
<tr>
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<td>0.72</td>
<td>0.30</td>
<td>LR</td>
<td>3</td>
<td>m</td>
</tr>
<tr>
<td>28</td>
<td>0.72</td>
<td>0.17</td>
<td>LR</td>
<td>2</td>
<td>m</td>
</tr>
<tr>
<td>9</td>
<td>0.44</td>
<td>0.34</td>
<td>LR</td>
<td>3</td>
<td>m</td>
</tr>
<tr>
<td>8</td>
<td>0.29</td>
<td>0.75</td>
<td>LR</td>
<td>3</td>
<td>m</td>
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<tr>
<td>17</td>
<td>0.22</td>
<td>0.71</td>
<td>LR</td>
<td>3</td>
<td>m</td>
</tr>
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<td>0.46</td>
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<td>m</td>
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<td>0.65</td>
<td>LR</td>
<td>3</td>
<td>m</td>
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<td>m</td>
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<td>m</td>
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<td>m</td>
</tr>
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<td>m</td>
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<td>12</td>
<td>0.53</td>
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</table>

32.61% 23.78%

HR – high-richness condition; LR – low-richness condition
**Table E.3.:** Factor solution for offshore team members

<table>
<thead>
<tr>
<th>Subject</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>Condition</th>
<th>Team</th>
<th>Gender</th>
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<td>0.43</td>
<td>0.18</td>
<td>HR</td>
<td>5</td>
<td>m</td>
</tr>
<tr>
<td>7</td>
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<td>0.25</td>
<td>0.43</td>
<td>HR</td>
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<td>m</td>
</tr>
<tr>
<td>8</td>
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<td>2</td>
<td>0.26</td>
<td>0.54</td>
<td>0.42</td>
<td>HR</td>
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<td>m</td>
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<tr>
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<td>0.45</td>
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<td>0.51</td>
<td>LR</td>
<td>3</td>
<td>m</td>
</tr>
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</table>

28.49% 19.69% 19.15%

HR – high-richness condition; LR – low-richness condition

**Table E.4.:** Factor solution for onshore managers

<table>
<thead>
<tr>
<th>Subject</th>
<th>F1</th>
<th>F2</th>
<th>Condition</th>
<th>Coordination</th>
<th>Team</th>
<th>Gender</th>
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</thead>
<tbody>
<tr>
<td>3</td>
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<td>0.11</td>
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<td>continuous</td>
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<td>m</td>
</tr>
<tr>
<td>8</td>
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<td>0.08</td>
<td>HR</td>
<td>continuous</td>
<td>5</td>
<td>m</td>
</tr>
<tr>
<td>4</td>
<td>0.63</td>
<td>0.31</td>
<td>LR</td>
<td>continuous</td>
<td>3</td>
<td>m</td>
</tr>
<tr>
<td>6</td>
<td>0.66</td>
<td>0.55</td>
<td>LR</td>
<td>continuous</td>
<td>3</td>
<td>m</td>
</tr>
<tr>
<td>1</td>
<td>-0.18</td>
<td>0.84</td>
<td>HR</td>
<td>dis-continuous</td>
<td>1</td>
<td>m</td>
</tr>
<tr>
<td>7</td>
<td>0.38</td>
<td>0.63</td>
<td>HR</td>
<td>dis-continuous</td>
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<td>m</td>
</tr>
<tr>
<td>5</td>
<td>0.33</td>
<td>0.67</td>
<td>LR</td>
<td>dis-continuous</td>
<td>3</td>
<td>m</td>
</tr>
<tr>
<td>9</td>
<td>0.52</td>
<td>0.63</td>
<td>LR</td>
<td>dis-continuous</td>
<td>2</td>
<td>m</td>
</tr>
<tr>
<td>10</td>
<td>0.55</td>
<td>0.54</td>
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<td>m</td>
</tr>
<tr>
<td>2</td>
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<td>0.64</td>
<td>HR</td>
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<td>m</td>
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</table>

35.03% 30.70%
## Table E.5.: Factor solution for offshore managers

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<th>F2</th>
<th>Media Condition</th>
<th>Team</th>
<th>Gender</th>
</tr>
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<td>m</td>
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</tr>
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<td>0.59</td>
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<tr>
<td>3</td>
<td>0.57</td>
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<td>3</td>
<td>m</td>
</tr>
<tr>
<td>11</td>
<td>0.45</td>
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<td>m</td>
</tr>
<tr>
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<td>0.67</td>
<td>HR</td>
<td>5</td>
<td>m</td>
</tr>
<tr>
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<td>0.17</td>
<td>0.66</td>
<td>HR</td>
<td>5</td>
<td>m</td>
</tr>
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<td>0.44</td>
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<td>0.08</td>
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<tr>
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<td>0.54</td>
<td>0.53</td>
<td>LR</td>
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<td>m</td>
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<tr>
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<td>0.51</td>
<td>0.45</td>
<td>HR</td>
<td>5</td>
<td>m</td>
</tr>
</tbody>
</table>

29.63%  26.16%

HR – high-richness condition; LR – low-richness condition
Table E.6.: Defining Q statements for the four groups

**Onshore team members**

- **High-richness condition:**
  
  Onshore and offshore need to closely coordinate their tasks to get things done (+4, SI: processes/coordination); Onshore and offshore need a close personal relationship, because it is essential that they give each other support and advice (+3, SI: relationships/support)

- **Low-richness condition:**

  When important tasks are planned, those who will implement them must have their say as well (+4, VC: tasks/planning); Offshore and onshore need to have equal voice and weight in developing plans on how and when things are done (+4, SI: tasks/planning);

- **Distinguishing statements \((p < .01)\):**

  The team should take control over how work is planned and allocated (0, +3, processes/control); Onshore and offshore have to have the same goals, objectives, and agendas; otherwise we will never achieve the best results for our asset (+4, +1, relationships/alignment)

**Offshore team members**

- **High-richness condition:**

  In order to make better decisions, onshore and offshore personnel have to participate equally in making decisions (+4, SI: tasks/decision-making); There is no need for the team leaders to get involved in day-to-day operations. Onshore and offshore personnel are more flexible and efficient if left alone (+4, VC: processes/coordination)

- **Low-richness condition:**

  Onshore and offshore need to closely coordinate their tasks to get things done (+4, processes/coordination); Planning is purely an onshore task; offshore is in charge of executing the work (-4, tasks/planning)

- **Distinguishing statements \((p < .01)\):**

  Onshore and offshore are too far apart to support each other on a personal level (-4, 0, SI: relationships/support); It has to be the team leader who sets the performance standards for the team and monitors whether the team performs accordingly (+3, -2, VC: processes/goal-setting)

**Onshore managers**

- **Continuous coordination:**

  Onshore and offshore need to closely coordinate their tasks to get things done (+4, SI: processes/coordination); Team leaders have the most experience and best overview so they should make all important decisions (-4, VC: tasks/decision-making)

Continued on next page
Appendix E. Items, instructions, and Q-factor analysis results in Study 5

Table E.6.: Defining Q statements for the four groups – continued from last page

- **Discontinuous coordination:**
  Any information about irregularities or incidents offshore should first go to the team leaders so that they know what’s going on, and they then distribute it to their team (+4, VC: tasks/informing); It has to be the team leader who sets the performance standards for the team and monitors whether the team performs accordingly (+3, VC: processes/goal-setting)

- **Distinguishing statements** ($p < .01$):
  The people at the sharp end should be empowered to decide on how to deal with any emerging problems themselves (+4, -1, VC: tasks/decision-making); Control of resources must be given to onshore and offshore in equal measure (+3, 0, SI: processes/control)

**Offshore managers**

- **High-richness condition:**
  Onshore and offshore have to have the same goals, objectives, and agendas; otherwise we will never achieve the best results for our asset (+4, SI: relationships/alignment)
  Planning is purely an onshore task; offshore is in charge of executing the work (-4, SI: tasks/planning)

- **Low-richness condition:**
  Any information about irregularities or incidents offshore should first go to the team leaders so that they know what’s going on, and they then distribute it to their team (+4, VC: tasks/informing);

- **Distinguishing statements** ($p < .01$):
  Team leaders should personally oversee that people have the right knowledge for the job. You cannot simply leave it to themselves or their colleagues (+4, -1, VC: relationships/support); The best way of solving a problem is if onshore and offshore discuss and develop a solution together rather than separately (+4, +1, SI: tasks/problem-solving)
Appendix F: Questionnaire items and scales used in Study 6
Appendix F. Questionnaire items and scales used in Study 6

**Table F.1.: Items for variables in Study 6**

<table>
<thead>
<tr>
<th>Scales and items</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Social identification (adapted according to Dimmock, Grove, &amp; Eklund, 2005)</em></td>
<td></td>
</tr>
<tr>
<td>Instruction: Thinking about your work, how strongly do you identify with the following?</td>
<td></td>
</tr>
<tr>
<td>Your gender (male/female)</td>
<td></td>
</tr>
<tr>
<td>Your age group (= 30, &gt; 30)</td>
<td></td>
</tr>
<tr>
<td>Being an onshore / offshore worker</td>
<td></td>
</tr>
<tr>
<td><em>Team identification (based on Van der Vegt &amp; Bunderson, 2005)</em></td>
<td></td>
</tr>
<tr>
<td>Instruction: When you think about the CE team you work with:</td>
<td></td>
</tr>
<tr>
<td>How much do you feel emotionally attached to ___?</td>
<td></td>
</tr>
<tr>
<td>How much do you feel a strong sense of belonging to ___?</td>
<td></td>
</tr>
<tr>
<td>How much do you feel that the team's problems are your own? ___</td>
<td></td>
</tr>
<tr>
<td>How much do you feel like part of a family in ___?</td>
<td></td>
</tr>
<tr>
<td>Note: Every item was given three times. ___ was replace with (a) to the onshore part of the team; (b) to the offshore part of the team; (c) to the team as a whole?</td>
<td></td>
</tr>
<tr>
<td><em>Intra-team conflicts (Jehn, 1995)</em></td>
<td></td>
</tr>
<tr>
<td>Instruction: When you think about the cooperation between onshore and offshore in the CE:</td>
<td></td>
</tr>
<tr>
<td>Relationship conflict:</td>
<td></td>
</tr>
<tr>
<td>There is a lot of friction among team members.</td>
<td></td>
</tr>
<tr>
<td>There are personality conflicts evident in the team.</td>
<td></td>
</tr>
<tr>
<td>There are tensions among members of the team.</td>
<td></td>
</tr>
<tr>
<td>There are emotional conflicts among members of the team.</td>
<td></td>
</tr>
<tr>
<td>Task conflict:</td>
<td></td>
</tr>
<tr>
<td>Members in the team disagree about opinions regarding the work being done.</td>
<td></td>
</tr>
<tr>
<td>There are conflicts about ideas in the team.</td>
<td></td>
</tr>
<tr>
<td>There is conflict about the work you do in the team.</td>
<td></td>
</tr>
<tr>
<td>There are differences of opinions in the team.</td>
<td></td>
</tr>
<tr>
<td><em>Team familiarity (self-developed)</em></td>
<td></td>
</tr>
<tr>
<td>Instruction: When you think about the CE team you work with (including onshore and offshore members), how much do you agree with the following statement</td>
<td></td>
</tr>
<tr>
<td>I know the members of my team very well.</td>
<td></td>
</tr>
<tr>
<td><em>Task interdependence (Campion, Medsker, &amp; Higgs, 1993)</em></td>
<td></td>
</tr>
<tr>
<td>Instruction: When you think about the CE team you work with (including onshore and offshore members), how much do you agree with the following statements</td>
<td></td>
</tr>
<tr>
<td>My team cannot accomplish its tasks without information or materials from other members within the team.</td>
<td></td>
</tr>
</tbody>
</table>

Continued on next page
### Table F.1.: Items for variables in Study 6 – continued from last page

<table>
<thead>
<tr>
<th>Scales and items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members of my team depend on each other for information or materials needed to perform their tasks.</td>
</tr>
<tr>
<td>Within my team, jobs performed by team members are all related to one another.</td>
</tr>
</tbody>
</table>

**CE performance (self-developed)**

Instruction: Please give your assessment of the performance of each group at the moment

**Meeting objectives**

- Quality of decision making
- Speed of decision making
- Effectiveness of problem solving
- Effectiveness of collaboration between on- and offshore
- Getting access to information
- Overall performance

**Satisfaction (self-developed)**

Instruction: Please circle or tick the face that most closely mirrors how you feel at the moment about

- The collaboration with your colleagues in the CE onshore
- The collaboration with your colleagues in the CE offshore
- Your overall impression of your work

**Communication frequency (self-developed)**

Instruction: How often do you communicate with your team members onshore/offshore through the CE?

- What technology do you use for communicating with onshore/offshore members and how often? [mark all that apply] – phone, email, audio-conferencing, video-conferencing, other

**Demographics**

- Personal Identifier
- Team (open item)
- Age (categories: < 20; 21 – 30; 31 – 40; 41 – 50; 51 – 60; > 60)
- Gender (categories: male, female)
- Job title (open item)
- Are you a team leader? (categories: no, yes)
- Work place (categories: onshore, offshore)
- Years in job (years)

All items were measured on a Likert scale ranging from 1 – ‘completely disagree’ to 5 – ‘completely agree’. 
THE ROLE of TECHNOLOGY in DISTRIBUTED TEAM COORDINATION

Petra Saskia Bayerl

The goal of this project was two-fold: firstly, to add to the theoretical knowledge about the impact of complex media combinations for distributed team coordination, and secondly, to increase the practical knowledge for organizations and designers on how to design and implement complex technological solutions for the support of distributed teams. The project was conducted as longitudinal field study in the offshore oil and gas industry investigating the implementation and use of Collaborative Environments in production teams. The production teams in this thesis were ongoing teams consisting of two interdependent but highly diverse subgroups, one in the onshore office (onshore subgroup), the other on offshore installations (offshore subgroup). I therefore referred to this type of teams as longitudinal asymmetric distributed teams (LADTs). Asymmetry, as used in this thesis, describes the existence of systematic differences in task-related aspects, demographics, and cultures between geographically dispersed subgroups. The notion of asymmetry is based on the concept of faultlines (Lau & Murnighan, 1998) and can be seen as an extreme case of diversity with a high potential for conflicts and coordination problems (e.g., Li & Hambrick, 2005; Polzer et al., 2006).

Asymmetry is not unique to oil production teams. Certain degrees and types of asymmetry can be expected also in distributed teams incorporating subgroups from different organizations or nations, or in industries with a clear split in roles (e.g., air traffic control, mining, space exploration, or military campaigns). Although an upcoming topic in the context of the diversity and faultline literature, asymmetry in distributed teams is not yet well described. Also, despite the growing literature on computer-mediated communication and distributed teams, the role of technology for team processes and outcomes remains unclear. This is in part due to the fast devel-
opment of technological capabilities over the last decades, but also to restrictions in the research itself. The extant literature on distributed teams has focused mostly on the effects of single technologies such as email or video conferencing comparing face-to-face with text-based, audio-based, or visual media (Credé & Sniezek, 2003; DeRosa, Smith, & Hantula, 2007; Roch & Ayman, 2005; Straus & McGrath, 1994). More critically, technology in this literature tends to be restricted to communication media largely ignoring the category of information technologies. To some extent this restriction is due to the fact that research into computer-mediated communication and distributed teams are mostly experimental using artificial settings and student groups. Comparing isolated media conditions provides a framework to study basic work processes and effects. The organizational reality, however, is considerably more complex. Distributed teams in organizations tend to use a range of information and communication technologies; combinations also referred to as Collaborative Environments (CEs). Likewise, tasks and processes in organizational teams tend to be more intricate than the ones used in the majority of experiments. Current literature on the role of technology for distributed teams moreover lags a longitudinal or process perspective. In consequence, results from experimental studies can provide little guidance for organizations and system designers on the design and implementation of complex technological solutions.

This project started with an investigation into types of asymmetries and their consequences on coordination and subgroup relationships in distributed teams (Study 1, Chapter 5). This initial study provided the background for the investigation of CE implementation and adoption (Study 2, Chapter 6) and the consequences of these implementations on team processes and outcomes (Studies 3 to 6 in Chapters 7 to 10). In the following, I provide a short summary of the content of the eleven chapters contained in this thesis including the key findings of the six empirical studies reported within.

**Chapter 1** provides a general introduction to the challenges of distributed team work and the role of technology for distributed team arrangements. Due to the geographic dispersion and lack of common context, distributed teams carry an increased risk for coordination problems, process losses, and conflicts. A strategy to improve team functioning is the implementation of advanced information and communication technologies. Chapter 1 introduces the concept of Collaborative Environments (CEs) as combinations of advanced data exchange and communication technologies to support distributed team work. It also introduces the concept of *longitudinal asymmetric distributed teams* (LADTs), which are the focus of this thesis. LADTs
are defined as ongoing teams composed of internally homogeneous, but compared to each other highly diverse subgroups. Chapter 1 ends with an outline of the thesis.

Chapter 2 reviews the theoretical and empirical literature in four areas: distributed teams, team diversity, computer-mediated communication, and technology implementation and adoption. In this chapter the challenges of longitudinal distributed working and asymmetries in distributed teams are discussed, as well as the role of information and communication technologies in shaping team processes and outcomes. The review shows that the present knowledge on distributed teams provides only limited insights into processes connected with ongoing distributed work arrangements, as it lacks information on longterm effects, as well as experiences in the field. In the second part of the chapter, I review literature on more specific aspects, namely effects of asymmetries on team functioning, implementation of technologies, and short- and long-term effects of technology changes in the context of CE implementations. Based on the gaps identified in these sections, research questions are developed that guided the six empirical studies reported in this thesis.

Chapter 3 describes the industrial and organizational context, in which this project took place. The PhD project was conducted in one of the major companies (‘super-majors’) in the offshore oil and gas industry, more precisely in the North Sea performance unit of this company. The chapter starts with a short overview of the challenges the offshore oil industry faces in the North Sea, namely raising costs due to maturing fields and aging infrastructure. It then provides a short introduction into the work processes and structure of production teams. Production teams consist of two highly interdependent subgroups: one in the onshore office (onshore subgroup), the other on offshore installations (offshore subgroup). These two subgroups form asymmetric distributed teams, in which each subgroup is characterized by its own disparate tasks, demographics, and culture. The company undertook a large-scale implementation of Collaborative Environments for all its operations teams. The main rationale for the CE implementation was the improvement of coordination processes between subgroups and easier availability of outside expertise. In the remainder of the chapter the concrete design of the CEs, as well as the rationale and the implementation process are described.

Chapter 4 illustrated the general methodological framework underlying the six empirical studies reported in this thesis. This project was a longitudinal field study with continuous presence in the field for two years. It employed a mixed methods approach using qualitative methods and quantitative methods in a sequential exploratory design. The primary levels of analysis are the subgroup and team. The
Chapter 5 reports the first empirical study. In this study I investigated asymmetries in the production teams and the consequences of asymmetry for team processes and relationships. Based on 58 semi-structured interviews, I identified three types of asymmetries that existed simultaneously in the production teams studies in this thesis: task-related, demographic, and cultural. These asymmetries affected two aspects of team functioning: intra-team coordination and subgroup relationships. The study further suggested that features of information and communication technologies can moderate the negative effects of asymmetries. Based on the findings in this study I argue that the implementation of information and communication technologies should be able to improve conditions for subgroup coordination by increasing mutual awareness and data availability. I further argue that information and communication technologies will play different roles in this process. While information technologies target the short-term problems of low visibility of processes and situation awareness in terms of plant status, communication technologies in the short term will increase social awareness and subsequently subgroup relationships. In the long-term richer communication media should also lead to a better understanding of each others knowledge and expertise.

Chapter 6 provides insights into the factors that impact acceptance and adoption of CEs from pre-implementation to early-usage and later-usage stages. Based on a comparative analysis of three teams, I formulated four theoretical propositions to extend existing models of technology adoption to the team level: (1) adoption must be conceptualized as a team-level construct, (2) adoption in teams is characterized by the two disparate dimensions valence and alignment, (3) models of team-based adoption must include team characteristics and intra-team dynamics, and (4) in distributed team settings cognitions and behaviors are prone to destabilization also in later-usage stages. The study further suggests that user satisfaction consists of two different aspects, namely technology and process satisfaction, which are nearly inseparable at the beginning of the implementation process but show a slow unlinking in the early- and later-usage phases. Chapter 6 ends with the formulation of a theoretical model to describe potential outcomes of technology implementations in distributed team settings. The model suggests two dimensions to describe users’ attitudes towards new technology: valence and alignment. Valence refers to the type of a team’s attitudes (positive or negative), while alignment refers to the degree of congruence among member attitudes. In this chapter I argue that different combi-
nations of positive/negative valence and alignment/non-alignment can describe user reactions and implementation success in teams. I propose that alignment in valence will lead to either adoption (for positive attitudes) or non-adoption (for negative attitudes), while non-alignment will result in compliance or blocked adoption depending on strength of attitudes and comparative subgroup dominance. Alignment or non-alignment with respect to type of attitudes should lead to the four states of congruent adoption, conflicting use, congruent non-adoption, and disparate non-adoption. Based on the valence-alignment model strategies are formulated on how to change users’ attitudes in these adoption states.

Chapter 7 investigates the impact of technology change on coordination processes in LADTs. This study was based on semi-structured interviews and observations of team processes before and after the implementation of CEs. I found that coordination in production teams is centered around nine primary activities: planning, executing, monitoring, reporting/informing, trouble-shooting, negotiating, coordination across team boundaries, documenting, and networking/maintenance of social relationships. These activities differed in their criticality (e.g., high for planning and monitoring, low for networking), cyclical nature (e.g., monitoring as continuous versus trouble-shooting as sporadic activity), scriptedness (i.e., reliance on fixed procedures), and responsible subgroup (e.g., planning as primarily an onshore task, executing as primarily an offshore task). Overall, the implementation of CEs resulted in a general decrease in routine communication accompanied by an increase in non-routine communications, as well as a move of interactions from management levels to lower levels of the organization. This study also identified three potential challenges for asymmetric distributed teams changing to richer media: (1) a blurring of traditional subgroup roles, (2) the loss of a longer-term, strategic focus for the team, and (3) the potential weakening of existing control systems. Detailed effects of the technology change are illustrated in the context of the five critical team activities planning, monitoring, trouble-shooting, executing, and reporting/informing. Based on these findings, considerations for the choice of information and communication technologies for asymmetric distributed teams are discussed.

In Chapter 8 three CE designs are compared in their differential effects on team coordination and outcomes. The three designs varied in the type of technological support and physical integration of subgroups and included a purely technological solution, which relied solely on advanced media to connect remote subgroups, a structural solution based on the physical integration of members into the remote subgroups, and a hybrid solution, which combined the use of advanced media with
the physical integration of members. The technological concept was identified as the least disruptive of the three, while providing the widest spread of effects. Risks and contingencies were its vulnerability for a lacking reliability of technological infrastructure, media preferences of individuals or subgroups, and the degree of interdependence between subgroups. The structural solution resulted in the least change of existing processes and relationships, but seemed most effective in teams with a small number of processes and tasks requiring close onshore-offshore integration. The hybrid approach combined the positive effects of the structural solution (easy availability of offshore expertise for onshore personnel and reduction in calls to offshore) with the easier access to information and people offered by the technological solution. Team learning and establishment of relationships were largely restricted to personnel integrated in the hosting group. Overall, structural integration was found to restrict the effects largely to the subgroup, in which the integration took place, while effects of technological integration are more scalable according to the type and availability of media in dispersed subgroups, while Based on the comparison of the three approaches I suggest that the technological approach seems best suited for situations, in which subgroups are highly interdependent, but many tasks rely on routine information and repeated processes with few exceptions or critical events. The structural approach seems a good option for more loosely-coupled distributed teams, in which subgroups share few very specific interdependent processes and not much in-depth coordination is needed in an ongoing basis. The hybrid approach seems well suited for situations in which critical, e.g., high hazard, tasks are performed in the remote location and where as much stress and strain should be taken off individuals at the remote location, or in which one side has a primarily supporting function for the other.

Chapter 9 describes findings on the effect of media capabilities on expectations of team members and managers towards vertical decentralization and lateral integration between subgroups (i.e., subgroup integration). For this study I used Q methodology supported by semi-structured interviews. The study was based on the assumption that the richer media in the CE environments would lead to a greater alignment of expectations between subgroups. Results largely supported this assumption. Expectations were more similar across media conditions than across geographical (onshore/offshore) or functional groups (members/managers). Further, in the high-richness condition (i.e., after CE implementation) member and manager expectations showed greater alignment than in the low-richness condition (before CE implementation). Based on these findings I argue that technology capabilities
may impact the type and alignment of cooperation expectations. Technology changes may therefore require modifications in managers' leadership styles and behaviors.

Chapter 10 focuses on the long-term effects of technology change on social identification, conflicts, and team outcomes (i.e., performance and member satisfaction). Its objectives were: firstly, to investigate the relative changes in identification with the subordinate group (own or remote subgroup) and the superordinate group (whole team); and secondly, to investigate the effect of technology change on team identification, conflicts, and outcomes over time. This study was based on four repeated waves of surveys from pre-implementation to two and a half years after CE implementation. The increase in communication frequency after technology change was related to an increase in identification with the whole team, although members consistently identified more with their own subgroup than the remote subgroup. Technology change was further related to less intra-team conflicts and better performance and member satisfaction up to twelve months after implementation. Identification was negatively related to the perception of conflicts and positively to team outcomes especially for onshore personnel.

Chapter 11 concludes the thesis summarizing the key findings and discussing theoretical and practical implications, as well as limitations and open questions for further research. The main theoretical contributions lay in the introduction of the concept of asymmetry and its effects on distributed team work, the reframing of IT implementation and adoption as a team-level process, the development of a model for IT adoption in distributed teams, a delineation of effects of technological versus structural means to bridge geographic distribution, and a detailed view on the processes, with which multiple technologies impact on team functioning and more specifically intra-team coordination in mature distributed teams. Results in this project illustrate that design and implementation of complex technology solutions require an interdisciplinary approach incorporating psychological expertise and design expertise. For organizations, the knowledge gained from this project can help anticipate effects of media choices on their distributed work force and guide decisions of technology choice and design. The valence–alignment framework introduced in this thesis further provides managers and organizations with a framework to analyze reactions of user to technology implementations and devise strategies against resistance. For designers this projects aims to raise awareness for the relevance of social interdependencies and dynamics for product acceptance and use, the possibility of disparate or even conflicting user requirements in multi-user contexts, and the importance of a stronger process view from initial attitudes to long-term use.
Curriculum Vitae

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Place of birth: Karlsruhe, Germany

Petra Saskia Bayerl is a postdoctoral researcher at the Rotterdam School of Management, Erasmus University, The Netherlands. She received her first master degree (Magister Artium) in German Language Studies in 2002 from Justus-Liebig University, Giessen, Germany. After graduation she joined the Research Unit for Applied and Computational Linguistics at Justus-Liebig-University as research assistant, where she worked in a three year project on the semantics of generic document structures funded by the German Research Society (DFG). During this time she also finished a second master degree in Psychology (Dipl.-Psych., April 2004; also Justus-Liebig University, Giessen, Germany) specializing in industrial/organizational psychology. After three years of research in Computational Linguistics she decided to return to the field of industrial/organizational psychology. She spent fourteen months in Tulsa, OK, where she acquired a third master degree in Organizational Dynamics from University of Oklahoma, USA. In November of 2006 she then joined the Faculty of Industrial Design Engineering at Delft University of Technology to obtain her PhD. She published in international peer-reviewed journals such as Computer-Supported Cooperative Work, Zeitschrift für Arbeits- und Organisationspsychologie, and Computational Linguistics and presented her work at international academic and industry conferences. Her current research interests are distributed team work, diversity, organizational change, and quality of linguistic manual annotations.
Publications in the context of the PhD project

Peer-reviewed journal papers, book chapters, and conference proceedings


### Posters and talks


