

# Relation work: Creating socio-technical connections in global engineering

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**Abstract.** In this article the notion of *relation work* will be put forward to describe efforts of connecting people and artefacts in a multitude of ways as part of facilitating global interaction and coordination in an engineering firm. Relation work can be seen as a parallel to the concept of *articulation work*. Articulation work describes efforts of coordination necessary in cooperative work, but, arguably, focuses mainly on task-specific aspects of cooperative work. As a supplement, the concept of relation work focuses on the fundamental relational aspect of cooperative work. Relation work forms the fundamental activities of creating socio-technical connections between people and artefacts during collaborative activities required to create and enact the human and electronic network and engage with articulation work in cooperative engagements. The concept of relation work is applied within an ethnographic study of War Room meetings in a Global engineering firm. It is argued that relation work is a prerequisite for other activities such as articulation work. Relation work is described in a number of dimensions, including connecting people with people, people with artefacts, and artefacts with other artefacts.

## Introduction

Engineering a cement factory is a highly complex collaborative engagement between approximately 300 geographically dispersed engineers, whose work over a two-year period is highly dependent. Specifically, the work entails numerous dependencies between tasks and sub-tasks, such as ensuring that the internal design of equipment fits the overall external design of buildings, or that the factory exterior fits the local landscape of the factory—one factory has approximately 6000 tasks and sub-tasks that must be coordinated. We have had

the pleasure of ethnographically investigating how engineers from a large global firm coordinated the work of engineering cement factories. In this paper we focus on one of the key coordinative activities, namely the execution of the so-called War Room meetings between engineers located in Denmark and India.

The concept of the War Room has been investigated previously in CSCW research. However, whereas the War Room in these studies referred to physical spatial arrangements, as in dedicated project rooms where participants are brought together for a short, concentrated period of time spent working on a particular project (e.g. Covi et al., 1998; Mark, 2001; Teasley et al., 2000), the War Room concept we investigate focuses on War Room *meetings*. The War Room meeting is an invention of the engineering company that is based on lean principles. Lean principles in question focus on the process and in particular of the interfaces between individual yet tightly coupled tasks. They form weekly 15-30 minute globally distributed meetings where select participants located in Denmark and India “meet” to identify key challenges and tasks that require particular attention. Thus, previous War Room studies differ from ours in terms of time (all time vs. weekly for 15-30 minutes), overall purpose (continues synchronous collaboration vs. coordinates activity), and geography (collocated vs. geographically distributed). However, similarities also exist. Our War Room meetings took place in particular dedicated rooms (located in India and Denmark), and used large wall-mounted posters to guide coordinative activity.

When we first began investigating the War Room meeting as a coordinative activity, we were looking at how the articulation work (Schmidt and Bannon, 1992; Strauss, 1985) was performed between the globally distributed participants, and, in particular, how the key coordinative artefact (the War Room poster) supported the articulation work required to make the collaboration function. However, during this study we found another type of work that was fundamental to the execution of articulation work, which we present in this article as *relation work*. Relation work forms the fundamental activities of creating socio-technical connections between people and artefacts required to create and enact human and electronic networks and handle articulation work in cooperative engagements. Relation work becomes particularly evident in collaborative engagements with a high degree of discontinuities, as is typical of global collaborations (Bjørn and Ngwenyama, 2010); but, we suggest that relation work might also be relevant in ordinary collocated collaboration.

We will proceed by introducing the theoretical framework of collaboration, articulation work, and relation work, followed by a presentation of the empirical case and methodology. Then we present the analysis, where we show relation work first as connecting people to people, second people to artefacts, and third as connecting artefacts to artefacts. Next we discuss our empirical observations and connect them to previous work, and finally we conclude by connecting relation work to larger debates within CSCW.

## Theoretical Framework

It is widely agreed within CSCW that collaboration can analytically be divided into work and articulation work, where articulation work is all of the extra activities required when two or more individuals have to collaborate to get a particular task done (Schmidt and Bannon, 1992). Articulation work is all the of tasks required to coordinate a particular task, including scheduling, recovering from errors, and assembling resources (Gerson and Star, 1986). In this way, articulation work implies an overhead cost of extra work in labour, resources, and time, and the justification for this extra work is that one participant alone is not able to accomplish the whole task without interdependent engagements with others (Schmidt & Bannon 1992). If we look at the case of the engineers, it is quite obvious that one engineer cannot accomplish the total work involved in engineering a cement factory; thus collaboration, and, consequently, articulation work, is required. Previous work in CSCW has focused on different strategies for handling the effort involved in articulation work, and key concepts are awareness and coordinative artefacts. Next we will introduce awareness and coordinative artefacts as they have been found in collocated settings. Following that we will reflect on how remote spatial arrangements might affect these strategies, which leads to the introduction of our concept of *relation work*.

### Awareness and collocation

CSCW research over the last two decades has highlighted the rich and subtle interaction that collocation affords. Importantly, the concept of *awareness* practices has sprung from this research. The idea of awareness, at least in CSCW, originally emerged in a number of work place studies, including Heath and Luff (1992; , 1996) of Line Control Rooms on the London Underground as well as the studies of air traffic control work by the Lancaster group (Harper and Hughes, 1993; Harper et al., 1989a; Harper et al., 1989b). In these studies, it was noted how collaborative activity in complex organizational environments rests on the individuals' abilities to create awareness through bodily conduct while engaged in their respective activities. That is, it was described how actors produce awareness by rendering a feature of their conduct or a feature in the environment *selectively* available to collocated others. In the course of their work performance, actors may find that the activity in which they are engaged becomes potentially relevant for others within the domain, and yet their colleagues are seemingly involved in something else. In such circumstances, an actor may modulate an activity (e.g., speak louder, stare in an obvious manner, or overtly move an object about) to enable others to gain awareness of some matter at hand, without demanding that anybody should respond.

Much production of awareness through bodily conduct relies on collocation, and previous studies of collocated War Rooms found that the proximity of the spatial arrangement allowed the team members to overhear each other, and by informally monitoring each others' activities, they also volunteered advice (Teasley et al., 2000). In Teasley et al.'s study, the success of the War Room was that the participants were ready at hand, and these authors did speculate whether it would be possible to create a similar War Room setting remotely (Teasley et al., 2000). In addition to the subtle "awareness" practices that Heath et al. (2002) describe, collocation also allows for frequent and informal conversation. For example, it may be the case that during the conversation "at the water cooler," "in the lunch room," or "in the hallway," important work-related exchanges are triggered even though that conversation was not the original intent of the trip there. Furthermore, it is most often possible to tell if someone is available for a conversation from cues such as open doors, knowledge of local schedules, habits, and practices. In addition, voice mail and e-mail are more likely to be answered by someone you do know well from sharing the same location (Herbsleb et al., 2000, p.320). These findings suggest that collocation may foster awareness and communication that plays a crucial role in the coordination of cooperative work.

### Coordinative artefacts

Coordinative artefacts support the aligning, scheduling, and integrating of interdependent activities in collaborative settings. Coordinative mechanisms are particular types of coordinative artefacts consisting of a protocol reducing efforts of articulation by being embedded within the artefact (Schmidt and Simone, 1996). If we identify the key artefact of the War Room meetings in our case of the engineers, it is clearly the *War Room poster*. The War Room poster is a large, brown paper wall-mounted in either Denmark or India. The poster is a coordinative artefact illustrating the plan, as well as all the dependencies between the activities of engineering the cement factory, divided into weeks and milestones. For each week there are connected lists of tasks that must be conducted, and the War Room meetings establish whether tasks are finished according to plan, or whether the plan has to be adjusted. There are strict protocols for how the War Room poster is to be used. If a participant during a meeting brings up an issue (a task which have not been done, a piece of information lacking to complete a task etc), the facilitator will create a yellow sticker writing three types of information: The issue, name of the responsible person to handled the issue, and the date. The yellow sticker will be placed on the War Room poster at the following week, where the responsible person should report back. In this way, the War Room poster does embed a particular protocol for use, and, as such, it can be labeled a coordination mechanism. Because the poster itself is a tangible object created by physical paper, the War Room poster is

a local object, used, however, in a global setting. Investigating the shared artefacts in a collocated War Room, Covi et al. found that the shared visual displays supported the work by making intangible work visible and editable via representations (Covi et al., 1998, p. 58). In this way, it was the tangible characteristic of the shared display which was essential in that study. Prior studies of how groups use electronic or physical scheduling also found that the size, location, and physical qualities of material tangible tools engender certain essential group processes, which current digital coordination tools fail to support (Whittaker and Schwarz, 1999). Likewise, the War Room poster in our case supports coordination by making the intangible plan visibly available in certain ways essential for the execution of the War Room meeting, which is not possible with the current digital schedule. Still the lack of digitalization also creates new challenges for the use of the War Room posters, due to the geographical dislocation of the participants.

### Spatial arrangements

Distance matters (Olson and Olson, 2000), and in contrast to the rich potential for interaction afforded by collocation, there are convincing accounts that the frequency of communication drops off sharply with the physical separation of co-workers. Allen (1977), in a study of engineering organizations, reported that the frequency of communication (including, for example, phone calls and emails) among engineers decreased with distance. He even noted that when engineers' offices were more than 30 meters apart, the frequency of communication dropped to nearly the same low level as people with offices separated by many miles. Kraut and associates (Kraut et al., 1990) found similar results in their study of scientific research collaboration. That is, they found that the rate at which scientists collaborated was a function of physical distance between offices, and that this effect was even more powerful than that of same-discipline scientists tending to collaborate. It seems that close physical proximity led to frequent conversations, during which common interests were discovered and acted upon.

These findings are particularly pertinent for globally distributed work practices. The global distribution of cooperative work tasks creates a number of specific challenges: spatial, temporal, and cultural each embedding discontinuities, which must be negotiated and re-negotiated over time (Bjørn, 2003). The geographical distribution of cooperative work across different parts of the world accentuates and highlights the challenges of cross-site collaboration and intercultural interaction and communication (Herbsleb et al., 2000). These observations concerning cooperation and geographical distance highlight the importance of understanding the dependencies among globally distributed work tasks and the efforts made to manage or articulate these interdependencies.

In a case study of an engineering organization spread across several sites, Herbsleb and Grinter (1999) investigated how the organization used a number of mechanisms, including plans, processes, and specifications, to coordinate the cross-site work. However, each mechanism was vulnerable to imperfect foresight and unexpected events, and substantial communication was necessary to coordinate activities and renegotiate commitments. The difficulties of knowing who to contact about what, of initiating contact, and of communicating effectively across sites led to a number of serious coordination problems. Among these problems were unrecognized conflicts, the assumptions made at different sites, and incorrect interpretation of communications. The most frequent consequence of cross-site problems was delays in the resolution of work issues where more than one site was involved. So, for example, if a part of the design needs to be changed, or if someone needs a better understanding of how some part of the product works, people at more than one site may need to be involved in information exchange, negotiation, and so on, in order to find a solution. Such issues arise very frequently in globally distributed work and are often resolved through articulation work.

## Relation work

Awareness activities and the use of coordinative artefacts are essential for handling the collaborative engagements between mutually dependent actors. However, as explained above, spatial arrangements where the participants are geographically distributed create particular discontinuities, challenging the performance of articulation work (i.e., the specifics of putting together tasks, task sequences, task clusters – even aligning larger units such as lines of work and subprojects – in the service of the connected work flow) (Strauss 1988, p.164). If we are to understand how the articulation work becomes challenged, we have to think about what is missing in the geographically distributed setup. *What got lost when we took away the local spatial arrangement supporting awareness and the use of coordinative artefacts?* Here it is important to notice that we do not claim that it is impossible to support awareness and coordination in geographical dispersed settings, what we investigate is how the geographical distribution impacted the organization, structure, and execution of the War Room meetings we have empirically observed. We speculate that what we lose is the fundamental networks connecting people and artefacts into one cooperative engagement. A network, which in the collocated setting was framed by the physical walls of the dedicated project room (Covi et al., 1998). We lost the unique and complicated interplay of human and electronic networks (Mark, 2001, p. 6). In such a situation, articulation work activities are highly constrained and require much more effort to be handled. However, is all of the work that is required really articulation work – or is it another type of work? What is the work that

geographically dispersed participants have to engage with besides articulation work? What is the work involved when geographically dispersed participants actively “connect” themselves, creating while enacting the socio-technical network that is fundamental for collaboration to emerge? We label this work that is fundamental for articulation work *relation work*.

Nardi et al. (2002) bring forward the concept of netWORK as the work individuals engage in when creating, maintaining, and activating their assemblages of people who come together to collaborate for a short or long period. People do not come together in friction free interaction smoothly mediated by technology, a “great deal of human communicative work is involved in bringing people together to make collaboration possible (Nardi et al., 2002, p. 209). While we agree that netWORK is essential, we also found netWORK activities were of a different nature than the relation work we saw in our empirical case. There is an important link between relation work and netWORK activities, however were netWORK concerns individuals intensional networks, relation work emerge in synchronous collaborative activities. *The concept of relation work denotes the fundamental activities of creating socio-technical connections between people and artefacts during collaborative activities, enabling, for example, actors in a global collaborative setting to engage each other in activities such as articulation work.* Articulation work cannot be handled in the same way in global environments as in collocated environments. The strategies of awareness and coordination mechanisms cannot be applied *a priori* to the global setting. Actors must create and connect the foundational network of globally distributed people and artefacts in a multitude of ways. That is, actors in a global setting have to achieve the connections that are more or less taken for granted in a single-site environment. Only with these relations in place may other activities, such as articulation work, move forward.

Relation work thus entails an overhead in work essential for geographically distributed collaboration, and the justification for this extra work is similar to that of articulation work. That is, when collaborating in a globally distributed manner, one must engage in the extra activities of relation work in situations where the distribution of actors does not *a priori* establish the network of connections between people, artefacts, and activities. What we suggest is a distinction between, on the one hand, *articulation work*, referring to “the specifics of putting together tasks, task sequences, task clusters – even aligning larger units such as lines of work and subprojects – in the service of work flow” (Strauss, 1988, p.164) and, on the other hand, *relation work*, understood as the fundamental efforts of achieving the very basic human and non-human relations that are a prerequisite for multi-site work such as, for example, global interaction and coordination.

At minimum, relation work is the relational aspect of articulation work, but it can be argued that it is a complementary concept. In articulation work,

communication is done to achieve an agreement as to who does what, where, and when, whereas relation work is done to achieve the right configuration of a network of people and things at a certain point in time for the purpose of facilitating multi-site cooperation.

## Methodology and Empirical Case

Investigating how engineers managed to coordinate their work when engineering cement factories on a global scale, we initiated an ethnographic workplace study (Randall et al., 2007) in January 2010, which is ongoing. The main focus of the study is to understand how engineers collaborate globally, including the use of various artefacts, engagement in activities, and, in particular, the execution of the War Room meetings. A combination of observation and interviews was used. We interviewed War Room meeting participants (facilitators, project managers, and engineers) in both Copenhagen and Chennai (19 individuals in total). We also observed approximately 11 occasions of War Room meetings (between 4-5 meetings pr occasion), 9 meetings from Chennai and the majority of meetings from Copenhagen. Being based in Copenhagen, we made two field trips to the Chennai location, first in February 2010, and again in November 2010.

### Global Engineering and the War Room concept

The engineering firm that provided us with our fieldwork setting is a supplier of cement and mineral factories all over the world. The company has more than 10,000 employees worldwide and has a local presence in more than 40 countries. The main locations for their engineering efforts are Copenhagen (Denmark) and Chennai (India). Most projects—including the one that we studied—required the joint efforts of both of these engineering departments. Approximately 300 engineering specialists from both Copenhagen and Chennai were involved. In order to coordinate their interdependent cooperative work tasks, the engineers used a series of coordinative artefacts, not least of which included conventional time schedules and ATLAS<sup>1</sup> charts. A cement project is initiated when a client places an order for a cement factory to be designed, built, and erected in, for example, Africa or Asia. The clients are large global actors with several cement or minerals factories all over the world. The engineers design while arranging for the factory to be erected in the location picked by the client within a particular time frame: normally 24 months.

The War Room meeting is a particular coordination activity within the company forming short weekly meetings between the global participants, guided

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<sup>1</sup> ATLAS is the information systems used to plan.



by the War Room poster and facilitated by the War Room facilitator. A War Room is:

“a way to manage projects, improve communication and foster collaboration across the different team members and functions involved in projects. A War Room serves to make communication and visibility of key project information more effective across all functions involved in the work. The War Room is our way of applying key lean principles such as visual coordination, teaming up around the task, ensuring information flow and introducing the Plan-do-check-adjust cycle within an order-execution project team. War Rooms have a specific flow of information and guidelines for use.” (Engineering company description)

War Room meetings support the management and coordination of all the tasks and dependencies involved when engineering a cement factory, focusing on making links between tasks visibly available for the participants, creating commitments to deadlines and deliverables. The War Room meetings are thus designed to keep track of the progress of the individual work, which is part of the shared tasks while identifying outstanding issues. War Room meetings are a series of meetings taking place in joined global locations where local physical rooms complete with coordinative artifacts and video conferencing technology make up highly structured environments for coordinative practices aimed at handling the integration of globally distributed work tasks within engineering.

The meetings entail a tightly scheduled series of short (10 – 15 minute) sessions, each focused on a particular part of the project, such as, for example, pyrotechnical aspects of the project or structural engineering. Each session has a facilitator who organizes and orchestrates the interaction. In a War Room session, the focus is on outstanding issues and challenges, making sure that someone is assigned responsibility for each issue. Each issue is noted on a yellow sticker and then displayed on the War Room poster, connecting the issue to particular time schedules and notes organized according to project. In each weekly meeting, the facilitator asks whether an issue from last week has been resolved or not. Unresolved issues are carried on to the next week.

## Relation Work in Global Engineering

Globally distributed participants may have several strategies for making global connections possible through relation work, creating and enacting the social-technical networks required for global collaboration. This includes creating connections between locations, people, artefacts—so that they all perform as one socio-technical network supporting the activity of War Room meetings. Next we will describe the relation work involved in creating these socio-technical networks required for executing the War Room meetings.

## Connecting locations

Every War Room meeting is initiated by making a video conference call from Chennai to Copenhagen, or *vice versa*. This video/audio link is the backbone of the connection between the two locations. Making the call is most often an unproblematic and trivial task. However, in the two episodes that we shall consider next, making the connection and keeping the connection becomes laborious, as a “technical breakdown” occurs. What we would like to highlight from the episode described below is the relation work put into making the connection for the video conference call, rather than the somewhat trivial temporary breakdown of technology.

It is quiet in the War Room in Chennai as the War Room facilitator initiates the meeting’s video conference call to Copenhagen. However, the call to Copenhagen goes unanswered – nobody is picking up. This is highly unusual. Repeated attempts are made, and about 10 minutes pass with no video connection to Copenhagen. The frustration in the room becomes palpable as time passes. The War Room schedule is tight, with only 10 to 15 minutes available for each meeting, and five War Room meetings are planned as a continuous set of activities. People start arriving for the second War Room meeting planned for that day. The facilitator does his best and starts performing a thorough check of the equipment in the room, including the laptop, the camera, and the Internet connection, in order to determine if there is a technical glitch. He finds all of the equipment in working order and still nobody is answering his scheduled call to Copenhagen.

Subsequently the facilitator receives a text message on his mobile phone; it is Copenhagen reporting that the laptop in Copenhagen – the other node in the video conference call – is in the midst of installing an automatic update to its operating system and hence cannot connect for some time. The engineers in Copenhagen are indicating that they are doing everything they can to connect. Over the course of the next 45 minutes, a host of options are considered for making the connection, including replacing the incapacitated computer in Copenhagen, or simply using ordinary telephones. In the end, and through the use of many text messages, they decide to wait for the computer in Copenhagen to finish its update. Finally, the laptop in Copenhagen is able to receive the call, Copenhagen comes online, and the War Room sessions can commence. By this time, the schedule for the subsequent War Room meetings had been completely reworked.

As indicated above, what is of interest here is the efforts put into making the global connection—efforts that become highly visible as a consequence of the breakdown of technology—efforts centered on making the connection or repairing it. These efforts include inspecting the computers, checking the Internet connections, and making sure the camera is operational, as well as the use of mobile phones to connect and resolve the technical impasse.

Arguably this work, this *relation work*, would not have been necessary had this project not been a multi-site engagement. That is, in a single-site environment, all of the effort put into making a connection between two computers for the purpose of a video conference call would have been completely redundant. There would have been no need for it, and, in this sense, the relation work described above is particular to multi-site interactions such as global collaboration. The argument is not that relation work is unique to multi-site environments, but that multi-site environments require a lot more of it than in a single-site environment, and in many cases these essential efforts are invisible, only appearing when the technology breaks down. All the connections that we may take for granted in a collocated environment have to be created in a global one when we connect local locations into the socio-technical network of global collaboration.

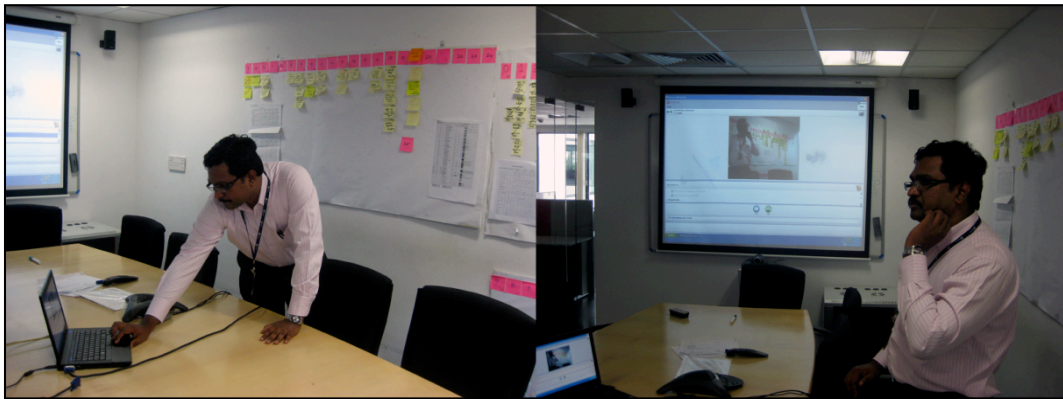


Figure 2. Efforts to connect Chennai to Copenhagen are initially without success, and substantial (relation) work is required to make the connection.

## Connecting people

Experienced War Room facilitators know their colleagues in the other location and are able to initiate the War Room meeting by addressing each other by name—for example, “Good afternoon, Ganesh,” or “Good morning, Nicolai.” This short sentence is more than a simple greeting. It also reflects knowledge about the time of day in the other location and knowledge of who the colleagues are, not simply as “Indian colleague” or “Danish colleague,” but as real people with real first names. This knowledge prevents a stereotypical understanding of the “the others” (as the Indian or Danish colleague) and instead puts focus on the person and the relationship between the participants as colleagues of a joint global organization. After observing several War Room meetings during this study, it became clear that this relationship was based on mutual respect between participants, which made it easier for the experienced facilitators to guide and keep the War Room meeting on track—it helped ensure all participants were listening, not interrupting, and answering questions essential for the success of the War Room meeting.

When we observed the less-experienced War Room facilitators (i.e., those who did not know people from the other location by name), particularly when the facilitator did not have direct technical knowledge of the particular area of concern, the meetings clearly took a different form. Here participants—both in Denmark and in India—were noisy, and the facilitator had to ask several times for answers to the questions. In one meeting observed from the Danish location, the Indian participants kept talking about a particular issue, ignoring the Danish facilitator until a more experienced facilitator, also at the Danish location, interrupted them by tapping his finger on the microphone, asking whether they were paying attention. Although this behavior could have been interpreted as rude, it was considered “OK” because of the mutual respect between the geographically distributed participants—respect that was based on their knowledge of each other.

The work that goes into establishing the connections between people, as in mutual respect and knowledge of each others’ names, time zones, etc., is part of the fundamental work of making the War Room meeting function; thus we label this relation work. What we see here is that relation work is not only something that must be addressed during the War Room meetings, but it comprises foundation work outside of the meetings. The relation work of establishing connections between people thus involves the work where the participants welcome each other, showing respect by addressing each other as people and not as anonymous “others”.<sup>2</sup>

Relation work may be about establishing rapport, i.e., an equal, respectful relationship, and it includes acknowledging the participation of all people present at the meeting. In addition to common courtesy, asking who is present is necessary with regards to practical issues of communication. In many cases, some actors present in one of the offices hosting the War Room meeting may not be visually available to the actors in the opposite War Room because of the location of the cameras. As may be seen in Figure 3, the camera in Chennai is located on the lid of the laptop and is providing a limited field of view to the actors in Copenhagen. For example, people arriving and leaving through the door of the room in Chennai are not visible in the video feed sent to Copenhagen. In a similar

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<sup>2</sup> One dimension of relation work may be establishing rapport; this dimension of relation work may also take place at social gatherings, such as dinner parties or small talk in the lunchroom. A manager of GlobalEngineering informed us that one of the benefits of flying Danes to meet their Indian colleagues, or vice versa, is that this creates the opportunity for people to engage in small talk and “get to know one another” in a relaxed and informal manner, face-to-face. According to the manager, the friendships or rapport created (through relation work) at social gatherings may later be translated into a smoother working relationship, where people are more attentive and responsive to one another's predicaments and needs.

manner, the camera on the table in Copenhagen only shows the actors in Chennai a portion of the room at any one time. This arrangement makes another type of relation work essential for the global interaction in a War Room setting, namely identifying the actors who are present by repeatedly asking, “Who is present?” The inability to see exactly who is present in the War Room meeting is particular to this kind of global, multi-site interaction, and it fosters repeated relation work. By comparison, the same kind of relation work is hardly necessary in a collocated meeting, as all of the participants can usually see each other.

This kind of relation work is common to the globally distributed War Room meetings. In contrast, actors in collocated meetings would probably not engage in relation work of this kind, as making out who is speaking is relatively effortless when actors are collocated. In other words, in a multi-site environment, the relation work associated with making out “who is there” or “who is speaking” cannot be taken for granted, as it may be in a single-site environment. This observation implies that although relation work is common to both single-site and multi-site work, it is far more pronounced and visible in the latter. This distinction is related to the fact that, at the very least, the actors’ opportunity to perceive their globally distributed collaborators is hampered and limited. For example, sight is obstructed or limited by the video feeds, the sound of other voices is blurred or transformed, smell is not conveyed at all, and, importantly, movement and physical interaction is restricted to one location of the War Room meeting. These limitations are obvious but nevertheless pertinent to global interaction.

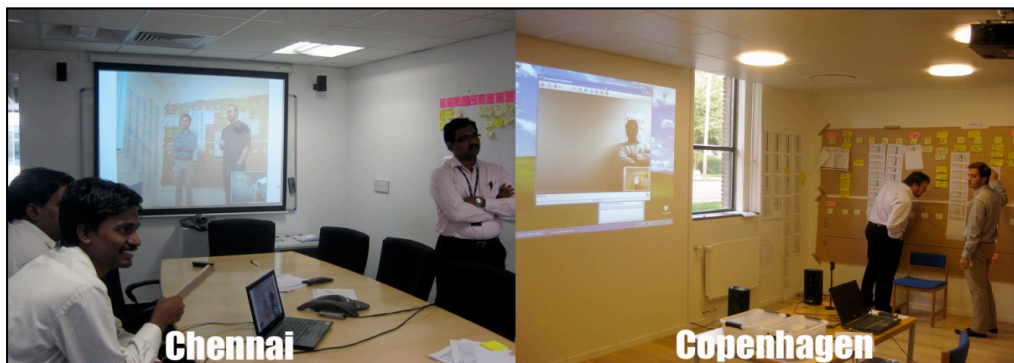


Figure 3. Several of the engineers present in Chennai are not visible to their colleagues in Copenhagen.

### Connecting artefacts

When GlobalEngineering gets a contract for a cement factory, they create a plan that includes milestones, deliverables, tasks, and their dependencies. This plan is created using the IT system ATLAS. All pertinent information is gathered in this plan, which is available to all relevant participants at all sites. However, this plan is “hidden” within the IT-system, and it is all too easy for participants to focus

exclusively on their own detailed tasks and deadlines rather than on how their tasks are connected to other tasks, and thus hindering awareness of their role in an interdependent relationship. A key role of the War Room meeting is to make each participant aware of the interdependence of the various tasks within the plan. The philosophy is that by highlighting the dependencies people will become committed to finishing their tasks on time, or even ahead of time. This assumption is supported by prior research arguing that publicly accessible representations is key for sense-making processes (Larsson, 2003) and that shared physical scheduling tools are preferable to be used in critical projects (Whittaker and Schwarz, 1999). The central artefact for this work is the War Room poster, also referred to as the “brown paper.” The poster is a visual representation of the ATLAS plan in that all milestones from the plan are added to the poster as pink stickers. Each week the War Room facilitator prints the deliverables for that particular week and monitors which tasks have been marked as “done” (green), “still ongoing – but soon late” (yellow), or “late” (red) within the ATLAS system. The facilitator brings the print-outs to the War Room meeting and tapes the paper lists to the poster.

During the War Room meeting the facilitator asks about all of the out-standing deliverables that he/she identified by examining the print-outs prior to the meeting. The facilitator also asks the participants present whether there are other issues they need to address. Each issue of concern raised “gets a yellow sticker,” meaning the facilitator takes a sticker and writes down the issue and the name of the person responsible for addressing the issue. The rule is that you can only write the names of people present; thus, if the person who is supposed to be addressing the issue is not at the meeting, the facilitator will write down the name of someone who is present, who will then follow up with the person responsible for addressing the issue. At the top of the note, the facilitator will write the date, then the task, and at the bottom, the responsible person. For example, a sticker might read: “Tom must contact Jim about MG-drawings (mil).” The facilitator then places the yellow sticker on the War Room poster under next week’s War Room meeting, which means that the facilitator will ask about the issue at the next meeting to see if it has been resolved. It is essential that there are no discussions during the War Room meetings, only follow up on outstanding issues. Discussions should be taking place outside the War Room meetings and only the results should be put forward.

The War Room poster is the central coordinative artefact between the engineers in GlobalEngineering when coordinating the dependencies between tasks. The results of the meetings—i.e., the outstanding issues that were identified—are only captured by the yellow stickers. Having the yellow stickers as tangible objects is part of creating a tangible “feeling” of the plan; you can see and touch the outstanding issues. However, because of the materiality of the stickers and the fact that the poster is a local device, if the participant responsible

for the task is at the opposite location, there is a risk that the commitment created during the meeting will disappear after the connection is closed. We observed this phenomenon during a meeting where the War Room poster was geographically located in India, but the issue identified was assigned to a member of the Danish project management team. This meant that the War Room poster was only visually available while the Internet connection was active, although the quality was bad, making it impossible for the Danish participant to examine the yellow stickers on the poster behind the Indian facilitator. Being fully aware of this limitation, the Indian facilitator read the content of the poster aloud, making this information audibly available for the Danish participants. The War Room meeting participants identified the issue and wrote the Danish participant down as being responsible for solving the task for next week. The following week the Indian facilitator read the yellow sticker aloud and asked the Danish participant about the issue, who then admitted he forgot. All the work of making the plan tangibly available becomes problematic when the poster is local and the team of participants is global. The engineers tried different approaches to solving this issue, for example, making a mirror wall in Denmark of the War Room poster in India, which was essentially a wall with yellow stickers, and they ended up creating an electronic document with a table listing the yellow notes. They can share the table electronically, but the tangibility aspect disappears. What we see here is an example of the relation work in a global interaction that goes into connecting people to artefacts (making them audibly available over geographical distance) and connecting artefact to artefact (connecting the mirror wall to the distant War Room poster, or creating the table of yellow stickers). Without this relation work—bringing local artefacts into the global collaborative space—the articulation work required to handle the complex interdependent tasks of engineering a cement factory would not be supported by the War Room concept.

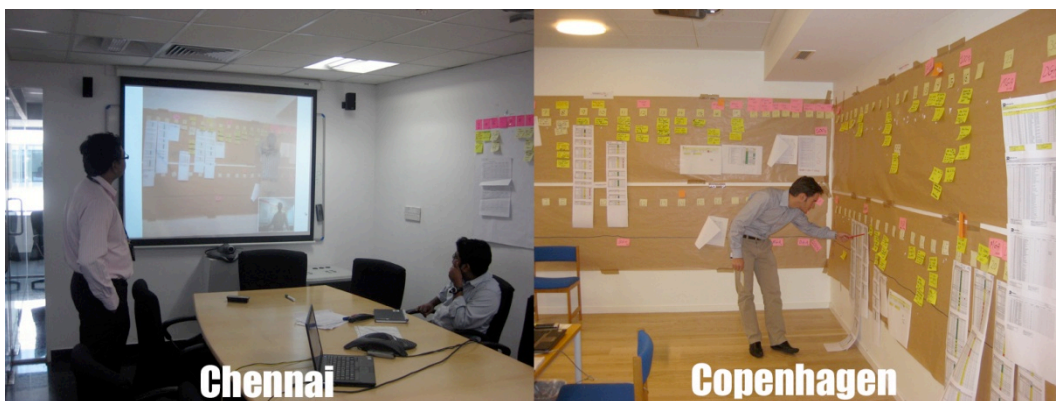


Figure 4. The engineer in Copenhagen is performing *relation work* (making the poster audibly available) in order to connect his colleagues in Chennai to the poster on the wall in Copenhagen.

## Relation Work as a Prerequisite for Articulation Work

The sociology of Anselm Strauss has proven especially useful for looking at cooperative work, as is testified by the wide use of his concepts, especially that of articulation work, within the CSCW community (e.g. Bardram and Bossen, 2005; Schmidt and Bannon, 1992; Schmidt and Simone, 1996). To better understand the efforts put into achieving the connections between globally distributed actors, we took articulation work as a starting point. However, we found that although lots of articulation work was done when the engineers collaborated across geographical distance, another other type of work was also being done. We propose the concept of *relation work* as an elaboration of the task-specific aspects of articulation work and argue that it may even be a complementary concept. Relation work, as we understand it, involves the work needed to create and enact the socio-technical networks that are a prerequisite for other collaborative engagement, for example, the performance of articulation work. The concept of articulation work as proposed by Strauss “refers to the specifics of putting together tasks, task sequences, tasks clusters – even aligning larger units such as lines of work and subprojects – in the service of work flow” (Strauss, 1988, p. 164). Strauss posits the concept of articulation work as part of a theory of action that stresses the ongoing efforts of actors to accomplish their tasks and goals in interaction with other actors. In opposition to a means-end view of action, where a linear process between start and end points is assumed, Strauss argues that the complexity within which action takes place, and the contingencies that most often arise, require an actor to continuously adjust and readjust his or her actions. Hence, action in its practice is a continuous readjustment of envisioned courses of action rather than a straight line from start to end strung out by rules or norms. When we move to considering several cooperating actors in a global setting, the process of continuous readjustment is further complicated by the fact that actors occupy different geographical positions and have different stances, cultures, and attitudes. Therefore, making first-order relations in a global setting is, in practice, an achievement: actors need to connect on a physical, cultural, and social network across multiple-sites in order to cooperate. This work of connecting the network of actors and artefacts is what we dub *relation work*.

Relation work, as we see it, is concerned with the achievement of the right network of people and artefacts across multiple sites and can be seen as the relational aspect of a multi-site work trajectory. The challenge of relation work arises from the fact that, in practice, a global setting is just an abstract space, that is, several localities have to be combined and connected in order to make up the global arena. Furthermore, not only actors but also things and information must be connected, and the establishment of the right combination of people, things, and information is hence an achievement that cannot be (and in practice is not) taken for granted. Efforts of relation work will most often be aimed at making



global interactions as smooth as possible (or just possible, in the first place). Factors such as, for example, efficiency (having short and to-the-point meetings), accountability (that agreements are kept), technological dependency (that the technology connecting multiple settings is reliable), and the atmosphere of the meetings (e.g., having a laugh) may all be influential criteria and have to be balanced between the various connections of work and flows of things and information involved.

Actors may have several strategies for making global connections possible through relation work, including connecting people with people, people with things, and things with other things. However, the strategies of awareness (Heath et al., 2002) and coordinative mechanisms (Schmidt and Simone, 1996) are not straightforward in the global situation. For the participants in the War Room meetings to become aware of each others' presence, relation work must be done in order to know who is there (in the local "other room") and who they are (as in names, respect, and knowledge, which ensure they refrain from stereotyping). Refraining from stereotyping and knowing the remote partners has a clear impact on the War Room meetings (as we saw when the facilitator knew the remote partner's name), thus prior netWORK activities seem to benefit the relation work between people. NetWORK as in the deliberate, carefully executed, hidden work constituted by participants' remembering and communicating (Nardi et al., 2002) outside the actual War Room meetings.

Gestures and facial expression are not by themselves visibly available (as we saw when the experienced facilitator tapped on the microphone to make the participants in the other location aware of what was going on) for all participants in the War Room meetings. Instead they require the relation work of locating oneself in front of the camera and still taking into account the quality of the digital signal. The technical infrastructure also requires relation work to ensure the connection between the locations, and if the technical connection breaks (during one of the observation we witnessed how a participant stumbled over the electrical cord attached to the wall socket, entirely disrupting the digital connection in the middle of a War Room meeting), it requires relation work yet again to re-create the connection. Thus, we argue that to bring awareness into the geographically distributed setting of War Room meeting as a strategy for handling articulation work, relation work is a prerequisite.

For the participants in the War Room meeting to be able to use the War Room posters as the coordination mechanism it is designed to be, we found several issues that had to be overcome through relation work due to the geographical dispersion of the participants and artefacts. The War Room poster as an artefact is only available in the global collaborative space as long as the connection is up and running. The second the technical infrastructure is gone, the poster becomes local. In our study we saw how the locality of the poster was experienced as problematic, and how the engineers tried to solve the issue by creating the mirror

wall of the distant posters, or by creating the electronic table of yellow notes. Each of these strategies aimed to make the War Room poster into a persistent global coordination mechanism that survived after the meetings and was available outside of the technical connection. However, this work requires the relation work of connecting artefacts with artefacts, again a prerequisite for handling the articulation work during the War Room meetings.

Relation work as a concept is highly linked with invisible work (Suchman, 1995), since it also disappears from sight as long as someone is attending the issues. Relation work only becomes visible when it causes a breakdown, when nobody is attending the work. We suggest that breakdowns caused by the lack of relation work can come in many different shapes and might be linked to key issues such as communication breakdowns, mistrust, uneven coordination, misunderstandings, etc.

Relation work forms the fundamental activities of creating socio-technical connections between people and artefacts during collaborative activities required to create and enact the human and electronic network and engage with articulation work in cooperative engagements.

## Conclusion and Perspectives

The introduction of War Room meetings as strategy for handling the coordination of task dependencies when engineering cement factories has significantly reduced the time required to complete projects. Whereas before the introduction of the concept GlobalEngineering took 52 weeks to settle the engineering part of the factory, the War Room meetings reduced the time to 15 weeks. When we ask GlobalEngineering why the War Room concept was such a huge success, they responded that it was about eliminating the air pockets in the plan through committing people to solving their tasks as quickly as possible, which is achieved by making the interdependencies visually available and tangible within the War Room poster. The success makes this case particularly interesting to investigate because if we can learn what kind of work goes into handling the War Room meetings, we can begin to identify areas that could be improved and then start to address these areas from a design perspective for collaborative technologies. One obvious challenge is the locally placed War Room poster, which required relation work by the participants as in when reading aloud the content of the poster locally making it globally available. We are currently collaborating with GlobalEngineering about finding new ways to share the poster globally. In our study we found that an essential part of the work that goes into making the War Room function is relation work, and new designs of collaborative technologies supporting this type of global activities should start here.

Relation work was a prerequisite for other activities such as articulation work, and may be described as the activities of creating socio-technical networks

comprised of people and artefacts facilitating cooperative interaction and coordination in a globally distributed setting. Relation work is particularly evident in geographically distributed work, which is also why this became the unit of analysis in this paper. However, it is quite possible that relation work might be a more general matter also relevant for collocated collaboration (this suggestion, of course, requires further investigation). We suggest that relation work is a prerequisite for all types of collaboration but is less troublesome in collocated settings compared to global settings. We see relation work as a key area of interest for the design of new types of collaborative technologies supporting global interaction.

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