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An exploratory study of facilitation in distributed requirements engineering

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Abstract There is an increasing need to build an understanding of group facilitation in distributed requirements engineering. Group facilitation is an important element of group approaches to requirements engineering, which is being challenged by the emergence of distributed practices in software specification and development. Thus thorough empirical investigation of human facilitation in computer-mediated requirements meetings is needed. This paper presents an exploratory study of facilitation in distributed requirements teams. Three professional facilitators mediate 15 three-person groups in an experimental simulation of software requirements negotiation. Facilitation in face-to-face meetings is contrasted with four group settings in which the facilitator is physically separated from the group or co-located with key stakeholders. Rich qualitative and behavioural data enables an understanding of differences and similarities in the facilitation of face-to-face and distributed groups and of aspects that were detrimental or beneficial to their facilitation. The empirical evidence indicates that a reduced richness of social behaviours in computer-mediated group settings (1) made the group facilitation problematic but also (2) enabled certain facilitation support in the medium itself. The findings of the study are discussed in the light of existing models of the role of the facilitator. Advice from the expert facilitators is presented in the form of recommendations for the facilitation of distributed requirements teams, and worthwhile directions for further research are outlined.

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1 Introduction

The software development world is experiencing an irreversible trend towards the globalisation of business [1]. Seeking lower costs and access to the global resource pool are main factors that have accelerated this trend and have contributed to multi-site and globally distributed projects. As a consequence, the communication of customers and developers is taking place across geographical and cultural boundaries, and the role of groupware systems to support distributed software development becomes critical. While computer-mediated communication can be synchronous (e.g., chat, teleconferencing) as well as asynchronous (e.g., email, bulletin boards), the importance of requirements meetings in which all relevant stakeholders participate translates into the need to design effective computer-supported synchronous meetings in distributed environments. There is a rich body of research on computer-mediated communication (CMC) carried out in the last thirty years. Research studied and described socio-psychological issues in computer mediation (e.g., [2, 3]) and the use of group support systems (e.g., [4, 5]).

However, problems in face-to-face requirements meetings can develop and a successful technique documented in the literature (e.g., [6]) is the facilitated group approaches to requirements engineering. Thus, the combination of distributed software development and the importance of the facilitator's role in requirements meetings has led to a pressing need for empirical studies to investigate facilitation in synchronous distributed computer-mediated requirements meetings.

Face-to-face requirements meetings have general characteristics that are particularly important to the

decision-making group [7]. Group members have access to a rich audio–video communication medium not often found in computer-mediated environments. In CMC in contrast, while research on remote collaborations indicates that high-quality audio is important to synchronous work [8], the addition of the video channel is more controversial. First, the video channel potentially allows visible information that is present in the face-to-face communication [9]. This information is about the behaviours of the other conversational participants, that is, the set of communicative actions that they perform with their eyes (gaze), faces (facial expressions), hands and arms (gestures), and the movements and orientation of their bodies (posture). Then, there is the information about the visible environment that conversational participants share, with its set of shared objects, access to shared events, and information about the movements and activities of other people.

Further, it appears that the effect of adding video to the audio channel is task and situation dependent. Evidence [9] shows that providing visual access to facial expressions, posture, and gesture, allows people to make inferences about other participants' affective or emotional state; furthermore, it changes the outcome of tasks that require access to affective information, such as negotiation and conflict resolution. Also, evidence on advantages of videoconferencing over high-quality audio conferencing on conversational fluency and interpersonal awareness was found in the context of a negotiation task using electronically shared data [10]. One question is to what extent the addition of visual information in videoconferencing systems enables the transmission of social cues in the interaction, when compared to face-to-face contact, and how important the availability of such cues is. On the one hand, media effects theories (e.g., [11, 5, 12]) characterise videoconferencing systems as ''less rich'' communication media than face-to-face meetings. Video-based systems usually transmit the image of the person's upper body and the quality depends on the communication bandwidth. On the other hand, evidence [13] was found that decisions made in ''less rich'' communication media were of higher quality than those reached in face-to-face meetings, presumably due to an enhanced ability to focus on the task-related matters and less on the interpersonal matters. Finally, particularly relevant is the study by Olson et al. [14], which investigated a design task (referred to as ''requirements definition'') in which results showed that the quality of the work with remote high-quality video was ''as good as in face-to-face'' and that remote work without video was not as good as face-to-face.

In requirements engineering, the role of facilitator in distributed computer-mediated teams is still subject for discussion and largely under-investigated. The three panelists (experienced facilitators) at the ICRE'98 [15] debated the notion of conducting requirements as a distributed team and considered that face-to-face meetings were essential to effectively manage conflict as it arises.

In this paper, we examine the problem of distributed facilitation in Requirements Engineering. Empirical evidence helps us build a better understanding of problems as well as opportunities for facilitation that are present in computer-supported requirements meetings.

The characteristics and importance of facilitated group approaches to requirements engineering are discussed in Sect. 2. Various views on the role of the facilitator are outlined in Sect. 3, together with a discussion of the activities and skills that facilitators use in mediating group meetings. Section 4 examines characteristics of facilitation in synchronous distributed requirements meetings, describing the analysis framework in the current study.

The study design and findings are presented in Sects. 5–7. The distributed setup, computer technology used, and data collection and analysis procedures in the study are described in Sect. 5. Rich qualitative data describing the facilitation of four distinct distributed group settings is presented in Sect. 6, followed by a more focused behavioural analysis in Sect. 7.

In Sect. 8, a discussion of the empirical findings is provided in the form of problems found in the facilitation of distributed requirements meetings as well as positive aspects of this facilitation. This is followed by the formulation of important research questions that emerged as a result of the detailed behavioural analysis.

The final sections discuss the limitations of the current study and conclude with recommendations for facilitators of distributed requirements meetings as well as worthwhile research directions to pursue.

2 Facilitated group approaches to requirements engineering

There is an increased recognition of the importance of group session approaches to requirements capture, analysis and negotiation. While group dynamics is one of the advantages of requirements meetings, problems can develop. On one hand, group meetings provide powerful means to involve the right people in the room, not only participants with the authority and knowledge to determine business requirements, but also system users with the ability to provide functional requirements. On the other hand, requirements teams are multidisciplinary and involve stakeholders with varying levels of skill and expertise. Face-to-face meetings are vulnerable to ''generic problem syndromes'' identified by Westley and Walters [16], which include disagreements on agenda, hidden agendas, dominance by some members, fear of volatile issues and hostility. Further, conflict emerges as another potential difficulty for such meetings. Requirements decisions are taken in a development environment characterised by technical, budgetary, and temporal constraints; these decisions affect not only the stakeholders' companies but also their own jobs [6]. Issues of politics, power, and influence make such meetings even more difficult and add to the complexity

of requirements negotiations. This is where the role of the facilitator becomes very important in managing group dynamics. Facilitated meetings are regarded as one successful technique in group approaches to requirements engineering [6].

Methods that employ a facilitator include the Joint Application Design [17], Quality Function Deployment (QFD) [18], Participant Design Workshops [19], ETH-ICS [20], and Cooperative Requirements Capture [6]. Macaulay [6] states that the productivity in JAD is increased by 20–60% over traditional design methods, and more recent studies indicate that facilitator-driven requirements collection processes are more effective than the conventional interview method [21].

Facilitation is about helping the group members to perform their collective task as a group [6], by managing relationships between people, tasks, and technology, as well as structuring tasks and contributing to the effective accomplishment of the meetings outcome [22].

3 The role of the facilitator

There are, however, diverse views on the facilitator's role in the literature. QFD [18] regards the facilitator as a project coordinator involved in planning the meeting, guiding the process, providing motivation and visibility in the workspace, training the team in the process and arbitrating the collaborative effort. Similarly, Viller [23] and Dubs and Hayne [24] describe the activities in which the facilitator is heavily involved. While Viller's [23] model places great emphasis on the facilitator's role in the human–human communication activities during the meeting, such as managing the agenda, observing group process, diagnosing problems, designing solutions, and making interventions, Dubs and Hayne [24] also place emphasis on the pre-meeting and post-meeting activities. During the meeting, activities of the facilitator range from ensuring that members identify and maintain a discussion focus, ensuring that everyone has an opportunity to contribute to the discussion and decisions, confronting the group regarding its process, and managing group creativity and conflict, to intervening when appropriate at the level of the group instead of the individual. The facilitator's level of control during the meeting is high during monitor, process, and recording activities, and low with regard to task activities. According to Dubs and Hayne [24], the task activity is highly content driven and thus is in control of the group; however, the other tasks are structure and process intensive and require the control of the facilitator.

Macaulay's more recent work [6] builds upon an understanding of these models and practical experience, and develops a richer model of the facilitator's role at a number of different levels. The levels include social, political, method, and activity control. The model pays close attention not only to the facilitator's role in mediating the group's social communication and in controlling activities, but also in mediating the political environment and as an expert in the application of the method.

In the same direction, Wood and Silver [17] elaborate on a number of skills that facilitators use in performing these activities. A good facilitator's repertoire includes abilities such as:

- *communicating well*, i.e., getting a point across clearly and succinctly;
- *separating idea from the person*, i.e., recognising spoken ideas for what they are rather than who is presenting them;
- *listening well*, i.e., listening to distinguish unproductive diversions from those with substance, and listening for hidden agendas;
- *listening with the eyes: seeing*, i.e., observing interpersonal cues and looking for gestures bearing messages, to tell when someone wants to speak and prompt that person to do so;
- *maintaining authority and control*, i.e., keeping aware of all aspects of the conversation and following up with decisive direction;
- *empowering the group*, i.e., helping the group to consider new options, evaluate and revise decisions;

The facilitator's ability to use these skills in facilitating distributed requirements meetings is the topic of the next section.

4 Facilitation in distributed requirements engineering

The field of requirements engineering is lacking evidence about human facilitation of computer-supported requirements teams. While researchers in the computer-supported cooperative work (CSCW) area acknowledge the importance of considering support for the facilitator's role in the design of computer support for group work [23], and studies show that even a small amount of facilitation in groups using group support systems can lead to effective meetings [25], the role of the facilitator in distributed requirements engineering is largely under-investigated.

Facilitation of geographically distributed requirements teams is a complex phenomenon that covers several dimensions:

1. Multi-site projects involve the interaction of people from two or more distributed locations and consequently the facilitator may be co-located with one, many, or no other stakeholders in the meeting.
2. According to theories of socio-psychology of telecommunications [12], the interpersonal relationships are affected in restricted communication and thus the social relationships among stakeholders are likely to be affected by the computer-supported link. It is then reasonable to assume that the difficulties experienced by face-to-face requirements teams would be exacerbated in distributed settings; in particular, in requirements conflict resolution meetings, which are

often politically and emotionally charged. Consequently the task of the facilitator in mediating group dynamics is more challenging.

3. Restrictions in the communication medium are likely to have an impact on the facilitator's behaviour in performing the facilitation activities described above. General characteristics particularly important to the requirements group involved in decision making include the following [7]: face-to-face meetings are regarded as a rich medium of communication in which people can see each other and be sensitive to each other's behaviour and reaction; they allow the participants to share the workspace, and whiteboards and flipcharts are useful visual aids in the creation and manipulation of shared artifacts such as analysis diagrams. In monitoring group dynamics and designing processes to assist the groups, facilitators are supported by both audio and visual channels, and access to minute details of group interaction. In contrast, a more restricted communication medium is likely to change this picture. Macaulay [6] anticipates that:

- The facilitator may or may not have met each group member face to face.
- Cues about member participation, behaviour, and attitude will come from new sources.
- Social skills will need to be adapted to the new medium and participants need to learn how to use the new media as an effective human communication tool.
- The facilitator will need to be an expert in the use of the technology.
- The technology will provide more help with documenting outcomes.
- Individual differences and socio-emotional problems will be harder to detect.
- The facilitator's ability to encourage creativity and innovative thinking may be limited by the media.
- Controlling activities should be easier.

Thus it appears that the reduced richness of social behaviours available in computer-supported communication media would bring about changes in the facilitation of distributed requirements meetings. Observing, attending, and monitoring social cues are activities critical to gaining an understanding of the group's interaction and the facilitators may need to use different skills when performing such activities. At the same time, however, activities such as documenting and controlling could be made easier given the use of the electronic medium.

In the remainder of this paper we describe an exploratory study of human facilitation in synchronous distributed requirements meetings. The analysis framework is described first, followed by a detailed discussion of four case studies of facilitation in face-to-face and computer-supported requirements negotiation sessions. A discussion of the empirical evidence and its implications is then followed by recommendations for facilitators of such settings and conclusions of the paper.

4.1 Analysis framework in the current study

An exploratory study was designed to investigate:

1. *Facilitation in diverse distributed requirements group settings*. Requirements meetings most often involve more than two people, playing diverse roles in system definition and development, coming together in a complex situation dominated not only by technical, but also social and organisational factors. It is equally important to investigate the facilitator's co-location with diverse roles as well as the remote facilitation in which the facilitator is mediating the group from a distance. The latter reflects the case of the facilitator joining the meeting from his or her own office. Facilitation in such distributed settings is compared to the traditional facilitation in face-to-face requirements meetings.
2. *Facilitator's ability to assist the distributed groups in accomplishing their task*. The monitoring activity is of particular interest, being the dominant step in detecting the state of the meeting [22] and subsequently affecting ability to help the group with its process. The facilitator's ability to assist the distributed groups in accomplishing their task is used in guiding the evaluation of the facilitation outcome in this study. In the absence of a well-defined measure, special attention is paid to the facilitator's comments with respect to their ability to exercise their skills, as outlined in the facilitator's repertoire in Sect. 3.
3. *Any aspects that are problematic or beneficial in the facilitation of distributed settings*. It is anticipated that the reduced richness of social behaviours in computer-mediated requirements meetings will cause the facilitation to be problematic and an exploratory approach is taken to identify any determining factors.

The next section describes the study that used this framework for collecting and analysing evidence about facilitation in distributed requirements engineering.

5 Study design

The exploratory study described in this paper was part of a larger empirical study of computer-supported distributed requirements negotiations [26, 27]. Although designed as a laboratory experiment, the study conducted in the laboratory setting also allowed the careful observation of professional facilitation in a controlled environment. The research goal was to identify patterns in difficulties and/or opportunities of facilitation in distributed settings by examining data provided by three facilitators involved in the same group task. Real-world

settings rarely allow the researcher to carefully study three similar situations.

The research method in the investigation of facilitation of computer-mediated requirements negotations was a qualitative exploratory study. Multiple data collection methods included questionnaires, interviews with study participants, as well as video recording of requirements negotiations. The analysis of questionnaire and interview data was complemented by behavioural analysis of requirements negotiations using SYMLOG methodology [28], as described in Sect. 7.

5.1 Study setting and participants

Three professional facilitators participated in an experimental simulation of requirements meetings. An experimental simulation brings experts together in the research laboratory for purposes of research [5]. In this study, facilitators were invited into the laboratory to facilitate requirements negotiations. Each of them mediated one face-to-face (F2F) and four different distributed group settings, as shown in Fig. 1. A description of the other three roles in the study is given before these group settings are discussed.

The task featured the negotiation of requirements for a bank management system. The system development had limited resources, i.e., development time. Two system users expressed requirements whose implementation in full was not feasible within the limited development time; thus, there was the need to negotiate requirements to fit the development timeframe. The roles involved were the two system users (Bank Teller and Personal Banking Representative (PBR), referred to as negotiators henceforth) and a system analyst. These roles were played by student volunteers (15 three-person groups) at the University of Calgary. The students were randomly assigned to groups. The prerequisite for participation was attendance at a software engineering course at the University of Calgary in which students have to do a large-scale project in which they play various stakeholder roles. No experience in negotiation was required, as real projects do not normally benefit from a stakeholders having uniform negotiation experience. Their experimental role descriptions are included in Appendix 1.

Thus the distributed group settings featured:

- the facilitator co-located with one negotiator (D1);
- the facilitator co-located with both negotiators (D3);
- the facilitator remote from the two negotiators (D2); and
- the facilitator remote from the entire group (D4).

5.2 Computer technology

Microsoft's NetMeeting system was used in enabling communication in the distributed settings. It is a widely available meeting system with full video/audio and real-time file-sharing capabilities. The equipment configuration is depicted in Fig. 2. The two rooms were equipped with two large electronic displays (Smart Technologies' Boards) (A) on which NetMeeting was run. The task was electronically mediated through the shared editor WordPad within NetMeeting, to reflect the results of the negotiation, and displayed on both electronic boards. Thus, each large display showed: the list of requirements (through WordPad), the video image of the physically co-located participants (referred to as *local* participants henceforth), the video image of the remotely positioned participants (referred to as *remote* participants henceforth) and the NetMeeting's controls. The image of participants displayed more than "talking heads," showing the table at which individuals were seated, the keyboard, and the papers manipulated. None of the facilitators had extensive experience in using the system nor used the keyboard during the meetings.

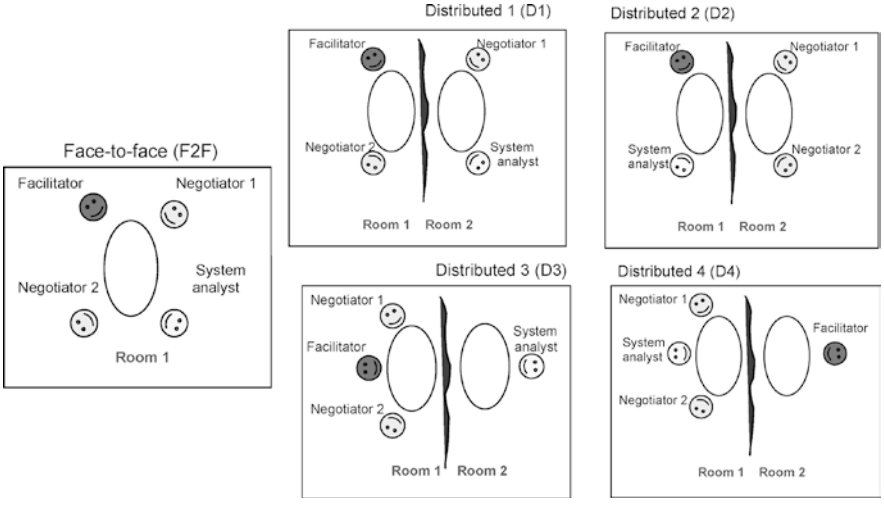


Fig. 1 Facilitation of face-to-face (F2F) and distributed requirements negotiations

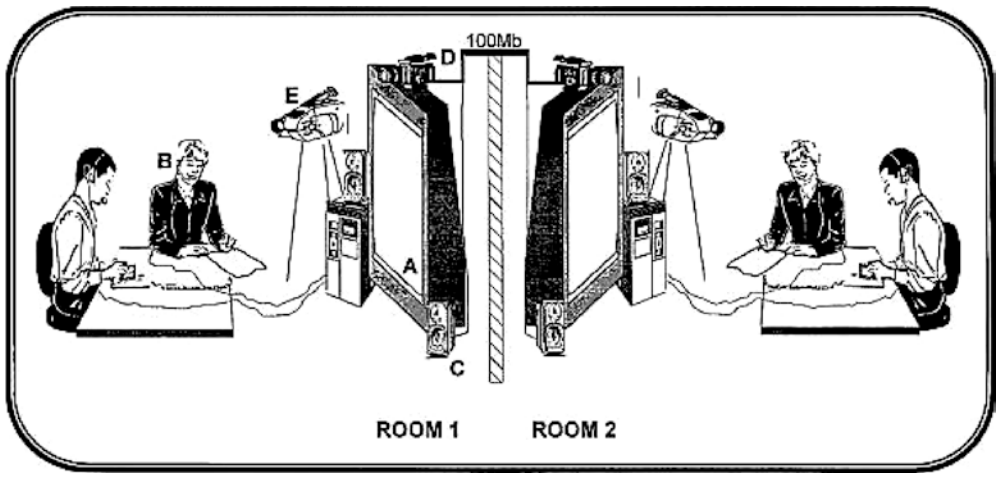


Fig. 2 Equipment used in the distributed conditions

The two rooms were connected such that the images and sounds from one room were transmitted with high quality to the other via audio/videoconferencing facilities (D) (a 100 Mb Ethernet link was used). The audio channels were full duplex, using noise-cancelling microphones for each participant (B), and the speakers (C) were placed around the electronic displays in each room. There was a few seconds delay in transmission of the video signal from one room to the other. The design of the task pictured itself as a list of requirements that needed to be manipulated; hence the manipulation of textual descriptions appeared as sufficient and the pilot studies indicated WordPad was an appropriate tool for the task. Furthermore, pilot studies indicated that NetMeeting was easy to learn and use, and reliable. The F2F groups used WordPad on the electronic display as well, as a place for the manipulation of the requirements.

No facilitation-specific tools such as agenda keeping, monitoring keystrokes, or voting tools were used in addition to the capabilities provided by NetMeeting. With relation to the facilitator's activities of monitoring, recording, and assisting the group process [22], it was assumed that the audio and video channels were appropriate tools for the monitoring activity, in that the facilitators could see and hear who would participate in the meeting and how much. The facilitators could also make use of the real-time shared applications to assist the group with the process. The recording activity was not of interest in this study. Although it is valuable for the monitoring activity in text-based interactions and for post-meeting analysis of what occurred, in this study the meetings were fairly short, no follow-up was necessary and the ability to follow the real-time conversation provided high visibility in the interaction.

5.3 Procedure

Each experimental simulation was presented as a 2-h session. Participants arrived to the study after they became familiar with their role description. There was no prior interaction between facilitators and students. Filling out background questionnaires and permission forms was followed by a demonstration of NetMeeting's features, which, however, did not prescribe how to use these features to support their task. The participants then completed a warm-up task, designed to familiarise them both with each other and with the medium, to set the microphones to achieve the best audio level possible, and to allow them to set the video display to achieve the best image of the participants in the remote meeting room. Following a 10-min break, the groups then started the software requirements session, which was presented as a scheduled meeting of 40 min. The sessions were ended after 40 min and the final list of requirements was recorded. All participants filled out a post-session questionnaire.

5.4 Data collection and analysis techniques

Multiple data collection procedures were used to gather rich evidence on aspects that were beneficial or detrimental to facilitation in distributed settings, when compared to the face-to-face meetings. In particular, post-session questionnaires and interviews collected quantitative as well as qualitative data on aspects such as the ability to monitor the group dynamics, group interaction and interpersonal relationships, and to observe negotiation behaviour or aspects of the communication setting that helped or hindered the negotiation process. This data was collected for each condition immediately after each session, in order to obtain accurate feedback about each treatment at a time. As participant–observers, the facilitators were also asked to use their best judgment in assessing some aspects of the group interaction and behaviour and indicate that in their responses. They were asked to consult the questionnaire before the first session was run in order to familiarise themselves with the questions that required their observation of the group interaction and behaviour. The qualitative data was analysed for patterns in the facilitation of each distributed group and is presented in Sect. 6.

For completion and clarity reasons, a description of the full analyses conducted in the study is summarised in Sect. 5.5.

For the recording and analysis of data on facilitation, the main author was a passive observer at all sessions and recorded aspects of the facilitators' behaviour. Further, all group meetings were video recorded for a behavioural analysis. The results of such analysis are presented in Sect. 7. A first observation to facilitation is that Facilitator 2 had a somewhat different facilitation style from Facilitators 1 and 3. Facilitator 2 took a more active role in directing the group through the process and in using the technology during the meetings. This observation triggered the need to perform an analysis on the facilitator's effect. A Kruskal–Wallis [29] test that compared the negotiation outcomes across the groups mediated by the three facilitators found no statistical significance. This result indicates that the difference in facilitation styles across the three facilitators was not statistically large enough to influence the groups' negotiation outcomes. At the same time, the result is not surprising, since the test has a low statistical power and the number of observations (i.e., five) can be considered low.

5.5 Study findings

Rich data was collected about the negotiation of requirements in face-to-face and distributed meetings. The intention was to achieve an assessment of groups' performance as well as to conduct more detailed analysis of the negotiation behaviour in diverse group settings, face-to-face and distributed.

The groups' performance in the requirements negotiation was conceptualised as the *negotiation outcome,* i.e., an evaluation of the final agreement in the negotiation. The negotiation outcome illustrated the extent to which the agreements were integrative of the stakeholders' most important interests (i.e., operations to be performed on the system) and provided equal benefit in the negotiation. An assessment of the groups' performance in the five group settings is summarised in Table 1. In that table, five different types of negotiation outcomes were recorded in the study, and arranged on an ordinal scale, from most to least integrated, as follows:

Table 1 The distribution of negotiation outcomes across one F2F and four distributed group settings; two F2F and two D1 group settings selected for behavioural analysis as described in Sect. 7

	F2F	D1	D2	D3	D4
Facil. 1	A	A	C	B	A
Facil. 2	F	A	B	B	D
Facil. 3	B	A	B	D	F

- A: most integrative agreement, optimal feasible outcome;
- B: less integrative agreement, greater benefit for one negotiator;
- C and D: less integrative agreements, comprised of critical requirements important to both negotiators;
- F: no agreement was reached within the allocated time.

The analysis performed on these results revealed that groups in F2F did not perform better than groups in any of the distributed settings. Further, the frequency of the most integrative agreements (type A) in distributed setting D1 (where the two negotiators were physically separated) was significantly greater than in all other distributed conditions combined, where the two negotiators were co-located (i.e., D2, D3, and D4) (non-parametric Fisher test, $p = .018$). These findings suggest that the distributed setting D1 was most conducive to negotiation, since the three groups in D1 reached the most integrative agreement (type A).

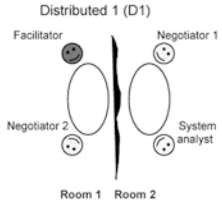
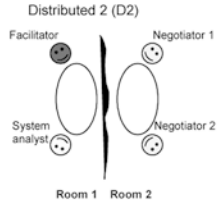
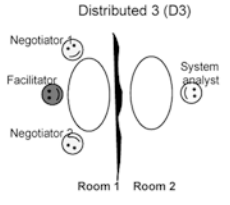
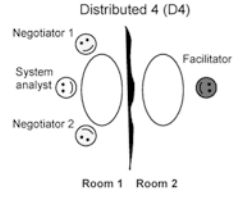
6 Facilitation of distributed group settings

This section presents rich qualitative data that describes aspects of facilitation of the four distinct distributed group settings in the study. This data is considered "rich" in comparison to quantitative data as it provides more insight into an aspect than a mere number. Data was collected using open-ended items in the questionnaire administered in the distributed conditions and using post-session interviews held with the three facilitators. The intention was to gather as much information as possible on aspects that were beneficial or detrimental to facilitation activities in distributed settings as compared to face-to-face meetings. This information is presented for all distributed group settings, D1 to D4. Each distributed group setting is introduced by discussing its distinguishing features with respect to facilitation. Then, aspects that were beneficial or detrimental to facilitation are presented in the form of major themes that emerged from the facilitators' comments. They are illustrated with excerpts from source data. Unless specifically specified, the word "participants" is used to refer to all participants in the study, i.e., students and facilitators, not facilitators. A summary of these aspects is presented in Table 2.

6.1 Facilitation in D1

The distinguishing feature of this group setting was the physical separation of the two negotiators and the co-location of the facilitator with one negotiator (Fig. 3). The setting is important for situations where two customers attend the meeting from two geographically distributed locations of the customer organisation, and the facilitator joins one of the customers.

Table 2 Aspects that were found to be beneficial or detrimental to facilitation in the distributed group settings

GROUP SETTING	Aspects that were beneficial to facilitation	Aspects that were detrimental to facilitation	Other distinguishing aspects
	**More formal and polite conversation between the negotiators** • Enhanced ability to follow conversation **Enhanced task orientation** • Enhanced ability to manage the process	**Interaction mainly through the shared display** • Difficulty to see interpersonal cues of the local and remote participants	*Facilitator 1: Another thing is that [one negotiator] said "I could lie to you and you couldn't tell", in other words "I could say that is critical for me, absolutely critical for me"... interesting to me was that he declared that he was honest.* *Researcher: What does it tell you?* *Facilitator 1: It tells me that he could get away with it this way, because [the medium] is more impersonal...*
	**Detachment from the two negotiators** • Enhanced objectivity	**Focus on the screen** • Difficulty to see interpersonal cues at the remote location **Main conversation at remote site** • Isolation effect • Lowered ability to maintain group cohesion • *Difficult to ensure equal contribution to decision* • Private conversations	
	**Co-location with the negotiators** • Enhanced ability to maintain group cohesion		
	**Detachment from the group** • Consistent context for observation **Use of shared display** • Things were made visible	**Technical problems** • Difficulty to monitor the interaction and group dynamics • Isolation effect • Difficulty to maintain group cohesion	*Facilitator 2: [meeting the people prior to the negotiation] ... really does make a difference... I had no real sense of physical stature or dominating characteristics. Felt like tunnel vision.*

Legend: contributes to **in bold:** aspects *in italics:* supporting evidence, anecdotal data

The facilitators' comments indicate a lowered ability to observe interpersonal cues in the interaction but also an enhanced ability to assist the group's process.

The ''screen'' between the two negotiators troubled the facilitator at one end of the videoconferencing Monitoring group dynamics relies largely on the ability to

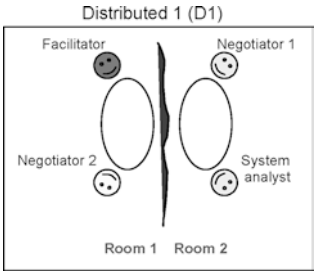


Fig. 3 Facilitation in D1

observe the interpersonal interaction, the individuals' participation and contribution to the process, and interpersonal relations generated by the participants. Aspects that hindered the observation of interpersonal cues in this group setting were reported.

"Seeing is one of the very important skills in the facilitator's repertoire. The facilitator looks for gestures bearing messages and much can be gleaned from the group simply by reading their eyes" (see p. 195 in [17]). In this setting the separation of the two negotiators at the two ends of videoconferencing caused the need to rely heavily on the "screen", i.e., "*although I was in the same room with the teller, my interaction with her and observations of her were more through the image on the screen. Very brief /few times of direct eye contact with her*" (Facilitator 3). This appeared to have lowered the ability to observe the local participant and "*having to use the screen to view the cues of the person in the room with me rather than being able to observe him directly*" was noted as a hindrance to facilitation (Facilitator 1).

A similar effect was reported with regard to observing the remote participants. Although the video channel was of high quality, it appears it was "not good enough" for the facilitators, possibly affecting their ability to ensure equal contribution of group members: "*I am not sure if it's a matter of not being able to observe or more a matter of not being attuned to observing ... sometimes in face-to-face interaction it is easier to get a sense of whether quiet means reflecting/thinking behaviour, or quiet means uninvolved or shy behaviour*" (Facilitator 3).

The restriction in the communication medium caused less communication, and more formal and structured conversations in the meetings That is, "*could certainly feel the distance. The technology added a degree of formality to the discussion and the relationship*" (Facilitator 3). Participants were more polite, i.e., "*people do not feel like they can speak at the same time so tend to let others finish statements*" (Facilitator 1), and "*politely waiting for sentence to finish before interrupting*" (Facilitator 3). Facilitator 2 regarded this as a potential advantage of computer-mediated communication: "*In this scenario, I think it was better to have the video in some ways … when you are face to face you tend to go much faster … it forces people to slow down, to think about how they are going to get things done, and it forces someone to concentrate on the display, and the task*."

The participants' (in diverse roles) comments indicate a change in the group's behaviour due to limitations of the communication medium. Concurrent contributions and turn taking in conversations across videoconferencing were not as smooth, i.e., "*It's difficult to understand if more than one person is speaking at once. I found myself pausing more to try to avoid this*", "*It was harder to interrupt when I needed to*" and the addressee in conversation was more difficult to identify across videoconferencing. However, the participants found ways to overcome these difficulties: "*There was some cross talk but then we just focused on one person speaking at a time*" and "*If I wanted an answer or opinion from a certain person, I would just address them by name. We spent enough time initially adjusting the mikes so that we could hear each other well*."

The enhanced task orientation of distributed sessions was further seen as beneficial in managing the group's process. Unlike face-to-face meetings, where "*discussion would have been more animated, spontaneous – perhaps more 'issues' would have been raised/emerged*" (Facilitator 3), the technology-mediated sessions were more sequential in approach, there "*was very little tangential communication to take the process off track*" (Facilitator 2), and "*once a process was defined we certainly stayed with it to see it through. In that way it was helpful*" (Facilitator 3).

A distinguishing characteristic of the computer-mediated negotiation The following is an excerpt from the interview with Facilitator 1 and it is included here as an illustration of an interesting feature of this group setting that was caught by the keen sense of observation showed by Facilitator 1. It illustrates a possible effect of the physical separation of the two negotiators.

> *Facilitator 1: Another thing is that [one negotiator] said "I could lie to you and you couldn't tell," in other words "I could say that is critical for me, absolutely critical for me" … interesting to me was that he declared that he was honest.*
> *Researcher: What does it tell you?*
> *Facilitator 1: It tells me that he could get away with it this way, because [the medium] is more impersonal, so if he really wanted to sort of misrepresent his side in order to get what he wanted, he might do it easier … he said "I could to this" so it's like "this is the choice I have but the choice I am making is to be honest with you;" he kind of caught it, I thought that was interesting.*

6.2 Facilitation in D2

In this group setting the facilitator joins the system analyst in the communication with the two negotiators at the remote site (Fig. 4). The setting is important for situations where the system analyst is in a remote location relative to the customer representatives, but joined in the meeting by the facilitator. Given the

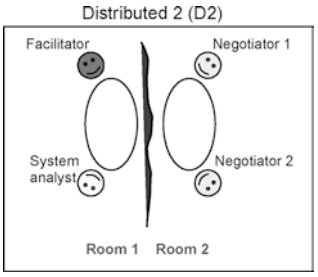


Fig. 4 Facilitation in D2

co-location of the two negotiators, a reported distinguishing feature of this group setting was that the main conversation took place at the remote site (in relation to the facilitator).

The facilitators' comments suggest not only an increased ability to remain objective in the facilitation but also aspects that were a hindrance in monitoring group dynamics, in supporting the group process, and in maintaining group cohesion.

Enhanced ability to remain impartial in the conversation "During discussion, the facilitator should recognise spoken ideas for what they are, rather than for who is presenting them … not only should the facilitator disregard *who* presents the ideas, but also *how* they are presented. This is easier said than done" (p. 194 in [17]). In this direction, a positive aspect reported by Facilitator 3 is the ability to remain detached from the interaction at the remote site, i.e., "*it was easier to distance myself from the 'friendly, extroverted, likeable' behaviour of the teller*" and "*easier not to get drawn into the friendliness of the teller, to remain more distant/objective in my role*."

Difficulty in monitoring group dynamics Facilitator 1 noted that in this group setting "*all used 'the screen' for interpersonal cues*" and believed that it was difficult to perceive the interpersonal relationship between the two at the remote site. The fact that the main conversation took place through the computer link, since "*the two seldom looked 'at' each other so that the statement target was not clear immediately*," was considered a hindrance in meeting facilitation. Keeping aware of all aspects of the conversation is an important aspect in the facilitator's activities that was affected in this group setting: "*I couldn't tell at the beginning whether they were talking to each other or talking to the developer … having the conversation mostly in the remote site and that's really where it was, and that itself I don't think it would have been too bad, but they didn't talk to each other, they talked to the screen, so I couldn't tell, I lost a whole lot of cues when they were talking. All I had to go with were the verbal cues, I mean other non-verbal cues I couldn't get, cause they were looking at the screen … There was one or two times that they actually glanced at each other … they did a lot of talking to each other, but through the screen, and when they did that I was really lacking a lot of information that I would normally have*" (Facilitator 1).

Lowered ability to ensure that everyone contributed equally to the decision Monitoring the level of agreement in negotiation was difficult: "*I suspect the PBR was less committed to the solution than the teller. Difficult to tell the degree of resignation even though I checked verbally re: his agreement*", and "*not sure I was accurately able to gauge the degree to which the PBR simply accepted the solution that the teller was so ecstatic about*" (Facilitator 3). When this situation was contrasted to face-to-face communication, Facilitator 3 believed that "*[in face-to-face] it would have been easier to ally with the PBR to ensure that his needs were being addressed adequately*", and that he "*probably would have been more persistent in trying to maintain equality in expression of interests*."

Lowered ability to assist the group process and maintain group cohesion In a similar manner, Facilitator 1 found that he was unable to follow and help the group with its process, since the process was directed mainly from the remote site: "*the process was not clear; the teller started this process about 'what I want' and then the PBR did the same and then … I cannot tell whether they came up with that list or just happened? Or it is the process that would lead to that? The fact that they were in the same room?* …."

"A good facilitator maintains authority and control in the session" (Wood and Silver, 1995, p. 195). In this group setting the facilitators' comments indicate that the physical isolation from the two negotiators meant in fact isolation from the main conversation and that appears to have affected their ability to maintain group cohesion and control, and to ensure that everyone was contributing equally to the process and to assist the developer in following the group process: "*what they did was 'I need that' … and then the developer had to jump in and impose a constraint that they would kind of missing and then it turned out to be fine. I found it difficult for him [analyst] to follow; the reason … he was unsure about his calculations … they were engaging him in the conversation … and he was trying to hear their conversations while he was trying to build this out. And I thought we had very little influence on the [other] side and I found myself wanting to make some statements more so that I did in any other session, cause I thought I wasn't involved, I wasn't following, and the only way I came in was to help him and to say 'are you sure, let's make sure that …', cause it was happening too fast*" (Facilitator 1).

6.3 Facilitation in D3

If the previous two distributed group settings featured the separation of facilitators from one or both negotiators, condition D3 was characterised by the co-location of the facilitator with both negotiators, while the system analyst joined the meeting from a remote location (Fig. 5). This group setting appears to have produced

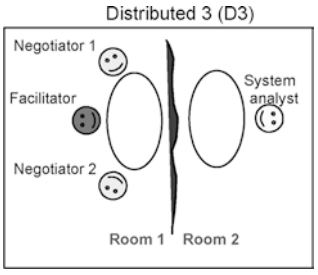


Fig. 5 Facilitation in D3

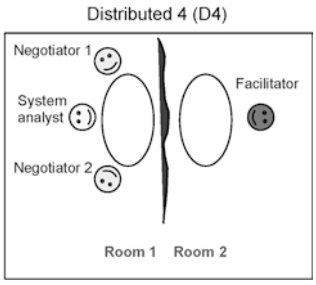


Fig. 6 Facilitation in D4

fewer difficulties in facilitating the meetings and the following paragraphs present mainly positive aspects of facilitation in this group setting.

Enhanced ability to monitor group dynamics and to maintain group cohesion The facilitators noted that being co-located with the two negotiators enabled the facilitators to have "*felt 'part' of the group*" (Facilitator 1), and that was beneficial to their ability to monitor group dynamics, i.e., "*being in the same room with the bank representatives made it easier to see the interaction between them, with the developer separated it did not appear to make it more difficult to observe*" and "*it didn't feel there were any great impediments to being able to see dynamics*" (Facilitator 3), indicating that this group setting resembled mostly, from the facilitator's perspective, the face-to-face situation.

The shared display caused a change in facilitator's behaviour The video image represented the window into the system analyst's room and the notepad was an important element in the communication with the system analyst. While Facilitator 3 noted that his tendency was to focus on the screen as well, unlike face-to-face situations where he would have had "*more face-to-face interaction with those in the room*," a positive aspect was recorded with regard to the group interaction. The focus on the screen was seen as possibly beneficial to the completion of the task, since it contributed to a more functional interaction: "*the task may have been simplified by keeping focus on the screen''* since in face-to-face the communication "*possibly would have been less focused on the task, more on the interpersonal*" (Facilitator 3).

6.4 Facilitation in D4

This group setting was one of the most important and interesting ones in the investigation of the facilitation in distributed requirements negotiations. Advances in communication technology represent promising opportunities for facilitators to mediate meetings from their own offices. In D4, the system analyst joined the two negotiators in a meeting mediated by the facilitator from a remote location (Fig. 6). Due to the total physical separation of the facilitator from the rest of the group, the facilitators commented on issues that were not raised in the other distributed conditions.

Consistent context for observing the interaction On the positive side, Facilitator 1 doesn't note any hindrances in this setting. He "*felt involved*" and the technology appears to have enabled him to monitor the interaction: "*could identify many interpersonal cues from the link*." When a comparison was made with face-to-face facilitation, he mentioned, "*my style would have remained the same*." Also, Facilitator 3 noted that the shared display played an important role in enabling him both to follow the group's activity and interaction with the list of requirements, i.e., "*typing and keeping it visible helped*," and to monitor the group dynamics from a detached position: "*seeing all three together was helpful in so far as it provides a consistent context for observing the interaction*."

Missing the personal "press the flesh" element It is worth noting that the comments reported above were provided by the two facilitators who mediated sessions without any technical difficulties. The session mediated by Facilitator 2 instead experienced some technical difficulties, although minor. The overload of the communication channels at one end caused some noise in the audio communication. Facilitator 2 noted that they were a hindrance to facilitation in this particular group setting and provided a different story than the one reported above. He appeared to have been most involved with the group process in all the other conditions, and in D4 he thought it was "*very hard to manage over the video*," due to "*voice time delay (me to them)*," "*lack of clarity on video*" and "*'graininess' of video of remote site*" which made it "*hard to see the eyes … and minute facial expressions*." Since "facilitators need to be able to get a point across clearly and succinctly" (p. 193 in [17]), the frustration reported by Facilitator 2 then becomes clear. With a lowered ability to communicate and see well at the remote site the facilitator is left with little in managing the meeting.

Feeling of isolation "A thread weaving throughout the facilitator's repertoire is listening … He listens for hidden agendas and for that crucial moment when the participants have reached consensus so the decisions can be restated, agreed to, and documented" (p. 194 in [17]). Facilitator 3 reported a sense of isolation that was

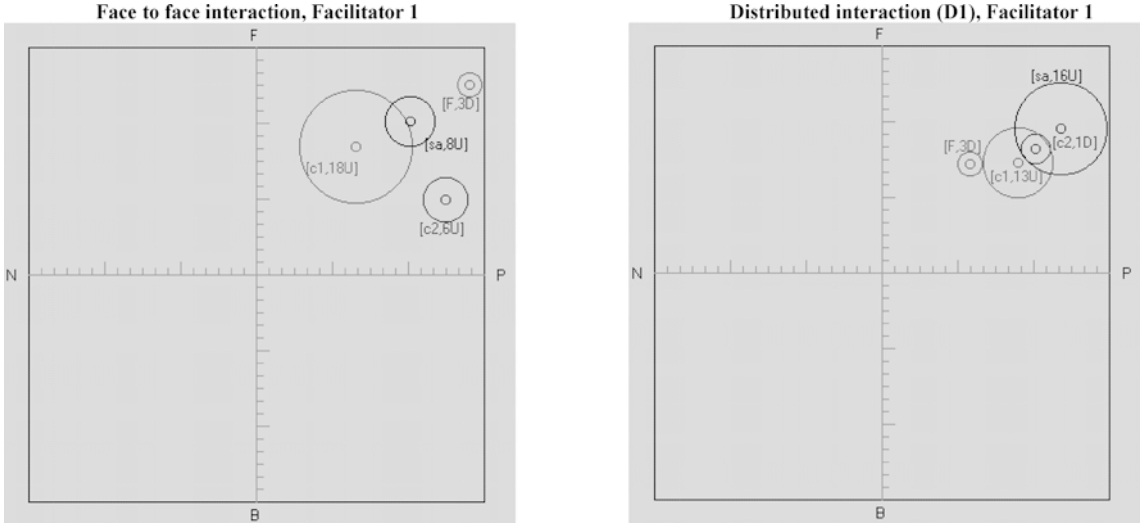


Fig. 7 SYMLOG field diagrams for group interactions in face-to-face and distributed group setting D1, Facilitator 1

possibly triggered by the inability to listen to the remote site very well: "*I really remember a sense of isolation; I think probably not hearing people was distracting … face-to-face would have reduced the isolation factor!*" Besides not hearing the group participants, the lack of good visibility of certain things at the remote site, i.e., "*what was being written on paper*" (Facilitator 2) appears to have influenced the ability to maintain group cohesion and work with the group process: "*from meeting start it was difficult to influence this group*" (Facilitator 2), "*I definitely felt like an outsider in the process. I'm not sure how important that was, however, to the outcome*" (Facilitator 3).

Need to see the people before the meeting! The circumstances around the meeting mediated by Facilitator 2 were such that he did not meet with the rest of the group prior to the meeting. This was an important factor that appeared to have influenced the meeting facilitation: "*It really does make a difference … I had no real sense of physical stature or dominating characteristics. Felt like tunnel vision.*"

Before we proceed to a discussion of this rich evidence, another type of analysis on the facilitation behaviour in face-to-face and distributed settings is described in the next section.

7 Behavioural analysis

Four groups in the study were chosen for a more detailed behavioural analysis, using SYMLOG methodology [28] in the form of four case studies. The videotapes of the four groups were transcribed, coded, and analysed. The intention was to identify any patterns in the group interaction that would indicate an impact of the facilitation of distributed settings, or relationships between a particular group setting (face-to-face or distributed) and facilitation behaviour.

This analysis is very time consuming and thus the selection of these four cases was based upon two criteria: minimising the number of selected cases, while analysing the most meaningful and relevant cases, explained as follows.

Results of an analysis of the negotiation outcome in all group settings (shown in Table 1) identified the distributed setting D1 as most conducive to negotiation; on an ordinal scale of A to F, the three groups in D1 reached the optimum feasible negotiation outcome (type A), as described in Sect. 5.5. Although the comparison of results in F2F and D1 did not reach statistical significance, the negotiation outcomes in D1 were of higher quality than in F2F, making D1 an interesting setting to investigate further. Then, different facilitation styles were observed in the study: Facilitators 1 and 3 were very similar and much less involved with the group interaction than Facilitator 2. Thus, groups mediated by Facilitators 1 and 2 in F2F and D1 respectively were considered for detailed behaviour analysis, as highlighted in Table 1.

Each diagram in Figs 7 and 8 shows the outcome of such analysis. A description of how SYMLOG analysis is conducted is included in Appendix 2. Each diagram represents the group members as images (in the form of a circle) along two dimensions: P–N (friendly vs. non-friendly behaviour) and F–B (task-oriented vs. socially emotional behaviour). The larger the circle, the more dominant the behaviour. In Figs 7 and 8 the circles identified by the letter *F* refer to images of facilitators and the numerical value refers to the dominance level (ranging from 18U to 18D; illustrating dominant and submissive behaviour respectively). Similarly, *c1* and *c2* refer to the images of negotiator 1 and 2 respectively, and *sa* to the image of the system analyst. This detailed

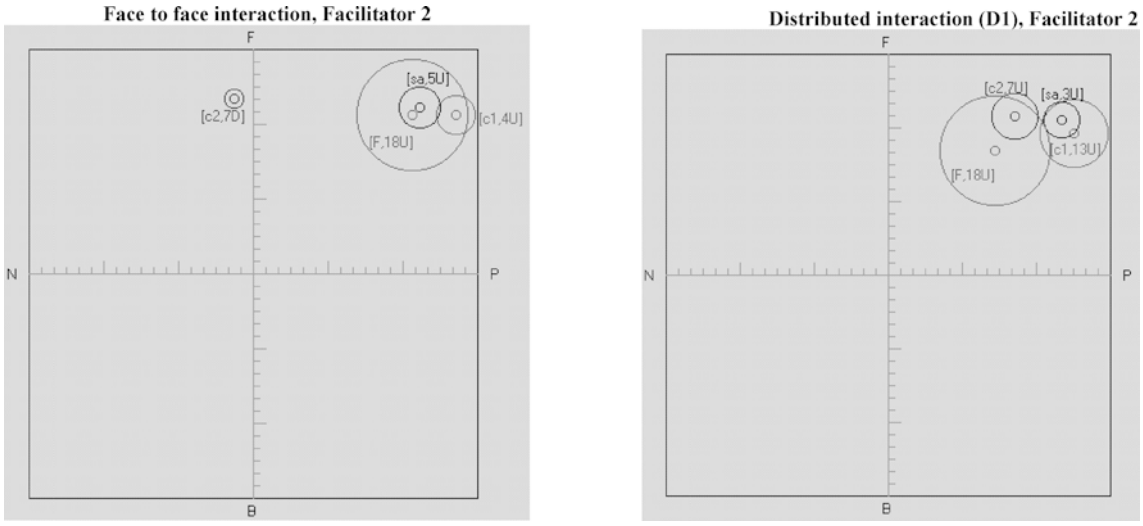


Fig. 8 SYMLOG field diagrams for group interactions in face-to-face and distributed group setting D1, Facilitator 2

analysis provided further insights into the facilitator's behaviour in F2F and D1 settings and they are discussed in the following sections, together with the evidence presented above.

8 Discussion

In this study, the computer technology consisted of real-time application sharing capabilities complemented by audio and video channels. No facilitation-specific tools such as agenda keeping or voting tools were used in addition to the capabilities provided by NetMeeting. With regard to the facilitator's activities of monitoring the interaction, intervening when problems developed, and assisting the group process [24], it was assumed that the audio and video channels were appropriate tools, in that the facilitators could see and hear who would participate in the meeting and how much. However, it was anticipated that group settings in which groups use a multimedia meeting system (restricting the transmission of social behaviours when compared to face-to-face meetings) would present challenges to the facilitation.

Our exploration of the facilitation of four possible distributed group settings in which the facilitators were co-located with key stakeholders revealed a number of important aspects of facilitation in distributed teams and they are summarised in Table 3. This section begins with a discussion of the positive aspects reported by facilitators. They represent interesting opportunities that the computer mediation may bring to facilitation at a distance – aspects that were not anticipated. This is followed by a discussion of aspects that hindered facilitation and caused the facilitation to be problematic in the distributed conditions.

8.1 Positive aspects of the facilitation of computer-mediated requirements negotiations

Two main themes emerged as positive aspects in the facilitation of four distributed conditions:

1. A *sense of detachment* from some or all participants in the group was reported as a positive aspect in computer-supported requirements negotiations. Detachment was perceived as a combination of physical separation and a decrease in the exchange of social cues. This resulted in an enhanced objectivity in facilitation, and a greater ability to evaluate participants' attitudes and to ensure that everyone contributed to the decision. An interesting finding was found in D4 where the total physical separation of the facilitators from the rest of the group seemed to have provided a consistent context for observation of group dynamics. This finding is surprising, since one would expect that group settings in which the facili-

Table 3 Summary aspects beneficial and detrimental to facilitation in distributed group settings

Aspects beneficial to facilitation	Aspects detrimental to facilitation
A sense of detachment from members of the group enabled impartiality and consistent context for observation Enhanced ability to follow the group process due to slower conversation and the use of the shared electronic workspace	Not seeing and hearing well hindered in: – Monitoring group dynamics – Observing interpersonal behaviour – Perceiving participants' attitudes – Gauging level of agreement – Maintaining equality of expression – Maintaining control and authority

tators were in a remote location from the rest of the group would suffer from a perceived lowered ability to observe the (remote) group.

2. The slowing down in computer-mediated conversation (with the exception of the group mediated by Facilitator 1 in D1) resulted in an *enhanced ability to assist the group with the process*. The fact that fewer conversational acts were exchanged made it easier for the facilitators to follow not only who contributed and what, but it also facilitated the group process. Further, there is evidence that the use of the shared electronic workspace resulted in an enhanced visibility of what would have been ''otherwise written on paper,'' and helped the facilitators follow the activities in the process. For example, Facilitator 2 took an active role in directing the group process and in managing the relationship between the task and technology. The objectives in the task were written on the shared notepad, while the shared artifact was easily maintained on the electronic workspace (e.g., changes were documented on the requirements list) and thus the group activities were kept visible at all times. It appears that the documenting and controlling activities were made easier in the computer-supported settings, as Macaulay anticipated (1999). However, there is evidence in the opposite direction, where a perceived feeling of isolation caused a lowered ability to maintain control in the meeting, as discussed in Sect. 5.2.

Nevertheless, these two aspects are particularly interesting since they were found to be beneficial to the facilitation in distributed settings. This evidence suggests that both the perceived detachment from the group interaction and the slowing down in conversation acted as ''*useful facilitation tools*'' in the distributed settings (Facilitator 1).

8.2 Negative aspects in the facilitation of computer-mediated requirements negotiations

If the detachment from some of the participants, on the one hand, was perceived as beneficial in ensuring the facilitators' objectivity in the meeting, it did, on the other hand, cause significant problems in facilitation. They largely relate to the ability to monitor the group interaction which, in turn, affected the facilitators' perceived ability to assist the group process activities.

Monitoring the group dynamics This activity has to do with observing the interaction and keeping track of what was being observed in the meeting, who is participating and how much, and relationships between participants, the tools being used, and the meeting technology [24].

The two main problems reported were difficulties in observing the interpersonal relationships between the participants, in particular the two negotiators, and in hearing the conversation well.

Seeing is one of the most important skills in the facilitator's repertoire [17]. Evidence was found that there were difficulties in seeing well in those distributed conditions that had some sort of separation between the facilitator and the two negotiators. Although one would expect that observing the participants located in the same room with the facilitator would not be problematic, this was not the case. In D1, where the facilitator was co-located with only one of the negotiators, problems in observing the local participant developed. Evidence was found that the ''screen'' between the two negotiators was a hindrance in viewing the cues of the local person, due to the lack of eye contact between the facilitator and the person in the same room. A possible explanation for this is in the design of experimental condition D1: the separation of the two negotiators resulted in the negotiator who was co-located with the facilitator attending mainly to the screen (i.e., the remote partners) and not to the facilitator.

Furthermore, observing the interaction between the two remote negotiators was no easier for the facilitator in D2. An interesting finding was the evidence related to a lower ability to perceive the interpersonal cues at the remote site, due to the communication of the two remote negotiators being mediated by the shared display. The facilitators were restricted in observing the attitudes of the negotiators towards each other, consequently lowering their ability to point out personal relationship problems.

This evidence confirms Macaulay's [6] prediction that the socio-emotional problems will be harder to detect in computer-mediated settings. The facilitators need to use different skills in attending to the group dynamics, since cues about member attitude and behaviour may come from different sources. It is that the facilitators rely more on the auditory channel to obtain cues about member participation (e.g., ''address by name'') and that the ability to listen well is becoming more important for the facilitators.

In this study, some technical glitches in the audio link in the D4 session mediated by Facilitator 3 seemed to have had a negative impact on the facilitation. This incident reveals potential for great impediments in facilitation when the audio channel is of low quality. Of note is that technical difficulties in the video channel were not reported and thus evidence of potential problems in facilitation due to low-quality video images was not found. ''*However, one should not assume that the quality of the video channel matters less, and both channels should be supported equally, since seeing and hearing well are equally important for facilitators*'' (Facilitator 3).

It appears, however, that relying on the verbal cues is only part of the solution, since they were not a sufficient indication of member behaviour, i.e., distinguishing between shy and quiet behaviour was problematic. In this case the facilitators' skills need to be adapted to the new medium in order to detect individual differences.

Assisting the group with the process activities Facilitators monitor the group task activity and play an active role in

pointing out potential problems to be dealt with [24]. The facilitators' ability to assist the group in achieving its goal is highly dependent on the monitoring activity. Evidence was found that problems developed because of a lowered ability to monitor group dynamics, especially in D2 and D4.

The hindrance in seeing well and subsequently in observing interpersonal relationships appears to have influenced the facilitators' ability to see the participants' attitudes in the negotiation and to intervene if problems developed. Evidence was found that the facilitators found it difficult to gauge the remote participants' degree of agreement with decisions being taken. It was reported that maintaining equality in expression of interests in the process was problematic. Similarly, not hearing well, especially when private conversations occurred at the remote site, made it difficult to observe whether the participants were following the conversation and the process. There is evidence that knowing whether there was a process in place or ensuring equal contributions to decisions at the remote location was problematic.

These factors appear to have caused the facilitator a feeling of isolation from the two negotiators or from the rest of the group, which subsequently resulted in a lowered perceived ability for the facilitator to maintain control and authority in the session.

8.3 Did the facilitators' behaviour change between group settings F2F and D1?

The field diagrams of the four groups in F2F and D1 (Figs. 7 and 8) indicate that both facilitators had consistent behaviour across the two experimental conditions. Facilitator 2 was more actively involved with the groups' process activities than Facilitator 1 and this is emphasised by the results of the SYMLOG analysis. While Facilitator 2 is represented as the most dominant figure on both field diagrams (Fig. 8), Facilitator 1 appears the least dominant figure on both field diagrams in Fig. 7. This is an interesting finding, since it may indicate that the facilitation behaviour did not change between the F2F and computer-mediated interaction, in spite of the evidence about problems in facilitating the distributed settings. Or, it may indicate that the facilitators' skills enabled them to adapt to the changes in the communication medium and find ways to overcome the restrictions in the medium.

Another interesting finding is that both groups in D1 reached the same negotiation outcome, i.e., the most integrative agreement. Although a Kruskal–Wallis analysis [29] did not find any statistical significance with respect to the facilitator's effect on the decision quality, these two facilitators had different facilitation styles. One question that emerges is whether having a human facilitator had any influence at all on groups achieving the task in this study. It may be that, as Facilitator 1 mentioned, there were facilitation tools in the medium itself (i.e., increased objectivity and enhanced ability to assist with the group process), and that the need for human facilitation in such computer-supported situations is minimal. However, participants' comments indicate that the human facilitation was helpful in this study. The fact that both groups in D1 reached the same outcome, in spite of the two different facilitation styles, may also indicate that the characteristics of the group were a stronger determinant factor of success than the facilitation style.

9 Limitations

Although a generalisation of results was not sought in this study, but rather an understanding of the aspects of facilitation in different distributed settings, a discussion of its limitations is relevant in understanding the empirical evidence. First, the task was fairly structured and, as discussed above, the need for assisting the groups in achieving resolution may have been minimal.

Another possible limitation is that the three facilitators mediated the five sessions, with few exceptions, in the same order (F2F, D1, …, D4) and a learning effect with the technology may have occurred. This implies that aspects that were found to be detrimental to facilitation during the early sessions might have been present during the later ones, but the facilitators may have devised strategies to overcome them by a more effective use of the technology. As Macaulay [6] anticipated, the facilitators may have learned how to use the new media as an effective communication tool.

However, it is worth observing that even if a learning effect occurred, evidence shows that this did not affect the negotiation outcome, since groups consistently achieved the most integrative agreements in D1 (second facilitated session). One would expect, if an effect occurred, that negotiation outcome of higher quality would have been observed in the last conditions, e.g., D3 or D4.

Further, this study explored the facilitation of single short sessions. Future research is needed to examine whether longer use of the technology in facilitation or multiple sessions would have any effect on the facilitation behaviour and perhaps diminish the difference between the conditions studied here.

10 Conclusions

This study investigated the largely unexplored aspect of human facilitation in distributed requirements engineering meetings. Results indicate that distributed facilitation was possible and that the medium itself provided useful facilitation support, although potential problems in facilitating computer-mediated requirements negotiations were identified. In designing the analysis framework, current models of facilitation in face-to-face meetings were considered in choosing which

aspects to investigate in distributed facilitation. This study revealed that computer-mediated group settings have affordances that supported distributed facilitation and that were not anticipated before. This indicates that the face-to-face model of facilitation may no longer be the most appropriate to predict the technological impacts on human facilitation, and, furthermore, that we need to enrich our understanding of distributed facilitation in requirements meetings and build richer models of it.

These findings have implications for the design of computer support for facilitation in distributed requirements engineering teams. Not only were high-quality audio and visual channels highly valued, but "*the use of the shared electronic workspace between the two sites was a key success factor in distributed settings*" (Facilitator 2).

In this study the requirements negotiation task was fairly structured and was designed as a scheduled meeting of 40 min. As long as the resources that make computer-mediated requirements meetings possible are only available for a predetermined amount of time (e.g., the videoconferencing room is scheduled for an hour), these results are relevant and thus distributed facilitation is possible.

This study represents a significant step in advancing knowledge, based on empirical evidence, of facilitation in distributed requirements engineering. There remain, however, many issues to be addressed in order to further research in this area. Before directions for further research are outlined, recommendations for the facilitation of distributed groups in requirements engineering are formulated.

10.1 Advice from the facilitators

This section outlines recommendations for the facilitation of future similar meetings, in the form of advice from the three expert facilitators in the current study:

- *Establish ground rules in the interaction*. The facilitators found that it was necessary, given the restrictions in the communication medium, to advise the participants to wait until the other participants had finished their statements and to address them by name, so that the statement target is clear in conversation.
- *Discourage private conversations between co-located individuals*. Private conversations at the remote site were found to be distracting, creating a sense of isolation, and hindered the facilitators' ability to follow the group's conversation and process.
- *Use a shared editing application to write down process steps*. The use of the WordPad application was found to be very helpful in keeping the agenda and a record of important decisions in the meeting. High visibility of the process steps and artifacts in the meeting is very important for the facilitator's ability to follow the group interaction and help achieve the common goal.
- *If possible, meet the participants in person prior to the distributed meeting*. When asked whether they would consider facilitating future distributed meetings, two facilitators responded that, although face-to-face meetings are preferred, they would not hesitate to do it again. The third facilitator mentioned that it would depend on the technological characteristics present in the communication link. Although facilitation in distributed settings may prove cost-effective, a significant trade-off that emerges is in the area of interpersonal relationships, i.e., "*I didn't build relationships the same way I would to in face-to-face*" (Facilitator 3), and "*… hard to build a relationship … and that may be a limiting factor, that may make the difference between successful and failed meetings*" (Facilitator 2). As Macaulay stated [6], in distributed requirements meetings, the facilitators may or may not meet the group members face-to-face. These findings suggest that face-to-face contact with participants before the meeting contributes to the establishing of interpersonal relationships beneficial both to the group interaction and its facilitation in computer-mediated meetings.
- *Have the purpose of the meeting (e.g., the group task) clearly defined*. The group task in this study was fairly structured and this appears to be a necessary ingredient for successful facilitation of distributed requirements meetings. This is suggested by Facilitator 1's note with regard to the design of such meetings: "*I know that personally I would facilitate in a distributed manner only if the task and timelines were clear … if more complex and open-ended the task, face-to-face meetings may be preferred.*"

11 Future research directions

Important paths for further research include the study of facilitated vs. non-facilitated groups to identify whether human facilitation is useful in computer-mediated requirements meetings and, if this is the case, the study of a larger sample of facilitators to mediate groups in each condition is necessary to identify the extent of the effects of the communication medium on the facilitation and negotiation outcome. Similarly, investigations of distributed requirements meetings when facilitation-specific tools such as agenda keeping or voting tools are integrated in the meeting support are important.

Moreover, facilitated meetings in which facilitators mediate the meetings in different orders, to eliminate a possible learning effect with the technology, need to be the topic of future studies. In this respect, industrial situations offer the opportunity to investigate facilitation of distributed requirements negotiations when technology with which the facilitators are familiar is used.

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Appendices

1.1 Appendix 1

The role description for system users is shown in Table 4 and the requirements to be negotiated is shown in Table 5.

1.2 Appendix 2: SYMLOG analysis

SYMLOG [1] is a methodology for the observation, coding, and analysis of group dynamics. It assumes that group interaction can be measured in terms of three dimensions. Each dimension represents a continuum on which people can be positioned according to their behaviour as group members. Dominant or submissive behaviours associated with perceived influence and power constitute an *upward–downward* (U–D) continuum. The socio-emotional oriented behaviour is assessed along a *positive–negative* (P–N) continuum. It illustrates a person's concern for establishing and maintaining interpersonal bonds with others. The task-oriented behaviour is assessed on the *forward–backward* (F–B) continuum; it illustrates an individual's concern for performance.

These dimensions are the three orthogonal dimensions in a cube (see Fig. 9), where the one-, two-, and three-letter codes (e.g., PB, UNF) represent behavioural codes [29]. Using the standard SYMLOG coding schema, a field diagram of the interaction is generated (such as those in Figs 7 and 8). The field diagram is a visual representation of images of group members in a two-dimensional plane whose vertical axis is the F–B dimension and the horizontal axis is the P–N dimension. The image of each group member is represented in this field as a circle whose radius conveys the level of dominance. The larger the circle, the more dominant the person.

These field diagrams are obtained as follows. For each interaction act, a SYMLOG coder records the following information: (1) the time of the act, (2) who is

Table 4 Role description for system users

	Teller representative	Personal banking representative
Critical operations	TC1. Browse client's list of all accounts	LC1. Open/inactivate accounts
	TC2. Access client's banking accounts profile (owner, date created, balance)	LC2. Update terms of credit accounts
	TC3. Access client's credit accounts profile (owner, date created, balance)	LC3. Browse client's list of credit accounts
	TC4. Pay bills, deposit/transfer/withdraw funds	LC4. Obtain history of transactions on client's credit accounts
High-priority operations	TH1. Obtain history of transactions on client's banking accounts	LH1. Access client's credit accounts profiles (owner, date created, balance)
	TH2. Obtain list of due dates on client's credit accounts	LH2. Obtain payments overdue on client's credit accounts
	TH3. Order new cheques	LH3. Obtain credit rating from an external agency
Medium-priority operations	TM1. Obtain history of transactions on client's credit accounts	LM1. Access client's banking accounts profile (owner, date created, balance)
No authority/responsibility to perform	TN1. Open/inactivate accounts	LN1. Pay bills, transfers, deposits
	TN2. Update terms of credit accounts	LN2. Order new cheques

Table 5 Requirements to be negotiated

R1.	The system shall enable the open/deactivate accounts operations.
R2.	The system shall display a screen showing history of transactions on banking accounts for the last 3 months.
R3.	The system shall enable the ordering of cheques on-line.
R4.	The system shall automatically provide credit rating from an external agency.
R5.	For each banking account, the system shall display detailed information on the account: owner(s), date created and balances.
R6.	The system shall enable transactions such as: deposit/withdraw/transfer/payment
R7.	The system shall display a screen with a profile of all accounts with information on: owner(s) and date created.
R8.	The system shall enable the updating of terms of credit accounts (e.g. grant credit, change payment terms).
R9.	For each credit account, the system shall display detailed information on the account:payments overdue, owner(s), date created, and balances.
R10.	The system shall display a screen with information on: client's due dates, liabilities (for all credit accounts) and assets (for all banking accounts).
R11.	The system shall display a screen showing history of transactions on all accounts a client holds, for the last month.
R12.	The system shall display the list of all accounts a client holds.

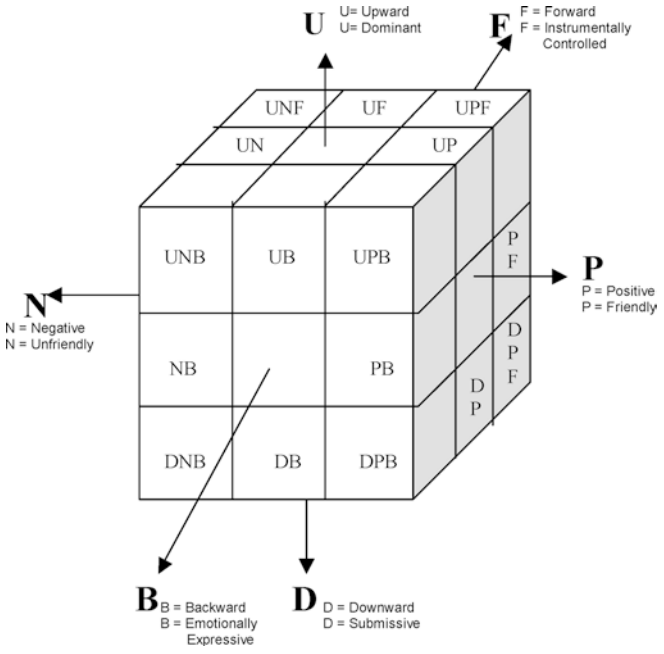

Fig. 9 SYMLOG three-dimensional space

Table 6 Scoring procedure for the location of each participant on the field diagram

p_i = Number of acts by the ith member scored P
n_i = Number of acts by the ith member scored N
P = Total number of acts scored P for the entire group
N = Total number of acts scored N for the entire group
m = Number of members
Location for participant ith on the PN dimension

$$= C(m) \cdot \left(m\sqrt{\frac{pi^2+ni^2}{P^2+N^2}} + 1 \right) \cdot Q(pi, ni)$$

where $C(m) = 18/\left(1 + \frac{m}{\log_e(m+5)+0.58}\right)$

and $Q(p_i, n_i) = \frac{p_i - n_i}{p_i + 0.4n_i}$ if $p_i \geq n_i$

$Q(p_i, n_i) = \frac{p_i - n_i}{n_i + 0.4p_i}$ if $n_i \geq p_i$

the sender, (3) who is the receiver, (4) a specification of whether the observed behaviour was overt or non-verbal, (5) the behavioural code, and (6) a comment describing the behaviour topic. For instance, a message sent by John to Mary showing dominant and unfriendly behaviour, at minute 23 of the interaction, would be coded "23 John Mary ACT UN 'Overrides others in conversation'."

After all interaction acts have been coded, raw interaction scores are calculated for each group member (initiator of messages) with respect to U, D, P, N, F, and B directions (see Table 6). For example, if a message sent by John was rated UN then 1 U is added to u_i and 1 N to n_i counters respectively. These counters are defined for each group member and are used in defining plotting data for the SYMLOG field diagram. These counters are shown for the P–N dimension, but it applies to the other two dimensions as well. Once the raw interaction scores are computed for all members, they are transformed into aggregated data for plotting SYMLOG field diagrams using the formula for Location of each Participant (Table 6). The field diagram summarises the average group behaviour for each member as a circle in a two-dimensional plane and whose radius conveys the level of dominance (the value of U–D dimension).

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