Supporting Decision-making in Distributed Design

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Preface

This Master’s Thesis has been performed as a project within the Research Trainee program at Luleå University of Technology (LTU) in Luleå, Sweden. The program aims at giving students the opportunity to perform their thesis work as an introduction to research studies at Ph.D. level. The research is currently carried out at the Polhem Laboratory at LTU, a competence centre funded by Luleå University of Technology, VINNOVA and the Swedish manufacturing companies that participate in the research.

I’d like to begin by expressing my gratitude to Prof. Lennart Karlsson, head of the Division of Computer Aided Design, who gave me the opportunity to participate in the Research Trainee program and also provided me significant help in my previous academic career. I’m also very grateful towards my supervisor Peter Törlind and my colleague Andreas Larsson for all the assistance and interesting discussions that have influenced the direction of my work. The people at the companies involved in the case studies, especially K-G Forsberg and Lars-Olov Edström at Alvis Hägglunds AB and Thomas Rozman and Egon Standberg at Volvo Car Corporation have provided valuable support to my work, and I appreciate this greatly.

Last but not least, I’d like to thank all my friends and of course my girlfriend for being as supportive as they have been during all the long hours of work.

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Abstract

Working within geographically dispersed teams presents a great potential for improving the product development process but it also implies a vast amount of challenges for the members of the distributed teams. To be able to get advantages from the diversity of different engineering cultures, it is of great importance to study the differences that exist between the work of co-located and distributed teams. This thesis focuses on the decision-making process within these teams and especially on how to improve it by means of computer supported tools.

Case studies have been performed at Alvis Hägglunds AB in Örnsköldsvik and Volvo Car Corporation in Gothenburg. Being international enterprises, and aiming at increasing the flexibility of the organizations, both companies are interested in developing ways of working that are well adapted for distributed collaboration. Performing case studies within an industrial context serve as an excellent way of gathering data for this type of studies because it gives the opportunity to observe issues that exist in real-world scenarios.

Based on the findings from the analysis of the observations done, a number of recommendations for distributed collaboration have been presented and discussed. Among these is the implementation of Web-based project portals, where different communication tools are gathered in one single user interface. By adapting these portals to the requirements of their users, their employment and acceptance is likely to increase, which is essential in order to successfully support the daily work of engineering design teams.
Sammanfattning

Att arbeta inom geografiskt åtskiljda grupper innebär en stor potential för förbättringar av produktutvecklingsprocessen, men det medför även en ansenlig mängd utmaningar för individerna i dessa distribuerade ingenjörsgrupper. För att kunna dra nytta av fördelarna med samarbetet mellan olika ingenjörskulturer är det av stor vikt att studera skillnaderna som finns mellan arbetssättet inom lokala och distribuerade grupper. I detta examensarbete har studierna fokuserat på beslutsprocessen inom dessa grupper och särskilt på de förbättringar som kan åstadkommas med hjälp av datorstödda kommunikationsverktyg.

Fallstudier har genomförts hos Alvis Hägglunds AB i Örnsköldsvik och Volvo Personvagnar AB i Göteborg. På grund av deras starka internationella karaktär och tack vare en strävan att öka flexibiliteten inom organisationerna, är båda dessa företag intresserade av att utveckla arbetssätt som är väl lämpade för distribuerat ingenjörsarbete. Att utföra studierna i en industriell miljö utgör ett ypperligt sätt att samla data för den här typen av studier eftersom det erbjuder tillfällen att observera de problemställningar som finns i verklighetsbaserade sammanhang.

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1 Introduction

This section will give a brief description of the background, purpose and scope of this thesis. Of special interest is the problem formulation, which is closely related to the choice of method used to analyze the problem.

The increasing globalization of engineering design teams is a phenomenon that presents a variety of opportunities and challenges for the future of product development. When designers with different backgrounds and cultures are able to think together in distributed environments important synergy effects can be achieved. The cultural diversity and geographical remoteness present significant opportunities for the work of global design teams. The ability to develop ideas from different educational and/or organizational fields is important for enhancing the innovative process. Also, when working in teams located in different time zones, there is a potential to accelerate development cycles by deriving advantage from overlapping work hours. When companies are able to make the required resources and expertise available worldwide, market closeness is achieved, which is another beneficial factor that has been observed in previous research. [1] [2]

The product development process is a series of activities marked by the continuous flow of information and decisions made in order to achieve progress in the design of the different products. The effectiveness of this flow is closely related to the nature of the problem-solving process that designers use in their everyday work. Previous research states that crucial issues that lead to unsuccessful decision-making are the lack of understanding about the group’s common goal, the purpose of the decisions to be made and the actions to be accomplished to fulfill those decisions [3]. This shared mental model needs to be developed during the process in order to achieve successful decisions that do not require further revision. Starting out from this viewpoint, the focus of this thesis is on how to improve this process in a manner that is suitable for team members with different cultures, backgrounds, goals and expectations. This is one of the significant challenges within distributed collaborative work, since the obstacles imposed by the geographical distribution of global teams tend to emphasize problems that exist within collocated teams.
1.1 Background

The research in this thesis is carried out at the Polhem Laboratory at LTU, a competence centre funded by Luleå University of Technology, VINNOVA and the Swedish manufacturing companies that participate in the research. The primary industrial participants in the project are: Alvis Hägglunds AB, developers of combat and all-terrain vehicles, Volvo Car Corporation, the well-known car manufacturer and Volvo Aero Corporation, developers and producers of components for aircraft and rocket engines.

At Alvis Hägglunds the problem to address has two different perspectives. In the short term the company wants to increase the organization’s flexibility by developing methods for collaborating with off-site companies. These companies will be responsible for certain parts of different projects and report to a project manager within Alvis Hägglunds. In the long term Alvis Hägglunds wants to facilitate communication with their customers all over the world, which is of special importance since their aim is to provide not only products, but also maintenance support for those products throughout the entire product lifecycle.

At Volvo Car Corporation, the integration of the company within Ford Motor Company, which also comprehends Land Rover, Jaguar, Aston Martin, Lincoln, Mercury and Mazda, has increased interest for distributed collaboration. Reducing costs by integrating technologies and knowledge in joint projects sharing the same platforms as well as minimizing the amount of travel needed within these joint venture projects is a key issue. These projects span across many different organizational levels, engineering cultures and knowledge domains. As shown in previous research done within VCC [4], these differences present a vast amount of challenges for these companies to overcome.

Volvo Aero Corporation performs development of engine components in close collaboration with partners outside of Sweden and currently working to improve this communication. Therefore they are also financiers of the research area to which this project belongs.
1.2 Problem formulation
When working in distributed environments, engineers encounter a vast amount of issues that impose difficulties to their everyday work. Such a simple thing as having several people looking at the same piece of paper and discussing its contents is something that hardly anyone reflects about when working in co-located teams, but can represent a lot of obstacles for a distributed team. These types of comparisons between the work of a co-located and a distributed team are essential in order to be able to draw conclusions about what kind of issues we have to encounter when trying to facilitate distributed collaboration. It is therefore important to study and analyze the differences between these two ways of collaboration and from those findings develop tools and methods that will attend to the needs of geographically dispersed engineering teams in an iterative way, (i.e. by analyzing, implementing and re-analyzing to achieve further development).

1.3 Aim
There are three main questions that are of special interest to investigate. These research questions are related to the past, the present and the future of the decision-making process in distributed environments, and read as follows:

- How does the decision-making process work in co-located and distributed engineering teams?
- What can be improved by means of existing technologies for distributed collaboration?
- What needs to be developed in order to further support decision-making in distributed design?

The first question addresses the importance of analyzing the actual behavior of engineers when faced with situations in which the distance between their co-workers and themselves represent obstacles in the decision-making process. The second question deals with the implementation of different tools for distributed collaborative work and most important, the effect these tools imply on the every-day work of engineers. Another focus is on the development of tools and methods that support decision-making, taking into account the difficulties implied by distributed environments. The third question focuses on an analysis of the
nature of decision-making and how new tools and environments could increase the effectiveness of decision-making in distributed design.

1.4 Scope
Delimitations were set for this thesis in order to focus on the formal communication in distributed settings. This formal communication takes place during meetings where a time and a place have been determined in advance. In conjunction with this kind of meetings, there is another very important element in engineering work which is the informal communication which here is defined as the casual encounters that team members may have in their everyday activities. This kind of interaction is essential, not only for the social interaction of the team members, but also for the progress and success of the different projects they might be involved in. Therefore, it is in this thesis taken into account to see how it influences the everyday work of the engineers, but it is not studied as an individual phenomenon.

Other parts of the research that are not within the scope for this thesis are technical issues as well as network security issues that arise when using the tools needed for distributed collaboration. These issues were also noticed but the solutions to these problems are not discussed here.
2 Method

This section will describe the different methods used for gathering data and building a general understanding about the problematic issues that exist in distributed collaboration concerning the decision-making process.

As stated in the previous section, the first goal of this thesis is to learn about how the decision-making process works in companies today. In order to gain acquaintance of the achievements already done within the field, a theoretical study was performed during the first part of the project. The advantage of observing different issues in real-life scenarios is an excellent way of gathering data for this kind of research and therefore, the main part of the studies consisted in ethnographical studies at two of the participating companies. Later on, a thorough analysis of the gathered data was performed to draw conclusions and give recommendations for future improvements in the decision-making process.

2.1 Theoretical studies

For the literature research I have used mostly databases with journal articles, such as ACM Digital Library [5], Decision Sciences Web [6] and Compendex & Inspec article databases in Engineering Village [7] as well as literature provided by my supervisor Peter Törlind and my colleague Andreas Larsson. This literature study gave me the opportunity to get an insight in the achievements that have been done within the area and which topics that are of interest to investigate. One factor that has provided significant help during the research has been the possibility to discuss different matters with my colleague Andreas Larsson. Andreas is currently studying the socio-technical aspects of distributed collaborative engineering [8], focusing on how the social interaction among designers influence the product development process. Andreas has a lot of experience within the field and this type of studies and the discussions with him have helped me understand how to perform ethnographic studies.

During a visit in August 2003 to the 14th International Conference on Engineering Design – ICED 2003 in Stockholm [9] I had the opportunity to attend to many presentations related to the field, which provided me with a considerable understanding about the research area in general.
The search engines Google [10] and Altavista [11] were used for searching information about enabling technologies for distributed collaboration available in the market today. Due to the vast amount of software that in one way or another support distributed collaboration, this part of the data gathering was rather extensive.

2.2 Ethnographical studies

The case studies described in section 4 have been performed using an ethnographical approach. Ethnography is a method of studying and learning about a person or group of people. Typically, ethnography involves the study of a small group of subjects in their own environment. Rather than looking at a small set of variables and a large number of subjects, the ethnographer attempts to get a detailed understanding of the circumstances of the few subjects being studied. Ethnographic studies are both descriptive and interpretive; descriptive, because detail is so crucial, and interpretive, because the ethnographer must determine the significance of what she observes without gathering broad, statistical information [12]. Although there are various perspectives on how researchers should perform this kind of qualitative data analysis, the essence of such activities almost always involves the process of noticing, collecting and thinking. Therefore, field work typically involves some combination of observation, informal interviewing and participation in the ongoing events of the group of interest.

In general, ethnography is concerned with understanding other people’s behavior in the context in which it occurs and from the point-of-view of the people studied [13]. This means making sense of a remark, sign or particular action by reference to the context in which it occurs.

Therefore, the ethnographical studies within this project, which were performed during a total of five working weeks, have been carried out through quiet participation during meetings and technical reviews, trying not to influence the work of the people involved in the meetings in order to get an insight of their natural ways of working. Field notes have been used during these studies for further revision and analysis. Also, videotaping during the meetings has been used as a way to capture more details of specific meetings, so that they could be analyzed thoroughly later on. To get an understanding about the different companies and their needs regarding distributed collaboration, informal interviews have been
performed continuously with the people involved in the projects of study. These interviews have given valuable information that helps clarifying the context in which the different issues take place.

Besides the participation during meetings and the informal interviews with the people involved in the study, I’ve also had the opportunity to study the flow of information through e-mail within one of the projects. This part of the study gave an insight into the extensive amount of information that is shared through this media and also kept me updated in the progress of the project during the time when I was not present at the company in which the study was performed.
3 Collaborative Work

3.1 Computer Supported Cooperative Work

In 1984, computer scientists Irene Grief of the MIT and Paul Cashman of the Digital Equipment Corporation organized a workshop of people from various disciplines who shared an interest in how people work, with an eye to understanding how technology could support them. They coined the term "Computer-Supported Cooperative Work" to describe their common interest [14].

Since the origins of the research area Computer Supported Cooperative Work (CSCW) there have been difficulties in defining exactly what the area comprehends. Bannon et al. stated in the late 80’s that CSCW should be conceived as an endeavor to understand the nature and characteristics of cooperative work with the objective of designing adequate computer-based technologies [15]. Further on, the authors discussed the advantages and disadvantages of having such a broad definition of the field, describing the diversity of backgrounds and perspectives of the researchers covered by the “umbrella term” CSCW as a potential strength, if utilized properly.

There are thus varied definitions of CSCW depending on the nature of the application. Certainly, CSCW is primarily concerned with people and computers. As stated by Monplaisir [16], it is an environment where computers provide support to a group of people in order to accomplish a common task or goal. More concisely, he says, CSCW is a “set of software, hardware, language, components and procedures that support a group of people in a decision related meeting.”

A time-location matrix is often used to categorize different systems used for collaboration. In this matrix, which can be observed in Figure 1, the systems are categorized regarding if the collaboration between its users take place at the same or at different times (synchronous vs. asynchronous collaboration) and whether or not the interaction happens at the same place (co-located vs. distributed collaboration).
Co-located

<table>
<thead>
<tr>
<th>Single user applications</th>
<th>Team rooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face meetings</td>
<td>Bulletin boards</td>
</tr>
</tbody>
</table>

Synchronous

<table>
<thead>
<tr>
<th>Collaborative Design</th>
<th>Web-based applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Videoconferencing</td>
<td>Document repositories</td>
</tr>
<tr>
<td>Shared applications</td>
<td>E-mail</td>
</tr>
</tbody>
</table>

Asynchronous

Distributed

As stated in the problem formulation in section 1.2, it is for the purposes of this thesis important to focus and make comparisons between the work of both co-located as well as distributed teams. The distinction between synchronous and asynchronous work will also be attended during the gathering and analysis of data.

In the following sections some enabling technologies for CSCW will be described closer. These systems cover different parts of the time-location matrix and it is therefore important to gain knowledge about their features to be able to draw conclusions about how they can support the decision-making process within distributed collaborative engineering and also point out what they are currently missing in that context. A more extensive listing of different software for CSCW can be found in Appendix 1.
3.1.1 Web-based Collaborative Workplaces

Collaborative workplaces are web-based interfaces which facilitate their users’ management of people, processes and content. The systems enable primarily asynchronous collaboration among the team members by providing tools for file storage, project planning and project related communication through the use of bulletin boards or discussion forums. Inside the workplaces, users are able to create project folders where files can be stored and revised by the other members in the project. The use of calendars, meeting schedules, etc. let team members keep track of the different activities within the project. The access to the workplaces is often secured by a password-activated entry, in order to keep the information available only for authorized users. The features in these systems are of great help for the organizations in which they are used because they significantly increase the possibility for collaboration among the individuals in the organizations.

Below, two of these systems will be described more closely. The first one, eRoom, is one of the systems used within Volvo Car Corporation and the second one is a relatively new product in the market, developed by a company that has its roots at Luleå University of Technology.

3.1.1.1 eRoom

In eRoom [17], developed by Documentum Inc., the workplace and the different projects can be created either from standardized templates or from user defined templates. New additions to the folders in the workplace are clearly marked to increase visibility about updates and changes. To upload files the users are able to drag-and-drop files directly from their desktop into the project environment. Access to the files can be restricted by adding read and/or write properties to the uploaded files.

In the eRoom environment project planning tools are available to the users in order to make the progress of the different projects visible to the team members. The status of the different tasks can be displayed as Gantt charts and the allocation of resources and updating of progress can be done by each individual member.

A search function is also available to increase the traceability of the uploaded documents and their content. With database management a
variety of projects can be organized by the same user, who is able to get an overview of the different projects’ status and assignment of responsibilities.

For communication between group members, eRoom allows the creation of forums where nested discussions can be carried out and viewed by the entire group. Polls can be used for quick decision-making regarding issues of low level of complexity. Also, an intercom function is available. With this feature, the group members are able to see who is online and send messages to them or invite them to a chat session.

With the component Real Time Sessions (RTS) the users are able to collaborate in real-time, using e.g. one-to-many presentations, whiteboard sharing and online meeting sessions.

The integration with Microsoft Office product enables users to work in environments they are familiar with and easily access their project rooms from this kind of software. As an example, synchronization between the
calendar in the project room and the group members’ own Outlook calendar is an available feature.

eRoom is currently used by several world-leading companies, including Ford Motor Company and thereby Volvo Car Corporation. The system is used in, for example, international collaboration projects between VCC, Ford, Land Rover and Jaguar.

### 3.1.1.2 Projektrum.net

Another Web-based application for collaborative work is a platform called projektrum.net [18]. This project portal is developed by Designtech Projektsamverkan AB, a “research spin-off” from Luleå University of Technology.

![](https://projekt1.mt.lth.se/index.php)

**Figure 3. Example of a user interface in projektrum.net**

In the project portal, a briefing board shows the current activities in all the projects that the user is involved in. Also, personal information such as the data stored in the personal or the project calendar as well as invitations to meetings sent by other team members are displayed there. A storage space
is available to store and organize files that either can be shared to the other people in the project or kept in personal folders that only the current user can have access to.

Among the features included in this system, there are project planning tools that allow the project members to create phases, activities and milestones in a manner that is recognizable for the entire group. Also, the organization of the different project groups can be published and different roles can be assigned.

For communication purposes, a built-in e-mail function is provided and also invitations to meetings can be sent to other team members.

Regarding the security of the system, the access to the project rooms is secured by a password protected entry. The files stored in the server as well as the communication during work are encrypted to keep the information inaccessible to unauthorized users.

### 3.1.2 Video Conferencing Systems

An essential aspect of human interaction is the ability to see the people involved in the communication to be able to perceive gestures and facial expressions that provide important additional information to the exchanged verbal communication. For that reason, videoconferencing systems have become popular means of telecommunication. By adding the ability to see the people involved in the communication, considerable advantages are achieved compared to other i.e. communication through telephone or written communication.

At first video conferencing systems were based on dedicated circuit switched telecommunication channels (e.g. ISDN lines). In recent years, as bandwidth available on the networks and speed of computers have increased, real-time transmission of video between general purpose work stations through the Internet has become a more and more useful application [19]. The Internet has evolved into a multi-service network infrastructure supporting many types of applications of voice, video and data communication. This convergence of telecommunication services into a unified IP based network infrastructure presents huge saving potentials for network operators, since it eliminates the need to maintain several communication networks in parallel. Thus, the incentives for video
communication over the Internet can be seen to be related both to the desire for richer means of interpersonal communication services and to the cost-effective realization of those services [20].

Video conferencing systems can be either point-to-point, including only two sites where the participants often are located in special videoconferencing rooms (see Figure 4); or multipoint, which allows many participants at separate places to attend meetings through their personal computers (see Figure 5). One example of commercial software mainly designed for each one of these two different types of systems will be explained more deeply in the sections below.

In addition to video and audio communication, many of these systems support complementary tools that further enhance distributed collaboration, such as shared applications, with which the participants can share and control i.e. CEA and CAD software, and shared whiteboards that help participants sketch and discuss ideas mainly in brainstorming and conceptual design stages. [21]

Figure 4. Schematic picture of a point-to-point video conference.
3.1.2.1 Alkit Confero

The Confero suite [22] is a software framework supporting real-time multimedia communication between two or more geographically distributed participants. The system is designed to support high-quality video and audio conferencing. Audio and video parameters can be configured so that the tool can be used for many different applications with different requirements on media quality, and with different requirements on computer hardware and network capabilities. In addition to audio and video communication, the tool also supports instant text messaging, streaming of multimedia clips from a server, session initiation and management and application sharing. The meetings held through Confero can be stored to disk for later playback. Media files stored on disk, produced by Confero or other media production tools can be streamed to Confero using Alkit Servo, a multimedia streaming server capable of transmitting audio and video clips stored on disk upon request. The system also includes tools for multipoint videoconferencing with different options depending on the available bandwidth.
By using Alkit Invito, another of the applications in the software package, users can initiate communication sessions not planned in advance. Whenever the system is running on the receiver’s computer, colleagues can send a request for communication that resembles the action of making a telephone call.

Alkit VNC is a modified version of AT&T’s Virtual Network Computing (VNC) software, allowing the participants of a collaboration session to share the view and control of any application. This is one of the essential features of the system, since it allows its users to work together on the same application, which greatly enhances collaboration.

Another useful feature of the systems is Rcamd, which allows a video camera to be remotely controlled by remote users to focus attention to what they feel is necessary at the moment.

![Figure 6. Videoconference held through Alkit Confero](image)

### 3.1.2.2 Marratech Work Environment

Marratech Work Environment [23] consists of two components: Marratech Pro, which is a freely available client software, and Marratech E-meeting Portal, the server software that connects the users during e-meetings and collaborative sessions. By creating an e-meeting room with the E-meeting portal, the host of a meeting can invite colleagues who enter by clicking on a web link that automatically runs the client software.
The software is mainly designed for multipoint conferences with either only audio, through Voice over IP, or audio and video of the different users. The participants of the meeting are displayed with thumbnails in the video pane which enables clicking on the current speaker for a larger video window. The interactive workplace is the main area of the user interface. Here the participants can upload images, document, presentations or other applications to discuss them with the rest of the meeting participants. There is also a chat window where the participants can share written communication such as web links, e-mail addresses or just informal messages. There are also features that enable written and/or verbal one-on-one side discussions with a specific participant. The meetings in the Marratech Work Environment can also be recorded for later playback. The recordings include all media used in the presentation, i.e. audio, video, whiteboard, chat, etc.

Figure 7. User interface in Marratech Pro 4.0
3.1.3 Instant Messaging Systems

Instant messaging (IM) is a technology that enables users to communicate through short text messages and the ability to share files, initiate video/audio conferences and use tools such as shared desktops and digital whiteboards. Since its introduction, in the later part of the 1990’s, the features of instant messaging have gained a lot of acceptance among Internet users.

During the emerging years, instant messaging was not considered a secure way to communicate within business applications. Normally in instant messaging services, messages and connection information are maintained on servers controlled by the provider of the instant messaging application used. Most programs do provide a certain level of encryption, but they are not so secure that any confidential information can be sent through the system. However, in recent years, the business world is opening its eyes to the benefits that can be obtained by the use of secure enterprise versions of these systems, which have gained a lot attention by companies in the last couple of years [24].

More than being another communication tool, the advantage of instant messaging systems lies in the creation of awareness that they provide their users with [25]. This presence awareness is enabled by showing each user’s availability through symbols that show if the current user is online and available for communication, away or occupied. These messages can be set manually or automatically according to the user’s preferences. They are used to indicate the users’ availability and eagerness to communicate with other users. In a distributed environment this compensates in some way for the unfeasibility of actually seeing what colleagues are doing and knowing when it is suitable to initiate a conversation.

Also, by emitting a subtle sound when one of the users in the contact list goes online, instant messaging systems provide support for unintended interaction, which has been found to be of essential importance among distributed communities, since very often naturally occurring informal contacts and communication attempts provide an opportunity for collaborators to learn about each other, and serve as a framework for collaborative tasks [26]. By recognizing when a certain co-worker goes online, the user might remember something he/she want to discuss with that specific person and establish communication through the instant
messaging system and then perhaps continuing the discussion through another media. This feature can serve the purpose of the random encounters that co-workers have in a co-located environment, for instance in hallway encounters or work related discussions during non-work interaction.

Below two of these instant messaging services are described. First, one of the market leading enterprise instant messaging services and then one of the systems that are freely available for download.

### 3.1.3.1 IBM Lotus Instant Messaging

IBM’s Lotus Instant messaging was designed to provide its users with a secure real-time communication and presence awareness tool. Besides text messaging, the system includes features that enable file-sharing, as well as audio and video communication. By using the module Web Conferencing, the users can share applications and/or work together on digital whiteboards while using verbal or written communication.

With the module Everyplace, it gives users instant messaging capabilities through Web-enabled mobile devices, like mobile phones and personal digital assistants (PDAs).

The communication is carried out through the customer company’s own server, which ensures security and enables storage of the communication flow. The system is compatible with IBM’s Lotus Notes and Domino, which are collaborative environments like the ones described in section 3.1.1. This compatibility extends the features in the system with tools such as calendars, to-do-lists and other collaborative applications [27].

Lotus Instant Messaging has recently won an award for the best corporate instant messaging solution in the market [28].
3.1.3.2 MSN Messenger

The MSN Messenger is one of the most wide-spread consumer (freeware) instant messaging systems in the market. Although being freely available for download, it comprehends a wide variety of tools for communication and is relatively easy to set up and use, which perhaps is what makes it so popular. Besides enabling its users to send messages to each other, the system also provides tools for audio/video conferencing, file sharing, digital whiteboards, application sharing and remote assistance [29].

Recently, Microsoft launched an enterprise version of MSN Messenger, MSN Messenger Connect for Enterprises, which aims at introducing Instant Messaging into the business world [30].
3.2 Decision Support Systems

Decision Support Systems (DSS) and Group Decision Support Systems (GDSS) are tools used for supporting interaction in co-located or distributed meeting environments, aiming at enabling a more effective decision-making process during these meetings. Decision support systems (DSS) are computer technology solutions that can be used to support complex decision-making and problem solving. One of the branches within DSS is Group Decision Support Systems (GDSS), which are interactive, computer-based systems that help a team of decision-makers solve problems and make choices. GDSS are targeted to supporting groups in analyzing problem situations and in performing group decision-making tasks. These tools help to create a better decision-making process and usually include such functions as: voting or polling, brainstorming, mind-mapping, categorization of ideas, weighting and statistics, anonymity and the ability of a meeting facilitator to use the software to enhance the meeting [31].
The move towards group decision support systems rose from the awareness of decision-making as a group phenomenon, and thus a requirement for computer support for the communication and the integration of multiple inputs in decision support systems. The interest in GDSS comes in part from the increasing interest in the area of computer support for groups, which can be seen in a variety of other research areas - for example human-computer interaction (HCI), computer-supported cooperative work (CSCW), and organizational design [32].

Normally, in a group decision support system the facilitator of each meeting will first make the agenda of the meeting, which will be projected onto a screen that everyone can see for co-located meetings or on one or more computer screens for distributed meetings (see Figure 10). Then the participants will type simultaneously in their ideas of the topic of discussion on the individual computers next to them. The computer will sort the ideas, and then the participants will then vote or comment on which ideas they like or dislike. In the course of the whole meeting, the system stores, categorizes and prints out all the ideas, comments and vote counts, so that each of the meeting participants will get a summary of the meeting when it ends [33].

What is so special about GDSS is that it enables meeting participants to simultaneously "talk", when the computer sorts and sends ideas to each one
of the terminals, all at the same time. That saves great amounts of time, because this is done electronically instead of manually, and the time saved will enable participants to spend more time developing and expressing their ideas. This can consequently increase the productivity and efficiency of the group.

The time-saving benefit might also have an added bonus: when productivity and efficiency in meetings increase, it is likely that the social processes in the groups involved increases, which strengthens the binding among team members.

With the acceptance among decision-makers for this kind of technologies, there is currently a vast amount of companies that provide software for facilitating decision-making [35] [36]. What characterizes most of these systems is that they provide tools for:

- Meeting planning
- Brainstorming
- Numerical and graphical summarization of group members' ideas and votes
- Worksheets, spreadsheets, decision trees, and other means of graphically displaying numbers and text
- Menus which prompt for input of text, data, or votes by group members

Figure 11 shows an example of a user interface. Here, a decision-tree has been created by the team members. In the tree, there are links to several documents that provide further information about the topics discussed. These meeting maps can be saved and distributed, which enables a straightforward way of sharing and storing the information created during the meeting.
Supporting Decision-making in Distributed Design
Mauricio Palmgren

Figure 11. Example of an online whiteboard that shows the history of an online conversation that led to a decision [37].

In the 21st century, the Internet and telecommunications technology can be expected to result in organizational environments that will be increasingly more global, complex and connected. The DSS technology of the future will be enhanced by mobile tools and services, thereby leading to widespread access to information and decision support tools [38].
4 Empirical studies
This section will describe the case studies, how the cases were selected and the scenarios at the companies in which the study was performed.

Case studies have been performed at Alvis Hägglunds AB and Volvo Car Corporation. Performing case studies within an industrial context serve as an excellent way of gathering data for this type of studies because it gives the opportunity to observe issues that exist in real-world scenarios. The observations were done during a total of four working weeks at Alvis Hägglunds AB and one working week at Volvo Car Corporation, which gave a sufficient amount of data to draw conclusions about how the work is currently performed at the companies. The main purpose of these studies has been to analyze how the companies work today in order to achieve an understanding of how to improve this process. Other purposes are to implement the recommendations achieved in the project and analyze how these changes influence the way of working compared to the situations observed in the first instance.

4.1 Alvis Hägglunds AB
At Alvis Hägglunds AB, a specific project within the company was chosen for the study. The criteria for the choice was that the project should involve a number of participants situated at different locations and a project manager whose responsibility was to make sure that the different activities were planned and performed on schedule by the members of the project group. For this purpose, a part of the project “Chassis Trainer System SPZ 2000” was chosen. This project involved a customer located outside of Sweden, several divisions at Alvis Hägglunds AB and several consulting companies, in different parts of Sweden, in charge of different parts of the project (see Figure 12).

The study was focused on a sub-project which was in charge of performing the mechanical design, i.e. the people in the project were responsible of developing the design that later would be the basis of the manufacturing phase. In this sub-project one project leader at Alvis Hägglunds was responsible for monitoring the progress in the project and the coordination between the different actors. This meant that he maintained communication with all the involved consulting firms and the different divisions within the
company that, in their turn, upheld the communication with the customer in Switzerland.

![Diagram of project structure](image)

**Figure 12.** Structure of the project of study. The green blocks represent the consulting firms involved, the blue box the structure within Alvis Hägglunds and the orange box the customer located outside of Sweden. The red arrows represent the primary communication ways studied, i.e. to and from one of the project leaders (PL). The communication represented by the black arrows was also studied to get a better understanding of the progress in the project as well as an insight in the communication with the customer.

The studies at Alvis Hägglunds AB were performed by observation of meetings between the project leader and various involved parties. Also, meetings between people at Alvis Hägglunds AB and representatives of the customer company were studied. Along with this type of studies, informal interviews were held with several people involved in the project or other projects that could use support for distributed collaboration. Most of the meetings were synchronous face-to-face meetings. The main purpose of studying these co-located meetings was to learn how the company works today in order to understand what kind of collaborative support they would need to increase the efficiency of the information sharing in a geographically dispersed setting.
Special interest was given to issues that delayed the decision-making process in some way. This type of problematic issues were in many cases not perceived as problems by the team members, but as will be explained in section 5, the studies and the analysis of the gathered data showed that different approaches could be used to further improve the process.

### 4.1.1 Current systems

During the co-located face-to-face meetings observed, the discussions were mainly concentrated around paper drawings from the CAD-models or printed documents that the engineers worked on. Also, whiteboards were used frequently to sketch drawings and annotations that enhanced the understanding for the topics of discussion. For sharing this information, different systems such as DocsOpen*, an internal system called PDA (Product Data Administration) or regular e-mail were used.

Studying the meetings with the customer gave a good insight in how distributed meetings are held at Alvis Hägglunds today. These meetings were held using ISDN-based videoconferencing, with good video and audio quality, but without the use of any computer supported tools.

### 4.1.2 Observations

The major part of the studied meetings involved two or several people discussing technical drafts or other kind of documents. The drafts were often printed in paper and during the discussions a vast amount of annotations were made on these papers. The papers functioned as a common ground for the discussions. The engineers had no trouble relating to the drawings on the drafts, rather the opposite; they all seemed to know exactly what was represented in the drawings.

Whiteboards were frequently used tools during discussions at early stages. Even though what was drawn many times couldn’t be interpreted by a person not participating in the meeting, these scribbles often served as valuable items for the discussion and the common understanding. The engineers could refer to these drawings in future meetings even if they were not available anymore. Although, when explaining a certain task for a

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person that did not participate in the meeting where the drawings were made, the same drawings had to be produced once again since they could not be saved during the previous meeting.

Visual communication was very important, especially during meetings at early stages of the projects, where ideas were generated and explained. When performing these brain-storming activities, the engineers often used body language and/or artifacts in the meeting rooms to clarify their ideas. In one of the meetings for example, the project leader used a loudspeaker, the walls of the room and cables on these walls to explain about a component that would be involved in the prototype they were working on. It was very clear that without this visual explanation, it would have been much more difficult for the other participants in the meeting to understand the function of these components. During the remaining part of the meeting, the engineers referred to this explanation on several occasions by pointing at spot where the project leader had placed the “component”. This shows that the visual communication was essential for this kind of meetings.

As stated by one of the group managers in the company, visual communication is crucial during strategic meetings and negotiation meetings with e.g. customer representatives. In these cases, visual communication is important from a different point of view. In a negotiation situation, the facial expressions and body language of the audience provide indispensable information to the speaker. The manager also added that this dependency on visualization decreases once the involved parties established a common ground and trust was built between them.

The documentation and the information sharing within the projects was an issue that repeatedly imposed difficulties for the progress of the discussions. Issues concerning the availability of certain documents relevant to the discussion seemed to be crucial since not having certain documents available at the right moment seemed to lead to delays in the progress of the decisions. The following example clarifies the statement above. It is an excerpt from a discussion between a group of engineers at Alvis Hägglunds and two representatives from the customer company:

- I haven’t got the change proposal.
- We sent it before a holiday, don’t you remember it?
- Hmm, no... Can you please send it again?

The topic discussed when the dialogue above took place had to be postponed until the next meeting because one of the engineers did not have access to that information at that specific time.

Another example that illustrates how a small documentation-related issue can create delays in the process can be seen below.

- XX, I don’t remember what we said about that on September 22nd, I wasn’t taking notes.
- Me neither, I have to get back to you about that.

As it can be seen, the fact that no annotations were taken during a previous meeting leads to bringing up the same issue in at least three different meetings, one where the decision was taken, one where the people involved realize that the information has been forgotten and one, or perhaps more, where the information is verified.

According to the engineers at Alvis Hägglunds, the high level of security that is prevalent in this kind of companies imposes yet another factor that makes it important to make the documentation as efficient as possible. Once a document is classified as “confidential”, it is a very tedious procedure to make any changes to it. Therefore, it is even more important to make sure that the correct documentation is done within the assigned time, so that further revision does not have to be done. Thus, documenting the different steps along the product development process in the sufficient amount and within the time schedule was considered as very important.

E-mail was the most commonly used way of sharing information. In most of the cases, this was a very efficient way of sending information to the desired recipients. Although, whenever a certain document required revision, the same document had to be sent back and forward among the different recipients, which in the long term resulted in a considerable amount of different versions of the same document being spread among the participants. This in its turn lead to confusion, since in future meetings, some of the participants were unsure of which version was the most updated. One of these information-sharing scenarios is explained in Figure 13 below.
Figure 13. Information-sharing scenario. The participants are situated at different locations (represented by the different colors). Participant 1 sends a document to all other participants for revision. Participant 5 is not available and receives the document several days later. After a discussion with participant 4, the document is sent back to participant 1, who makes the required modifications and sends the document to all participants once again.

The lack of awareness about the progress of the different activities that had to be done by distant members of the group was something that in some cases raised problematic issues. In the following example, two engineers discuss the problems that can arise further on in the project due to the unawareness about the activities of other people involved in the project:

- The electronics in the Swiss-wagon is going to expand.
- That’s going to be a critical situation regarding time, because we have to wait for XX’s work.
- Yes, the problem is that we won’t be able to know exactly how much they have done.

Another issue that influenced the progress of the decisions within the project was the availability of persons with key roles such as the project leader. Whenever this person was not available at his workspace, the
people whose work depended in some way on the instructions from the project leader had to find alternative ways of doing their job, which thereby lead to delays in the process. It was evident that in certain cases, the people working on a specific sub-system felt the need to communicate directly to people working on related sub-systems without using the project leader as a middle-hand. In the following excerpt one the representative of one of the consulting firms explains to the project leader that a closer communication in the project was needed:

- *There are specifications that we still don’t know anything about.*
- *XX has to find that out.*
- *The problem is that there is a gap between us and [Company].*
- *We will have to keep on working with what we have... [Company] is responsible for system safety, but each one has to do their part.*
- *We would like to bandy ideas directly with YY if we have specific questions about safety. To avoid roundabouts...*

In this case it was very clear that straighter communication paths as well as awareness of the progress of the related sub-systems would significantly simplify the work of the engineers involved in the project. Cases like this one were very frequent during the course of this distributed collaboration project.

### 4.2 Volvo Car Corporation

The studies at Volvo Car Corporation were made with the same method as the studies at Alvis Hägglunds AB, i.e. mainly through quiet participation in meetings of different types and informal interviews with the people involved in the meetings. The purpose of these studies was to compare the similarities and differences that exist between the decision-making processes at these two companies.

For the case study, a project leader at the Painted Body Engineering department, working within the so-called EuCD project was followed in his different meetings during a total of four working days. The EuCD project is a joint venture project between VCC, Ford of Europe (FoE) and Land Rover; developing a common platform for certain future models of
the different brands. This project leader was followed more closely by my colleague Andreas Larsson, who also was performing ethnographical studies for his research. Andreas studied people at two different departments within VCC. Because of the related nature of our research, it was very fruitful to perform studies during the same meetings and still having different focuses. Our different observations lead to interesting discussions about the issues we had observed.

4.2.1 Current systems
Different types of technology were used for different types of meetings. In the majority of meetings, telephone conferencing was used as the main channel of information. Sometimes NetMeeting† was used to view documents, CAD-drawings, PowerPoint presentations or any other application that enhanced the understanding of what was to be said. The system was used if the startup worked flawlessly and little effort had to be spent by the participants to get the technology working. This is an important aspect, since it seemed to be of greater significance to have a “good enough” system working than to spend more effort on making a perhaps better system work. The main purpose was to start the meeting in the most effective manner.

For storing documents, the people at Volvo used two different systems, eRoom (see section 3.1.1.1) or Lotus Notes‡, depending on the specific project. Most of the people involved in the EuCD project used eRoom, because of the cross-organizational nature of the project and the fact that Ford, who originally used that system, was managing the project.

4.2.2 Observations
At Volvo Car Corporation there were similar issues as the ones observed at Alvis Hägglunds. The main difference between the two companies is of course the size of the organization, which is much bigger at VCC. This lead to much more complex meeting structures, where the participants came from widely spread units within the organization, both locally and internationally. The meetings where often interlinked with each other and the participants entered and left the meetings according to which points on

† Microsoft’s real-time collaborating and conferencing system.
‡ Document management system developed by IBM (see section 3.1.3.1)
the agenda they were involved in. This often led to considerable amounts of time spent on waiting for these topics to be treated, whenever previous topics exceeded the assigned time.

Keeping track of documents was also an important issue at VCC. Although systems for document managing were used more rigorously than at Alvis Hägglunds, the size of the organization caused problems regarding information sharing. In the example below, we can observe an excerpt from a telephone conference between engineers at VCC and their colleagues at Ford of Europe in Cologne, Germany. It relates to the problem of not knowing if the information that has been sent actually has reached the right recipient and if the intended actions have been performed.

- We’ve sent lists of specifications 8-10 times!
- Where did you send the information?
- To a lot of people!
- We have to look into it to see what our actions were.

The problematic issue implied by the enormous amount of information and documents sent through e-mail was experienced at many levels in the organization. In a debate article published in one of the companies corporate magazines [39], one of the employees raise the question about how important the information sent through e-mail within the company really is. The author discusses the necessity of sending copies of e-mails to involved parties that don’t need the information and the costs of labor spent by the recipients handling this information. In one part of the article he states:

I do wonder if whether it could be uncertainty about our personal decision-making mandate that makes us feel the need to show others – especially our managers – the way we’ve handled a particular matter....

Further on, he continues:

I often hear people saying things like “I haven’t got to your e-mail yet, because I was away on business for two days and I’ve got 70 unread messaged in my Inbox. And half of them are flagged for high priority”.
These statements were supported by the people involved in the project of study and raise the question about if there could be a more effective way of spreading information so that the right people get it at the right time and in the appropriate amount.

The awareness about people and process also seemed to be issues that demanded special attention. Being a large corporation with a complex and wide-spread organization, it becomes even harder to maintain the level of awareness required to avoid problematic issues.
5 Analysis

This section will describe the analysis of the main observations done during the case studies at the two different companies with regard to issues that in some way repeatedly delayed the course of the decision-making process.

When performing the analysis of the data gathered during the case studies, a qualitative approach was used. This means that rather than expressing the results in a quantitative manner, the results are presented in a descriptive way. The reason for making the analysis in this manner is that the observed meetings varied significantly in structure. Therefore, making quantitative deductions from specific meetings would not give a holistic view of the issues that have been found, nor would the statistical data be satisfactory. In the following sections, the most important findings in the analysis will be explained in more detail.

5.1 Flow of documents

During the studies, problematic issues caused by the immense flow of documents sent within the projects were clearly noticed. There are a lot of difficulties involved with handling such a big amount of documents, keeping track of different versions and having the documents available whenever they are needed. As could be seen on the examples from the observations described in chapter 4, there were often situations when the decision-making process was delayed because of further revision needed for certain documents that were not available at the specific time of the meeting on which they were discussed. Another negative aspect of the huge document flow is the uncertainty about which team members have received the information if they have done it at all. In certain occasions also the time at which the information was received was important for the progress of the different activities. The considerable response time of certain issues caused delays in the critical actions that had to be performed.

The figure below exemplifies an information-sharing scenario in which documentation is developed. In chapter 4, situations where the revision of a document was done through direct channels to all its recipients were discussed. As could be noticed, documents were sent back and forward among the participants, causing a considerable amount of replies that did
not always reach the required recipient at the right time and sometimes reached recipients that were not really involved in the process. As opposed to this scenario, the picture below shows a way of working in which the document is accessed by the participants according to their own requirements. Given that the system is understood and used properly by the group members, this might be a useful way of spreading information and producing documentation.

![Diagram](image.png)

*Figure 14. As opposed to the scenario described in Figure 13, the document is posted in a document repository and can be accessed by all team members who can make additions, modifications, include comments, etc.*

Systems for storing information in this manner were available at both of the studied companies, but not used to their full potential. The question that arises is why the technology is not accepted by the users to the extent that it could be. When developing computer supported tools for distributed collaboration it is of great importance to attend to the user-friendliness of the systems. In the next chapter this aspect will be discussed and possible ways of increasing the use of these kinds of technologies will be suggested.
5.2 Documentation burden

Documenting the different topics discussed and the different decisions made during meetings is something that the engineers regarded as a necessary but time-consuming task. This often led to an incomplete documentation and this in turn meant that several topics needed to be revised.

Storing the design rationale is essential for the successful progress of the product development process. In many cases it is not only valuable to store the actual decisions made but also the line of arguments that led to those decisions in order to keep track of how they were made. In this manner there is a possibility to document information that might not be regarded as valuable at the time of the decision but may prove to be useful in a future occasion. This information needs to be easily accessed to work as a foundation for further decisions taken. In some cases it might be important to store the decisions related to choices that were rejected and the reasons for not following these specific paths. In that manner, not only knowledge about the chosen concepts is stored, but also valuable knowledge about ideas that already have been evaluated but did not seem feasible at the time and within the context of discussion. This knowledge is important since the conditions might change character in new contexts where similar situations are to be evaluated. The question is how to achieve a high and effective level of documentation without inflicting on creative activities of design engineers.

As discussed in chapter 4, a considerable amount of the meetings involved some kind of printed document as a central part of the discussions. Annotations were made by the participants either on their own papers or directly on the document used for the discussion. The question that arises when observing this phenomenon is how these discussions could take place in a distributed environment, when the distance between the participants make it impossible to work in the same way. Computer supported tools available today, such as shared desktops and digital whiteboards can help to address these issues, but still an important question is how to store the information and make it available and understandable in the future. Developing not only technologies but also procedures for the adequate use of these technologies is essential for this kind of research and will be discussed further in the following chapters.
5.3 Dependence upon resources

In some cases the projects where found to be very vulnerable to the key role assigned to certain members of the group, such as the project leaders. Whenever these people were not available for a certain reason, the progress of the different issues was in some way truncated due to the fact that certain actions could not be accomplished and new information channels had to be found. For teams working in distributed environments this phenomenon represents even bigger obstacles. Due to the decreased awareness implied by distance, the importance of an effective division of tasks increases.

For a company such as Alvis Hägglunds, in which the expertise is located at the company in Örnsköldsvik, and the collaborating companies located in different parts of Sweden as well as customer are spread all around the world, it is even more important to be able to make use of this expertise without having to send resources to the site at which they are needed. By using tools for distributed collaboration, the experts could solve problems without having to travel to a certain location. This would also decrease the negative effects the dependence upon these experts, since the problems would be able to be solved in a quicker and more cost-effective manner.

5.4 Awareness

The knowledge about one’s colleagues’ presence, location and thereby their availability and the progress achieved in the project is known as the awareness about people and awareness about process, respectively. Working in distributed teams this phenomenon does not happen as naturally as in co-located teams, where the everyday interaction of people helps building this awareness. Supporting this kind of interaction is essential for the improvement of the outcome in distributed projects. Communication issues owing to lack of awareness were often seen in the projects of study.

At both companies the projects had very complex structures, a fact that increases the need for making resources available and visible to the people involved in the projects. Being able to reach distant colleagues in a quick and easy manner would highly increase the effectiveness of the different steps in the product development process.
Also, the awareness about the progress of the different tasks in the projects was found to be lacking during the case studies at the different companies. The use of project managing tools clearly needs adaptation and further development to fit better into distributed collaboration settings, which imply a greater importance of making project plans, schedules, etc. visible to all the team members in the projects, regardless of their geographical location.
6 Recommendations for Distributed Collaboration

In this section some recommendations for improving the efficiency of distributed collaboration concerning decision-making will be given. These serve as the foundation for further work in the area, since it implies new ways of working for the people involved in the study, a fact that should be further analyzed to observe their benefits and disadvantages.

One important question that arises from the observations described in sections 4.1.2 and 4.2.2 and analyzed in section 5 is how the activities of group members working in co-located environments can be supported in distributed settings. Using tools that support this distributed interaction should not complicate the course of actions in the users’ every-day work, which would lead to a negative attitude towards using them.

One way of attending to many of the issues stated above would be the use of web-based project portals, similar to the collaborative workspaces described in section 3. Although, the tools available in the market today do not take care of all matters observed, their usage would provide an understanding of how these tools can be improved in order to further address the problematic aspects of distributed collaborative work.

In Figure 15 below, the structure for such a project portal is shown. The purpose is not to provide yet another tool for distributed communication, but instead to present a tool box that embraces the desired tools in one single place. Gathering tools for synchronous as well as asynchronous communication, document repositories and project planning tools in a single user interface that can be accessed from virtually everywhere through the Internet would act as a common workspace for the members of the distributed teams. This virtual workspace would play the role of the collocated office environment by providing means for different types of interaction.

By gathering these tools in a single environment, the usage of the different systems is likely to increase. If the users do not have to explicitly access a certain system to i.e. upload files but instead are constantly working in that environment, the familiarity and acceptance of the technology would grow steadily in time.
For synchronous communication, the users need ways of communicating that in the best possible manner resemble the essential face-to-face interaction. The transmission of conversations involving not only the spoken information but also all the physical gestures and objects we need to show when communicating with other people can be achieved by means of high-quality video and audio conferencing tools. To be able to work on the same document or computer program, there is a need for application sharing and/or desktop sharing tools. For quick and simple communication as well as for creating awareness for the availability of the group members, instant messaging and/or chat tools should be supported. When dealing with large groups involved in the collaboration and complex decision-making scenarios, the use of decision support systems would be of valuable help.

Figure 15. Structure of a web-based project portal that addresses the communication needs for handling projects performed in distributed environments.

Regarding the asynchronous communication, i.e. the communication that does not take place at simultaneously, e-mail is of course a useful tool.
Although, as discussed in section 5.1 the vast amount of documents sent through e-mail, raises a need for other communication tools that fulfill the specific communication purpose in a better way. For example, a question in which the content as well as the history of the discussion is important, could advantageously be carried of through a discussion forum, where all the group members can read the entire discussion about a certain topic and insert their own questions or arguments to the desired part of the discussion. Saving the history of the discussion and its hierarchical structure could be of great value when dealing with similar issues in the future or when a certain issue needs to be revised. In certain situations, announcements need to be made to the group by using briefing boards within the project portal, just as we would use a bulleting board in our co-located office premises instead of sending personal letters to all our co-workers.

Handling documents within a project presents a great challenge to distributed as well as co-located groups. Having the right document available at the specific time of discussion would in many cases shorten the time needed to achieve a decision that relates it. Therefore, the use of document repositories, where personal as well as group documents can be stored and retrieved when required. Another important feature that can be supported within these systems is version handling. In certain situations it is of use to store different stages in the development of the documentation stored. By adding this possibility through a collaborative workspace it is possible for all the group members to work on the same documents and still keep track of the different versions as well as being able to assign different rights to other users in order to determine what actions can be done by them.

Project planning tools can be visualized for the members of the group to achieve a common understanding of the different stages that the project has to go through and the time at which these stages have to be completed. It is also important that the allocation of resources is clear for all the group members in order to propagate the knowledge about the responsibilities within the group and the project’s structure. The team members should be able to make necessary changes to the project plan to shed light upon problematic issues within the project that can be addressed by the project leader or other members of the group.
7 Discussion & Future Work

In this chapter, the findings of this thesis are discussed from the viewpoint of the problem formulation and the aim of the thesis presented in chapter 1. Finally, some ideas for future investigation are discussed.

The vast amount of issues that need to be addressed with respect to distributed collaboration presents a lot of opportunities for research within the area. From studying and analyzing the work of real engineering situations, this thesis has presented some recommendations that have the potential of considerably facilitating the work of engineers working in distributed environments.

The observations that have been done help us to get more acquainted with the requirements that presently exist regarding decision-making within geographically dispersed teams and raise important questions about how to improve this process with the aid of computer supported tools. Although, it is important to keep in mind that the majority of these issues arise from the gap that exist between the technology and the social nature of the work of its users, which is something that is currently being studied intensively by researchers within the field.

The employment and development of computer supported tools aimed at supporting this kind of collaboration is favored by studies of this sort since the features of these systems need to be well-adapted to the needs of their users. Putting the users and their requirements in focus helps us understand the social nature of engineering design and adapt the development of new technologies to support this kind of work. In that manner, acceptance of these technologies is more likely to increase among users and only then their advantages can be properly measured.

Therefore, new approaches need to be employed not only within the usage of technologies that support engineers in their decision-making processes, but also in the way that the work and its documentation are done. Meeting agendas, for example, are often documents that are used before and at the beginning of meetings and thereafter their usage decreases. An interesting feature would be to increase the functionality of the meeting agendas by making them into dynamic documents that later will serve as a compilation of what has been brought up during the meeting, the topics discussed, the
decisions made and further actions to be performed. In that manner, the integration of the time-consuming planning and documentation tasks would save time for the creation of the documents and the retrieval of the information contained in those documents. One way of achieving this goal could be to use templates for the meeting agendas (preferably posted on a project portal), notify the project participants and later use that same document to keep track of the issues brought up during the meeting and structure them in a way that makes it easy to retrieve the information for every member of the group, regardless if they took part of the meeting or not. In that way, time will be saved because the process of preparing and storing the information will be supported so that the engineers minimize the time spent on these different actions will be minimized. The flow of documents will decrease since the revision process is shortened and the documentation is developed at the time when the different issues are discussed. When documenting the different topics continuously, there is also an opportunity to classify the information into different subjects and assign specific tags to them in order to increase the ability to search for specific information in the future. This way of decreasing the documentation burden and facilitating retrieval of information within engineering projects could imply a more efficient product development process, especially within distributed collaboration.

When working in distributed teams, different engineering cultures meet each other. The challenge is to be able to take advantage of the good characteristics of these different collaborating cultures, instead of making one culture adapt to the other. This could be achieved by developing tools and methods that neutralize differences and allow engineers to work in a manner that is natural for them and still being able to collaborate with colleagues that use different approaches in their way of solving problems and making decisions. In order to achieve this, further studies within cross-cultural groups need to be performed to gain knowledge about specific issues related to that kind of settings.

In the future, an implementation of the recommended systems and analysis of these implementations are needed in order to gain further knowledge about the different problematic issues that have to be addressed within distributed collaboration. Further studies are needed within the field to validate the results of this thesis in similar distributed engineering settings. It would also be interesting to find similarities with other related areas, e.g.
distributed education or e-learning, to which the findings could be adapted. This way of continuously learning by analyzing current work and implementing initial findings has been used successfully within the Distributed Collaborative Engineering group at the Division of Computer Aided Design, where this thesis has been carried out.
8 References


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Appendix 1 – CSCW Software

A. Web Collaboration Software  
B. Hosted Web Collaboration Environments  
C. Online Classrooms & E-Learning: Software  
D. Web Conferencing - Meetings & Presentations  
E. Video Conferencing Systems & Services  
F. Screen Sharing  
G. Instant Messaging & Chat
1A - Web Collaboration Software

These software packages were designed to support collaborative work and intranets can be installed on the customers' own server, behind a firewall.

**BSCW Shared Workspace System** ([http://bscw.gmd.de/](http://bscw.gmd.de/))

A Web-based environment for collaborative document editing and other shared work.

**Developer:** Fraunhofer FIT and OrbiTeam Software GmbH

**Platforms:** UNIX, Windows

**BrightSuite** ([http://www.brightsuite.com](http://www.brightsuite.com))

Features both asynchronous collaborative tools (forums, calendars, scheduling, etc.) and real-time tools (conferencing and instant messaging). Source code is available for complete customizability. Requires Microsoft Access, SQL Server, or MySQL.

**Developer:** DCASoft

**Platform:** Windows

**Cassiopeia** ([http://www.cassiopeia.com](http://www.cassiopeia.com))

Suite of applications for workgroup collaboration.

**Developer:** PeopleatWork Systems

**Platforms:** UNIX, Windows NT

**Caucus** ([http://www.caucuscare.com](http://www.caucuscare.com))

High-end, customizable forum system that readily interfaces with other groupware applications. Also available as a hosted service.

**Developer:** CaucusCare

**Platform:** UNIX

**Convea** ([www.convea.com](http://www.convea.com))

Intranet platform for collaborative work, featuring threaded discussions, real-time chat, instant messaging, group scheduling, file management, and more. Requires Internet Explorer.

**Developer:** Convea Ltd.

**Platform:** Windows
EPMAC (www.empac.com)
- Project management and team collaboration software enabling task
  management, resource management, issue tracking, messaging, document
  sharing and versioning. Also available as a hosted service.
  **Developer:** American eBusiness Solutions
  **Platform:** Windows 2000

eRoom (www.eroom.com)
- Collaborative work environment requiring a Web browser plus eRoom
  client software.
  **Developer:** eRoom Technology, Inc. (formerly Instinctive Technology)
  **Platform:** Windows NT

Exchange Server (www.microsoft.com/exchange)
- Server software that facilitates exchange of data among Microsoft Outlook
  users.
  **Developer:** Microsoft
  **Platform:** Windows

Facilitate.com (http://www.facilitate.com)
- An environment for collaborative group work, including realtime chat,
  asynchronous discussions, surveying, and brainstorming tools.
  **Developer:** Facilitate.com, Inc.
  **Platform:** Windows NT, Macintosh

FirstClass Intranet Server (http://www.firstclass.com/)
- Designed as a complete intranet server, with forum and e-mail capabilities.
  Forums can be accessed via a Web browser, but to take full advantage of
  FCIS requires special client software.
  **Developer:** Centrinity
  **Platforms:** Windows NT, Macintosh

Forum MATRIX (http://www.foruminc.com/)
- A platform for collaborative document editing and asynchronous
  discussions. Requires each user to install a Java plugin.
  **Developer:** Forum Enterprises, Inc.
  **Platforms:** Windows, UNIX (written in Java)
Groove (http://www.groove.net/)
   Peer-to-peer collaboration system.
   Developer: Groove Networks
   Platform: Windows

GroupSystems (http://www.ventana.com/)
   A suite of team-based decision software tools, including brainstorming,
   topic commenting, group outlining, voting, surveys, etc.
   Developer: Ventana Corp.
   Platform: Windows NT / Citrix WinFrame

Hipergate (http://www.hipergate.org/)
   Open source Java-based suite of applications, including collaborative tools,
   contact management, project management, content management, and more.
   Developer: KnowGate
   Platform: UNIX

iManage WorkTeam (http://www.imanage.com/)
   Platform for collaborative work, including forums, team calendars,
   document management, etc. Part of iManage's WorkSite product line.

Intellekt Discussions (http://www.soundtechnique.com/magiclamp/)
   A system designed for focused, facilitated discussions. Requires Internet
   Explorer 5.5 or higher.
   Developer: Magiclamp Associates
   Platforms: UNIX, Windows (written in Perl)

Intranet Connections (http://intranetconnections.com/)
   Intranet software for employee collaboration, featuring discussion forums,
   bulletin boards, event calendars, in/out board, e-form builder and survey
   polls. Requires Cold Fusion.
   Developer: SQBox Solutions Ltd.
   Platform: Windows

IntraSmart (http://www.mindbridge.com/)
   Intranet software featuring message boards, group calendars, company
   directory, document library, and more.
   Developer: Mindbridge
   Platforms: UNIX, Windows, Macintosh
Intraspect (http://www.intraspect.com/)
"Knowledge management" software for workgroups.
**Developer:** Intraspect
**Platforms:** UNIX, Windows NT

Knowledge Forum (http://www.knowledgeforum.com/)
Designed to facilitate building "community knowledge", allowing users to view the knowledge base from different perspectives.
**Developer:** Learning in Motion, Inc.
**Platform:** Windows, Linux, Macintosh

Groupware system featuring forums, chat, email, support for distance education, automatic translation of posts into user-selected languages, and other features. Users may participate in forums by email.
**Developer:** Stockholm University, & KTH Technical University
**Platform:** UNIX

Livelink (http://www.opentext.com/livelink/)
Web-based groupware applications suite that includes forums.
**Developer:** Open Text Corp.
**Platforms:** UNIX, Windows NT

Lotus Domino (http://domino.lotus.com/)
Domino permits any Web browser to interact securely with a Notes database (including discussions).
**Developer:** Lotus Development Corp. (subsidiary of IBM)
**Platforms:** UNIX, OS/2, Windows NT

Lotus QuickPlace (http://www.lotus.com/products/qplace.nsf/)
Team collaboration work space. Also available as a remotely hosted service.
**Developer:** Lotus Development Corp. (subsidiary of IBM)
**Platform:** Windows NT

Metalayer Community Hub (http://www.metalayer.com/)
Portal software designed for corporate collaborative communities.
**Developer:** Metalayer.com
Netscape Collabra Server
(http://home.netscape.com/comprod/server_central/)
Successor to Netscape News Server
Developer: Netscape Communications Corp.
Platforms: UNIX, Windows NT

Open Team Support
(http://web.soi.city.ac.uk/homes/mjd/Team/Team.html)
A free Web-based center for collaborative work. Supports discussion, voting, an information repository, and other features. This is a research project still in progress.
Developer: Mike Dilworth
Platform: UNIX (written in Perl)

Oracle Collaboration Suite (http://otn.oracle.com/products/cs/)
Server software for enterprise collaboration.
Developer: Oracle

OutlookFolders (http://www.outlookteam.com/)
Server software that performs many of the same functions as Microsoft Exchange Server, at a far lower cost. Allows team members to share information from their individual Outlook databases.
Developer: Quester
Platform: Windows

Outlook Inside (http://www.iondata.net/oinside.htm)
Outlook based workgroup solution that does not require Exchange Server.
Developer: OpusFlow
Platform: Windows

PhpCollab (http://www.phpcollab.com/)
Open source project collaboration system (under development).
Developer: various
Platforms: UNIX, Windows

Projistics (http://www.projistics.com/)
Project management and collaboration system featuring task, resource and time management, calendar and status reports, opportunity management, resource management and knowledge management using a document center and knowledge base, customizable workflow engine, issue and bug tracking, change management system, and risk management system.
Developer: Nagarro
Platform: Windows

ProVillage Collaboration Engine (http://www.provillage.com/)
Suite of applications designed for workgroup collaboration.
Developer: ProVillage, Inc.
Platforms: Windows, UNIX

Quicktranet (http://www.quicktranet.com/)
Software for quickly creating a company intranet, including chat rooms, threaded message boards, news, calendars, and other features. Also available as a hosted service.
Developer: CS Enlign Inc.
Platform: Windows 2000

RealizationEngine (http://www.realizationsystems.com/)
Open source system for collaborative work using threaded discussions. Available free under the GNU General Public License. Non-GPL licenses can be purchased. Also available as an inexpensive hosted service.
Developer: Realization Systems, Inc.
Platforms: UNIX, Windows

SamePage (http://www.accentuate.com/)
Workgroup collaboration environment. (This SamePage software should not be confused with the company named Same-Page, makers of the eStudio collaboration software.)
Developer: Accentuate Systems, Inc.
Platform: UNIX

Simplify (http://www.tomoye.com/)
A platform for building intranets for collaboration, implemented entirely in PHP. Requires MySQL or other SQL database.
Developer: Tomoye
Platforms: Linux (Windows version under development)

SiteScape Forum (http://www.sitescape.com/)
Groupware featuring forums, chat, document management, calendars, etc. User interface can be extended and customized using Tcl.
Developer: SiteScape, Inc.
Platforms: UNIX, Windows
TEAMate (http://www.mmb.com/)
Web interface to the TEAMate client/server groupware system.
**Developer:** MMB Development Corp.
**Platform:** UNIX

TeamCenter (http://www.inovie.com/)
A suite of groupware tools, including a "collaborative outliner" that functions similarly to a tree-structured discussion forum. Implemented entirely in Java.
**Developer:** Inovie Software, Inc.
**Platforms:** Windows 95 & NT, UNIX

Teamspace (http://www.teamspace.com/)
Virtual team rooms including message boards, chats, calendar, team administration, file sharing, project management, idea generation and evaluation. Also available as a hosted service.
**Developer:** 5 POINT AG, Germany
**Platforms:** UNIX, Windows

Teamware Office (http://www.teamware.com/products)
Groupware system that works with proprietary client software or a Web browser.
**Developer:** Teamware
**Platforms:** UNIX, Windows

WebShare (http://www.radnet.com/)
A platform for building groupware applications. Comes with a group discussion application template.
**Developer:** Radnet, Inc.
**Platform:** Windows NT

Web-4M (http://www.jdhtech.com/)
Primarily a suite of realtime groupware tools, but features private newsgroups. Implemented entirely in Java.
**Developer:** JDH Technologies
**Platforms:** Windows NT, UNIX, Macintosh

WikiWikiWeb (http://c2.com/cgi-bin/wiki)
A simple but powerful tool that’s unlike anything else. Essentially, a wiki is an open-ended, interlinked set of web pages that anyone can edit or add to. A wiki can be used as a discussion forum, a database, an organically grown
encyclopedia. There are now many versions, written for many different platforms.

**Developer:** Ward Cunningham and others  
**Platforms:** Many

A collection of services for Microsoft Windows Server that you can use to share information, collaborate with other users on documents, and create lists and Web Part pages. Also serves as a development platform for creating collaboration and information-sharing applications.  
**Developer:** Microsoft  
**Platform:** Windows

**Work2gether** ([http://www.kmtechnologies.com/](http://www.kmtechnologies.com/))  
Project collaboration software. Team members just need a web browser to work together.  
**Developer:** KMtechnologies, Inc.  
**Platform:** Windows NT

**Zeno** ([http://zeno.fhg.de/](http://zeno.fhg.de/))  
Open source groupware designed to support structured, goal-directed discussion about designs, plans, proposals or other documents subjected to review by a group.  
**Developer:** Fraunhofer Gesellschaft  
**Platform:** UNIX, Windows NT (Requires Java and a JDBC-compatible database)
1B - Hosted Web Collaboration Environments

These web sites host private online workspaces for collaborative work and virtual teams. They offer a variety of business-oriented communication tools and better security than sites designed for public communities. Most are oriented primarily toward asynchronous communication, but some also offer real-time communication tools as well.

BigMind Catalyst (http://bigmindmedia.com/)
Developed by BigMindMedia. Highly customizable social space for collaborative work, learning, in-depth conversations, project management, and problem-solving in a well-organized environment.

Buzzsaw (http://www.buzzsaw.com/)
Online workspace oriented toward engineering firms and the construction industry. Uses WebEx conferencing.

Communispace (http://communispace.com/)
Communispace builds corporate communities based on their own software.

Desyma (http://www.desyma.com/)
Hosts forums and chats with their IP-Forum and IP-Interact software.

EPMAC (http://www.epmac.com/)
Also available as licensed software.

eStudio (http://www.same-page.com/studio/)
Developed by Same-Page. A "virtual office suite" with 15 collaboration tools, including message boards, real-time chat, group calendars & scheduling, project tracking, presentations, contact management, project time logging, document management, and more.

eUnify (http://www.eunify.net/)

Facilitate.com (http://www.facilitate.com/)
Tools for brainstorming, categorizing and decision making designed to enhance productivity in the meeting room and over the internet.
Group Jazz (http://groupjazz.com/)
Custom-designed conferencing spaces for collaborative work, using Caucus software.

GroupMind Express (http://www.groupmindexpress.com/)
Designed for group decision making and project tracking. Used primarily in conjunction with real-time phone or face-to-face conferencing.

HotOffice Intranet Office Suite (http://www.hotoffice.com/)
Offers document management, group contact manager, bulletin boards, web-based email, and chat rooms.

IBiz-Groupware (http://ibiz-tools.com/groupware/)
Features forums, chat, project management, request tracking, resource booking, time sheets, and other features for collaborative work.

iCohere (http://www.icohere.com/)
Complete workspace solution that integrates conferencing, document management, instant messaging, and other collaboration tools.

Intranets.com (http://www.intranets.com/)

linkUall (http://www.linkuall.com/)
Can be used free of charge if you will tolerate advertising banners and some space usage limits.

Lotus QuickPlace (http://www.lotus.com/home.nsf/welcome/quickplace/)

NetSharer (http://www.clixgalore.com/)
Low cost service offering features for collaboration, sharing, exchanging, and managing files and documents securely online.

OfficeMaster (http://www.officemaster.net/)
Offers forums, conferencing, calendaring, web publishing, email, address books, and more.

OPMcreator (http://www.opmcreator.com/)
Offers project management, project calendars, discussions, and document sharing with support for 2D and 3D CAD data designs.
OrbiTeam (http://www.orbiteam.de/)
Uses the BSCW Shared Workspace System.

Orchestra (http://www.crossdraw.com/orchestra/)

Planet Intra (http://www.planetintra.com/)
Offers Planet Intra service for light duty, and Intra.Net service for larger organizations.

Projectplace (http://www.projectplace.com/)
Uses the BSCW Shared Workspace System.

Project Spaces Extranet (http://www.forumone.com/)
Developed by Forum One.

Support Crossing (http://webcrossing.com/)
Designed for teams of customer support personnel, with features such as trouble ticket tracking. Based on the popular Web Crossing software.

TaskComplete (http://www.taskcomplete.com/)
Enables a team to organize and track projects using a web-based task list with integrated calendar, discussion, and document management capabilities.

TeamCast (http://www.teamcast.com/)

Team Crossing (http://webcrossing.com/)
Team collaboration based on the Web Crossing software.

TeamOn (http://www.teamon.com/)

TeamPortal (http://www.teamportal.co.uk/)
Developed by ISC Limited.

teamspace (http://www.teamspace.com/)
Developed by 5 POINT AG.
TeamSpace (http://www.flypaper.com/)
Developed by flypaper.com.

Teamware Pl@za (http://www.teamware.net/)
Allows creation of intranet portals, with discussion forums, document management, personalized workspaces, and user-updateable pages.

Techportfolio (http://www.techportfolio.ca/)
Free service for personal and noncommercial use only. Offers forums, calendars, contact managers, and other tools for collaboration.

VerveShare (http://www.verveshare.com/)
Service targeted at schools, nonprofits, religious and volunteer organizations to support interaction among students, faculty, alumni, and affinity groups.

WebWorkZone (http://webworkzone.com/)
A service of SiteScape. Their software is also available as a product.

WorkZone (http://www.trichys.com/)
Developed by Trichys. Extranet or intranet for secure collaboration and document sharing.
1C - Online Classrooms & E-Learning: Software

These software products for online learning feature some form of asynchronous forum or message board facilities for group discussion.

**Blackboard CourseInfo (http://blackboard.net/)**
- Multimedia authoring tool for Web-based instruction, featuring threaded discussions and real-time chat.
- **Developer:** Blackboard, Inc.
- **Platform:** UNIX, Windows NT

**CaMILE (http://www.cc.gatech.edu/gvu/edtech/CaMILE.html)**
- Freeware designed for educational use. Prompts students to indicate the type of message being posted.
- **Developer:** Mark Guzdial, Georgia Institute of Technology
- **Platforms:** UNIX, Windows, Macintosh

**ClassWeb (http://classweb.ucla.edu/)**
- Open source system for building web sites for university classes, including message boards based on WWWBoard
- **Developer:** UCLA
- **Platform:** UNIX

**Dialogue (http://www.magictree.com/)**
- Free message board software designed for use in an educational setting. Very simple to use. Includes an e-mail notification feature.
- **Developer:** Mark Pelczarski, Magic Tree
- **Platform:** Windows

**Moodle (http://moodle.org/)**
- Free, open-source course management system with a wide variety of function modules, available in dozens of languages.
- **Platforms:** UNIX, Windows, Macintosh (written in PHP)

**TopClass (http://www.wbtsystems.com/)**
- A system for developing and delivering Web-based training, including discussion forums.
- **Developer:** WBT Systems
- **Platforms:** UNIX, Windows, Macintosh
Virtual-U (http://virtual-u.cs.sfu.ca/)
A system for design and delivery of education over the Web, with support for discussion forums.
Developer: Virtual Learning Environments, Inc.
Platform: UNIX

Web Course in a Box (http://www.madduck.com/wcbinfo/)
Freeware tool to help instructors manage course-related Web sites, including discussion forums with file attachments and archives.
Developer: MadDuck Technologies
Platforms: UNIX, Windows, Macintosh

WebCT (http://www.webct.com/)
A tool for developing Web-based educational environments, including forums, chat, and e-mail.
Developer: University of British Columbia
Platform: UNIX

Web Training Toolbox (http://www.janison.com.au/)
A collection of tools for developing interactive training, including forum and chat functions.
Developer: Janison Solutions
Platform: Windows (requires Microsoft's Internet Information Server)
1D - Web Conferencing - Meetings & Presentations

A+ Conferencing (http://www.aplusconferencing.com/)
Low cost, reservationless web conferencing, phone conferencing, and video conferencing.

Agile Live (http://www.agilelive.com/)
Offers WebEx web conferencing services on either a pay-per-use basis or per-seat unlimited use basis.

ASAP (As Soon As Present) (http://convoq.com/)
Developed by Convoq. Combines instant messaging with web conferencing. Using an IM interface, you can instantly initiate a conferencing session. Conference scheduling is also available. Inexpensive hosted service.

Assemble Conferencing (http://www.assembleconferencing.com/)
Offers Express Presenter for presentations, Web Collaborator for meetings, plus phone conferences either with or without reservations.

aveComm (http://www.avecomm.com/)
Developed by Atinav Inc. Available as a hosted web conferencing service through ASP partners, or can be licensed on an OEM basis.

Breeze Live (http://www.macromedia.com/)
Developed by Macromedia. Oriented toward online presentations, featuring PowerPoint slides, live and recorded video, audio, Flash presentations, and live screen sharing.

Bridgit (http://www.smarttech.com/products/bridgit/)
Developed by Smart Technologies, Inc.

Cata (http://www.catatech.com/)
Hosted web conferencing service providing online meeting facilities for up to 50 people for a monthly fee.

Centra (http://www.centra.com/)
Centra offers three conferencing software products: Centra Symposium for virtual classrooms, Centra Conference for large group presentations, and Centra eMeeting for meetings. All of these are also available as hosted ASP services through CentraNow.
Click to Meet (http://www.fvc.com/)
Developed by First Virtual Communications (formerly CUSeeMe).
Software for collaborative meetings. Features voice and video telephony,
streaming media, and data collaboration. Offers an XML-based developer's
kit which allows custom applications to be built.

Communicast (http://communicast.com/)
Hosted service designed for presentations. User interface for audience
members is very simple but allows many forms of interactivity.

Communiqué Conferencing
(http://www.communiqueconferencing.com/)
Hosted service offering web conferencing via WebEx and other software,
as well as pay-as-you-go phone conferencing.

Connex International (http://www.connexintl.com/)
Hosted service offering web conferencing, webcasting, audio, and video
conferencing.

DC-MeetingServer (http://www.dataconnection.com/)
Developed by Data Connection Ltd. A conferencing server designed for use
by service providers who will sell online meeting services, or for direct use
by large-scale enterprises.

Defero (http://www.deferolc.com/)
Defero offers software for collaborative work, such as audio/video
conferencing and collaborative viewing and editing of documents,
including 2D and 3D CAD/CAM files.

Divine (http://www.divine.com/)
Hosted service offering a variety of conferencing platforms for group
collaboration and customer support.

Dreamcast F.A.S.T. (http://www.dreamcastfast.com/)
Licensed software featuring realtime audio and video at half or full duplex,
along with web conferencing capabilities.
eBlvd (http://www.eblvdlinks.com/)
Inexpensive peer-to-peer web conferencing service. Flat monthly rate, unlimited usage. Features text chat or Voice over IP, whiteboard, web tours, and application sharing.

eCollaborate (http://www.ededicated.net/)
Developed by eDedicated.net. Hosted web conferencing service featuring VoIP, PowerPoint presentations, and meeting recording and playback.

eCollaboration (http://www.ecollaboration.net/)
A pay-as-you-go site that makes Microsoft NetMeeting easier to use.

Elluminate (http://www.elluminate.com/)
Conferencing software designed for live learning and training. Available as a hosted service or as licensed software.

Encounter Collaborative (http://www.e2c.com/)
Offers a range of hosted conferencing services, from simple screen sharing via their own ShareItNow to full-scale web conferencing using Microsoft LiveMeeting.

e-Vis (http://www.evis.com/)
A hosted service meant for engineers and manufacturers. In addition to standard web conferencing features, e-Vis offers 2-D and 3-D visualization of models from CAD/CAM systems, project management features, threaded e-mail based discussions, and more.

ezenia! (http://www.ezenia.com/)
Offers two licensed software products to facilitate collaborative meetings: InfoWorkSpace, with text chat, whiteboard, and other web conferencing features, and the Encounter family of products, which incorporates live video and audio.

eZmeeting (http://ezmeeting.com/)
Developed by Sigma Design. Hosted web conferencing service sold on a monthly per-seat basis. Offers real-time presentations, with annotation capabilities, whiteboard, file sharing, and instant messaging. Includes a viewer capable of displaying Office documents, PDF files, CAD drawings and 3D models.
Genesys Conferencing (http://www.genesys.com/)
Small group meetings and webcasting of Powerpoint presentations to large groups.

Gentner Communications (http://www.gentner.com/)
Offers web conferencing services under the name TheDataPort.com, as well as audio and video conferencing.

GRClive (http://www.qksrv.net/)
Developed by GrassRoots Communications. Offers internet web conferencing services providing video conferencing, audio, document and file sharing, and collaboration on demand. Low monthly fee; no per minute costs.

GrouputerNet (http://www.grouputer.com/)
Web conferencing designed for small and large meetings, learning, and decision making. Offers both synchronous (real-time) and asynchronous modes of discussion. Uses proprietary client software.

HelpMeeting (http://www.helpmeeting.com/)
A collaboration service based on Microsoft NetMeeting.

HorizonLive (http://www.horizonlive.com/)
Designed for delivering online presentations to an audience, especially for distance learning. Available as a hosted service or as licensed software.

hotComm (http://www.hotcomm.com/)
Offers both peer-to-peer and server-based conferencing. Participants can send any item on their Windows desktop to other users with a single click. Also offers IM-Live which lets post or email a link through which anyone can instantly initiate a chat session with you.

HP Virtual Classroom (http://education.hp.com/hpvc/)
Hosted conferencing service from Hewlett-Packard, built on Placeware's PlaceServer engine.

iLinc (http://www.ilinc.com/)
Designed for both online meetings and distance learning applications. Uses a small downloadable client rather than a web browser. Offered as a hosted service or as licensed software on a per-seat basis.
IMConferencing (IMC) (http://www.imconferencing.com/)
Developed by LiveOffice. Instant messaging combined with web conferencing features and conference calling. Offered as a hosted service on a per-seat basis.

iMeet (http://www.imeet.com/)
Developed by NetSpoke. Java-based service designed for meetings, and includes components for scheduling, registration, evaluation, and archiving. This is a remotely hosted service.

InstantPresenter (http://www.instantpresenter.com/)
Service designed for live presentations, featuring VoIP, optional webcam video, slide shows, and whiteboard.

InterCall (http://www.intercall.com/)
Hosted web conferencing services using Mshow, MeetingCenter, Conference Place, Present Online, and other software. Also offers video conferencing, streaming media, and a variety of online event management solutions.

Interwise Enterprise Communications Platform (http://www.interwise.com/)
Very high end suite of conferencing applications targeted at large corporations.

Intranets.com (http://www.intranets.com/)
Inexpensive hosted web conferencing and web collaboration service.

IPx Connect (http://www.ipxconnect.com/)
Hosted conferencing services. Offers IPNexus for web conferencing, and IPVideo to combine video conferencing with web collaboration.

iTeleFusion (http://www.global-soft.net/)
Developed by GlobalSoft. Designed to be installed behind the firewall for use at companies with multiple locations. Combines live video, VoIP, data conferencing, and instant messaging.

JBlurb (http://www.jblurb.com/)
Features web conferencing, instant messaging, document sharing, and PowerPoint presentations.
LaunchForce (http://www.eloquent.com/)
Developed by Eloquent. Designed for large-scale online presentations, especially product launch events.

Link Conference Service (http://www.linkconferencecall.com/)
Remotely hosted web conferencing and phone conferencing.

Liveproof (http://www.liveproof.net/)
Remotely hosted meeting center featuring voice conferencing, document sharing, application sharing and demos, and web tours.

Lotus Sametime (http://www.lotus.com/home.nsf/welcome/sametime)
Features instant messaging (compatible with AIM), whiteboard, and application sharing. A developer's toolkit allows building custom applications.

Loudeye Express (http://www.loudeye.com/)
Hosted, reservationless conferencing service designed for presentations. There is a monthly fee for presenters, with no per-seat cost.

MeetingOne (http://www.meetingone.com/)
Remotely hosted service providing web tools for managing and participating in phone conferences. Also offers web tours, and web conferencing via Microsoft NetMeeting.

MeetingPlace (http://www.meetingplace.net/)
Developed by Latitude Communications. Designed to be integrated permanently with a company's existing communication infrastructure. Available as licensed software or as a hosted service.

Meetingroom7 (http://www.meetingroom7.com/)
Offers a virtual shared desktop, in which any Windows application can be run, allowing PowerPoint presentations, collaborative document editing, web tours, etc.

Microsoft Exchange Server (http://www.microsoft.com/exchange/)
Features instant messaging and chat, audio and video conferencing, data sharing, whiteboard, scheduling, and more. Custom applications can be built.
Microsoft Office Live Meeting (http://placeware.com/)
Formerly Placeware. Web conferencing, PowerPoint presentations, whiteboard, web tours, live software demos, polling, streaming video.

Mshow (http://mshow.com/)
Developed by InterCall. Designed for large group webcasts and online presentations. Presentations can include streaming video and audio, PowerPoint presentations, web tours, and application demos. Voting, polling, and instant messaging between participants is also supported.

NetDIVE (http://www.eauditorium.com/)
NetDIVE offers a complete suite of software systems and services for web-based conferencing, collaboration and community building: eAuditorium for web conferencing, WeMeeting for instant messaging, SiteSticky web chat, CallSite for online customer interaction and the NES email server. NetDIVE also offers the free Oxygen web browser.

NetMeeting (http://www.microsoft.com/windows/netmeeting/)
Free peer-to-peer web conferencing software from Microsoft.

Obvio (http://www.obvioweb.com/)
Offers services for web and audio conferencing and webcasting.

PictureTalk (http://www.pixion.com/)
Developed by Pixion. Enterprise web conferencing with support for clustered servers using Mac OS X Server, Windows NT/2000 Server, or Solaris; thousands of concurrent connections. Supports LDAP.

PresentAnytime (http://presentanytime.com/)
Designed for online sales presentations and training. Available as a hosted service or as licensed software.

Present Online (http://www.conferencing.net/)
Developed by Conferencing.net. Hosted web conferencing service offering application sharing, polling, web tours, chat, and whiteboard.
Raindance (http://www.raindance.com/)
Formerly Evoke. Hosted service offering web conferencing, presentations, live webcasting, recording and playback of conferences, application sharing, web tours, and live polling.

RCI (http://www.callrci.com/)
Offers audio conferencing, video conferencing, web conferencing, and broadcast messaging services.

RoomTalk Communicator (http://www.roomtalk.net/)
Hosted service offering VoIP conferencing along with web conferencing features.

SalesWebMeeting (http://saleswebmeeting.com/)
Hosted service offering web conferencing with VoIP. Per-minute fees.

SaveOnConferences (http://www.saveonconferences.com/)
Offers low-cost telephone conference calling, with Spectel web conferencing available at no extra cost.

SmartMeeting (http://www.smartmeeting.com/)
Hosted collaborative meeting service with some unusual features, including both real-time and asynchronous meeting participation, 2D or 3D interactive environment, avatars with facial expressions, video streaming, and more.

SmileTiger (http://www.smiletiger.com/)
Conferencing offerings include eMeeting Server, eTraining Server, eSupport Server, and Web Presentation Server, plus hosted web conferencing services..

SNT Conferencing (http://www.sntconferencingservices.nl/)
Provides conferencing services in the Netherlands, including audio conferencing, video conferencing, web confencing, and tailored events.

Sonexis ConferenceManager (http://www.sonexis.com/)
Offers web and audio conferencing as a hardware/software appliance installed at your site.
SpaceCruiser (http://www.oridus.com/products/spacecruiser.html)
Developed by Oridus. General purpose client/server conferencing software designed to be installed behind your corporate firewall. The SpaceCruiser server also supports a variety of conferencing applications specialized for IC design and engineering work.

Spectel DataXchange (http://www.spectel.com/)
Offers web conferencing services for a variety of vertical markets.

SwitchPort (http://www.limusolutions.com/)
Developed by Limu Solutions. Hosted service designed for large-scale corporate collaboration, e-learning, and knowledge management.

Sykaro Web Conferencing (http://www.sykarocom/)
Hosted service offering audio and video conferencing, chat, instant messaging, web tours, whiteboard, and polling.

Talking Communities (http://www.talkingcommunities.com/)
Offers VoIP voice conferencing combined with web cobrowsing. Online conferencing rooms can be rented on a monthly basis, or you can purchase your own conferencing server. Also offers very inexpensive pay-per-minute conferencing at On-Demand Conferencing.

Tavos Service (http://www.tavos.com/)
Conferencing service featuring full motion video, VoIP, multicasting, application sharing, and group web browsing.

TelSpan (http://www.telspan.com/)
Offers reservationless web conferencing and audio conferencing.

Telus Web Conferencing (http://www.teluscentral.com/)
Offers pay-as-you-go access to WebEx for business users in Canada.

The Conference Depot (http://www.theconferencedepot.com/)
Inexpensive web conferencing, phone conferencing, and video conferencing for small groups.

ThePacketCenter.com (http://www.thepacketcenter.com/)
A collaboration service based on Microsoft NetMeeting.
Umeeting (http://www.umeeting.com/)
Hosted web conferencing service that also offers a persistent discussion forum and library for ongoing communication after a real-time meeting.

VIA3 (http://www.viack.com/)
Developed by VIACK Corporation. A highly secure online meeting service. Participants use proprietary client software rather than a web browser.

Virtual-Workspaces (http://www.virtualdesign.net/)
Developed by VirtualDesign.net. Hosted collaboration toolset, offering multipoint audio and video conferencing, CAD file viewers, threaded discussion, community space and application sharing.

VoiceCafé (http://www.voicecafe.com/)
Offers a variety of conferencing environments, all with secure voice communication delivered over the internet, some with live video. Uses WebDemo as its conferencing engine.

Voxwire (http://www.voxwire.com/)
Conference rooms featuring VoIP and co-browsing for a flat monthly fee based on the number of seats. Requires Internet Explorer with plugin.

Developed by Eedo. Conferencing software designed especially for e-learning applications. Video conferencing via webcam is available as an add-on. Uses WebDemo as its basic conferencing engine.

WebConference (http://webconference.com/)
Low-cost service that allows sharing your desktop with multiple participants over the web.

Web Conferencing Central (http://www.web-conferencing-central.com/)
Hosted conferencing service offering web presentations, application sharing, and document sharing.

Web Conferencing Warehouse (http://webconferencingwarehouse.com/)
Developed by Obidicut. Low cost access to name-brand web conferencing platforms.
WebConferencing4U (http://www.webconferencing4u.com/)
Developed by Obidicut. Name-brand web conferencing at discount prices, including WebEx, Placeware, WebDemo, and StartVisuals.

WebDemo (http://www.linktivity.com/)
Developed by Linktivity. Designed primarily for delivering demonstrations to an audience over the internet, but also serves well for online meetings, training, and support applications. Features voice and text chat, web tours, and whiteboards. Available as a licensed server software package.

WebEx (http://webex.com/)
Offers a Meeting Center for online collaborative work, Support Center for customer support interactions, Training Center for e-learning and online training, and OnStage for large events and seminars.

WebInterpoint (http://webdialogs.com/)
Developed by WebDialogs. Simple web conferencing, available as a hosted service or licensed software.

WebTrain (http://www.webtrain.com/)
Hosted web conferencing service oriented toward live training.

Web-4M (http://www.jdhtech.com/)
Collaboration software offering chat, audio and video conferencing, whiteboard, presentations, application sharing, phone, news, email, calendar, document sharing, training assessment tools, and more.
1E - Video Conferencing Systems & Services

**AliceStreet Conference Center** ([http://www.alicestreet.com/](http://www.alicestreet.com/))

Unique video conferencing software that provides a 3-D simulation of an actual conference room. PowerPoint presentations can also be delivered.

**CMEI Video** ([http://www.cmeivideo.com/](http://www.cmeivideo.com/))

Offers video conferencing along with instant messaging. Also offers pre-recorded video streaming.

**e-Boardroom** ([http://www.e-boardroom.net/](http://www.e-boardroom.net/))

Flash-based video conferencing with up to six simultaneous webcam feeds. Also features real-time document sharing. Hosted service; soon to be available for private installations.

**FocusFocus** ([http://www.focusfocus.com/](http://www.focusfocus.com/))

Hosted service that allows adding video conferencing and chat rooms to your web site.


Macintosh-based instant messenger with live audio and video conferencing capabilities. Compatible with AIM.

**Imajet Communications** ([http://www.imajet.com/](http://www.imajet.com/))

Systems for boardroom and desktop video conferencing.

**International Video Conferencing, Inc. (IVCi)** ([http://www.ivci.com/](http://www.ivci.com/))

Provides conferencing solutions by installing and managing systems built by a variety of vendors, including video conferencing, web conferencing, streaming, audio/visual systems and network services.

**MCI Conferencing** ([http://e-meetings.mci.com/](http://e-meetings.mci.com/))

Phone and video conferencing with optional web conferencing features.

**OmniScreen** ([http://www.omniscreen.com/](http://www.omniscreen.com/))

Video conferencing service powered by Imajet.
Polycom (http://polycom.com/)
Offers a range of group video conferencing and desktop video conferencing systems. Polycom Office combines web conferencing features with live video.

Radiance Communications (http://www.radiancecomms.com/)
Phone and video conferencing services, primarily serving Singapore and Malaysia.

Santa Cruz Networks (http://www.santacruznetworks.com/)
Formerly Reality Fusion. High end video conferencing and data conferencing products for reselling carriers, large enterprises, and government agencies.

Session (http://www.wave3software.com/)
Developed by Wave Three Software. Full motion video over IP and voice over IP, combined with application sharing. Uses peer-to-peer communication. Supports Windows and Macintosh clients.

SightSpeed (http://www.sightspeed.com/)
Exceptionally high quality desktop video conferencing. Enables natural visual communication synchronized with a normal phone conversation, at a much lower cost than traditional video conferencing systems. Offers the (rare) capability for Windows and Macintosh users to video conference with each other.

Unreal Media Server (http://umediaserver.net/)
Free streaming media server for Windows operating systems, similar to those offered by Real Networks and Microsoft. Can be used for live video conferencing or to deliver stored video or audio streams. Requires some technical expertise to set up, but the software is free.

VidiTel (http://www.viditel.com/)
Developed by Santa Cruz Networks. Multipoint desktop video conferencing over the internet. Up to six participants can video conference simultaneously.

Virtex C3 (http://www.virtexc3.com/)
Offers live desktop video and audio conferencing, and web delivery of recorded video presentations.
WebVideo4U (http://www.webvideo4u.co.uk/)
Offers Flash-based streaming media, including video messaging, video phone, video conferencing, and video chat.

WiviTel (http://wivitel.com/)
Developed by Rize International. Portable video conferencing and screen sharing service for Asian cities, for up to 200 parties per call (six visible simultaneously).
1F - Screen Sharing

**Glance (http://www.glance.net/)**
Screen sharing made simple. Glance is a very easy to use tool that lets you instantly show your computer screen to anyone you choose over the web. The other person needs only a plain web browser. Free trial.

**GoToMyPC (http://www.qksrv.net/)**
Allows you to access your computer remotely via a web browser.

**Hello (http://www.qksrv.net)**
Free, easy to use service offering one-click picture sharing with friends, with an instant messager-like interface.

**ShareItNow (http://www.shareitnow.com/)**
Developed by Encounter Collaborative. Inexpensive, easy to use tool for sharing an image of your desktop with one person or a large audience.

**VGA2Web (http://www.epiphan.com/)**
Developed by Epiphan. Hardware-based screen-sharing. The device takes the output from a VGA port or computer monitor and broadcasts it to your audience over the web.

**VNC (Virtual Network Computing) (http://www.realvnc.com/)**
Free, open source software which allows you to view and interact with one computer using a simple remote control viewer program on another computer anywhere on the Internet. The two computers need not be the same type - for example, you can use VNC to view a Linux machine from a Windows PC.
1G - Instant Messaging & Chat

Active Data Online WebChat (http://www.activedataonline.com.au/)
Chat software based on HTML and text. Requires Microsoft .NET Framework and MS Access or SQL Server.

AIM (AOL Instant Messenger) (http://www.aim.com/)
Free instant messaging software and service from America Online.

Akonix L7 Enterprise (http://www.akonix.com/)
Instant Messaging gateway providing organizations with tools to securely manage use of public IM services such as AIM, ICQ, MSN, and Yahoo.

Bantu IM & Presence Platform (http://www.bantu.com/)
Instant Messaging platform for business, featuring encryption and firewall compatibility.

Chat Essentials (http://www.chatessentials.com/)
Offers GlassRoom chat software and GlassHelp live help software either as licensed software or as a hosted service.

ChatSpace (http://www.chatspace.com/)
High-end chat software designed for online communities and customer support applications.

ChatWeaver (http://our.affiliatetracking.net/)
Chat software with user interfaces designed for both plain HTML and Java-enabled browsers. Also available as a hosted service.

ConferenceRoom (http://www.webmaster.com/)

DigiChat (http://www.digichat.com/)
Chat and instant messaging, with simple message boards. Available either as licensed software or as a hosted service with a monthly fee.

eDial Web Communications Console (http://edial.com/)
Secure, enterprise-level instant messaging that works with a standard web browser.
Effusia Business Messenger (http://www.liquidcs.com/)

Enigma Community Suite (http://www.sereon.com/)
Developed by Sereon Technology. Sophisticated software suite designed for chat-based online communities. Available as licensed software or as a hosted service.

e/pop (http://www.wiredred.com/)
Developed by WiredRed Software. Secure instant messaging software designed for business use. A software developer kit allows building customized IM applications.

eStudio (http://www.same-page.com/)
Developed by Same-Page. Platform for online collaboration; free for the first 30 days. In addition to live text chat, eStudio features message boards, calendars, project tracking, presentations, and more.

GCN (Global Communications Network) (http://www.gcn.cx/)
Free service featuring instant messaging, chat rooms, and web email. Requires software download (free).

havChat (http://www.hav.com/chat/)
Chat/whiteboard software developed by hav.Software. Both the server and client software are implemented entirely in Java.

ICQ (http://www.icq.com/)
Free instant messaging software and service.

Imici (http://www.imici.com/)
Offers instant messaging for both business and personal use, with support for encryption and firewalls, interoperable with other major IM systems.

IMlogic (http://www.imlogic.com/)
Offers enterprise instant messaging security and management software compatible with major IM systems.
Jabber (http://www.jabber.org/)
Free open-source instant messaging software, aiming for cross compatibility with other major IM systems. Jabber.com offers associated commercial services.

JMessenger (http://www.jmessenger.com/)
Free service allowing you to offer instant messaging on your site.

MessagePal (http://messagepal.com/)
Inexpensive, easy to install instant messaging software designed for secure communication among users within a local area network.

MSN Messenger Service (http://messenger.msn.com/)
Free instant messaging software and service from Microsoft. Includes voice chat and telephone paging features.

raiderSoft Free Java Chat (http://freechat.raidersoft.com/)
Free hosted service, allowing you to put chat rooms on your own web site.

SiteSticky (http://www.eauditorium.com/)
Developed by NetDIVE. Chat software available as licensed software or hosted service. In addition to basic text chat, offers voice chat, avatar chat, and other features.

Softros Messenger (http://messenger.softros.com/)
Instant Messenger software for LANs and intranets.

SPiN Chat System (http://chat.spin.de/en/)
Java-based chat software available as licensed software or hosted service.

Sprint Instant Message (http://www.sprintbiz.com/icc/sim/)
Free instant messaging software and service. Compatible with ICQ, MSN, and Yahoo.

Web Crossing (http://webcrossing.com/)
Features a choice of interoperable Java and HTML chat clients. Can be configured as regular chat rooms or as "auditorium" chats with a stage and audience, and may be seamlessly integrated with Web Crossing's forum and email software.
World Crossing (http://worldcrossing.com/)
Free service allowing you to set up Web Crossing chat rooms for your own web site or group.

Yahoo! Messenger (http://messenger.yahoo.com/)
Free chat & instant messaging software and service.