ABSTRACT

Distributed Group Support System (DGSS) is a technology that can help groups to overcome some of the problems associated with being in different places and different time zones. The purpose of this paper is to propose a framework for DGSS research that will encompass the major issues involved in the application of DGSS. The issues, compiled from a literature review and a small scale survey of practitioners, include topics such as security of information, identification of approved members, and the role of a facilitator. The changing structure of organizations due to downsizing and globalization, is being assisted by the increased access to communication media, such as videoconferencing, fax, and high speed data networks. As the changes take place there is a need to define the use of the technology, and to define the structure of the distributed group.

1.0 Introduction

The modern organization is characterized by a structure in which people work and make decisions in groups. Lately there has been an increased emphasis on team-based organizations and autonomous teams [31]. Globalization, virtual corporations, downsizing and the need to make decisions in real time, makes it necessary for groups to work together while the participants may be in different locations.

It is therefore logical to support the work of distributed groups with information technology, especially when the cost of travel is growing rapidly and the participants may even communicate in different languages. The discipline that is being developed to do just that is termed distributed workgroup computing (a term coined by Microsoft Corp) or Distributed Group Support Systems (DGSS, a term used in the academic world).

DGSS supports people working in groups at different locations and possibly at different times. The support can be directly related to decision making or it may be indirect (e.g., supporting communication in the preparation of a document).

Since DGSS is new there is very little theoretical or empirical research on the topic. The purpose of this paper is to identify the most important issues of DGSS and then propose a framework for DGSS research.

The paper is divided into four parts: in section two an overview of the traditional GSS framework is provided and compared with that of a proposed DGSS framework. A review of findings from DGSS research is provided in section 3. Section 4 summarizes DGSS issues which need to be addressed and organizes them according to the framework.

Appendix A provides a list of DGSS issues identified by practicing managers. The list is divided into synchronous (at the same time) and asynchronous (at different times) sections. The issues from the framework were compiled from three sources: first, the review of DGSS; second, frameworks for Group Support System (GSS); and finally, from 69 practicing managers in Southern California.

2.0 The GSS Research

2.1 The GSS Frameworks

A common GSS research framework is the one developed by McGrath [24]. Several researchers have adapted and used this research framework to form a more comprehensive or suitable framework for GSS research [11,26]. The skeleton of this framework is shown in Figure 1 where four types of characteristics influence the processes and consequently the outcomes. Group characteristics include mainly group demographics. Task complexity and the activities involved in completing a task (such as idea generation) make up task characteristics. Contextual characteristics identified in the literature include cultural differences, time, and conflict. Technological characteristics refer to the GSS or technological components the group members use (such as anonymity) for a particular task under a certain context.
viewpoint, this framework shows that the process outcomes, including efficiency and effectiveness, is dependent on the group process which in turn is determined by group, task, contextual and technological characteristics.

CHARACTERISTICS
Group --> Task --> Processes --> Outcomes
Contextual -->
Technological -->

Figure 1: GSS Research Framework

2.2 Distributed GSS Framework

Most research to date on GSS has focused on the decision room environment where a group of participants meet face-to-face in the same room, working on a common task [10,33]. A new set of issues and challenges faces researchers interested in spatially separated participants who are meeting either synchronously or asynchronously. While the framework in figure 1 is useful for GSS research in a decision room context, the framework does not take into account some of the research issues that are particular to dispersed or distributed GSS. For example, is the inability of participants to see one another face-to-face necessarily a liability?

2.2.1 Synchronous DGSS

Synchronous DGSS technologies support same time but different place meetings. The participants are distributed across multiple sites linked by various communication technologies. Some of the technologies are computer conferencing with screen sharing, audio-conferencing (conference calls), and various types of video-conferencing. The distance barriers created by the participants in different locations may create meeting process problems. Group size is not dependent upon the limits of a single facility. Reliability of the communication network is critical to the success of the meetings.

2.2.2 Asynchronous DGSS

Asynchronous technologies link participants in meetings conducted at different points of time while being physically apart from each other. E-mail, voice-mail, and workflow management systems such as Lotus Notes are some types of supporting technology. The issue here is more than just time and distance barriers. While there is a need to share information, there may be schedule conflicts amongst the group members. Attention to on-going coordination may be necessary during implementation to assist the members to stay on task, meet decision deadlines and ensure timely participation by everyone. Timely feedback is important to the continuing progress of the group. Access to the on line information is critical to the ability of the participants to take part in the meeting.

CHARACTERISTICS
Distributed
Group --> Task --> Processes --> Outcomes
Contextual -->
Communication Issues -->
Technological -->

Figure 2: Distributed GSS Research Framework

3.0 Experimental Research of Distributed Groups

Types of Meetings:
With computer support
| FTF | Distributed |

Without computer support
| FTF | Distributed |

Figure 3: Structure of DGSS Research

Most of the DGSS research has compared face-to-face group processes and outcomes to distributed groups using GSS tools. The majority of the groups preferred the face-to-face setting. There are more positive relationships for face-to-face interaction with any of the intervening or dependent variables. Reaching consensus in a dispersed group was difficult while face-to-face groups usually came to consensus [13, 17, 25]. Face-to-face groups exchanged more information than distributed groups [17]. Individuals must enter the information into the computer which slows down the ability to share information, and produces more terse sentences. In a distributed group, if the computer is the only communication channel, clarification of ideas and feedback is not easily obtained.

Cooperation was difficult for dispersed groups using computer conferencing [32]. In a later study,
Burke and Chidambaram [5] found that groups with more experience were able to cooperate as well as face-to-face groups.

The quality of decision between face-to-face groups and dispersed groups was not different for most experiments [2, 5, 7, 13, 17]. Face-to-face groups had a higher level of satisfaction with the group process [6, 13, 21, 30]. Face-to-face groups communicate more easily. There is more social presence which encourages information sharing. Members can ask more questions and obtain immediate feedback.

Dispersed groups are able to function using computer mediated support, however most groups favor face-to-face meetings. If members of organizations have a choice of meeting context, they will choose face-to-face over dispersed. As many organizations downsize and flatten their structures, it may not be possible to meet face-to-face. For multi-site organizations, dispersed meetings using a variety of communication channels may be necessary to complete tasks in a timely and efficient manner. The studies need to look at how people adapt to using computer mediated support and to identify the types of environment that will successfully support dispersed meetings. If the quality of the decisions is the same for face-to-face and dispersed groups, organizations may safely choose to use communication channels to bring widely dispersed people together.

In the computer-mediated communication condition there is less influence and control of a dominant person, moderator, or leader. Lack of leadership could have caused difficulties in reaching a group decision efficiently, electronic communication involves a process of depersonalization or a redirection of attention away from one's audience [21]. This may be a major problem with the use of the media.

The act of talking forces only one person to talk at a time so others have to listen. In computer conference, multiple tasks can go on at the same time, this means that some times meanings are lost and have to be relayed again. Some of the research shows that mediated meetings are longer than face-to-face [9, 13].

Only two studies combined GSS and audioconferencing [6, 7]. Adding communication channels increased the ability of the distributed group to share information in less time. The distributed groups rated the communication effectiveness of the process higher when GSS was combined with audio conferencing. The quality of decision in face-to-face and distributed groups were found to be the same in most experiments. Face-to-face groups communicate more easily and there is more social presence. Members easily share information and obtain clarification. More studies of distributed groups using combinations of communication technology are needed. With today's technology, is is possible to make multiple channels of communication available to distributed groups.

4.0 Research Issues Suggested for Distributed GSS

4.1 Task

Traditional face-to-face GSS research does not consider that face-to-face meetings may not be needed throughout the entire life-cycle of a task. At different stages of the task, there may be different requirements. In some cases, face-to-face meetings are preferred, for example, when immediate feedback is needed for goal clarification, trust building, role clarification, and group commitment. In other cases, there may be a need to communicate without meetings. Participants may only need graceful asynchronous communication. They may need to log into a shared-screen work space, evaluate changes, make comments, and exit.

The determination of the stages in the life cycle that are more suitable than a face-to-face mode and stages that do not require such environment may depend on factors such as nature of the task, the urgency of arriving at solution and the culture of the organization.

A "concurrency of transmission" problem is pronounced in the asynchronous meetings when messages are sent directly to each participant. Participants can receive messages in different sequences. There may be no automatic feedback from the receiver to the sender. Receivers may send ambiguous cues regarding messages received. It may become unclear to which version of an issue or to what message a participant is responding. Managing delivery of messages becomes an important activity.

4.2 Group Memory and Information Base

One of the mechanisms in which DGSS can help process gains is through its group memory [16]. Groups need to have an access to the documentation (group memory) of the past meetings, which is dynamic over space and time. In some decision making situations, the completion of a task may take multiple steps lasting months or years. New members maybe added to the group. Hence, there are numerous incentives for the development of dynamic and accessible group memories to support on going group processes. Some of the information in the group memory may include [19].

1) internal information such as organizational missions, goals, objectives, and basic policies;
(2) publicly available information, (federal, state and local) and private external databases;

(3) information on what expired in the past to bring new group members up to date on the issue;

(4) information to provide continuity between one meeting and the next;

(5) information on crisis scenarios and "game playing" in anticipation of future events;

(6) information for group coordination and work flow management;

(7) information from different experts in the organization.

Specialized information possessed by group members is a scarce resource [23]. The DGSS can serve as a tool to solicit the information needed and to form dynamic group database for solving problems. A team may not have all the expertise needed to solve all problems. The team may want to identify and communicate with the corporate expert who may be in a different location. The team may want to search various databases. Groupware software, such as Lotus Notes may be useful. For example, hundreds of experts and specialists can be reached via Notes at Price Waterhouse [22].

4.3 Groups Versus Teams

Most GSS studies have focused on a single meeting (or small number of meetings) by a group of people who are not expected to work together again. Results of decision room GSS studies have been criticized as being an artifact of the research methodology because it does not reflect the actual conditions of meetings in organizations [23]. In a distributed environment, participants are often part of a work team. Participants may already know each other. Even if participants are not acquainted prior to the meeting, they are expected to work with one another again after the first meeting. They will continue to work on the same task now, or on another task in the future. Research has shown that behaviors of ad-hoc groups differ from groups whose members worked together in the past or are expected to work together in the future [8]. The research on the distributed environment cannot rely on single-meeting ad-hoc groups since such meetings are the exception not the rule.

4.4 Role of the Facilitator

In the decision room mode, the facilitator's role is central. He(sha) often plays the role of the technology expert as well as the process facilitator. The former role requires the facilitator to start up and control the system so that the participants need not have to have the technical knowledge of the system. The latter requires the facilitator to administer the meeting protocols, gauge the group's procedural problems, and keep the group focused on the task [11].

In a synchronous DGSS session, the need for a facilitator may not be a major problem. However, in a dispersed asynchronous meeting, the requirement for a physical facilitator becomes a major system limitation. When a meeting lasts days, weeks, or even months, participants may interact whenever it is convenient for them asynchronously, or they may opt to communicate synchronously. Often, there is no facilitator or even a coordinator for such circumstances. The role of the facilitator is often carried on by one of the participants. The facilitator role needs to be specified for different DGSS scenarios. A possible area for investigation is the use of an intelligent agent or an expert system which will assist in managing the meetings. Some groupware software offers features which are intended to ease the coordination problems.

4.5 Verification of Identity

The dispersed environment requires special security measures in addition to the usual controls, such as limiting attendance, using passwords, and isolating the communication network. In a decentralized environment, individuals may masquerade as either a valid participants or as the system host. There may be some difficulty in limiting attendance. In the decision room context, participants have face-to-face interactions, and they receive acknowledgment of their participation in the meeting, either explicitly or implicitly. In distributed synchronous computer conferences, the set of interactive partners is defined but the number of participants is not limited by the size of a decision room. Participants in a decentralized session may not be sure if an individual is present and participating, present and observing, or has left the session since the anonymity issues prevent identification of specific user actions.

4.6 Temporal Issues

Face-to-face and synchronous distributed groups may potentially differ from asynchronous distributed groups in the temporal patterning of work in four ways: production, reception, transmission and simultaneous composition [23]. The differences in work patterns between a single site decision room and a distributed group support are mainly in the production of information. Face-to-face groups have spoken communication and visual cues. However, there is no
spoken communication or visual cues in the distributed group unless video and audio technology is added. Participants have access to the same amount of text information, but visual triggers, nonverbal cues and body-language signals are missing from the discussions. With multiple sites, the reading load is likely to increase since text may be the only way to share information. The decision process in such a case will slow down.

The other temporal patterning of work, reception, transmission and simultaneous composition, remains similar for these environments. In both environments, people can read the shared text. The communication systems allow fast transmission of information whether the recipient is a few feet or several miles away, and the GSS supports simultaneous composition of text information in both environments.

4.7 Elimination of Non-Text and Auditory Cues

Nonverbal and verbal cues serve at least three important functions in group communications: they help regulate the flow of communication; they express emotion; and they transmit subtle meanings. McGrath and Hollingshead [23] believe that the regulatory function helps group members regulate succession of speakers, and determine the timing of turn taking. As a result, there is an increase in the turbulence of the flow of communications.

The emotive function suggests that subtle meanings in spoken speech may be partly replaced by written speech. While written speech includes jargon and more complex syntax, the writer can add emphasis through use of punctuation and redundancy. Special symbols and conventions can be used to replace the expressive functions of verbal cues. More research is needed to identify tools which can be added to the computer conferencing environment to provide standard cues for regulating communication and supporting an emotive function. Participants need seamless ways to show emphasis, commitment, disagreement and other expressive feelings.

Additional channels of communication provide a richer media environment, such as desktop videoconferencing, and increased audio capabilities of the workstation. Richer media supports the transmission of nonverbal and verbal cues. Media richness research is complicated because different types of media can be combined to support distributed groups. Audio and video technologies are becoming cheaper, easier to use, and the networks bandwidth capabilities are expanding. This trend supports better communication methods. The research in distributed groups is supported by the findings in research in the media richness studies, such as those examining E-mail applications.

4.8 Increased Chance of Partitioned Meetings

Gavish et al.[14] pointed out that remote participants can become disconnected from a synchronous meeting due to a failure in a communication link. Depending on the activity, it may or may not be desirable to permit disconnected participants to reconnect to continue work on the problem. The integration of multiple groups' comments may be difficult to accomplish, especially when the resulting comments are inconsistent. The method to support these activities in distributed group meetings requires further investigation.

4.9 Design of Distributed GSS Environments

Shared presentation aids for decision room GSS, such as flip charts and RGB projector screens are not available for the distributed environments. Interface design of the DGSS thus becomes even more critical because of the lack of such presentation devices. Without special channels of communication, participants are restricted to sharing text information which may not be sufficient for easy and fast completion of tasks or reaching consensus.

Groups in the decision room often make use of a public projected screen. The display contrast, background lighting, and font size of the text or graphics can make the shared information easily accessible. In the distributed environment, the "representation" issue becomes even more acute since other "cues" may not be available. The wrong form of representation may affect the conduct of work and influence participation. Also, presentation may influence the opinions of the participants.

The spatial arrangement of participants in a single site decision room may affect performance and determine status. In the distributed environment, spatial arrangement is no longer an issue. Participants may be alone in single work sites, or there may be group-to-group meeting rooms. Single site meeting room conventions do not apply in the distributed environment because people are restricted in their physical position choices. People in different sites cannot move together to work in sub group nor can they meet informally outside the meeting to discuss issues.

In a distributed environment, especially in an asynchronous one, participants have reported that they are no longer in full control of the changes to their system. Information from co-workers may be added to the shared database perhaps without the knowledge of all of the group members. Information in various document versions may appear and disappear during
real time group editing systems. A monitoring system could convey the progress or changes made to the "object" since the last time it was accessed. There must be a way to smooth coordination between joint work and individual work. People need to be able to control who sees their work in progress, and protect the parts of the document that are private to ensure that the public cannot view these parts.

4.10 Effects of GSS on Organizations

Huber [20] made the following propositions:
1. Availability of GSS leads to GSS use.
2. Use of GSS leads to increased information accessibility.
3. Increased information accessibility leads to changes in organizational design.
4. Increased information accessibility and changes in organizational design lead to improvements in the effectiveness of intelligence development and decision making.

The impact of distributed workgroups on organizational structure and culture could be significant if Huber's theories on GSS and the organization's nature are verified in real life settings. The use of GSS in organizations has not been prolific. However, this situation is changing rapidly due to availability of groupware such as Lotus Notes, Workflow, and desktop screen sharing. We see the changing structure of organizations due to downsizing and globalization, and it is being assisted by the increased access to communication media, such as videoconferencing, fax, and high speed data networks. Will Huber's theory hold for distributed GSS even though is not yet supported by experience? One major question is: What is the role of the new technology in organization? The availability of the DGSS technology does not create the need for it. There must be an awareness of the types of groupware available and then an influential person in the organization may be able to develop applications for the technology. As the applications become useful then there is an adoption and diffusion of the technology. Currently, the practitioners have too many questions which have no answers (Appendix A). Research is needed to find the answers and to help develop the support tools which will make the groupware even more useful to distributed groups.

5.0 Distributed Group Support Systems Framework

We have reviewed the traditional GSS research and identified some of the issues in experimental DGSS research. The future research issues are proposed from the many questions raised by the practitioners. By combining the variables, the processes and outcomes gathered from the three sources, we propose a framework in Figure 4 adapted from Pinsonneault and Kraemer [29] to study Distributed GSS. The major difference is in the need to define the technology, to provide for security and privacy in the meetings and to define the structure of the distributed group. Facilitation, culture and organizational levels effect the ability of the participants to share information, to stay on task and to completely explore the task. The contextual variables change because the group members are located in multiple sites.

CONTEXTUAL VARIABLES

Distributed Group Structure
- Size
- Location
- Time zone
- Level in organization
- Facilitator
- Leadership
- Training

Communication Issues
- Feedback
- Commitment to process
- Transmission/reception of Information
- Concurrency of transmission

Figure 4: Changes in Contextual Variables in DGSS Framework

The quality of the decision and the acceptance of the decision remain important. However, the satisfaction levels of the members and the productivity of the group are different. Now the members not only contend with the computer software but must interact with the communications technology. This affects their ability to be productive because the technology can limit their ability to share relevant information, to gain clarification of undeveloped ideas and to obtain feedback. The users are dependent upon the technology much more than in a face-to-face meetings. The next phase in the development and refinement of the framework involves surveying a wider group of practitioners, identifying tools which will enhance the multi-site meeting process and developing procedures and training methods which will help organizations to take advantage of the benefits of using a GSS in a multi-site environment.

Appendix A: Issues for consideration
These issues were raised by practicing managers and provide a basis for the proposed DGSS framework.

I. Synchronous Systems

Group Issues
- Is cultural dynamics well supported?
- Who should participate in such meetings?
- How do you implement management controls on tasks assigned to people in a distant location?
- How much training is needed to participate and how is the meeting conducted?
- How do many people access the system at once from multiple sites?

Task
- What tasks are most suitable for this type of conferencing (planning, development, decision-making, negotiation, voting)?
- Does the technology really promote teamwork and cooperation?

Contextual Issues
- Can non-verbal communication signals be read easily and accurately (e.g., body language)?
- Will people object to their faces being shown on a screen in one or several locations?
- What negative effects exist? (e.g., intrusive, waste of time)
- What methods are used to coordinate the progress of working on one task?
- What features will be installed to maintain security and protect privacy?
- What controls are needed to assure reliability of the system?

Communication Issues
- What will be the impact of decreased social interaction?
- What will be the effect of reducing personal contact?
- How large can the group be for effective meetings?
- What are the procedures for handling latecomers?
- How does the system provide support for private discussions?
- How does electronic support effect participation?
- What is the effect of having observers at videoconferences?
- How does the system handle informal and spontaneous communication?
- Is communication going to be more guarded? less free and spontaneous?
- Will changes in communication style affect the quality of decision making?
- Should anonymous input be encouraged?

Technology
- Is video support beneficial and under what conditions (informal, formal, urgent)?
- Does the technology really promote teamwork and cooperation?
- Should anonymous input be encouraged?
- What features will be installed to maintain security and protect privacy?
- Is technical quality of video and graphics reliable and consistent?
- What controls are needed to assure reliability of the system?
- How does a company select the appropriate hardware and software?
- What level of technical capacity and quality of video must be supported?
- How do many people access the system at once from multiple sites?
- What technical requirements are needed to allow sub-groups to meet at the same time if required?

Outcomes
- How can a group conduct a cost-benefit analysis or a cost-justification analysis when large amount of information must be shared and modified?
- What impact will electronic conferencing have on individual status measures (e.g., travel)?
- Is there an increase or decrease in the amount of irrelevant information shared?
- How does this type of meeting increase productivity?
- How does a company justify such systems and measure the benefits?
- Will the technology change organizational structure and culture?

II. Asynchronous Systems

Group Issues
- Does the competitive culture of many organizations make it possible to share information without immediate feedback?
- Will some cultures find the communications too impersonal?
- What will be the impact of lack of social interaction?
- How will people react to "talking to a machine" and receiving a delayed reply?
- How will people feel when they can not become personally familiar with the people they must work with?
- Status is measured in some companies by the amount of travel. What impact will electronic conferencing have on that status?
- What will be the role of the facilitator or coordinator?
What tasks are most suitable for this type of conferencing (planning, development, decision-making, negotiation, voting)?
Does the technology really promote teamwork and cooperation?

Contextual issues
How does a group assure timely responses and assure completion of tasks?
Do length and content of messages need to be controlled?

Communication Issues
What supports are required to handle information overload?
What procedures are needed to prevent misinterpretation of information due to slow feedback?
Does such system encourage too much communication or too little?

Technology
What supports are needed to manage a meeting?
What is required to build an economically feasible system?
How to call an emergency synchronous meeting if needed?
How does the system assure security and protect privacy?
Can message templates enhance ease of communication?
What support is needed for people conversing in different languages?
What types of training are best for users?

Outcomes
How can a group conduct a cost-benefit analysis or a cost-justification analysis when large amount of information must be shared and modified?
What impact will electronic conferencing have on individual status measures (e.g., travel)?
Is there an increase or decrease in the amount of irrelevant information shared?
Can this type of meeting increase productivity?
How does a company justify such systems and measure the benefits?
Will the technology change organizational structure and culture?

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