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A Comparison of the Decision Quality of Group Decisions Made in a Face-to-Face Environment with Decisions Made Using a Distributed Group Decision Support System

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AFIT/GIR/LAS/97D-13

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THESIS

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THESIS

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Hope D. Cullen

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Abstract

The Air Force is increasingly turning to a team-approach for decision-making. When team members are geographically separated it can be expensive for them to meet in a traditional face-to-face setting. Group Decision Support Systems (GDSS), designed to help groups make decisions, may be able to support these groups in a distributed mode. The assertion of this thesis is that a GDSS can indeed support such distributed processes and that these processes will be of higher quality than decisions made in a face-to-face environment.

This study explores decision quality in terms of quality of the outcome, and acceptance of the decision by group participants. Through a laboratory experiment, groups of three or four members met to solve a management problem. Results suggest that quality of the decision depends upon the type of group interaction, the order of that interaction and the scenario difficulty. The analysis found no statistically significant difference for decision quality in either type of group interaction. Additional research is necessary to examine the potential for Air Force use of distributed GDSS to reduce travel costs without reducing decision quality.

A COMPARISON OF THE DECISION QUALITY OF GROUP DECISIONS MADE IN A FACE-TO-FACE ENVIRONMENT WITH DECISIONS MADE USING A DISTRIBUTED GROUP DECISION SUPPORT SYSTEM

I. Introduction

The Issue

As with other large organizations, the Air Force is increasingly moving towards group decision-making techniques. "In today's competitive world, a growing number of organizations are faced with decisions that are multi-dimensional, complex, and require input from diverse decision makers for their implementation" (Bidgoli, 1996:56). Because no one person has all the experience, research, or information in order to solve the problem without the assistance of others, decisions are more and more frequently being made by groups rather than individuals (Nunamaker and others, 1996). This has led to the team approach to decision-making.

The Air Force uses the team decision-making approach for strategic planning, quality improvement, and other situations that have significant consequences for the organization or national security. Currently, team decision-making often requires individuals to travel from geographically separated locations to meet at a centrally located site. This results in extensive costs for travel and time of generally busy individuals, or use of other expensive media such as video teleconferencing. Costs of decision-making meetings could be significantly reduced if the Air Force could find an effective method to conduct geographically dispersed meetings using the resources already available. One potential solution to this problem may be the use of a Group Decision Support System (GDSS). If a distributed GDSS results in a decision that is of higher quality than a decision made in a traditional face-to-face meeting, then the Air Force may be able to reduce communication costs without sacrificing outcome quality.

The Research

GDSS are computer-based systems designed to support and aid the efforts of work groups (Heminger, 1989). Primarily software programs, they take advantage of network systems and enable groups to meet either in a central site, or from widely distributed locations. Due to the nature of computer enhanced communication, groups can also either meet concurrently or over a period of time. Essentially, groups can meet in four different situations. These situations are summarized in figure 1.

		Time	
		Same	Different
Place	Same	Same time Same place	Different time Same place
	Different	Same time Different place	Different time Different place

Figure 1. Time/Place Matrix

The majority of studies have focused on the same time/same place quadrant of the matrix. The focus of this research will be on the same time/different place quadrant, in which the team meets at the same time but from geographically distributed locations. Finding ways to use technology to make this type of communication possible may have significant impacts on future Air Force team meetings.

Previous research has also shown that a high quality decision outcome in a team effort is the result of productive group dynamics (Timmermans and Vlek, 1996). Groups that interact well together tend to allow for more equalized opportunity for participation, a moderate and effective amount of constructive conflict, and arrive at a more informed or "better" decision (Timmermans and Vlek, 1996). Because team decisions are becoming increasingly common in industry and the military, many aids and tools are being developed to help optimize group dynamics by altering the communication process within groups (DeSanctis and Gallupe, 1987). GDSS is one of these tools. The research of GDSS use, while extensive, has primarily focused on determining *why* groups make better decisions, often either assuming that better processes lead to better decisions, or evaluating the outcome as a secondary measurement. There is surprisingly little examination of whether or not the quality of the outcome is actually improved.

This study will focus directly on the quality of the decision outcome, without consideration of group dynamics. Because of the nature and purpose of GDSS, group dynamics will still be a factor, as they cannot be entirely eliminated from the study. However, the study will attempt to control for process-mediated factors and focus on the quality of the decision.

Decision Quality

The two types of criteria generally considered when evaluating decisions and decision aids are process criteria and outcome criteria (Timmermans and Vlek, 1996). Since GDSS were developed to improve group interaction, it is not surprising that most studies have attempted to measure success using process criteria. Some examples include conflict occurrence and resolution (Miranda and Bostrom, 1993-4), anonymity of communication (Valacich and others, 1992), use of parallel communication, formal and informal leadership emergence, information retention and process organization (Poole and others, 1993).

Outcome criteria reflect the quality or effectiveness of a decision once it has been made or implemented. Decision support systems have been analyzed along a variety of dimensions, particularly in quasi-experimental and experimental settings, but there has been little standardization of outcome criteria. Criteria include rater assessment (Joyner and Tunstall, 1970; Aldag and Power, 1986; Cats-Baril and Huber, 1987); numerical figures such as organizational profit (Chakravarti and others, 1979); and confidence in the decision (Aldag and Power, 1986; Cats-Baril and Huber, 1987). With the exception of the study by Joyner and Tunstall, these assessments were conducted on decisions made by individuals.

Experiments assessing the quality of decisions made by groups are also relatively scarce. Research has focused on outcome criteria in field or case studies, evaluating a decision once it has been implemented. Such studies determine decision quality through group member confidence in outcome (Alter, 1980) and follow-up interviews to assess perceived effectiveness of implementation (Heminger, 1989). Decision implementation is the most common determinant of its quality or effectiveness in field settings.

One advantage of experimental methods is that all participants will assess the same scenarios and decision quality can be assessed at the time the decision is made. Vroom and Yetton have developed a decision-making model that examines this outcome quality. According to their model, a good decision is determined by two criteria: decision acceptance and decision quality (Yukl, 1994). Decision acceptance can be evaluated in terms of acceptance of the people who are responsible for its implementation into the organization's daily operations. Alternatively, it can be evaluated in terms of acceptance by the participants of the group that made the decision. It is this second type of decision acceptance that will be looked at in this study. The more agreement the group has regarding the final outcome, the greater the level of decision acceptance.

The second dimension, decision quality, is the "objective aspects of the decision that affect group performance aside from any effects mediated by decision acceptance" (Yukl, 1995:163). A decision is of high quality when the best of all the alternatives is selected, resulting in the most optimal consequences for the organization. Decision quality can be quantified for those situations where all the alternatives can be developed and analyzed. In an experimental setting, decision quality has been evaluated by expert ratings (Gallupe and DeSanctis, 1987; Lam, 1997).

Group Decision Support Systems

Group Decision Support Systems are defined as "an integrated combination of computer, communication, and decision support technology designed to support group work" (Watson and others, 1994). GDSS are designed to aid decision making at one of three levels. Level one GDSS provide the technology to remove common communication barriers, enabling smoother and more effective group interaction. Some level one tools include real-time discussion platforms, such as GroupSystems' categorizer, and decision-making tools like rating scales and voting capabilities. Level two GDSS include decision modeling and statistical analysis tools, helping to alleviate the uncertainty in making decisions. This enhanced form of GDSS may include capabilities for risk analysis, multiattribute utility methods and social judgment formulation. Level three GDSS incorporate expert advice to apply or create rules to govern a particular meeting situation (DeSanctis and Gallupe, 1987). This study focuses on level one GDSS technology and results.

In a typical GDSS session there are four phases of work:

- Gather Ideas—this is the brainstorming part of the session, where everyone thinks creatively without regard to the logic or practicality associated with each idea
- Edit the Ideas—the group consolidates similar ideas, and eliminates ideas that are repetitive
- Evaluate Results—questions and comments about ideas are brought up and discussed.
- Determine Solution—the solutions are ranked or voted on, and the decision is made. (Thornton and Lockhart, 1994:10)

These phases are typical in both GDSS and traditional settings. The GDSS adds structure and format to meetings, and enables team members to meet in any of the situations mentioned in the time/place matrix.

Problem Statement

The purpose of this study is to compare a team decision using only distributed GDSS communication with a decision made in a traditional face-to-face team decision-making environment. It is expected that a GDSS-aided group decision-making session will result in decisions that are better than those made in traditional decision-making meetings according to the outcome criteria defined by Vroom and Yetton's leadership model.

Research Approach

This study will consist of a laboratory experiment in which I will attempt to compare the quality of the group decision made by groups in each of two conditions. In the first condition, groups will gather in a face-to-face setting, without the aid of computer systems. In the second condition, groups will meet solely via the group decision support system, simulating a distributed environment.

It is expected that the decision made by the group in the GDSS environment will result in a better decision than the traditional face-to-face environment. The quality of the decision will be determined by comparing group decisions to a pre-defined set of answers along a continuum, as determined by Vroom and Yetton's leadership decision-making model (Yukl, 1994). Rather than a single decision, groups will be required to rank order a given set of possible solutions. A group of experts will also rank this list, forming the standard against which to measure the experimental results. The expert ranking of alternatives equates to the decision quality dimension of Vroom and Yetton's model. This process will be further detailed in chapter three.

Thus, my study could show that decision-makers do not always need to meet in a traditional face-to-face environment in order to make a high quality decision. "...as computers become more ubiquitous in the workplace, the need for collaboration—and computer-based collaboration—will surely continue to increase" (Nunamaker and others, 1996:165). If the decision made using a GDSS is better than a decision made in a face-to-face session, then the practical implications for using GDSS in the Air Force may increase significantly.

II. Previous Research

Approaches to GDSS Research

An assortment of meaningful research has been conducted in the realm of group decisions and GDSS, despite its relatively new status in the field of Management Information Systems. GDSS was designed to serve two purposes. First, it was designed to improve group communication and dynamics, thus improving the group process and making it more efficient and effective (Easton and others, 1989). Second, it was created to improve the quality of the outcome of a meeting, in many cases the outcome being the group decision (Gallupe and DeSanctis, 1988). These two goals have been measured via studies regarding process criteria and outcome criteria, respectively. Researchers have attempted to isolate and analyze various aspects of these criteria to determine system success.

There are two approaches generally followed when studying GDSS. The process approach is the most prominent, in which researchers seek to isolate the process gains and losses from using a GDSS. In this approach researchers feel that process gains or losses directly improve or impair outcomes respectively (Nunamaker and others, 1991:45). This method of study has far overshadowed the outcome approach, which seeks to quantify and measure the outcome itself, without regard to the process. Of particular interest to my study is one particular area of the outcome approach: measurement of decision quality in a distributed GDSS environment. One study (Gallupe and McKeen, 1990), found that there was no improvement in the quality of a decision made in a dispersed

GDSS environment over the quality of the decision made in a face-to-face environment (1990). Outcome quality in a distributed environment has undergone significantly less scrutiny than other areas, and it is here where my efforts are focused.

Group Decision Support Systems

The Environment. Groups meet for a variety of reasons and task assignments. GDSS is a type of computer-mediated communication that alters the dynamics of a group and to produce beneficial results. To some extent the results depend on the group's purpose and context. Figure 2 depicts four environmental settings which affect group dynamics.

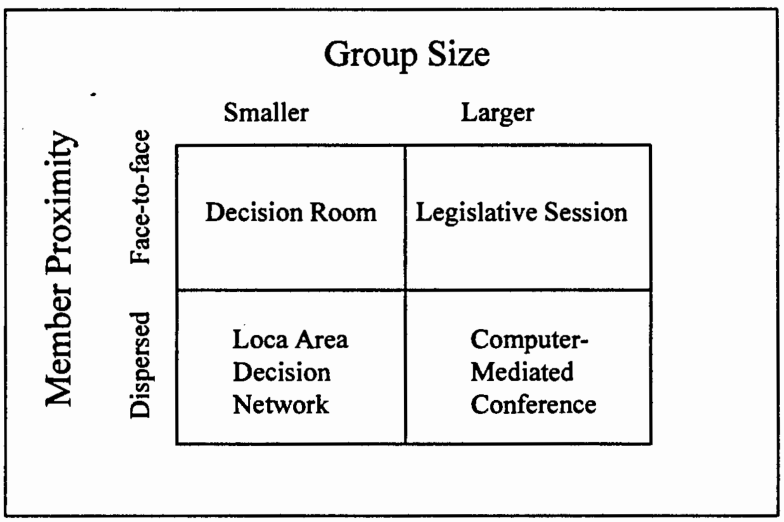

Figure 2. Size/Proximity Matrix. (DeSanctis and Gallupe, 1987:589)

In each of DeSanctis and Gallupe's environments, some type of computer-mediated communication is implied to enhance the meeting. In the Decision Room, a smaller group meets face-to-face. This can be considered the electronic equivalent of a traditional meeting. Group members have the option of communicating verbally or via the computer to reach their meeting goals.

In the Legislative Session, a larger group meets face-to-face. The procedure is similar to that of the Decision Room, but there are more individual members. While these two environments have been studied extensively, it is the two dispersed environments which are of interest to this study. In the Local Area Decision Network, a small group meets in a dispersed fashion. "Project teams, sales groups, and other committees may benefit from electronic communication that particularly address the needs of groups who are physically dispersed" (DeSanctis and Gallupe, 1987:599). With this design, group meetings may take place over a longer period of time and do not necessarily need the presence of a human facilitator to guide the session. "An electronic facilitator can prompt participants for specific inputs to the meeting or guide the session according to a predefined agenda or decision procedures" (DeSanctis and Gallupe, 1987:599). The title of this environment (Local Area Decision Network) is misleading, though, as members may dispersed all across the globe.

The Computer-Mediated Conference is for larger, dispersed groups, however, this approach has rarely been used.

The GDSS System. The typical group decision support system is devised of a series of workstations, a facilitator station, a network server, specialized GDSS software, and a public viewing screen. The workstations and server are arranged in the traditional local area network (LAN) organization. In the case of dispersed meetings, the LAN is replaced with other means of connection such as modems or network backbones.

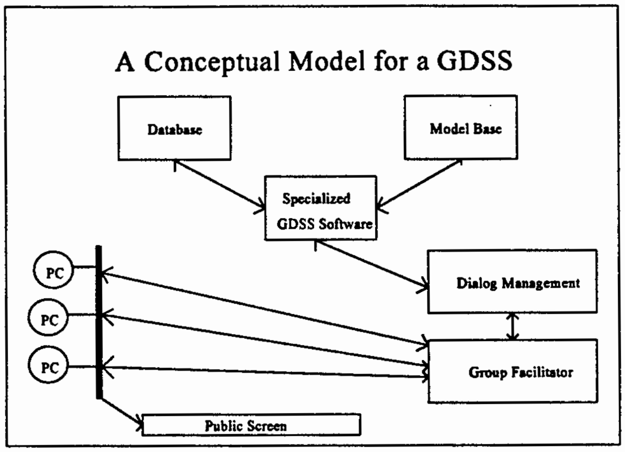

Figure 3. A Conceptual GDSS Model. (Bidgoli, 1996:58)

GroupSystems Software. GroupSystems, the software used for this study, is a computer package developed by Ventana Corp. The primary function of the software is to serve as a support for group meetings. It was designed on the concept of the toolkit, which contains tools to assist the group in session planning and management, group interaction, organizational memory, individual work, and research data collection (Nunamaker and others, 1996). The advantage of having a toolkit is that is allows flexibility for some aspects of the process at the same time restricting users to the tools necessary for that particular meeting. Although these may seem mutually exclusive, this distinction serves a very important purpose. While "each tool provides a different approach to support a particular activity, providing various combinations and styles of process structure, process support, task structure, and task support" (Nunamaker and others, 1996:51), tools are locally restrictive so participants in any single meeting can only use the tools associated with achieving the objectives of that particular phase.

There are three types of meeting processes that can be supported by the software. They are chauffeured, supported and interactive.

Chauffered	Supported	Interactive
One person enters group information	All group members can enter comments	All group members can enter comments
Electronic Black-board can provide group memory	Electronic Black-board can provide group memory	All comments in group memory accessible via workstations
Verbal communication predominates	Both verbal and electronic communication	Electronic communication predominates

Figure 4. Meeting Processes. (Nunamaker and others, 1996:52)

This study focuses on the interactive meeting process. It provides the parallel communication, group memory, and anonymity necessary to overcome process losses due to things such as failure to remember, socializing, domination, interruption, and conformance pressure (Nunamaker and others, 1996:53). In terms of this study, while GroupSystems can provide different levels of computer assistance, the interactive session is the one most readily attributable to a dispersed (Local Area Decision Network) environment.

There have been more than a dozen years of research, both in the laboratory and in the field, on the usefulness of GroupSystems. Of the more than 150 studies, researchers have looked at the software in terms of organizational function and buy-in, multicultural issues, designing software, collaborative writing, electronic polling, leadership and facilitation, and business process reengineering (Nunamaker and others, 1996).

GroupSystems is an effective tool, in which group members continue project work from individual workstations at different times and different places. Because of these characteristics and qualifications, as well as the widespread use and acceptance throughout the Department of Defense, this particular software was appropriate for the conditions of the experiment.

Outcome Criteria

Outcome criteria in decision-making refers to the quality of the decision regardless of the method used to obtain it. In discussing outcomes, the aim is to focus on the decision itself, and the factors used to determine its quality or "goodness," rather than on any process gains or losses.

Upon examining current research, it appears obvious that it is very difficult to separate the process criteria from the outcomes, since in most research, the positive or negative effects on the outcome are a result of some change in the process. GDSS as a means of interaction and communication "seemed to solidify attention toward areas of agreement and disagreement, and thus, channel the group toward constructive resolution of differences" (Sambamurthy et al., 1994:541). This study also evidenced that as suggested by Gouran, "criteria for reflecting on ideas and proposals and discussion of negative points of solutions should enhance decision-making outcomes" (Sambamurthy and others, 1994:542).

Decision quality in a field environment has often been perceived by group members as a decision that has been formed through consensus (Watson and others, 1988). Analysis of the literature shows that this is not necessarily the case. One study discovered that "face-to-face groups were more apt to reach consensus during the allotted decision period, but that there was no relationship between quality of the decision and consensus" (Gallupe and McKeen, 1990:2). Therefore, despite perceptions by group members, decision quality is not derived from the level of agreement within the group or group members' satisfaction with the outcome.

It is interesting to note that although GDSS was created to improve group decision-making, we have relatively little information regarding how much "better" the decisions that groups make really are. There have, however, been some attempts to operationalize decision quality and measure it. For example, Steeb and Johnson (1981) defined decision quality along three measurement continuums: decision content, decision breadth, and decision feasibility. Decision content refers to how comprehensively the group discussed substantive mission issues. Decision breadth is how wide a range of situational factors, opportunities, and constraints the group considered in finding possible solutions. Finally, decision feasibility concerns how appropriate the recommended course of action is in terms of costs and objectives (Steeb and Johnson, 1981). Results of the study indicated that groups in a GDSS-mediated environment scored higher in terms of decision content and breadth, but there was no significant difference in the decision feasibility.

Gallupe and DeSanctis furthered this research, looking at the effects of group decision making for tasks of varying difficulty. The authors modified Steeb and Johnson's definition of decision quality, measuring decision quality in terms of decision content (relative closeness to expert decisions), and decision reasoning (degree of similarity between group reasoning and expert reasoning to arrive at the decision) (Gallupe and DeSanctis, 1988). The researchers believed that for tasks of higher difficulty, the overall decision quality would be increased by using GDSS, but that there would be no difference in the decision quality for a task of lower difficulty. Results actually showed that decision quality was improved for both lower and higher difficulty tasks, with greater improvement for tasks of greater difficulty. These results suggest that future studies may need measure more than one task to account for differences in difficulty.

Lam (1997) measured decision quality by a grading system in which six possible rank orderings of the solution were possible. Alternatives were graded in terms of most to least preferred based on the scenario goals and objectives (Lam, 1997). In this case, groups using the GDSS made decisions of significantly higher quality. The study also recognized that decision quality increased as complexity of the task structure increased. This is a logical conclusion, since one of the primary process gains from GDSS was intended to be improved structure for ill-structured tasks (Nunamaker and others, 1996). The results of this study are similar to those of Gallupe and DeSanctis, who found that groups benefited more from a GDSS-supported environment with increasingly difficult tasks.

Researchers have also attempted to measure decision quality in remote computer-mediated sessions. As discussed previously, Gallupe and McKeen measured decision quality by comparing a group's ranking of the decision alternatives to a panel of experts, who were used to establish rankings for the "best choice." Groups were assigned to one of three conditions: face-to-face, face-to-face with GDSS support, and distributed GDSS. The results of this study indicated that there was no significant improvement in the quality of a decision made by a computer-mediated group, both in a face-to-face setting and in a dispersed environment (1990). The researchers state that one reason for this conclusion is that the task was not difficult or complex enough to recognize any differences. Again, this is not inconsistent with the findings of Gallupe and DeSanctis in that GDSS-assisted decisions improve in quality when the task complexity increases. These results may also indicate that multiple tasks and a repeated measures design are necessary to account for effects such as task difficulty in studies of decision quality.

Results remain inconclusive about the quality of the decision made by GDSS groups. While the majority of studies indicate the use of GDSS improves decision quality (Dennis and others, 1989), a few studies indicate no significant impact. Thus, this study aims to add to this body of research, helping to determine whether or not the use of GDSS in a distributed environment truly does increase decision quality.

Process Criteria

Group meetings are often characterized by the dynamics of the group, and the outcome can be dependent upon how the group interacts and communicates. Many researchers acknowledge the "central role that group interaction plays in determining whether a group will arrive at a low or high-quality decision" (Gouran and Hirokawa, 1983:168). There are many components to group interaction, including but not limited to level and types of participation, social rankings (both factors considered in terms of anonymity), problem structure, proximity, amount and types of communication, and group conflict and resolution. Researchers have measured the impact of process criteria in a variety of ways. Often these measurements include the number of ideas generated, the satisfaction by individual members of the group, equality of participation, and user perceptions. Generally, researchers found that using a GDSS resulted in greater number of ideas generated, more equal participation among users, and users were typically more satisfied with a GDSS in a field setting (Nunamaker and others, 1996). Examination of individual criterion indicates that results reflect these different measurements.

Group Communication. Group Decision Support Systems are "integrated computer-based systems which facilitate solution of semi- or unstructured problems by a group who has joint responsibility for making the decision" (Vogel and others, 1987:1). One of the claims of GDSS support is that the use of the system enhances group communication by adding structure to an unstructured problem or process. Research tends to support this claim (Nunamaker and others., 1991). Groups in a GDSS-mediated environment have been found to increase the "organization of the decision process over manual and baseline groups. [They] also generated more discussion that reflected insight into the procedures" (Poole and others, 1993:207).

Another impact on group communication is a moderate deemphasis of interpersonal relationships. Groups in a GDSS environment have been found to have a greater proportion of analytic remarks than face-to-face conditions, suggesting the tendency of computer-mediated groups to focus on more impersonal discussion (Poole and others, 1991). This may be a positive impact of the computer-mediated environment, since a "higher proportion of the remarks might be task oriented and explicit decision proposals" (Siegel and others, 1986:163). This study used a repeated measures design and suggests that future research may also benefit from a comparison of these GDSS groups to the same groups' participation in a face-to-face decision-making environment.

Siegel's study also indicated that communication was less efficient in a computer-mediated environment, as it took group members more time to make a decision than did a face-to-face group (1986). This may be due to the fact that since parallel communication is possible in a computer-mediated environment, there were more comments for each individual to read and process. Poole and others also noted this factor. "[GDSS groups] did not have more discussion of criteria or more critical examination of ideas or more nonproductive uses of evaluation than other conditions" (1993:208). They indicate that this may be the result of mechanical friction from the GDSS in which short term groups are not able to realize all the potential benefits of GDSS capabilities in critical analysis (1993). But, while the process itself may not appear to be more efficient, the task orientation of the group leads to more decision proposals as a fraction of the total number of remarks (Siegel and others, 1986:174). This may off-set the increased amount of time it took to make a decision, ultimately resulting in a more productive group meeting, from which more decision alternatives had been identified to discuss and reach a decision.

Conflict Management. One of the ways groups interact is through conflict and the methods of resolving conflict. Research suggests that the use of GDSS results in more constructive conflict and resolution. Miranda and Bostrom contend that some conflict is necessary and leads to enhanced group interaction and outcome. Two types of conflict were identified in their study. These are issue-based conflict, which focuses on the task and can lead to positive interaction and outcome, and interpersonal-based conflict, which diverts group attention from the tasks at hand and is ultimately detrimental to group problem resolution. Groups, when they encounter conflict, often handle it in three different ways. These are distributive behaviors, avoidance (of the conflict) behaviors, and integrative behaviors. Research indicates that integrative behaviors, particularly when associated with issue-based conflict, lead to the most positive group interaction and outcome, while distributive and avoidance behaviors do not help the group to reach conflict resolution. In their study, Miranda and Bostrom found that meetings occurring in a GDSS-environment led to intermediate behaviors which resulted in less issue-based and interpersonal-based conflict. They also noted that GDSS-supported groups resolved this conflict with more integrative and less avoidance and distributive behaviors. Since groups in the GDSS environment experienced less of both types of conflict, results suggest that factors of the GDSS-environment such as anonymity and increased impersonal discussion, as discussed by Poole and others, may be a significant factor in reducing this distracting type of conflict, resulting in a more productive meeting (1993).

Anonymity. Anonymity refers to "the extent to which group member contributions are identified to others; group members can make contributions without being identified as the author of those contributions" (Valacich and others, 1992:220). Since the early days of GDSS research, supporters have claimed that anonymity is a positive factor in group meetings.

Some common problems experienced by groups include "extreme influence exerted by high-status members, the lack of acknowledgment of low-status members' ideas, and a low tolerance exhibited toward minority or controversial opinions" (Wilson and Jessup, 1995:212). Many studies have produced evidence that anonymity tends to reduce the impact of group member status and leads to more equal participation.

Connolly, and others found that groups with anonymous inputs generated more problem solving solutions than groups that contained comments from identified group members (1990). Results of this study also indicated that more critical comments were made in anonymous groups and resulted in "generally higher output for critical groups" (Connolly and others, 1990:696).

A field experiment by Wilson and Jessup validated the laboratory findings of Connolly and others, and concluded that anonymous groups generated more total comments, more unique ideas and more ideas of higher rarity than did identified groups. Ultimately, anonymity "appears to have reduced behavioral constraints on group members and led them to contribute more freely, and less inhibitedly, to the group discussion" (Jessup and others, 1990:318).

Proximity. Proximity in a GDSS meeting is the relative "closeness" of individual members of the group to one another. A typical GDSS-meeting occurs in a single conference room in which the group can interact using both the computers and typical face-to-face conversation. In a dispersed GDSS meeting, group members meet only using the computers, and the group is often facilitated by an individual in a remote location.

Proximity affects group interaction in terms of its influence on other group interaction factors such as group conflict and anonymity. Group conflict is suggested to increase in a distributed environment (Siegel and others., 1986). This is not necessarily a negative effect, since as discussed earlier, conflict can lead to better group interaction and results as long as it is productive in nature.

Anonymity is also enhanced by dispersed GDSS. A study by Jessup and Tansik suggests that anonymity may be increased in a physically dispersed environment because group members cannot readily see who is contributing to the meeting (1991).

The interaction of these two factors tends to have the most significant impact on group decision-making processes and decisions. A recent study by Er and Ng found that groups in an anonymous and dispersed condition resulted in generating the most comments, and were generally short in nature (1995). This suggests that the group was more task oriented, and focused on clarification of comments and ideas.

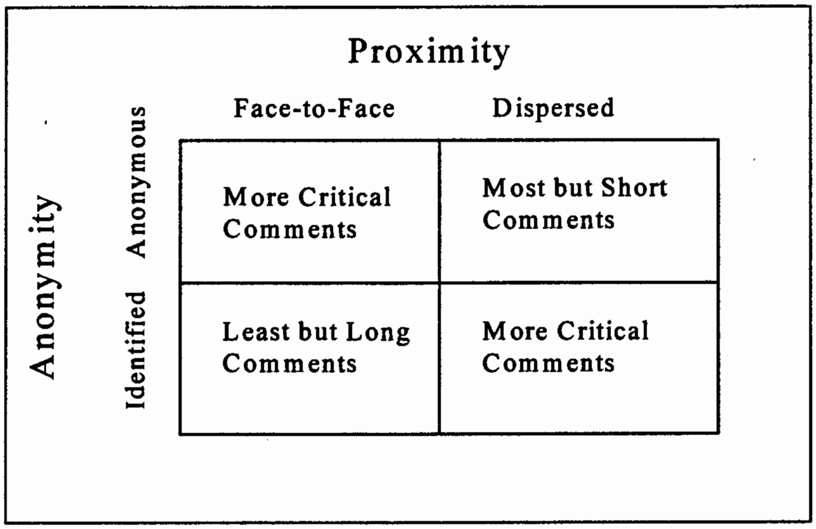

Figure 5. Proximity/Anonymity Matrix. (Er and Ng, 1995:81)

Group Size. In a typical face-to-face setting, group productivity and task accomplishment tends to deteriorate as group size increases. Research suggests that the optimal group size for a task is 3-5 members (Nunamaker and others, 1991). When a group increases much beyond that size, process losses become more significant than process gains. A study by Hackman and Vidmar indicated that dissatisfaction with group processes also increased as the size of the group increased (1970).

GDSS research indicates that GDSS-supported groups perceive more process gains when groups are quite large. Outcome measures and group member satisfaction have both been suggested to increase, particularly for interactive meeting processes, when groups are comprised of 12-20 members (Nunamaker and others, 1991).

Upon reviewing the data, it appears that process criteria has been measured extensively. Outcome criteria has not undergone as much scrutiny and results are inconsistent. Most researchers measuring decision quality found that quality of the decision increased as task difficulty increased. This suggests that additional research using the same groups with two different scenarios may help understand these results. An experiment which alternated scenarios and method of group interaction (distributed GDSS and face-to-face), using the same groups for each condition, may help explain some of these inconsistencies.

III. Methodology

Experiment

A laboratory experiment was designed to examine the results of group decisions made in both a traditional face-to-face and a GDSS-mediated distributed environment.

Sample

Groups consisted of volunteers, primarily Air Force Officers, from the management programs at the Air Force Institute of Technology. One foreign officer from the Australian Air Force, and one civilian government employee also took part in the experiment. Volunteers have each had some degree of management experience, including direct supervision of personnel and projects. Each has also had a moderate level of experience in group decision-making, and has completed at least one semester of work in their respective masters' level programs.

The majority of Air Force volunteers have been in the military between three and ten years, with a few having experience up to eighteen years of active duty service. All were either captains or first and second lieutenants, with the exception of one major. Previous jobs included but were not limited to flight commander, executive officer, project manager, and squadron section commander. Volunteers came from a variety of career fields including communications, transportation, logistics management, contracting, acquisition management, and cost analysis.

Groups of four people were established in a semi-random fashion. The experiment took approximately one and a half hours, so groups were formed according to schedules. I tried not to put any four people in the same group who were from the same graduate program or four people with exactly the same perceived level of experience in GDSS. Due to time limitations, if one member of a group failed to show up at the scheduled time, the experiment was conducted using the remaining three volunteers. This occurred in only two groups. As previously discussed, research shows that process gains from GDSS use tend to increase as group size increases. For practical and scheduling purposes, groups larger than four were unattainable.

Experimental Design

The experiment consisted of two situations. Groups of three or four people met and attempted to solve a scenario problem, adapted from Experiences in Management and Organizational Behavior (Hall and others, 1975). Both situations were conducted in the Air Force Institute of Technology's (AFIT) Group Decision Support System Laboratory. In the GDSS portion, each individual sat at a computer workstation in a corner of the room, isolated from other members of the group by a set of five foot tall partitions. The partitions were used to provide a reasonable approximation of a distributed environment. When groups met face-to-face, it was around a conference table in the center of the same room.

Attempts were made to isolate the method of interaction as the only difference between groups. In order to account for effects due to order and practice, some groups began interacting in the face-to-face environment, while others started with GDSS. Also, to control for differences in scenario difficulty, the two scenarios were alternated between types of interaction. As a result, four treatments were devised.

Treatment 1: Groups met in the face-to-face environment first, making a decision about the first scenario. Then, they met in the GDSS environment and attempted to solve the second scenario. (Scenarios are reproduced in Appendix A)

Treatment 2: Groups met in the face-to-face environment first, making a decision about the second scenario. Then, they met in the GDSS environment and attempted to solve the first scenario.

Treatment 3: Groups met in the GDSS environment first, making a decision about the first scenario. Then, they met in the face-to-face environment and attempted to solve the second scenario.

Treatment 4: Groups met in the GDSS environment first, making a decision about the second scenario. Then, they met in the face-to-face environment and attempted to solve the first scenario.

Procedure

Each group was given one of the four treatments. The procedure used for groups given treatment one is described below and modified for other treatments.

The group first sat around the conference table in the center of the room. They were given a packet of materials necessary to complete the first experimental condition. The packet contained an instruction sheet, the scenario, two individual attribute forms (described in detail later), and a sheet with the five alternative methods a leader could use to solve the scenario from Vroom and Yetton's Leadership decision-making model (Vroom &Yetton, 1973).

After individuals read the instructions, they watched a video which in the face-to-face setting simply reinforced the instructions. Next, individuals read the scenario on their own and filled out the first attribute form on a scale of one to ten, depending upon how closely each attribute related to the scenario. They did this on their own without any group discussion. Attributes were rated prior to group discussion in order to clarify the scenario and topics under discussion in each individual's own mind. (Individual attribute form is reproduced in Appendix B.)

After they filled out the form, the facilitator gave the group 15 minutes to discuss the attributes and their associated ratings with respect to the scenario. They were instructed to come up with a group decision, but they were not required to form a consensus. After discussion, each individual again rated the attributes on the one to ten scale. Then the facilitator would take each individual rating and compute an average rating for each attribute, using the same formula as used by the voting tool in the GroupSystems software. This served as the group's decision.

In the next step, the group was given 10 minutes to discuss the five alternative methods the leader (referenced in the scenario) had to choose from to make a decision to solve the scenario problem. (Alternative method form is reproduced in Appendix C.) Again, the purpose was to reach a group decision. The group was told that after discussion they would individually rank order the alternative methods from best to worst with respect to the scenario. The group was not asked to reach consensus, and they were instructed that the group decision would be the result of a computed rank sum of each individual's vote. After time was up, each person ranked the methods based on group discussion.

The group then took a five minute break and returned for the second condition, this time using the GDSS. This condition was run similar to the first, in an attempt to control for any inadvertent variables that may have affected the result. The group was given a packet containing step-by-step instructions, a computer reference sheet for individuals to refer to when using the computer, the scenario, one individual attribute rating form, and the post-experiment questionnaire.

Group members read the instructions on their own, then watched the video, which not only reinforced the instructions, but also gave them a brief introduction on how to use the software for the GDSS. Each person sat at his own computer workstation, and read the scenario. Then he/she filled out the individual attribute rating form on the 1 to 10 scale. The facilitator then brought up the seven categories from the attribute rating form onto the group's individual computer screens, and the group was given 15 minutes to discuss the attributes with respect to the scenario. The group communicated solely through the computer in an attempt to reach a decision about each attribute. As a group member made a comment about a particular attribute, he/she would submit it to the group by pressing the enter key, and it appeared as a comment under the same attribute on everyone else's computer screen. After discussion, the facilitator brought up a rating screen, and individual members again rated the attributes based on group discussion.

Next, the facilitator brought up each individual's computer screen with Vroom and Yetton's five decision-making alternatives, and the group discussed them in the same manner as the attributes (via the computer network). After ten minutes, each individual rank ordered the five alternatives from best to worst.

The facilitator then printed out the computer results and calculated results from the face-to-face condition. Results were given to the group, who looked them over and filled out the post-experiment questionnaire, which asked groups how satisfied they were with their decisions in each condition. (Post-experiment questionnaire is reproduced in Appendix D).

Decision Quality

Decision quality was measured using two variables. Attribute quality reflects a comparison between groups' ratings of the attributes and expert ratings. Outcome quality compares group and expert rankings of five alternative solutions for two scenarios. These criteria are based on the decision making model developed by Vroom and Yetton.

Vroom and Yetton's model was developed in order to determine the quality of a decision made by the leader of a group or organization (Vroom and Yetton, 1973). This model is based of empirical evidence which concerns the likely consequences of each decision-making style the leader can use. There are five separate decision-making styles the leader can use, based on the type of problem presented. These alternative methods are as follows:

> AI: The leader solves the problem or makes the decision himself, using information available to him at the time.

AII: The leader obtains the necessary information from his subordinate(s), then decides on the solution himself. He may or may not tell his subordinates what the problem is in getting the information from them. The role played by the subordinates in making the decision is one of providing the necessary information to him, rather than generating or evaluating alternative solutions.
CI: The leader shares the problem with relevant subordinates individually, getting their ideas and suggestions without bringing them together as a group. Then the leader makes the decision which may or may not reflect his subordinates' influence.
CII: The leader shares the problem with his subordinates as a group, collectively obtaining their ideas and suggestions. Then the leader makes the decision which may or may not reflect his subordinates' influence.
GII: The leader shares a problem with his subordinates as a group. Together they generate and evaluate alternatives and attempt to reach agreement (consensus) on a solution. The leader's role is much like that of a chairman. The leaders does not try to influence the group to adopt his solution and he is willing to accept and implement any solution which has the support of the entire group. (Hall and others, 1976:100)

Vroom and Yetton then developed a feasible set of solutions from their decision-making flow chart, based on a set of problem attributes. Based on this model, the case should result in a problem type that is conducive to a set of decision-making methods. These seven attributes are used to move through the decision tree to come up with the problem type.

A. Does the problem possess a quality requirement?
B. Do I have sufficient information to make a high quality decision?
C. Is the problem structured?
D. Is acceptance of the decision by subordinates important for effective implementation?
E. If I were to make the decision alone, am I reasonably certain that it would be accepted by my subordinates?
F. Do subordinates share the organizational goals to be attained in solving this problem?
G. Is conflict among subordinates likely in the preferred solution? (Yukl, 1994)

In using the decision-making model, the person making the decision assess the individual attributes as yes or no questions. By answering each question yes or no, the person follows the respective branch to end up with the problem type. From this problem type, the manager chooses the most appropriate method of solving the problem of that particular type.

There is evidence that Vroom and Yetton model is an effective decision-making method, and that it mirrors the choice made by experienced managers (Margerison and Glube, 1979; Field, 1982). I used the model as a tool to assess quality of the group decision.

Expert Ratings

Results were compared to the assessment of three expert raters. Two of these raters are instructors at for the graduate programs in management at (AFIT), and both are familiar with Vroom and Yetton's leadership decision making model. They both hold the rank of Major, and have had experience in similar decision-making situations as those referenced in the scenarios. The third expert is a retired Colonel, also a graduate of AFIT, and has had extensive experience in leadership decision-making situations. Experts were given the scenarios and asked to rate the attributes and rank the decision alternatives available to the leader in the scenario. Experts did not meet in a group setting, but rather performed their ratings individually, and were given as much time as they needed to complete the two scenarios.

Quality of the decision was looked at in terms of both attribute quality and outcome quality. Attribute quality is defined as on how many of the seven attributes the groups concurred with the expert raters. Outcome quality is the relative closeness in ranking of the five alternative solutions the groups were to those of the experts.

The expert ratings for the attributes was an average of each individual's rating, and the results were translated from a total ranking to a yes or no answer in accordance with the attributes. Ratings were recorded on a scale of one to ten. If the experts' average rating was between 1-5, that answer became a "no". If the experts' average rating was between 6-10, that answer was a "yes". Expert results are summarized in Table 1.

Table 1. Expert Ratings

Attribute Number	Raters' Decision Scenario #1	Raters' Decision Scenario #2
1	Yes	No
2	No	No
3	No	No
4	Yes	Yes
5	No	No
6	Yes	Yes
7	Yes	Yes

In ranking the five alternative solutions that the leader in the scenario could choose from in order to solve the scenario problem, the experts were in general agreement as to what that order should be. For both scenarios, all experts chose CII and GII as either the first or second choice, and AI or AII as either the fourth or fifth choice. Because of this, the following grading system was developed to score groups' rankings:

Table 2. Expert Rankings

1. CII or GII	2 points
2. CII or GII	1 point
3. CI	0 points
4. AI or AII	1 point
5. AI or AII	2 points

Decision Acceptance

The second dimension of determining the quality of outcomes as defined by Vroom and Yetton is acceptance of the decision by the participants. This was measured in two ways. First, the level of agreement of participants in the group was measured by the average standard deviation of each individual's vote on the ranked solution alternatives. A group's average standard deviation was compared between the GDSS and the face-to-face conditions.

Second, groups' satisfaction with the results in each of the two conditions was measured using a post-experiment questionnaire. The item total reliability of the two items that measured satisfaction of face-to-face results was .61, and the reliability of the five items that measured satisfaction of GDSS results was .78. While the reliability for face-to-face results may be relatively low, it still provided an adequate measure of group member satisfaction.

Group Decision Support System Software

As mentioned previously, the software used in this study was "GroupSystems for Windows" by Ventana Corp. Tools incorporated into the experiment were for communication and voting only. Tools included the Categorizer, in which the attributes or alternative methods (depending on the particular screen the group was viewing and discussing) were listed. Once discussion began, individuals made comments about each category, and read other comments made about the categories. Also, the voting tool, both 10-point rating scale (for the attributes) and a rank ordering tool (for the alternative methods) was used to record each person's vote. These factors and software availability made using GroupSystems practical for this experiment.

IV. Analysis of Results

Measures

A repeated measures analysis of variance (ANOVA) was used to explore the effects of type of group interaction, order, and scenario on group decision quality and acceptance. Each group completed two sessions in which they rated solution possibilities for two different scenarios using a GDSS or face-to-face method of group interaction. Decision quality was measured in terms of the quality of ranked solution possibilities (outcome quality--OQ) and the quality of rated attributes (attribute quality--AQ). Decision acceptance was measured both in terms of agreement of users within groups (average standard deviation--AS) and user satisfaction of results (satisfaction results--SR).

The order variable referred to which type of media was used first for group interaction (GDSS or face-to-face) , and scenario simply referred to scenario #1 or scenario #2.

Decision Quality

A significant three way interaction was found for outcome quality, order, and scenario ($p < .015$). This implies that the outcome quality was different depending on the scenario and order as well as the hypothesized type of group interaction. The means and standard deviations for the eight different conditions are presented in Table 3 and graphically presented for each scenario in Figure 6 and Figure 7. In both figures, order refers to the type of interaction that was used first in each treatment. Along the x axis, 1 signifies that face-to-face interaction was used first (the left side of the graphs) and 2 indicates that GDSS interaction was used first (the right side of the graphs).

Table 3. Three-Way Interaction Effect for Outcome Quality

Type of Interaction	Order	Scenario	Mean	Standard Deviation
GDSS	first	1	5.000	.000
GDSS	first	2	2.333	1.528
GDSS	second	1	2.750	1.708
GDSS	second	2	3.750	2.630
Face to face	first	1	5.250	.957
Face to face	first	2	4.000	1.633
Face to face	second	1	1.333	1.155
Face to face	second	2	4.333	1.528

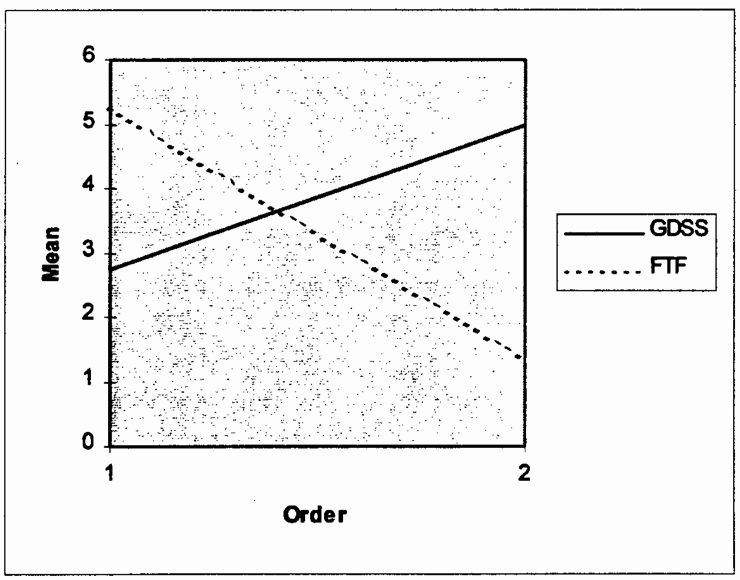

Figure 6. Order Effect for Scenario #1

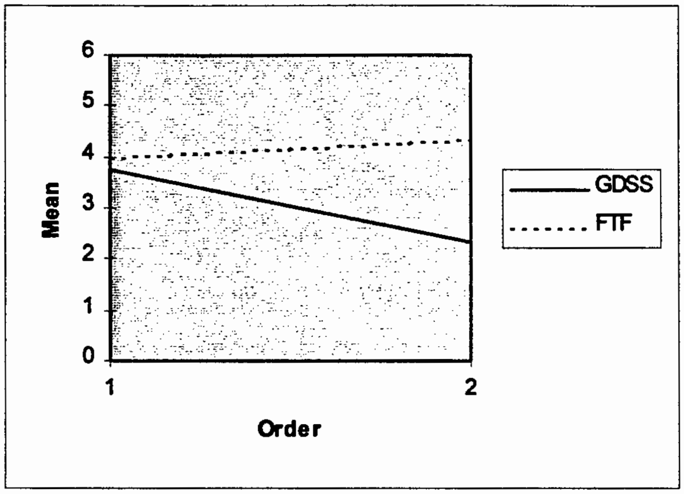

Figure 7. Order Effect for Scenario #2

For scenario #1, groups achieved a higher outcome quality score on their first session regardless of the group interaction method they used during that session. The decision quality of their second session declined. Figure 7 shows that a different pattern of results occurred for the second scenario. When groups met face-to-face the order did not appear to impact the outcome quality. When groups met using GDSS, the outcome quality was much higher if they met in a face-to-face condition first than if they met in the GDSS condition first. There was no main effect for the type of group interaction (p<.697, n.s.).

The analysis of the attribute quality variable indicates that there is also a significant three-way interaction between attribute quality, order, and scenario (p<.005). This implies that the attribute quality was different depending on the scenario and order as well as the hypothesized type of group interaction. The means and standard deviations for the eight different conditions are presented in Table 4 and graphically presented for each scenario in Figure 8 and Figure 9.

Table 4. Three-Way Interaction Effect for Attribute Quality

Type of Interaction	Order	Scenario	Mean	Standard Deviation
GDSS	first	1	6.000	1.000
GDSS	first	2	4.000	1.000
GDSS	second	1	3.750	1.258
GDSS	second	2	5.500	1.732
Face to face	first	1	6.000	.817
Face to face	first	2	5.000	.817
Face to face	second	1	2.667	.577
Face to face	second	2	5.333	2.082

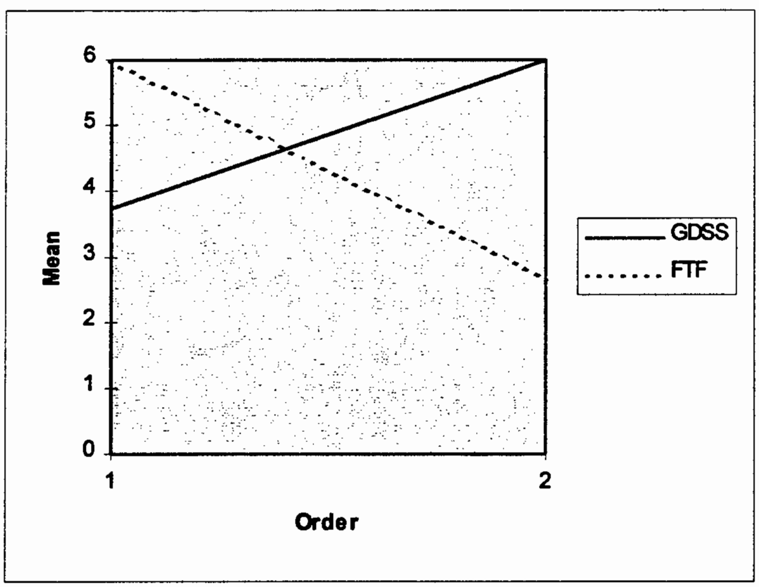

Figure 8. Order Effects for Scenario #1

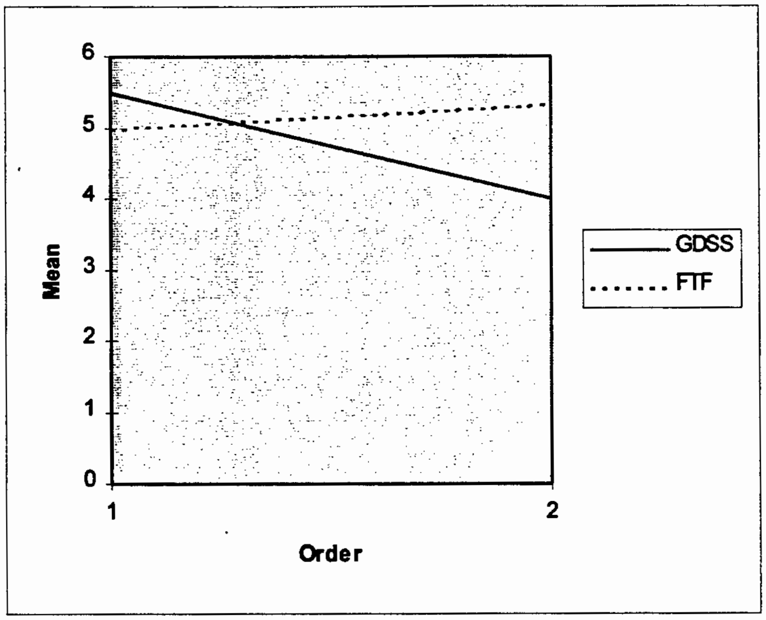

Figure 9. Order Effects for Scenario #2

Results for attribute quality indicate that for scenario #1, regardless of the type of group interaction used, whichever one was used first resulted in a higher attribute quality than the second condition. This seems to confirm the results found for the first scenario when outcome quality was measured. In the second scenario, however, the reverse is true. As depicted in Figure 9, whichever method of group interaction was used first resulted in a lower quality score than when the same method of group interaction was used in the second condition. Like outcome quality, there is no main effect for attribute quality in terms of the method of group interaction used to make the decision ($p<.907$).

Decision Acceptance

The second operational definition of decision quality is decision acceptance by members of the group. As previously mentioned, this was measured by the groups' average standard deviation of the outcome in each condition and group members' satisfaction with the outcome as indicated on a post-experiment questionnaire.

Average standard deviation did not appear to be subject to any interaction effects as is evidenced in Table 5.

Table 5. Interaction Effects of Average Standard Deviation

Interaction	F Value	Significance Value
Standard Deviation	8.253	p < .018
Standard Deviation * Order	.168	p < .691
Standard Deviation * Scenario	.01	p < .924
Standard Deviation * Order * Scenario	.002	p < .970

As is shown in the table, there is significant effect due to the method of interaction used for the groups' decision in the GDSS and face-to-face conditions. Results indicate that groups tended to form greater agreement in the face-to-face condition (resulting in a lower average standard deviation) than they did in the GDSS condition. This is illustrated in Table 6Table 6.

Table 6. Average Standard Deviation

Type of Group Interaction	Mean—AS
Face-to-face	.176
GDSS	.666

Results indicate that there was a significant main effect for average standard deviation (*p*<.018). Groups in the face-to-face condition had a lower average standard deviation, and therefore a greater level of agreement. Because there were no significant interaction effects, it suggests that this is the case no matter what method of interaction was used first, nor which scenario was used.

Results of group member satisfaction were subject to a slight interaction effect due to order ($p < .17$) While this effect is not significant at the alpha = .05 level, it may be problematic. A statistically reliable interaction effect due to order may in fact exist, but there may not be sufficient power to detect it. A cautious approach is to increase the significance level to alpha = .2, and treat this unwanted interaction as a significant effect. When groups met in the face-to-face condition first, satisfaction with face-to-face results was slightly higher than when groups met in the face-to-face condition second. A comparison of these means showed they were not statistically different from each other. However, satisfaction with GDSS results was statistically lower when groups met in the GDSS condition first, than when groups met in the GDSS condition second (t=-2.21, p<.05). Standard deviations are summarized in Table 7.

Table 7. Order Effects for Satisfaction with Results

Condition	SR for Face-to-face Decisions		SR for GDSS Decisions	
Condition	Mean	Standard Deviation	Mean	Standard Deviation
Face-to-face first	4.577	.608	2.781	2.375
GDSS first	4.458	.801	3.286	1.587

V. Conclusions

Analysis of Results

Results of this experiment showed little support for my hypothesis. Both measures of decision quality indicated a significant three-way interaction effect between scenario, order, and method of group communication. There were no main effects for method of group communication. Measures of decision acceptance suggest that these groups were in greater agreement when they met face-to-face, and the level of satisfaction with the results, while slightly dependent upon order, was also greater when the groups met face to face.

The scenario effects may have occurred for several reasons. Although both scenarios were adapted from typical examples used by Vroom and Yetton, the scenarios may have differed in terms of relative difficulty for the sample used in this study. The first scenario was a problem in which the leader was to develop a plan to fix a problem with a new system. Group members, whose positions in the military are roughly equivalent to the level of middle management, may have encountered the type of problem from scenario #1 more frequently than the problem in the second scenario. The second scenario was purely a personnel problem. The sample was primarily comprised of two types of people: former section commanders, who have had extensive experience dealing with personnel issues, and officers with a technical background, in which they did not have nearly the same level of personnel experience. Although this was not measured quantitatively, when I observed these groups, I found that for scenario #2, those with more personnel experience tended to argue for the answer that was more closely related to that of the experts, while the group members with the more technical background tended to take a more extreme, and in this case, authoritarian, approach.

When divided by scenario, it appears that for scenario #1, results for decision quality are dependent upon order. As depicted in Figure 6 and Figure 8, whichever type of media that was used first, resulted in the higher level of decision quality. This may have occurred because of boredom, in which whatever condition the group encountered second did not net the same quality results. While this may be a viable explanation, if this were the case, this effect would probably also have been seen for scenario #2. Also, scenario #1 appeared to be the scenario that most groups had an equivalent level of experience in dealing with, and the order effect may have been due to a change in the way groups interacted after completing the first condition. When groups met face-to-face first, they tended to try to form consensus by finding a "middle ground" upon which they could all agree. When they then met in the GDSS condition, they still attempted to find an equitable compromise, and the electronic media may have hindered that process, thus lowering decision quality. When groups met in the GDSS condition first, they seemed more likely to give opinions on the scenario itself, in search of the best solution, rather than simply attempting to reach consensus. This may have resulted in a greater level of decision quality, since GDSS appeared to be used in the manner for which I had intended, rather than as a device simply to try and get the group to form a consensus. Again, the possible reasons for these results were my observations, and not measured factors.

For scenario #2, the outcome quality, depicted in Figure 7, appeared to always be better in the face to face condition, regardless of what order it was done. The GDSS results, however, seemed to decrease in quality when GDSS was used second. This may again be the result of the sample. Members of a group who were extremely experienced in personnel issues may have been able to influence other group members who did not have the same level of background experience. Since GDSS research indicates that use of a GDSS reduces individual influence, this may explain why the outcome quality was greater in the face-to-face condition. Groups in the face to face condition were more susceptible to influence of very experienced group members, while in the GDSS condition, that influence was reduced, motivating less experienced members to vote more in accordance with their own ideas.

Attribute quality for scenario #2 resulted in an effect for which it is difficult to an explanation. GDSS attribute quality appeared to increase when the GDSS was used second, and the same is true for attribute quality in the face-to-face condition. While this interaction effect exists, the data also suggests that the effect is slight and the overall attribute quality for both conditions remains higher and more stable than the attribute quality of scenario #1.

Group member satisfaction with results rendered the same outcome with respect to order. Groups who met in the face-to-face condition first reported that they were more satisfied with the face-to-face results than when face-to-face was the second condition. Groups who met in the GDSS condition first reported that they were more satisfied with GDSS results than when the GDSS condition was second. In both cases, the groups were more satisfied with the results of the face-to-face condition. This finding is consistent with previous GDSS research which suggests that groups are more satisfied with a GDSS if they have a stake in the outcome, such as during a field test, but are less satisfied with GDSS results in a laboratory setting (Nunamaker and others, 1996:170). This is also consistent with research that suggests satisfaction and outcome quality may increase as group size increases (Nunamaker and others, 1991).

Average standard deviation, while not subject to significant effects due to order, still produced a significant main effect. Almost every group tended to form consensus, or near-consensus when they met in the face-to-face condition. This may be due to the small size of each group, three or four people, in which consensus is easily attainable, particularly when meeting face-to-face. Also, the nature of GDSS tends to reduce the influence of dominant group members and therefore the motivation of some group members to form consensus in that condition (Connolly and others, 1990).

Limitations

The primary limitation of this study is the unwanted three-way interaction effect. I had hoped to isolate the type of group communication in order to discern if a better decision could be made using the GDSS. What I discovered is that for this study, the results were highly circumstantial, possibly indicating that either there were problems with my design or that GDSS may not be suitable for all types of problems. I believe that both of these are possible. The design of this study added significant structure to the process in both the face-to-face and GDSS conditions. Previous GDSS research indicates that one of the benefits of GDSS is the addition of structure to an ill-structured problem or process (Vogel and others, 1987). Because I imposed that structure on both conditions, it may have had an impact on the results.

Also, the problems chosen for this study could have been solved by any single person, and did not necessarily need the involvement of a group. If replicated, it might be better to divide the problem into sections so that each group member only received a piece of the total answer, and all individuals would need to be able to communicate their piece in order to find the best result. This may be a more effective way of isolating the type of group communication to find out if a better decision can be made using the GDSS.

One final limitation of this study is the amount of time groups were given to discuss the scenarios. In the face-to-face setting, groups usually finished discussion before time was concluded. But, in the GDSS condition, groups felt that they did not have enough time to say everything they wanted to say. Groups probably tended to finish early in the face-to-face environment because there were only three or four members in each group. This is any easy group size to manage, and everyone usually has a chance to give his/her opinion. In the GDSS setting, groups probably suffered from a learning curve of the system, as well as not being able to type as fast as they could speak. Time limits were set in order to keep the amount of time the experiment would take down to a reasonable level. The experiment was usually 1.5 hours in length. If the experiment lasted much longer than that, the probability that people would volunteer would most likely decrease.

This limitation may explain some of the results found in the study, such as the low satisfaction group members felt with the decisions made using the GDSS. If groups were given more time in which to finish discussing the scenarios on the GDSS, satisfaction and decision quality may both have increased.

Applications

While this experiment did not find support for the stated hypotheses, it may still have value for the Air Force. The effects found in the measures of decision quality and decision acceptance indicate that there may be some factor in group communication that affects the quality of group decision in a face-to-face environment, that may be reduced or eliminated in a GDSS environment. If GDSS reduces the effects of things such as boredom due to repetition without significantly reducing the quality of the outcome, it may help groups to attain consistent results over time. Many decisions are the result of a series of meetings rather than a single interaction. While I can only speculate at this time, further research in this area may be of value to groups who meet many times to reach a single decision. Previous research suggests that groups, once they have adapted to using a GDSS, tend to exhibit greater cohesiveness and more productive types of conflict management, than groups who regularly meet in a face-to-face environment (Chidambaram and others, 1990).

The data, while inconclusive, also suggests that there may be no statistically significant difference in decision quality between face-to-face and distributed groups communication via a GDSS. If this is shown to be the case, a distributed GDSS may have many practical advantages to the Air Force. For example, meetings in the Air Force often include members who are geographically separated, with no loss of decision quality. A distributed GDSS could help these meetings to take place, and overcome associated logistical problems. If group members were located at different areas on the base, the GDSS could enable them to meet without driving to a single location. If group members were located at different bases, the GDSS could enable them to meet without requiring them to leave their location. This could eliminate both time and monetary costs of busy group members, while still allowing them to make a decision of adequate quality.

Finally, there is significant research on the many process gains of using a GDSS to facilitate meetings. If results indicated that utilizing a GDSS produced a decision of inferior quality, I believe it would not matter how significant the process gains were, it would not be an effective tool for making decisions. Only if the decision is of equal or better quality than a decision made in a face-to-face setting would the process gains become a factor. Ultimately, a group wants to make the best decision it can make. Research tells us that process gains found using a GDSS may result in a better process. This study, while not conclusive, suggests that decision quality does not necessarily suffer when moving from a face-to-face to a distributed GDSS-supported group meeting environment. If this assertion is supported by further research, it could provide definite advantages to the way the Air Force makes group decisions.

Appendix A: Scenarios

Scenario #1

(Modified from Experiences in Management and Organizational Behavior, Hall and others.)

You are the operations officer at the 82nd Maintenance Squadron. The organization's chain of command has always been searching for ways of increasing efficiency. They have recently installed new equipment and streamlined the processes, but to the surprise of everyone, including yourself, the expected increase in productivity was not realized. In fact, production has begun to drop, quality has fallen off, and satisfaction has deteriorated.

You do not believe that there is anything wrong with the equipment. You have had reports from other organizations who use the same equipment and they confirm your opinion. You have also had representatives from the contractor that built the equipment go over it and they report that it is operating at peak efficiency.

You suspect that some parts of the new procedures may be responsible for the change, but this view is not widely shared among your immediate subordinates, who are four flight commanders, each in charge of a section, and your supply officer. The drop in production has been variously attributed to poor training of the personnel operating the new equipment, lack of adequate incentives, and poor morale. Clearly, this is an issue about which there is considerable depth of feeling within individuals and potential disagreement between your subordinates.

This morning you were called into the Commander's office. He just read the turn-around times for repairs for the past six months and wanted to express his concern. He indicated that the problem was yours to solve in any way that you think best, but that he wanted to know, within a week, what steps you planned to take.

You share your Commander's concern with the increasing turn-around times and know that your personnel are also concerned. The problem is to decide what steps to take to rectify the situation.

Scenario #2

(Modified from Experiences in Management and Organizational Behavior, Hall et al.)

You are supervising the work of 12 AFIT-trained engineers. Their formal training and experience are very similar, permitting you to use them interchangeably on projects. Yesterday your Commander informed you that a TDY-assignment had been received from an overseas base for four engineers, for a period of six to eight months. The Commander decided that all four assignments would be filled from members of your section.

All your engineers are capable of handling this assignment, and from the standpoint of present and future projects there is no reason why any one should be retained over any other. None of the 12 engineers has done any overseas tours, so previous duty is not a consideration. The problem is somewhat complicated by the fact that the overseas assignment is in what is generally considered to be an undesirable location.

Appendix B: Individual Attribute Rating Form

Please rate the scenario on the following seven attributes. Ratings are on a scale from 1 to 10, with 1 being the least or worst, and 10 being the best or most.

1. How important is the quality of the decision?

1	2	3	4	5	6	7	8	9	10
Not important at all									Extremely Important

2. To what extent do you (as the leader) possess sufficient information/expertise to make a high-quality decision?

1	2	3	4	5	6	7	8	9	10
No Information at all									Complete Information

3. To what extent is the problem a structured one?

1	2	3	4	5	6	7	8	9	10
Completely Unstructured									Completely Structured

4. To what extent is acceptance or commitment on the part of subordinates critical for you to effectively implement the decision?

1	2	3	4	5	6	7	8	9	10
Not Critical at all									Extremely Critical

5. If you chose to make the decision without input, to what degree of certainty will your decision receive acceptance by subordinates?

1	2	3	4	5	6	7	8	9	10
Completely Uncertain									Completely Certain

6. To what extent will the subordinates be motivated to attain organizational goals reflected in solving the problem?

1	2	3	4	5	6	7	8	9	10
Completely Unmotivated									Completely Motivated

7. To what extent will the subordinates be likely to be in conflict over possible solutions?

1	2	3	4	5	6	7	8	9	10
Completely Unlikely									Completely Likely

Appendix C: Alternative Approaches to Solving the Problem

(Developed as part of the Leadership Decision-Making Model by Vroom and Yetton)

AI: You solve the problem or make the decision yourself, using information available to you at that time.

AII: You obtain the necessary information from your subordinate(s), then decide on the solution to the problem yourself. You may or may not tell your subordinates what the problem is in getting the information from them. The role played by your subordinates in making the decision is clearly one of providing the necessary information to you, rather than generating or evaluating alternative solutions.

CI: You share the problem with relevant subordinates individually, getting their ideas and suggestions without bringing them together as a group. Then you make the decision which may or may not reflect your subordinates' influence.

CII: You share the problem with your subordinates as a group, collectively obtaining their ideas and suggestions. Then you make the decision which may or may not reflect your subordinates' influence.

GII: You share a problem with your subordinates as a group. Together you generate and evaluate alternatives and attempt to reach agreement (consensus) on a solution. Your role is much like that of chairman. You do not try to influence the group to adopt "your" solution and you are willing to accept and implement any solution which has the support of the entire group.

Ranking:

1.

2.

3.

4.

5.

Appendix D: Post-Experiment Questionnaire

After learning the results of your attributes and alternative rankings, please fill out this questionnaire.

1. How satisfied were you with the alternative rankings in the traditional face-to-face setting?

1	2	3	4	5
Completely Unsatisfied				Completely Satisfied

2. How satisfied were you with the alternative rankings in the Group Decision Support System (GDSS) setting?

1	2	3	4	5
Completely Unsatisfied				Completely Satisfied

3. To what extent do you believe, in the GDSS environment, that the group made the best decision it could make?

1	2	3	4	5
Not at all				Completely Sure

4. To what extent do you believe in the GDSS environment, you could have made a better decision by yourself?

1	2	3	4	5
Not at all				Completely Sure

5. To what extent do you believe, in the face-to-face environment, that the group made the best decision it could make?

1	2	3	4	5
Not at all				Completely Sure

6. To what extent do you believe in the face-to-face environment, you could have made a better decision by yourself?

1	2	3	4	5
Not at all				Completely Sure

7. To what extent do you believe the GDSS was a more effective tool than the traditional face-to-face setting?

1	2	3	4	5
Extremely Ineffective				Extremely Effective

8. To what extent do you believe the GDSS was a more efficient tool than the traditional face-to-face setting?

1	2	3	4	5
Extremely Inefficient				Extremely Efficient

9. To what extent do you believe the GDSS interface resulted in more satisfying results than the traditional face-to-face setting?

1	2	3	4	5
Completely Unsatisfying				Completely Satisfying

10. To what extent do you believe that if there were more participants in the group, you would have chosen GDSS instead of a face-to-face environment?

1	2	3	4	5
Would definitely not Choose GDSS				Would definitely choose GDSS

11. How many people should be part of the group before you chose GDSS as the preferred method of interaction?__________

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13. ABSTRACT (*Maximum 200 Words*)

The Air Force is increasingly turning to a team-approach for decision-making. When team members are geographically separated it can be expensive for them to meet in a traditional face-to-face setting. Group Decision Support Systems (GDSS), designed to help groups make decisions, may be able to support these groups in a distributed mode. The assertion of this thesis is that a GDSS can indeed support such distributed processes and that these processes will be of higher quality than decisions made in a face-to-face environment.

This study explores decision quality in terms of quality of the outcome, and acceptance of the decision by group participants. Through a laboratory experiment, groups of three or four members met to solve a management problem. Results suggest that quality of the decision depends upon the type of group interaction, the order of that interaction and the scenario difficulty. The analysis found no statistically significant difference for decision quality in either type of group interaction. Additional research is necessary to examine the potential for Air Force use of distributed GDSS to reduce travel costs without reducing decision quality.

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