Using a GDSS to Facilitate Group Consensus: Some Intended and Unintended Consequences

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Abstract

A cumulative body of experimental research is emerging that examines the ability of computer technology to support the processes and outcomes of small group meetings. For the most part the group decision support system effort has been concerned with demonstrating the usefulness of the technology in planning and decision-making situations where the quality of the meeting's outcomes can be objectively assessed. In many decision situations, however, there is no objective measure of decision quality available. Rather, the group must reconcile differences in opinion, personal preference, or judgment and achieve consensus about a particular mode of action. As a contribution to the accumulating research on GDSS, the current study examines the effects of a GDSS in resolving conflicts of personal preference. In a task requiring resolution of competing personal preferences, 82 groups—the largest sample size in the GDSS literature to date—were randomly assigned to one of three experiment conditions: (1) a computer-based support system (GDSS); (2) a manual, paper and pencil, support system; or (3) no support whatsoever. Groups were either of size 3 or 4 persons. Use of the GDSS was expected to facilitate democratic participation in group discussion, move group members toward agreement with one another, and result in a high level of satisfaction with the group decision process. While several of the intended effects of the technology were observed, the groups experienced some unintended consequences as a result of using the GDSS. In general, the GDSS technology appeared to offer some advantage over no support, but little advantage over the pencil and paper method of supporting group discussion.

Keywords: Decision support, group decision support systems, problem solving


Introduction

Group decision support systems (GDSS) combine computer, communication, and decision support technologies to support problem formulation and solution in group meetings. The goals of a GDSS are to reduce the "process loss" associated with disorganized activity, member dominance, social pressure, inhibition of expression, and other difficulties commonly encountered in groups and, at the same time, to increase the efficiency and quality of the resulting group decision (Turoff and Hiltz, 1982; Huber, 1984a; DeSanctis and Gallupe, 1987). These goals are similar to those that historically have been associated with information technology. That is, the hope has been that computers will bring greater efficiency, reliability, and quality to the nature of work.

Much of the literature on computer-supported communication and decision making rests on the assumption that the addition of the electronic medium to verbal information exchange will lead to better decisions and actions, and to higher productivity. The electronic medium should allow greater participation in decision making and increase access to meeting information. Consequently, the resources of a group should be fully extracted in a group discussion; a more democratic decision process should emerge; and some structure should be added to what is otherwise a "muddling through" process for groups (DeSanctis and Gallupe, 1987; Huber, 1984a; Gray, et al., 1981; Rohrbaugh, and Wehr, 1978). Siegel, et al. (1986) argue that the reduction of social context cues in computer-mediated communication should "reduce normative influence relative to informational influence. This should reduce the im-
The empirical literature suggests that many of the hopes for GDSS can be realized. For example, Lewis (1982) and Galupe (1985) find that groups supported by a GDSS make higher quality decisions than groups without GDSS support. Applegate (1986) and Steeb and Johnston (1981) have demonstrated the viability of GDSS in live planning situations. Positive effects of a GDSS on groups have also been reported by Gray, et al. (1981), Turoff and Hiltz (1982), and Siegel, et al. (1986). Computer support has been shown to foster a democratic approach to the decision process, with more equality of participation among members (Siegel, et al., 1986). Improved satisfaction with the decision process has been reported (Applegate, 1986), as well as a greater shift away from initial individual preferences (Siegel, et al., 1986).

These intended effects of the technology have been demonstrated for a limited number of task types. To date, positive effects of GDSS have been observed for idea generation (Applegate, 1986; Lewis, 1982), problem finding (Galupe, 1985), intellective choice (i.e., selection of a "correct" answer among a given set of alternatives) (Turoff and Hiltz, 1982), and planning tasks (Applegate, 1986; Steeb and Johnston, 1981). In two of these studies, group members were dispersed and interacted with one another via a communication network (Turoff and Hiltz, 1982; Siegel et al., 1986), while in the other studies, group members...
Group Decision

met in a face-to-face conference room setting. In all cases, each member had direct access to the GDSS, and in most of the studies the performance of the group is compared to an objective measure of decision quality.

Of course, many organizational meetings occur without prior or post knowledge of the "correct" outcome of a group meeting. For this reason, this study aims to build on the available knowledge of GDSS impacts by examining the usefulness of the technology in situations where a group must resolve competing personal preferences and maximize agreement on a solution to a problem. In such situations, achieving high decision quality is not the primary goal of the group meeting. The theory of GDSS would argue that the technology should be as useful in achieving consensus as in identifying correct solutions. In either situation, the GDSS should foster more even participation in the decision and a more systematic, or structured, group decision process. If the intended effects of GDSS may be obtained for personal preference tasks, then the potential domain of application of the technology would be expanded.

In addition, this study attempts to measure the conflict potential in the subject groups (i.e., differences in preferences with respect to the decision) so that the effects of the GDSS for different levels of conflict can be gauged and controlled. Several studies report higher levels of conflict and negative emotional expression in computer-mediated communication than in face-to-face communication (Applegate, et al., 1986; Siegel, et al., 1986; Gallupe, 1985). It is unclear, however, whether increased conflict is a direct result of computer-mediated communication itself, or whether the GDSS simply provides a mechanism that brings out existing differences among group members. If the former interpretation holds, then whether the GDSS improves decision making depends on the balance between the negative effects of conflict and the positive GDSS effects. If the GDSS creates conflict, rather than bringing out conflicts that are already there, then group consensus should be low, even for groups with little conflict potential. However, if the GDSS merely facilitates expression of existing conflicts, without adding new conflict, then consensus should improve as groups are able to recognize and deal with their differences in the context of the GDSS.

Much of the GDSS research is being conducted in laboratory settings where the organizational context and other factors can be controlled, permitting precise assessment of the impact of the technology on group outcomes. In most previous laboratory experiments, the approach has been to compare groups that use a GDSS with groups that have no support in order to identify the relative advantage that these systems can offer to decision-making groups. Prior experimental work in the GDSS area is summarized in Table 1. This study aims to build on the available GDSS research by systematically comparing groups supported with a Level-1 GDSS with groups that have either no support whatsoever ("baseline" groups) or a paper-and-pencil ("manual") support system that contains the same decision structure as the GDSS (cf. Lewis, 1982). Without two control groups it is impossible to determine whether increments or decrements in outcomes are due to the GDSS or simply due to imposing a problem-solving structure on the group. The comparison of baseline to manual groups permits determination of simple structure effects. The comparison of manual and GDSS groups permits determination of computer system effects. The comparison of baseline and GDSS groups permits determination of effects due to support versus no support. Consistent with prior experimental work, this study is limited to considering the usefulness of a GDSS for a small group meeting. Because there is some evidence that group size can have an impact upon interaction patterns (Bales and Borgatta, 1965; Reynolds, 1971) groups of three and four persons were chosen.

Variables and Hypotheses

The major concern of this study is with the effects of a GDSS on the level of group consensus for a task requiring resolution of conflicting personal preferences. The major independent variable is the level of support for the group. GDSS groups received a Level-1 GDSS. Manual support system groups were supported with structure through a paper-and-pencil version of the GDSS. Baseline groups were freely-interacting and were given no support system whatsoever. A second explanatory variable is conflict potential, which is measured as a continuous variable by assessing the degree of pre-meeting consensus with the method developed by Spillman, et al. (1980). The statistical methods used in this study, in effect, controlled for pre-meeting consensus in the analysis of effects of level of support on post-meeting consensus. This allows for determination of support effects uncontaminated by differences in pre-meeting consensus among groups (see Cook and Campbell, 1979) and enables (or allows) us to assess the effect of pre-meeting on post-meeting consensus.

Degree of post-meeting consensus is the major dependent variable of the study. In addition to
consensus, various other dependent measures have been taken, including members’ perceptions of the outcome and decision process, and equality of influence.

Individual group members’ decisions were recorded before and after the group meeting to compute pre- and post-meeting consensus in each group. The Spillman, et al. (1980) technique has been used to calculate consensus from the individual choices of each group member.

To control for possible effects of team size within each experimental condition, half of the groups had three members and the remaining groups had four members. Three- and four-person groups are very small, and the impact of a GDSS may be more dramatic in larger-size groups. However, the average number of people attending an organizational meeting is only five (Datamation, 1986). More importantly, the interest of the study is in determining whether the effects of a GDSS can be detected in small groups. Group size in this study is similar to that in previous research (Lewis, 1982; Gallupe, 1985; and Siegel et al., 1986).

Using these variables, three hypotheses have been developed. The theory of GDSS would argue that the use of the technology should facilitate resolution of conflicting preferences and, consequently, create a high level of consensus in the group. Within the context of this study, groups with access to a GDSS were expected to achieve higher post-meeting consensus than groups without GDSS support for two reasons.

First, the GDSS provides a meeting structure for the group. By providing a menu of facilities, such as idea generation, rating, ranking, and voting, the system suggests that the group consider the procedures they use in reaching their decisions. Group research strongly suggests that groups can benefit from reflecting on the process of their meeting, regardless of the specific process that they eventually follow (Hackman and Kaplan, 1974; Hirokawa and Pace, 1983).

Second, the electronic medium associated with the GDSS should allow the structure to be invoked and applied more quickly than is possible with a manual system. Groups with manual support were expected to achieve higher post-meeting consensus than baseline groups, which had no support system. In addition, groups with low conflict potential (i.e., high pre-consensus) were expected to achieve higher post-meeting consensus than groups with high conflict potential in all conditions.

H1. The degree of post-meeting consensus will vary as a function of the type of support given to the group.

Table 1. Summary of GDSS Experimental Research in Laboratory Settings

<table>
<thead>
<tr>
<th>Researcher(s)</th>
<th>GDSS Level</th>
<th>Task Context</th>
<th>Task Type</th>
<th>Group Size</th>
<th>Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steeb and Johnston</td>
<td>2</td>
<td>Foreign embassy takeover by a terrorist group</td>
<td>Planning</td>
<td>3</td>
<td>GDSS and no support</td>
</tr>
<tr>
<td>Lewis (1982)</td>
<td>1</td>
<td>Severe financial problems in a university</td>
<td>Idea generation</td>
<td>3</td>
<td>GDSS, manual, and no support</td>
</tr>
<tr>
<td>Gallupe (1985)</td>
<td>1</td>
<td>A firm is losing profits at the same time that sales are rising</td>
<td>Problem finding</td>
<td>3</td>
<td>GDSS and no support</td>
</tr>
<tr>
<td>Current Study</td>
<td>1</td>
<td>$500,000 can be allocated to 6 competing projects</td>
<td>Preference allocation</td>
<td>3, 4</td>
<td>GDSS, manual, and no support</td>
</tr>
</tbody>
</table>

1This summary is limited to studies of face-to-face meetings in which all group members interface with the decision support system.
2GDSS level refers to the type of technological support for the group. A Level-1 GDSS is a communication medium only, whereas a Level 2 provides structured techniques, such as mathematical models, for improving the group’s decision.
3This categorization of task types is based on McGrath (1984).
H1a. Post-meeting consensus will be higher in the GDSS groups than in the manual support or baseline groups, controlling for initial level of conflict.

H1b. Post-meeting consensus will be higher in manual support groups than in the baseline groups, controlling for initial level of conflict.

This hypothesis implies that the GDSS will bring out pre-existing conflict rather than creating conflict itself. Indeed, the design of the GDSS employed in the present study (summarized below) is intended to lead to lower levels of conflict than those used by Siegel, et al. (1986) and others, because it allows both face-to-face and mediated communication.

The theory of GDSS would argue that a GDSS will result in a more democratic decision process, with more equal participation among members. This occurs because a GDSS provides a framework within which group members who are reluctant to contribute are encouraged to participate and potentially influence the group discussion (Siegel, et al., 1986). The structure provided in this study suggested that each group member should state his or her personal preferences at a number of points during a team meeting. Ranking, rating and voting are methods for getting participants to express a personal judgment. As a result, in groups supported by a GDSS, there should be greater equality of influence because the relative contribution of those less willing to participate is increased. For similar reasons, groups with a manually supported structure are also expected to have a more equitable distribution of influence than baseline groups.

H2. Equality of influence will vary as a function of the type of support given to the group.

H2a. Influence will be more even in the GDSS groups than in the manual support groups.

H2b. Influence will be more even in the manual support groups than in the baseline groups.

If hypothesis H2 is supported, the findings of this investigation will be in accord with prior experimental research. While prior studies do not examine equality of influence, they do look at equality of participation (Siegel, et al., 1986), a measure that is conceptually similar. Measures of influence and participation are both predicated upon determining the extent to which group decision-making is a democratic process. The measure of influence will compare each team member's choice with the group's choice. In contrast, the consensus measure is based upon team members' choices after the meeting.

While positive effects on group outcomes have been observed in many studies (Applegate, 1986; Siegel, et al., 1986; Turoff and Hiltz, 1982), there is also some indication that the use of GDSS technology can lead to negative sentiments on the part of group members. Gallupe (1985) finds that, compared to non-supported groups, GDSS groups in a face-to-face setting report lower satisfaction with the group decision process, less confidence in the final solution, and a higher degree of conflict in the course of group discussion. Given these results, some differences in attitudes toward the GDSS were anticipated.

H3. Attitudes toward the group process will be different in the GDSS groups than in the manual system and baseline groups.

Our approach to examining this hypothesis is very exploratory. A battery of attitudinal questions was given to each group member at the end of the experiment. The questionnaire consisted of a group process satisfaction measure developed by Green and Taber (1980), a decision quality measure designed by Gouran, et al. (1978), and some additional questions developed by the authors. Both Green and Taber, and Gouran, et al. report evidence supporting the reliability and validity of their measures. The instrument was pretested on 20 groups, and several expert informants commented on it. This information was used to "sharpen" and revise the instrument to its final form.

Research Method

Subjects and group composition

Forty-four three-person and 38 four-person groups participated in the study. The groups were made up of graduate and undergraduate students enrolled in introductory MIS classes at a large urban university. Many of the students were employed full-time in business settings, and most were working at least part-time. On average, the participants were 24 years of age with slightly more than two and a half years of work experience in a business or related setting. Approximately 60 percent of the subjects were male. All of the groups were "live" groups in that they had been actively working together as teams on other class assignments. In this way, the initial socialization
that occurs early in group formation could be avoided during the data collection.

The GDSS
The GDSS, called “Software Aided Meeting Management” (SAMM), Version 1.1, was designed, coded, and tested by a research team before it was used in the experimental setting. Approximately five groups used the system prior to actual data collection as a pre-test for the smooth operation of the software. The training materials for the software were also tested in this manner and then refined prior to actual data collection. Pre-tests indicated that people were comfortable using the system following a 20-minute training session. The software was developed rather than purchased because the available commercial GDSS software was either chauffeur-driven (not allowing each group member to interface with the system), too limited in scope (message storing only, without preference rating, ranking, or voting), or hardware-dependent (running only under specialized operating systems). Lack of standard commercial software in the GDSS area has led most researchers to develop their own systems.

The system is described in DeSanctis and Dickson (1987) and is being used for several related studies of group DSS (Poole and DeSanctis, 1987; Watson, 1987; Zigurs, 1987). Basically, the system incorporates a rational problem-solving agenda (Dewey, 1910). The software is similar to that used by Lewis (1982) and Gallupe (1985) in that it performs the basic functions of recording, storing, and displaying problem definitions, and of criteria for evaluating solutions, alternative solutions, and a final group decision. Group members can enter relative weights for solution criteria, and the system will aggregate and display average group weightings. In addition, the system will cumulate and display ratings, rankings, and votes associated with one or more alternative solutions to a problem. These features have been identified as appropriate for supporting the communication needs of groups (Huber, 1984b; DeSanctis and Gallupe, 1987; Joyner and Tunstall, 1970).

Group members can enter individual ideas, messages, weights, ranks, or votes at their private terminals, and the public screen is used to display group ideas, messages and aggregated (average) values of weights, ranks, and votes. As noted earlier, our interest was in studying the impacts of a Level-1 system on group consensus. Consequently, no modeling techniques were included in the system. The system is easy-to-use and menu-driven. Figure 1 shows the main menu for the system. Between one and three sub-menus underlie each of the items on the main menu.

Manual and baseline conditions
In the case of the manual groups, subjects were provided with an 11-page handout outlining the same agenda that was on the GDSS. Each page of the handout, which corresponded to a screen within the GDSS, explained an agenda item, giving details parallel to those in the sub-menus of the GDSS on how to accomplish the item. Manual groups were given only a flip chart to display ideas publicly. Every effort was made to ensure that manual groups had the same structural aids as the GDSS groups, the only difference being that the manual groups operated without a computer system. GDSS groups were provided with a 20-minute training session on use of the system; manual groups were also trained in how to use the

Figure 1. Main Menu for Software Aided Meeting Management, Version 1.1

**Agendas**

1. Define/View Problem
2. Define/View Selection Criteria
3. General Discussion
4. Define/View Alternatives
5. Rate Alternatives
6. Rank Alternatives
7. Vote or Straw Poll or Alternatives
8. Define/View Decision
9. Conclude Meeting
meeting structure. Baseline groups were given no structure, flip chart, or training. They were told to operate with their own resources. Both the manual and baseline procedures had been pre-tested on a small number of groups prior to actual data collection for the experiment.

**Task setting and validation**

The research task, or the “foundation task,” (Watson, 1987) requires subjects to allocate a given sum of money among six competing projects that have requested funds from a philanthropic foundation. Conflict arises because the team members have varying preference structures, which results in different allocation patterns. The projects that subjects can fund are based upon the personality components scheme described by Spranger (1928), who asserts that there are six basic interests or motives in personality: the theoretical, economic, aesthetic, social, political, and religious. The six projects that can be funded correspond to Spranger’s six personality traits, or values. Table 2 shows the six projects and the personality value to which each is designed to appeal. (See Appendix A for the task.) The task was pre-tested and iteratively refined over the course of six months, and over 100 students participated in these pretests of the experimental task. Correlation analysis based on the 300 experimental subjects was used to check that the amount allocated to a project by an individual was significantly correlated with that person’s values as measured by the study of values instrument (Allport, et al., 1970).

**Experimental procedures**

Experimental groups were assigned to one of three rooms. Two of the rooms were used interchangeably for baseline and manually supported groups; these were conference-style rooms, each containing a round table with comfortable seating for four people. In the “decision rooms” that were set up for the GDSS groups (cf. DeSanctis and Gallupe, 1985; Gray, et al., 1981), each subject had a terminal and was able to readily view the public screen.

The experimental procedure was as follows:

1. Subjects listened to a standard introductory script read by the administrator of the experiment and then read a background statement.
2. Subjects completed a consent form, a background questionnaire, and the study of values instrument.
3. Subjects individually allocated funds to the six projects requesting support from the philanthropic trust. (These measures were used to calculate pre-meeting consensus.) Subjects individually allocated funds to five sets of six projects each. One of these allocation tasks was later used in the group meeting and the individual scores were used to calculate pre-meeting consensus.
4. Groups allocated funds to the six projects requesting support from the philanthropic trust.
5. Subjects completed a post-meeting questionnaire for measuring an individual’s perception of the group’s decision-making process, and individually allocated funds to the 6 projects requesting support from the philanthropic trust. (These were used to calculate post-meeting consensus.)
6. The administrator conducted a debriefing of the subjects.

During step 4 of the experiment, the group decision-making phase, teams were placed into one

<table>
<thead>
<tr>
<th>Personality value</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical</td>
<td>To purchase additional volumes for the community’s library system.</td>
</tr>
<tr>
<td>Economic</td>
<td>To create a tourist bureau to develop advertising and other methods of attracting tourism into the community.</td>
</tr>
<tr>
<td>Aesthetic</td>
<td>To purchase art for display in the community’s art gallery.</td>
</tr>
<tr>
<td>Social</td>
<td>To establish a community arts program featuring art, music, and dance programs for children and adults.</td>
</tr>
<tr>
<td>Political</td>
<td>To purchase a new computer system for the county government in order to hold local taxes constant.</td>
</tr>
<tr>
<td>Religious</td>
<td>To establish an additional shelter for the homeless in the community.</td>
</tr>
</tbody>
</table>
of the three treatment groups discussed previously. Instructions for the GDSS [and Manual] groups were as follows:

In your group meeting you will follow an agenda, because this is the established practice for most organizational meetings. You are expected to use your personal judgment in following the agenda. In general, a group will follow the agenda; however, it may vary the order in which topics are handled and decide not to follow the strict sequence of the agenda. The agenda appears as the initial screen [page] of your terminal [handout]. There are one or more screens [pages] underlying each agenda item that explain its use....

You are required to use the computer system [handout]. You may vary the sequence of the items, and you do not have to use every method of assessing the group's collective opinion of alternatives. However, you must use the computer system [handout].

Baseline groups were simply told to use their own resources as a group in making decisions. All experimental conditions were instructed: "You will work as a group. It is important that you make decisions as a group. You should make a decision that is acceptable to all members of the team."

Results

Hypothesis testing

Analysis of the data indicates that there were no differences in pre-consensus, post-consensus, equality of influence, or attitudes for three and four-person groups. Therefore, the data for both group sizes has been combined to test the three hypotheses of the study.

H1: Effect on Consensus

Consensus was measured using an adaption of the method developed by Spillman, et al. (1980). This method produces a scale in the range 0 to 1, where 1 implies complete agreement in the group. Table 3 provides descriptive statistics for the three experimental conditions on measures of pre-meeting and post-meeting consensus.

For each of the three conditions, the average level of consensus improved and the variance in consensus was reduced following the group meeting. Post-meeting consensus was highest in groups receiving the manual decision aid. Table 4 shows the results of the regression analysis for effects of decision aid, pre-meeting consensus, and the interaction of these variables on post-meeting consensus. While analysis of covariance might have been the preferred approach to testing Hypothesis 1, that technique could not be used because of the presence of an interaction between the experimental treatment variable and pre-meeting consensus (the covariate). The regression results indicate that, while post-meeting consensus is significantly related to pre-meeting consensus, there are no significant differences due to the decision aid treatment. Hypothesis 1, as formulated, is not supported.

To further explore the combined effect of decision aid and pre-consensus, the correlation between post-meeting and pre-meeting consensus was examined. Table 5 shows that while there is no relationship between pre-meeting and post-meeting consensus in baseline groups, there is a significant correlation for manually supported and computer assisted groups. Figure 2 illustrates the different relationships between pre- and post-meeting consensus for the three treatment groups.

Figure 2 suggests that, in both manual and GDSS conditions, post-meeting consensus is related to pre-meeting consensus. In the baseline groups, however, there was little relationship between pre- and post-meeting consensus. In the manual and GDSS conditions, group members apparently became aware of their pre-meeting agreement and differences, whereas the baseline

<table>
<thead>
<tr>
<th>Consensus</th>
<th>Decision Aid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td></td>
<td>(N = 27)</td>
</tr>
<tr>
<td>Pre-meeting mean</td>
<td>.27</td>
</tr>
<tr>
<td>Std. dev.</td>
<td>1.00</td>
</tr>
<tr>
<td>Post-meeting mean</td>
<td>.55</td>
</tr>
<tr>
<td>Std. dev.</td>
<td>.19</td>
</tr>
</tbody>
</table>
Table 4. Regression Results for Effect of Decision Aid and Pre-Meeting Consensus on Post-Meeting Consensus

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid</td>
<td>150.7</td>
<td>2</td>
<td>2.16</td>
<td>.123</td>
</tr>
<tr>
<td>Pre-Meeting Consensus</td>
<td>212.8</td>
<td>1</td>
<td>6.09</td>
<td>.016</td>
</tr>
<tr>
<td>Decision Aid × Pre-Meeting Consensus</td>
<td>190.6</td>
<td>2</td>
<td>2.73</td>
<td>.072</td>
</tr>
<tr>
<td>Model</td>
<td>597.4</td>
<td>5</td>
<td>3.42</td>
<td>.008</td>
</tr>
<tr>
<td>Error</td>
<td>262.1</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Square = .186</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Correlation Between Pre-Meeting and Post-Meeting Consensus by Decision Aid

<table>
<thead>
<tr>
<th></th>
<th>Decision Aid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>Correlation coefficient</td>
<td>-0.022</td>
</tr>
<tr>
<td>Significance</td>
<td>0.913</td>
</tr>
</tbody>
</table>

Figure 2. Post-Meeting Consensus as a Function of Pre-Meeting Consensus by Type of Decision Aid
condition did not encourage members to reveal their pre-meeting opinions. The implication is that structure, in either manual form or in a GDSS, facilitated expression of agreement or conflict in the group.

H2: Effect on Equality of Influence

Equality of influence was measured in a two stage process. In the first stage, the influence of each person in a group was measured by comparing the relative distance of that person's individual solution from the group's solution and from a "fair" decision. A fair decision is considered one that results from each member having equal influence upon the group's decision. The second stage of the method was to combine the influence measure for each group member into a measure that indicates how equal the influence was in the group. This measure was computed by calculating influence scores for all subjects in the experiment and then combining the scores of each group to arrive at a measure of equality of influence in that group. The lower the value for the scale, the more equal the influence.

Table 6 presents descriptive statistics on equality of influence for the three experimental conditions. The trend in the means is in the expected direction, with equality of influence being most equal in the GDSS groups and most unequal in the baseline groups. Notice that the variance for the equality of influence measure is extremely high in the baseline condition. In fact, the variances across decision aid conditions are significantly different (F = 19.08, p < .001). The variances are so extreme that no transformation of the data is successful in achieving the equality of variance necessary for analysis of variance. Analysis of variance using the regression approach suggests that the differences across experimental conditions in their influence scores are not significant and that pre-meeting consensus is not a meaningful predictor of the dependent variable. (See Table 7.) A Kruskal-Wallis analysis on the ranks on the influence measure confirms the finding of no significant difference among the three experimental conditions (chi square = 1.05, p = .59).

Hypotheses 2a and 2b are not supported. However, the difference in variances across the conditions is interesting in itself. Lower variances in the manual and GDSS conditions would suggest that the imposition of structure on the meetings reduces the dispersion across groups with respect to member influence.

H3: Effects on Group Attitudes

An exploratory approach is used to examine the impact of various decision support systems upon group attitudes. The subjects' answers for each of the items in the post-meeting instrument were used in a linear discriminant analysis, a useful method of exploratory data analysis when causal relationships are not well understood (Johnson and Wichern, 1982). The decision aid received by each group is used as the classification variable. A stepwise discriminant analysis with a significance level of 5% selected seven variables for a linear discriminant function. The results are displayed in Table 8, which lists each question contributing a variable to the discriminant function, the width of the scale used to collect responses, the significance of the variable, and the mean score of the variable for each of the three treatments.

The perception of the issues explored in a group's discussion is the most important variable in discriminating between the three treatments. GDSS groups reported that their discussion was less substantial than the other two forms of decision support. In addition, GDSS groups described their problem-solving process as less understandable. The manual groups were the most confident that their solution was correct. The least confident were the baseline groups, and the members of these groups also reported that they made the fewest suggestions about doing the task. The baseline groups indicated a higher emergence of informal leadership than the other two treatments. GDSS groups perceived a higher level of input into the group's final solution. The group task was found easiest by the non-supported groups, with the other two groups reporting about the same level of difficulty.

The results of the linear discriminant analysis indicate that the attitudes of the three groups did differ. Because of the exploratory nature of this analysis, no formal methods have been used to test for significant differences in attitudes.

Some qualitative findings

Formal hypothesis testing was the major purpose of this study, and the quantitative analyses presented above must form the primary basis of any conclusions drawn from the study. Nevertheless, there were certain consistencies in behavior of the groups during the experimental sessions that are worth noting. These observations are based on the 40 hours of video and audio tape recordings of the experimental sessions. These observations
Table 6. Equality of Influence (Mean and Standard Deviation) for Three Experimental Conditions

<table>
<thead>
<tr>
<th>Decision Aid</th>
<th>Baseline (N = 27)</th>
<th>Manual (N = 26)</th>
<th>Computer (N = 28)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equality of</td>
<td>.596</td>
<td>.563</td>
<td>.557</td>
<td>.572</td>
</tr>
<tr>
<td>influence mean</td>
<td>.126</td>
<td>.051</td>
<td>.041</td>
<td>.07</td>
</tr>
<tr>
<td>Std. dev.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Analysis of Variance Using the Regression Approach for Effect of Decision Aid on Equality of Influence

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-meeting consensus</td>
<td>.328</td>
<td>1</td>
<td>1.025</td>
<td>.31</td>
</tr>
<tr>
<td>Decision aid</td>
<td>.645</td>
<td>2</td>
<td>1.006</td>
<td>.37</td>
</tr>
<tr>
<td>Error</td>
<td>24.34</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25.45</td>
<td>79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8. Discriminant Analysis: Post-Meeting Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Scale Width</th>
<th>Significance</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you describe the issues explored in your discussion?</td>
<td>7</td>
<td>0.0001</td>
<td>Baseline 5.28</td>
</tr>
<tr>
<td>How would you describe your group’s problem-solving process?</td>
<td>5</td>
<td>0.0039</td>
<td>Manual 1.68</td>
</tr>
<tr>
<td>To what extent are you confident that the group’s solution is correct?</td>
<td>5</td>
<td>0.0138</td>
<td>Computer 3.64</td>
</tr>
<tr>
<td>Did you make suggestions about doing the task?</td>
<td>5</td>
<td>0.0252</td>
<td></td>
</tr>
<tr>
<td>Did anyone emerge as an informal leader?</td>
<td>5</td>
<td>0.0363</td>
<td></td>
</tr>
<tr>
<td>To what extent does the final solution reflect your inputs?</td>
<td>5</td>
<td>0.0380</td>
<td></td>
</tr>
<tr>
<td>How easy or difficult did you find the task in a group setting?</td>
<td>5</td>
<td>0.0449</td>
<td></td>
</tr>
</tbody>
</table>

1Scale anchored on 1 (trivial) to 7 (substantial).
2Scale anchored on 1 (understandable) to 5 (confusing).
3Scale anchored on 1 (not at all) to 5 (to a very great extent).
4Scale anchored on 1 (extremely easy) to 5 (extremely hard).
have not yet been confirmed in any quantitative way, but they may be useful for explaining the lack of increase in consensus for the GDSS treatment groups vis-a-vis manual groups.

1. Use of the GDSS tended to reduce face-to-face interpersonal communication in the group.

This was suggested by several observations. First, group members appeared to interface more with the system than each other. Even though they were seated around a conference table, they frequently turned to their individual computer screens and keyboards or faced the large screen while talking to one another. Second, even though the members met face-to-face around a conference table, the electronic communication still had an asynchronous quality in that there was a delay between the presenting of an idea, vote, or comment and the other group members' viewing of that idea, vote, or comment. This was reflected in the verbal "quiet time" spent by the group as it read screens or entered text or data into the system, either as individuals or as a group. Rather than consisting of continuous verbal exchange, the meeting had periods of quiet (work) time in the midst of verbal discussion. This resulted in reduced eye contact between group members and a corresponding increase in social distance among members.

2. Use of the GDSS presented a challenge to the groups, thus making their meeting task more difficult than groups without the GDSS.

The GDSS groups appeared to struggle with the problem of how to effectively use the technology. This struggle was evidenced on two levels. First, each group member had to become comfortable with the user interface provided by the GDSS software. The 20-minute training period was sufficient time for group members to know how to use the system without asking questions or referring to the user manual. However, despite the fact that the system is menu-driven, simple in design, and easy-to-use, each user still had to think about what keys to push during the group meeting. The system was novel to them, and some mental effort was required to use the system.

In addition to becoming facile with the system interface, GDSS users faced a second challenge. They had to learn how to incorporate the features of the system into the group meeting. Whereas the groups using the manual system treated the system features as structural cues from which they would quickly develop an approach to meet their particular needs, the GDSS groups let the technology drive the group meeting and were less creative in their use of the structural cues provided by the system. With a few exceptions, GDSS users seemed to want to follow the features of the system in a very precise way, hoping that the system would somehow lead them into the "best" decision. In contrast, the manual system users appeared to utilize the support methodology as a tool, not as a "group director" who would guide them through each meeting activity. In this sense, the GDSS created a set of cognitive challenges that went beyond the task itself. Questions such as, "What should we do first?" and, "OK, what screens do we want to use now?" arose much more frequently in the GDSS groups than in the manual system groups, despite the fact that the features provided by the two approaches were identical.

3. Groups using the GDSS appeared to become very procedure-oriented, rather than issue-oriented, in their discussions.

The preference task used in this study required groups to detect differences in individual values and then resolve these value differences through discussion. Research on groups indicates that in such circumstances, groups rarely attend to the process they employ; rather, they jump directly into discussion of issues (Hirokawa and Pace, 1983). The introduction of structure thus should improve the quality of the meeting outcomes by forcing the group to consider their decision process. The manual system had this positive effect in this study. In the case of the GDSS groups, however, the groups became overly concerned with procedural matters, attending more to doing rating and voting than to the issues underlying the ratings and votes. Comments such as, "What do you want to do next?" or, "What items do you want to add to this list?" or, "How do you want to vote on these items?" were much more frequent in the GDSS groups than in groups supported with the manual system.

Discussion

This study has produced several noteworthy findings:

The main statistical test indicates no difference in mean values of post-meeting consensus among the GDSS, manual, and unsupported groups. However, secondary analysis indicates that post-meeting consensus is positively related to pre-meeting consensus in the manual and GDSS groups, whereas there is no relationship in the
baseline groups. This implies that GDSS and manual groups deal with potential conflicts in a way that improves group consensus, while baseline groups do not. A possible explanation is that baseline groups have no framework to assist them in discovering pre-meeting level of agreement in the group. As a result, they start the consensus-building process from scratch. In contrast, the structure provided to manual and GDSS groups enables them to find their initial level of agreement and build upon it to create post-meeting consensus. The finding that the GDSS improved group consensus, coupled with the finding of no overall differences in consensus level among the conditions, suggests that the GDSS do not, in itself, create conflict. Instead, by providing a structure, it seems to facilitate conflict management in the groups.

In studies of computer conferencing, Kiesler (1986) notes that the electronic medium of communication results in a loss of social context cues, which results in more negative, or "flaming," communication among members. There is some qualitative evidence that the same effect has happened in the GDSS groups in the current study. Even though the groups met face-to-face and had non-verbal and other cues available to them, heightened interaction through the electronic medium, coupled with greater human-computer interaction relative to human-human interaction, seemed to increase the sense of distance among members. At times the groups sought context information. For example, in response to a controversial idea presented on the large screen, there might be comments such as, "Who said that?" followed by people turning to observe each other's faces. The group's cognitive struggle and procedural orientation may imply that chauffeurs will be necessary in GDSS settings. Or it may be that repeated use of a GDSS will reduce these problems. Notwithstanding, in this case the GDSS does not seem to have produced conflicts that have a negative impact on group outcomes. The positive intended outcomes of imposing a structure seem to outweigh the negative impacts of more aggressive communication.

No differences are found in equality of influence among the three conditions. This is inconsistent with the findings of previous studies. However, there is less variation in influence scores in the GDSS and manual conditions than in the baseline groups. This suggests that imposing structure regularizes influence patterns in groups.

Overall, the results on consensus and equality of influence for the GDSS and manual conditions tend to be similar, showing different patterns than the results for the baseline condition. It may be that a finding of "no difference" is the best we could expect, since only a Level-1 GDSS was employed. Enhancements provided by a Level-2 system may be required in order to detect notable improvements from the use of a GDSS. Firm conclusions on this point, however, must await further research, particularly interaction analysis that compares the pattern and style of group processes across baseline, manual, and computer-support conditions.

There was a difference in attitudes among the three treatments. The manually supported groups seemed to have the most "positive" attitudes. It appears that the novelty of the GDSS may have produced some unintended sentiments in computer-supported groups. The newness of the technology could explain why GDSS groups reported less substantial discussion of the issues and a less understandable problem-solving process. Group members expected the computer to produce the solution for them. They focused on using the system very mechanically and were sometimes dismayed when the system did not magically give the "right" answer. These effects may be transient and disappear with sustained usage. In many groups the system became an end in itself. Practice, or use of a facilitator or chauffeur, may lessen this effect. In the case of the small group meeting, it is desirable to have a user-driven system without the expensive cost of a facilitator. More work on GDSS design and group instructions (learning) is needed before abandoning the idea of having groups use a GDSS on their own without technical or other assistance. Negative effects point to the importance of further study of a GDSS in the laboratory before moving into the field. Only by use of control groups can we expect the relative added value of a GDSS to group meetings be assessed.

This study has several important limitations that prohibit generalization of the findings to other populations or settings. The groups in this study were small, and further research might examine whether the same results will occur in larger groups. In addition, there is the common problem of current GDSS research in that the software system used was home-grown by the researchers. While the research of Siegel, et al. (1986) on computer support of remote group decision making suggests that the impacts of the technology are "relatively robust with respect to software variations" (p. 177), there is always the question of whether a differently designed Level-1 GDSS, or the same GDSS with Level-2 features, would change the nature of the findings of this study. Fi
nally, there is the usual concern with the use of students as subjects and the appropriateness of such a sample for understanding the nature of managerial meetings.

This investigation has identified some intended and unintended effects of using a decision support system for groups. As intended, the presence of a suggested structure for the group meeting improved the degree of post-meeting consensus. Also, in contrast to the baseline and manual system group meetings, users of the GDSS reported more input into the group's solution and were less likely to perceive that there was a leader in the group. The relationship between pre-meeting and post-meeting consensus was similar in GDSS and manual groups, but post-meeting consensus was not significantly higher in the GDSS groups than in the baseline or manual groups. Although the structure provided in the GDSS and manual conditions reduced the variance across groups on their equality of influence, use of the GDSS did not result in more equal influence of group members on the final solution. The most surprising unintended effect was that GDSS users, compared to the other experimental groups, perceived the issues discussed in the group meeting to be more trivial and the group's problem-solving process to be less understandable. In the future, GDSS research should press further to sort out what Kiesler (1986) calls "intended technological effects" (faster processing, fewer errors, more equal participation), "unintended social effects" (heightened conflict), and "transient effects" (effects that will diminish with group experience with the system) of the technology on groups. Research on group behavior indicates the importance of using groups with a meaningful history and future whenever possible.

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Appendix

The Research Task: Personal Trust Foundation

Background

Uncle Sylvester is dead. He had lived a most productive life and accumulated a small fortune. As you were his favorite, you have been made the sole trustee of your uncle’s estate. Your uncle had considerable respect for your personal values, and he had directed that, upon his death, you should decide how to allocate the funds that he had placed into the Personal Trust Foundation. This is the opportunity of a lifetime. You alone will decide how to spend the money. Just imagine, you can help those people or projects that are closest to your heart.

The Foundation’s goal is to fund projects in the community in which your uncle worked and lived most of his life. You are required to select programs that you consider to be deserving of a donation from your uncle’s foundation. Because he was a man who never sought publicity, your uncle has specified that you should not be influenced by the extent to which a program will honor him or preserve the public’s memory of him. Although many factors may influence the decisions regarding which programs to fund or not to fund, the most critical factor is the degree to which a program agrees with your personal values.

Directions

You must evaluate competing requests for funding and make judgments about their relative merit. Many programs have merit, but limited resources require that you select the programs that you prefer to fund. You have discretionary funds available, and a number of projects are requesting access to these funds. Your job is to select those that should receive support. Your goal in selecting projects for funding is to choose those programs that agree with your personal values.

Begin when you are ready.

Personal Trust Foundation: $500,000

You have $500,000 to allocate from this fund. Proposals received from various organizations for projects are listed below. Each project is in need of $500,000 but can benefit from any contribution that you might make. The greater the contribution that you make to a particular project, the more likely it is that the chosen project will succeed.

Proposed project

<table>
<thead>
<tr>
<th>Proposed project</th>
<th>Recommended level of Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To purchase a new computer system for the county government in order to hold</td>
<td>$</td>
</tr>
<tr>
<td>2. To purchase additional volumes for the community’s library system.</td>
<td>$</td>
</tr>
<tr>
<td>3. To create a tourist bureau to develop advertising and other methods of</td>
<td>$</td>
</tr>
<tr>
<td>attracting tourism into the community.</td>
<td>$</td>
</tr>
<tr>
<td>4. To establish a community arts program featuring art, music, and dance</td>
<td>$</td>
</tr>
<tr>
<td>programs for children and adults.</td>
<td>$</td>
</tr>
<tr>
<td>5. To establish an additional shelter for the homeless in the community.</td>
<td>$</td>
</tr>
<tr>
<td>6. To purchase art for display in the community’s art gallery.</td>
<td>$</td>
</tr>
<tr>
<td>TOTAL FUNDS ALLOCATED</td>
<td>$500,000</td>
</tr>
</tbody>
</table>