

December 1996

# A Meta-Analysis of Effectiveness, Efficiency, and Participant Satisfaction in Group Support Systems Research

Alan Dennis  
*University of Georgia*

Barbara Haley

Robert Vandenberg

Follow this and additional works at: <http://aisel.aisnet.org/icis1996>

---

## Recommended Citation

Dennis, Alan; Haley, Barbara; and Vandenberg, Robert, "A Meta-Analysis of Effectiveness, Efficiency, and Participant Satisfaction in Group Support Systems Research" (1996). *ICIS 1996 Proceedings*. 20.  
<http://aisel.aisnet.org/icis1996/20>

This material is brought to you by the International Conference on Information Systems (ICIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in ICIS 1996 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact [elibrary@aisnet.org](mailto:elibrary@aisnet.org).

# **A META-ANALYSIS OF EFFECTIVENESS, EFFICIENCY, AND PARTICIPANT SATISFACTION IN GROUP SUPPORT SYSTEMS RESEARCH**

**Alan R. Dennis**  
**Barbara J. Haley**  
**Robert J. Vandenberg**  
University of Georgia

## **Abstract**

Group Support Systems (GSS) have been the subject of much research over the past decade, but drawing overall conclusions about their effects has not been easy. In some studies, GSS use has improved performance, while in others, it has had no effects, or even resulted in decreased performance. This study presents a meta-analysis investigating the effects of GSS use in face-to-face decision making on effectiveness, efficiency, and participant satisfaction. The results suggest that, in general, GSS use improves decision quality, increases the number of ideas generated, requires more time to complete the task, and has no effect on participant satisfaction. However, the effects depend greatly on the size of the group and whether the process used by the group (solely electronic communication or a combination of electronic and verbal) matches the task (idea generation or decision making). Large groups benefitted significantly more from GSS use than small groups (for whom GSS use had few benefits). Groups for whom the process matched the task (electronic communication for idea generation and a combination of electronic and verbal for decision making) benefitted significantly more from GSS use (better decisions and more ideas) than groups for whom the process did not match.

## **1. INTRODUCTION**

Group Support Systems (GSS) have been the subject of much research over the past decade, and many studies have been published on the effects of GSS use. Unfortunately, drawing some overall evaluative conclusions about the effects has not been easy. In some studies, GSS use improved group performance, while in others, it had no effect, or even resulted in decreased performance. Many researchers reviewing this body of research have expressed concerns about the inconsistencies in the findings (e.g., Benbasat, DeSanctis and Nault 1993; Bui and Sivasankaran 1990; Dennis and Gallupe 1993).

In an effort to address these concerns, McLeod (1992) and Benbasat and Lim (1993) conducted statistical meta-analyses of the cumulative research findings up to 1990 and 1992, respectively. The conclusions from these analyses were consistent with theoretical expectations in that GSS use was found to have overall positive effects on decision quality and on the number of alternatives or ideas generated, but, unexpectedly, to have negative effects on participant satisfaction.

A significant time period has passed, and many more studies have been completed since 1992 (Benbasat and Lim's cutoff date for including studies). In fact, twenty-three of the studies included in the present study were not available when the previous meta-analyses were written. Benbasat and Lim found that the publication year of a GSS study had a significant effect on the outcome of GSS use, suggesting that a meta-analysis including more recent studies may offer valuable insight into the cumulative body of GSS findings.

---

**Acknowledgment.** We would like to thank Frank Schmidt and Jose Cortina for their helpful assistance in designing the meta-analysis procedure.

The purpose of this study is to present a meta-analysis investigating the effects of GSS use in face-to-face decision making. We focus on three constructs believed to be among the most influenced by GSS use, and thus, of importance to researchers and practitioners: (a) effectiveness, (b) efficiency, and (c) participant satisfaction (Nunamaker et al. 1991a). We also consider two factors that may have important effects on performance: group size and process by which the GSS is used.

## **2. GROUP SUPPORT SYSTEMS AND THEIR EFFECTS ON GROUP WORK**

Although different types of GSS can be used in a variety of ways (Jessup and Valacich 1993), this study focused solely on GSS used to support face-to-face meetings. Most business meetings that incorporate GSS occur in a face-to-face setting, and numerous research studies have addressed this particular approach. In face-to-face settings, the computer-mediated electronic communication provided by the GSS either supplements or replaces verbal communication. Conceptually, electronic communication consists of many different components, each of which introduces “process gains” and “process losses” (Nunamaker et al. 1991b). Two process gains are particularly important: parallelism and anonymity (Nunamaker et al. 1991b).

Parallelism is the ability of group members to simultaneously enter information. All participants have computer workstations enabling them to contribute information and opinions through typed media. Since participants type at the same time, no participant need wait for others to finish before contributing information, and the comments are shared immediately with all other participants. In contrast, the need to wait in verbal discussions (termed production blocking) has been identified as a major cause of poor performance in verbally interacting groups (Diehl and Stroebe 1987; Lamm and Trommsdorff 1973). The parallelism provided by the GSS mitigates production blocking resulting in process gains (Valacich, Dennis, and Connolly 1994).

Anonymity enables group members to contribute comments without being identified and, as such, is believed to result in an increased motivation to participate over that in non-anonymous situations. Without anonymity, individuals, particularly low status participants, may withhold ideas due to negative evaluation apprehension (Diehl and Stroebe 1987; Lamm and Trommsdorff 1973) or may feel pressured to conform to the group majority or senior participants’ views (Hackman and Kaplan 1974). Anonymity reduces the reluctance to contribute information, because it shields the contributor from group reaction (Connolly, Jessup and Valacich 1990).

GSS use is not without costs, however. Offsetting the “process gains” from parallelism and anonymity, electronic communication introduces several sources of “process losses” (Nunamaker et al. 1991b). One important source of process losses is the physical act of typing. Obviously, typing is slower than speaking, so GSS use imposes temporal delays in the communication process. A second important loss is media richness (Daft and Lengel 1986). Different media vary in their ability to convey different types of information (e.g., specific words, voice inflection, gestures) and in their ability to provide feedback (e.g., how quickly someone can respond to a comment). Daft and Lengel argue that face-to-face verbal discussions are richer than written text because verbal discussions include the nonverbal aspects such as vocal inflections and gestures, and faster feedback. This richer medium is particularly important in decision making tasks where participants need to develop a shared understanding, but it offers less advantage for less equivocal information exchange tasks (Daft and Lengel 1986; Rice 1992).

Under what circumstances would GSS lead to better (or worse) performance in terms of effectiveness, efficiency, and participant satisfaction? Logically extending the above material would suggest that the general answer is one of balance. Namely, improved performance occurs under conditions in which the process gains from GSS use are structured purposely to outweigh process losses. Assuming that improved performance was the desired outcome, we anticipated that researchers would design studies to create conditions under which GSS use would benefit groups. Therefore, we hypothesized:

*Hypothesis 1: Across all studies, GSS use will have a generally positive influence upon effectiveness, efficiency, and satisfaction.*

Although it is important to first demonstrate support for the omnibus hypothesis, it is perhaps more interesting and more useful to consider the conditions that may modify the influence of GSS process gains. Two conditions of theoretical and practical relevance are group size and matching process to task.

## 2.1 Group Size

Before the introduction of GSS, the optimal group size in verbally interacting situations was believed to be three to five participants (Shaw 1981). Larger sizes resulted in dramatically increasing problems due to production blocking. By contrast, the parallelism in GSS groups enables everyone to contribute at any given moment in time without waiting for others. Thus, theoretically there should be no production blocking, even in large groups (Valacich et al. 1993).

Anonymity also can be provided in a GSS. How it results in a gain, however, depends on group size. Anonymity is impossible to maintain in two person face-to-face GSS groups, and is questionable even in three or four person groups (e.g., one can recognize another's writing style, etc.). In larger groups (e.g., greater than five), anonymity becomes more effective because it becomes increasingly difficult to identify the author of a comment. As such, participants in GSS meetings with large groups likely view anonymity to be more of a shield than when interacting in small GSS groups. Thus, anonymity should have stronger effects in larger groups — or at least in groups larger than some minimum needed to enable a participant's identity to "get lost in the crowd."

There is some empirical support for the fact that greater differences between GSS and non-GSS groups occur under large group conditions than under small group conditions (Benbasat and Lim 1993; Dennis and Valacich 1993; Gallupe et al. 1992; Valacich et al. 1993). Therefore, we hypothesize:

*Hypothesis 2: GSS use will have greater performance effects in large groups than in small groups.*

## 2.2 Matching Process to Task

Task technology fit theory suggests that certain technologies (e.g., GSS) may have different effects when used to perform different tasks (Goodhue and Thompson 1995). Certain GSS characteristics and the way in which they are used may better "fit" the needs of different tasks (Sambamurthy and Poole 1992). Thus, in order to better understand the effects of GSS use, we need to examine more closely how the process gains and losses they offer may fit different types of tasks.

The electronic communication provided by a GSS can be used either to augment or to replace traditional verbal discussion. In some studies, participants have been restricted in their use of the GSS so that they can only communicate electronically, and as such, no verbal communication was permitted (e.g., Gallupe et al. 1992; Strauss 1996). In other studies, participants combined both electronic and verbal media (e.g., Gallupe, DeSanctis, and Dickson 1988; Jarvenpaa, Rao, and Huber 1988). In others, the GSS was used without electronic communication, and basically was treated as an electronic blackboard (e.g., Jarvenpaa, Rao and Huber 1988; Tyran, George and Nunamaker 1993). While the overall expectation has been that situations promoting electronic communication should result in more positive outcomes than situations combining electronic communication with verbal communication, the actual balance between process gains and losses may depend upon the task undertaken by the groups.

McGrath (1984) divides tasks into four broad categories, two of which are particularly relevant to GSS research: (a) generation tasks (of ideas and plans), and (b) decision-making tasks (both intellective, where there is a correct answer, and judgment, where there is not). For generation tasks, participants must work together to produce a list of ideas. Generation tasks are typically additive tasks in that the outputs of all participants are combined to form the group output. Further, members need not select among the ideas nor come to consensus on a shared understanding of the ideas. Decision-making tasks, in contrast, require participants to develop a shared understanding of both the criteria and alternatives, and reach a consensus on which alternative(s) is best.

The process gains resulting from electronic communication (parallelism and anonymity) are equally important for both generation and decision-making tasks. Process losses due to typing speed also are likely to be felt equally for both tasks. The mechanism through which task type may moderate the effects of GSS on the dependent variables is the process loss due to media richness. In short, decision-making tasks require participants to reach consensus on a shared meaning — a situation benefitting from the "richness" offered by verbal discussion (Daft and Lengel 1986). Generation tasks have no such requirement, making media richness less important.

As a result, for generation tasks, the benefits of using purely electronic communication should outweigh the losses. Conversely, decision-making tasks with the requirement of high media richness to reach agreement should benefit from a combination of both electronic and verbal communication. Therefore:

*Hypothesis 3: GSS use will have greater performance effects when the process by which the GSS is used matches the needs of the task (solely electronic communication for generation tasks and a combination of electronic and verbal communication for decision-making tasks) than when the process does not match the task.*

### **3. METHOD**

#### **3.1 Selection of Studies**

When selecting studies for the meta-analysis, we looked for all studies that met three criteria: 1) a treatment group (GSS use) and a control group (verbal interaction without a GSS) were directly compared; 2) group members met in the same room at the same time; and 3) effectiveness, efficiency, and/or satisfaction were measured. The first criterion was dictated by the meta-analysis technique which required the effects of GSS presence on the dependent variables, and not other constructs. The second criterion was used because groups that meet face-to-face may differ in theoretically important ways from distributed groups (Valacich et al. 1993) and to ensure that Hypothesis 3 could be tested (most distributed groups do not use a process that combines both electronic and verbal communication). The use of effectiveness, efficiency, and satisfaction is discussed in the dependent measures section of this paper. All studies that met these criteria were included in this study.

To locate studies, we performed computer searches on a dozen databases, did manual searches through leading MIS, psychology, and communication journals, read previous literature reviews, and posted messages soliciting studies on the GSS-L listserv. This resulted in 218 studies, of which 35 met the criteria for use in our analyses (indicated by an \* in the reference list). Of those studies, 21 crossed the GSS and non-GSS condition with levels of some other independent variable. For example, Gallupe et al. (1992) reported the comparison between GSS and non-GSS groups for five levels of group size. Studies containing several such comparisons were disaggregated and treated as separate data points (e.g., the Gallupe et al. [1992] study resulted in five data points). The data set used in the analysis therefore had 64 data points.

It should be noted that four field studies were included in the meta-analysis. Due to different design characteristics, some researchers argue that field studies should be excluded from a meta-analysis primarily consisting of lab studies. We believe this is inappropriate. Although the effect sizes may differ between the two types of studies, they should be directionally consistent across all studies if there is any internal validity to the theoretical premises explaining the effects (Cook and Campbell 1979). Otherwise, the ability to generalize is questionable beyond the artificiality of a laboratory context. Nonetheless, a “design” dummy code was included in the current analysis to check this assumption.

#### **3.2 Dependent Measures**

A number of dependent variables have been used in GSS research over the years. From a theoretical standpoint, there are few compelling reasons to choose one variable over another (it would be difficult to conclude, for example, that consensus is theoretically more important than decision quality). From a practical standpoint, one of the key issues facing managers is how GSS affects performance within organizations. Therefore, following the work of Drazin and Van de Ven (1985), we chose to examine three dependent variables: (a) effectiveness as operationalized through decision quality, and/or the number of ideas/alternatives discussed; (b) efficiency as defined by the time to complete the task; and (c) participants’ satisfaction. These variables have featured prominently in previous research and meta analyses (Benbasat and Lim 1993; McLeod 1992; Pervan 1995).

The effects of the GSS condition upon the various dependent variables were transformed to  $d$  values according to the equation presented by Cohen (1977); see Hedges and Olkin (1985) and Hunter and Schmidt (1990). In brief, the mean value on the

dependent variable for the non-GSS subjects is subtracted from the mean value for the GSS subjects, and this difference is divided by the pooled standard deviation from both conditions. The net effect of this transformation is that the differences are now standardized to a common metric across all studies which in turn means that effect sizes may be statistically combined and evaluated.

### **3.3 Analytic Procedure**

It is beyond the scope of this paper to describe in any detail the statistical algorithm underlying a meta-analysis (see Hunter and Schmidt 1990). In brief, the procedure computes a weighted average across all effect sizes on a given dependent variable (we used the random effects approach). This average  $d$  is corrected for sampling error variance and, thus, is considered to be the least biased estimate of the underlying population (true) effect. In the present case, positive effects meant that GSS use resulted in higher values along the dependent variables, and negative effects meant that GSS use resulted in lower values along the dependent variables. If this  $d$  is statistically significantly different from zero (and a 95% confidence interval around it does not include zero), we conclude that GSS has a significant effect, either positive or negative.

### **3.4 Hypothesis 1**

With Hypothesis 1, estimated effect sizes had to be statistically different from 0. Further, a test of homogeneity in variance should have indicated that 75% or more of the variance across the effect sizes of a given dependent variable was due to sampling error variance (Hunter and Schmidt 1990). Failure to find that 75% or more of the variance across effect sizes cannot be accounted for by sampling error alone, however, is not grounds for rejecting a hypothesis. It has been demonstrated that the most likely source of such variance is artifacts within the database (Hunter and Schmidt 1990). Thus, a first step includes a careful examination of the database to identify and remove such artifacts. One artifact that is easily identifiable and controllable is the presence of outliers within the database (see Hunter and Schmidt 1990, pp. 68, 93, 207 and 262-263, for reasons why outliers are most likely aberrant and artifactual). The present study employed a disjoint cluster analysis procedure to remove outliers (Hedges and Olkin 1985; Mullen and Rosenthal 1985). When we could not account for 75% of the variance through sampling error alone, the distribution of effect sizes was cluster analyzed using a very conservative alpha level (.01). We removed any study that was statistically significant from the others in the database, and re-conducted the main analyses. If the test of homogeneity still failed, this meant that the distribution of effect sizes was a function of some systematic influence such as a moderator variable.

### **3.5 Hypotheses 2 and 3**

The two theoretical moderators from Hypotheses 2 and 3 (group size and process matched to task) were coded into the database as follows. Studies with group sizes of five or less were coded a 1 (small), while those with greater than five person groups were coded a 2 (large). We choose a size of five because it is arguably the maximum optimal group size for non-GSS groups (Shaw 1981). Similarly, idea generation, decision making, or a combination of idea generation and decision making were coded 1, 2, and 3, respectively. Process was coded as 1 (a combination of electronic and verbal communication) or 2 (electronic communication only). Studies where process matched the task (electronic communication for idea generation and a combination of electronic and verbal for decision making or for idea generation and decision making) were coded as a 1, and non-matched studies were coded as a 0.

Tests for our two theoretical moderator variables (group size and process matched to task) were done on the entire data set including outliers (outliers were only removed to determine overall population-level effect sizes). The data for each moderator variable were partitioned by coding level and analyzed separately using the same process as described in Hypothesis 1. The values were then compared using t-tests to check for differences between coding levels.

## 4. RESULTS

### 4.1 Hypothesis 1: Overall Effects

We hypothesized that GSS use should have positive effects on effectiveness (decision quality and number of ideas), efficiency (the time to complete the task) and participant satisfaction. Table 1 presents the results. The effects to focus on are those after removing outliers (the specific outliers removed are discussed in the next section).

H1 was partially supported. GSS use on average across the set of studies resulted in higher decision quality ( $Z=2.42$ ,  $p<.008$ ), and a greater number of ideas ( $Z=3.67$ ,  $p<.001$ ), but did so at the cost of less efficiency (took more time) ( $Z=3.90$ ,  $p<.001$ ). There were no significant effects for satisfaction ( $Z=.11$ ,  $n.s.$ ). Effects for decision quality and time were relatively homogeneous, but even after removing outliers, the test of homogeneity for the number of ideas failed.

**Table 1. Overall Effect Sizes**

Measure	n	Effect Size	Homogeneity Q	Percent Explained
<b>Decision Quality</b>				
Overall	35	.154?	83.26***	69%
After removing outliers	34	.191**	49.72*	90%
<b>Number of Ideas</b>				
Overall	26	.769***	81.66***	32%
After removing outliers	24	.600***	64.36***	46%
<b>Time</b>				
Overall	15	.451*	26.25*	55%
After removing outliers	14	.547***	10.78	100%
<b>Participant Satisfaction</b>				
Overall	43	-.077	398.89***	31%
After removing outliers	39	.007	148.43***	74%

?<.10   \*p<.05   \*\*p<.01   \*\*\*p<.001

### 4.2 Hypothesis 2: Group Size

We hypothesized that effect sizes would be stronger in large group conditions than in small group conditions. The findings generally supported H2 (see Table 2). Effect sizes for large groups were statistically larger than those for small groups on the number of ideas ( $t(24)=2.32$ ,  $p<.015$ ) and on participant satisfaction ( $t(43)=5.78$ ,  $p<.001$ ). The effect size for time was smaller for large groups (i.e., less time taken), but only approached significance ( $t(13)=1.54$ ,  $p<.074$ ). While the effect size for decision quality favored large groups, it did not differ from small groups ( $t(33)=0.83$ ,  $n.s.$ ).

In considering the meta-analyses on small and large groups separately, GSS use in small groups had no statistically significant effect on decision quality, significantly increased the time to complete the task, and significantly reduced satisfaction, but did significantly increase the number of ideas. Thus, in general, GSS use impaired the performance of small groups more than it helped. In contrast, GSS use in large groups statistically increased decision quality, number of ideas, and participant satisfaction, and it had no significant effect on time. In general, GSS use improved performance of large groups.

Table 2. Effect Sizes of Potential Moderators

Group Size	Small		Large		Significantly Different?
	n	Size	n	Size	
Decision quality	25	.142	10	.318*	No
Number of Ideas	20	.615**	6	1.300**	Yes*
Time	10	.580***	5	.042	Maybe?
Participant Satisfaction	29	-.309**	14	.439**	Yes***
Process to Task	Matching		Non-Matching		Significantly Different?
	n	Size	n	Size	
Decision Quality	13	.378**	22	.022	Yes*
Number of Ideas	13	1.257***	13	.234	Yes***
Time	5	.240	10	.602*	No
Participant Satisfaction	21	.126	22	-.291*	Yes***

?<.10   \*p<.05   \*\*p<.01   \*\*\*p<.001

4.3 Hypothesis 3: Matching Process to Task

Effect sizes were expected to be stronger in conditions where process matched task. The findings generally supported H3. Effect sizes for matched groups were statistically larger than those for non-matching groups for decision quality (t(33)=2.00, p<.027), number of ideas (t(24)=4.36, p<.001), and participant satisfaction (t(43)=3.43, p<.001). While the effect size favored matched groups for time (i.e., less time taken), they did not statistically differ from the unmatched groups (t(13)=1.04, n.s.).

Once again, considering each group separately highlights an interesting pattern. When process did not match task, GSS use had no statistically significant effect on decision quality, or the number of ideas generated, but took longer and reduced participant satisfaction (see Table 2). In short, GSS use impaired performance when the process was not matched to task. When process matched the task, GSS use significantly improved decision quality and the number of ideas, without increasing the time required to complete it or affecting participant satisfaction.

5. DISCUSSION

The purpose of the current study was to draw some overall conclusions across studies about GSS use in face-to-face situations. While GSS use in general resulted in greater effectiveness (i.e. , decision quality and the number of ideas generated), it did so at the cost of efficiency as reflected in the increased time to complete the tasks. These findings are similar to those found in past meta-analyses (Benbasat and Lim 1993; McLeod 1992). This pattern, however, does not tell the full story. The tests of two theoretical moderators (group size and process matched to task) found that, as hypothesized, GSS use has its strongest positive effects when conditions are structured to favor process gains: that is, when used by larger rather than smaller groups and by matching process to task.

Somewhat unexpected were the nonsignificant findings for participant satisfaction in the test of Hypothesis 1, especially because past meta-analyses found that, satisfaction decreased with GSS use (Benbasat and Lim 1993; McLeod 1992). However, the test of Hypothesis 2 found that in small groups, GSS use decreases satisfaction, while it increases satisfaction in large groups. The combination of data from both small and large groups in Hypothesis 1 resulted in an average effect size near zero.



It appears that optimal conditions (large groups and matched tasks) for GSS use must exist before satisfaction may be enhanced; however, the nonsignificant effect size for matched task indicates that GSS use does not necessarily increase satisfaction. GSS use resulted in dissatisfaction when applied in less than optimal conditions as indicated by the statistically significant negative average  $d$  values for small groups and non-matching groups. These findings suggest that perhaps GSS use is viewed by participants to be a hygiene factor (dissatisfier) as proposed by Herzberg in his classic work (Herzberg, Mausner and Synderman 1953). Namely, if conditions are optimal, the presence of GSS in the face-to-face environment should not be expected to increase satisfaction to a high degree, but instead to prevent dissatisfaction.

A possible future hypothesis could explore whether, in face-to-face situations, GSS is not unlike other tools in the work environment that are perceived as hygiene factors; that is, like other tools there is nothing inherently or intrinsically satisfying about the tool itself. However, if the conditions for tool use are not optimal (one has a straight-edged screwdriver when a Philips-head is required), then a user becomes quickly dissatisfied with it. The pattern of outcomes for participation satisfaction are quite suggestive that this process may be operating with GSS as well. However, to be completely confident in this, more research is needed.

An examination of the outliers can also shed some light on the effects of GSS use. Perhaps one of the more interesting outliers is the Dennis, Hayes and Daniels (1994) study, which was one of only two studies to find that GSS use decreased the time required to complete a task and decreased it rather dramatically (an effect size of almost -2). It was also one of the few field studies in our data set. One of the obvious differences between this study and all the other studies in our data set was the size and complexity of the tasks. The amount of time spent in face-to-face meetings for the projects in this study was typically one to five weeks (yes, that was *weeks not hours* spent in *face-to-face meetings*, not elapsed or calendar time). This is several orders of magnitude different from all other studies. One implication is that while GSS use may increase or have little effect on the time required to complete “short” tasks (e.g., those that can be completed in an hour or less), it may reduce the time needed for extremely complex tasks that require many hours of face-to-face meetings to complete.

Task complexity also played a role in two other outliers. GSS groups working on the more complex task in Gallupe, DeSanctis and Dickson (1988) generated more alternatives relative to non-GSS groups than in other studies, while GSS groups working on the less complex task in the same study were less satisfied relative to non-GSS groups than in other studies. Thus, GSS use may be more useful for higher complexity tasks than for lower complexity tasks. These may also represent measurement effects unique to this study. The number of alternatives considered by the groups in this study differed by only two items (4.67 for the GSS groups versus 2.50 for the non-GSS groups), so while there was considerable difference statistically between the two means, the absolute difference was quite small. Likewise, satisfaction was measured by a single item questionnaire measure with a mean difference of just over one point on a seven point scale (3.72 versus 2.50).

Two other outliers suggest that group size is important. The large GSS groups in the Aiken et al (1994) study (groups with more than forty members) reported higher satisfaction relative to non-GSS groups than in other studies. The large GSS groups in the Gallupe et al. (1992) study (twelve member groups) generated more ideas relative to non-GSS groups than in other studies. The implication is that larger GSS groups may generate more ideas and be more satisfied.

The remaining three outliers come from the same study (Straus and McGrath 1994). The GSS groups working on this study’s judgment task made decisions of lower quality and were less satisfied relative to non-GSS groups than in other studies, while GSS groups working on the intellectual task were less satisfied relative to non-GSS groups than in other studies. In this study, participants worked in three-person groups and could only communicate electronically; two participants’ view of each other was intentionally obstructed by a partition and the third participant was seated with his or her back to the other two. Comments were not anonymous, so the only contribution provided by the GSS was parallelism to overcome production blocking which is not a major problem in a three-person group. However, the slowness of typing and the decreased media richness needed for both of these decision making tasks were likely major causes of the poor performance in GSS groups. In short, the process by which the GSS was used did not match the needs of the task, so the poor performance is likely due to this mismatch.

In summary, this study has clear implications for GSS users. First, while GSS use is likely to have some positive impacts, it is important to ensure its appropriate use. GSS use will be more successful when the process by which it is used matches the task (solely electronic communication for idea generation tasks, and a combination of electronic and verbal communication

for decision making tasks). Indeed, using it with a process that does not match the task (e.g., eliminating verbal discussion for decision making tasks) will impair performance relative to face-to-face verbal discussion to such an extent that you are better off not using it (unless, of course, a face-to-face meeting is not possible). Second, GSS use is likely to be more beneficial to larger groups than smaller groups. While our results suggest that GSS use generally benefits larger groups, they also suggest that GSS use causes more harm than good for small groups. Our advice: don't use it to support face-to-face idea generation or decision making in small groups (i.e., five members or less). This advice also applies to researchers. If the researcher is looking to test GSS in conditions where GSS use should be beneficial, he or she should study larger groups.

## 6. REFERENCE

- \*Aiken, M.; Krosp, J.; Shirani, A.; and Martin, J. "Electronic Brainstorming in Small and Large Groups." *Information and Management*, Volume 27, 1994, pp. 141-149.
- \*Anson, R.; Bostrom, R.; and Wynne, B. "An Experiment Assessing Group Support System and Facilitator Effects on Meeting Outcomes." *Management Science*, Volume 41, Number 2, 1995, pp. 189-208.
- Benbasat, I.; DeSanctis, G.; and Nault, B. R. "Empirical Research in Managerial Support Systems: A Review and Assessment." In C. Hosapple and A. Whinston, Editors, *Recent Developments in Decision Support Systems*. Berlin: Springer-Verlag, NATO ASI Series, Volume 101, 1993, pp. 383-437.
- Benbasat, I., and Lim, L. H. "The Effects of Group, Task, Context, and Technology Variables on the Usefulness of Group Support Systems: A Meta-Analysis of Experimental Studies." *Small Group Research*, Volume 24, 1993, pp. 430-462.
- Bui, T., and Sivasankaran, T. R. "Relation between GDSS Use and Group Task Complexity." *Proceedings of the Twenty-Third Hawaii International Conference on Systems Sciences*, Volume 3, 1990, pp. 554-563.
- \*Cass, K.; Heitz, T. J.; and Kaiser, K. M. "An Investigation of Satisfaction When Using a Voice Synchronous GDSS in Dispersed Meetings." *Information and Management*, Volume 23, 1992, pp. 173-182.
- \*Chidambaram, L., and Bostrom, R. P. "Evolution of Group Performance Over Time: A Repeated Measures Study of GDSS Effects." *Journal of Organizational Computing*, Volume 3, Number 4, 1993, pp. 443-469.
- \*Chidambaram, L., and Jones, B. "Impact of Communication Medium and Computer Support on Group Perceptions and Performance: A Comparison of Face-to-Face and Dispersed Meetings." *MIS Quarterly*, Volume 17, Number 4, 1993, pp. 465-491.
- Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. New York: Academic Press, 1977.
- Connolly, T.; Jessup, L. M.; and Valacich, J. S. "Effects of Anonymity and Evaluative Tone on Idea Generation in Computer-Mediated Groups." *Management Science*, Volume 36, 1990, pp. 689-703.
- Cook, T. D., and Campbell, D. T. *Quasi-experimentation: Design and Analysis Issues for Field Studies*. Chicago: Rand McNally, 1979.
- Daft, R. L., and Lengel, R. H. "Organizational Information Requirements, Media Richness and Structural Design." *Management Science*, Volume 32, 1986, pp. 554-571.
- \*Dennis, A. R. "Information Exchange and Use in Small Group Decision Making." *Small Group Research*, in press.
- \*Dennis, A. R. "Information Exchange in Group Decision Making." *Proceedings of the Academy of Management*, 1993, pp. 283-287.

Dennis A. R., and Gallupe, R. B. "A History of GSS Empirical Research: Lessons Learned and Future Directions." In L. M. Jessup and J. S. Valacich, Editors, *Group Support Systems: New Perspectives*. New York: Macmillan, 1993, pp. 59-77.

\*Dennis, A. R.; Hayes, G. S.; and Daniels, R. M. "Re-engineering Business Process Modeling." *Proceedings of the Twenty-Seventh Hawaii International Conference on Systems Sciences*, Volume 4, 1994, pp. 244-253.

\*Dennis, A. R., and Valacich, J. S. "Computer Brainstorms: More Heads are Better Than One." *Journal of Applied Psychology*, Volume 78, Number 4, 1993, pp. 531-537.

Diehl, M., and Stroebe W. "Productivity Loss in Brainstorming Groups: Toward the Solution of a Riddle." *Journal of Personality and Social Psychology*, Volume 53, 1987, pp. 497-509.

Drazin, R., and Van de Ven, A. H. "Alternative Forms of Fit in Contingency Theory." *Administrative Science Quarterly*, Volume 30, 1985, pp. 514-539.

\*Gallupe, R. B.; Bastianutti, L. M.; and Cooper, W. H. "Unblocking Brainstorms." *Journal of Applied Psychology*, Volume 76, Number 1, 1991, pp. 137-142.

\*Gallupe, R. B.; Cooper, W. H.; Grise, M.-L.; and Bastianutti, L. M. "Blocking Electronic Brainstorms." *Journal of Applied Psychology*, Volume 79, Number 1, 1994, pp. 77-86.

\*Gallupe, R. B.; Dennis, A. R.; Cooper, W. H.; Valacich, J. S.; Bastianutti, L. M.; and Nunamaker, J. F. "Electronic Brainstorming and Group Size." *Academy of Management Journal*, Volume 35, Number 2, 1992, pp. 350-369.

\*Gallupe, R. B.; DeSanctis, G.; and Dickson, G. W. "Computer-Based Support for Group Problem-Finding: An Experimental Investigation." *MIS Quarterly*, Volume 12, Number 2, 1988, pp. 277-296.

\*Gallupe, R. B., and McKeen, J. D. "Enhancing Computer-Mediated Communication: An Experimental Investigation into the Use of a Group Decision Support System for Face-to-Face Versus Remote Meetings." *Information and Management*, Volume 18, 1990, pp. 1-13.

\*George, J. F.; Easton, G. K.; Nunamaker, J. F.; and Northcraft, G. B. "A Study of Collaborative Group Work With and Without Computer-Based Support." *Information Systems Research*, Volume 1, Number 4, 1990, pp. 394-415.

\*Glasson, B.; Atkinson, D.; Chang, V.; and Whiteley, A. "Empowering System Developers Through Alternate Methods and Technologies: Testing the Efficacy of GDSS." *Proceedings of the Twenty-Seventh Annual Hawaii International Conference on System Sciences*, 1994, pp. 224-233.

Goodhue, D., and Thompson, R. L. "Task-Technology Fit and Individual Performance." *MIS Quarterly*, Volume 19, Number 2, 1995, pp. 213-236.

Hackman, J. R., and Kaplan, R. E. "Interventions into Group Process: An Approach to Improving the Effectiveness of Groups." *Decision Sciences*, Volume 5, 1974, pp. 459-480.

Hedges, L. V., and Olkin, I. *Statistical Methods for Meta-Analysis*. Orlando, Florida: Academic Press, 1985.

Herzberg, F.; Mausner, B.; and Synderman, B. *The Motivation to Work*. New York: John Wiley, 1953.

Hunter, J. E., and Schmidt, F. L. *Methods of Meta-Analysis*. Newbury Park, California: Sage, 1990.

\*Hwang, H.-G., and Guynes, J. "The Effect of Group Size on Group Performance in Computer-Supported Decision Making." *Information and Management*, Volume 26, 1994, pp. 189-198.

\*Jarvenpaa, S. L.; Rao, V. S.; and Huber, G. P. "Computer Support for Meetings of Groups Working on Unstructured Problems: A Field Experiment." *MIS Quarterly*, Volume 12, Number 4, 1988, pp. 645-666.

Jessup L. M., and Valacich J. S., Editors. *Group Support Systems: New Perspectives*. New York: Macmillan, 1993.

Lamm, H., and Trommsdorff, G. "Group versus Individual Performance on Tasks Requiring Ideational Proficiency (Brainstorming): A Review." *European Journal of Social Psychology*, 1973, pp. 361-387.

\*Lewe, H. "Computer Support and Facilitated Structure in Meetings — An Empirical Comparison of their Impact." *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences*, 1995.

\*Lewis, F. L. "A Decision Support System for Face-to-Face Groups." *Journal of Information Science*, Volume 13, 1987, pp. 211-219.

\*Massey, A. P., and Clapper, D. L. "Element Finding: The Impact of a GSS on a Crucial Component of Sensemaking." *Journal of Management Information Systems*, Volume 14, Number 1, 1995, pp. 1-22.

McGrath, J. E. *Groups: Interaction and Performance*. Englewood, New Jersey: Prentice Hall, 1984.

McLeod, P. L. "An Assessment of the Empirical Literature on Electronic Support of Group Work: Results of a Meta-Analysis." *Human-Computer Interaction*, Volume 7, 1992, pp. 257-280.

\*McLeod, P. L., and Liker, J. K. "Electronic Meeting Systems: Evidence from a Low Structure Environment." *Information Systems Research*, Volume 3, Number 3, 1992, pp. 195-223.

\*Mennecke, B. E.; Hoffer, J. A.; and Valacich, J. S. "An Experimental Examination of Group History and Group Support System Use on Information Sharing Performance and User Perceptions." *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences*, 1995, pp. 153-162.

Mullen, B., and Rosenthal, R. *Basic Meta-analysis: Procedures and rograms*. Hillsdale, New Jersey: Erlbaum, 1985.

Nunamaker, Jr., J. F.; Dennis, A. R.; Valacich, J. S.; and Vogel, D. R. "Information Technology to Support Negotiating Groups: Generating Options for Mutual Gain." *Management Science*, Volume 37, Number 10, 1991a, pp. 1325-1346.

Nunamaker, Jr., J. F.; Dennis, A. R.; Valacich, J. S.; Vogel, D. R.; and George, J. F. "Electronic Meeting Systems to Support Group Work." *Communications of the ACM*, Volume 34, Number 7, 1991b, pp. 40-61.

\*Ocker, R.; Hiltz, R. S.; Turoff, M.; and Fjermestad, J. "Computer Support for Distributed Asynchronous Software Design Teams: Experimental Results on Creativity and Quality." *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences*, 1995, pp. 4-13.

\*Olson, J. S.; Olson, G. M.; Storosten, M.; and Carter, M. "Groupwork Close Up: A Comparison of the Group Design Process With and Without a Simple Group Editor." *ACM Transactions on Information Systems*, Volume 11, Number 4, 1993, pp. 321-348.

Pervan, G. "The Measurement of GSS Effectiveness: A Meta-Analysis of the Literature and Recommendations for Future GSS Research." *Proceedings of the Twenty-Seventh Annual Hawaii International Conference on System Sciences*, 1995, pp. 562-571.

\*Rhee, H.-S.; Pirkul, H.; Jacob, V.; and Barhki, R. "Effects of Computer-Mediated Communication on Group Negotiations: An Empirical Study." *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences*, 1995, pp. 270-279.

Rice, R. "Task Analyzability, Use of New Media, and Effectiveness: A Multi-Site Exploration of Media Richness," *Organization Science*, Volume 3, 1992, pp. 475-500.

\*Sambamurthy, V., and Poole, M. S. "The Effects of Variations in Capabilities of GDSS Designs on Management in Cognitive Conflict in Groups." *Information Systems Research*, Volume 3, Number 3, 1992, pp. 224-251.

Shaw, M. *Group Dynamics: The Psychology of Small Group Behavior*, Third Edition. New York: McGraw Hill, 1981.

\*Siegel, J.; Dubrovsky, V.; Kiesler, S.; and McGuire, T. W. "Group Processes in Computer-Mediated Communication." *Organizational Behavior and Human Decision Processes*, Volume 37, 1986, pp. 157-187.

\*Strauss, S. G. "Getting a Clue: The Effects of Communication Media and Information Distribution on Participation and Performance in Computer Mediated and Face-to-Face Groups." *Small Group Research*, Volume 27, Number 1, 1996, pp. 115-142.

\*Strauss, S. G., and McGrath, J. E. "Does the Medium Matter? The Interaction of Task Type and Technology on Group Performance and Member Reactions." *Journal of Applied Psychology*, Volume 79, Number 1, 1994, pp. 87-97.

\*Tyran, C. K.; George, J. F.; and Nunamaker, J. F. "Group Support for Technical Review Teams: An Exploratory Investigation." *Proceedings of the Twenty-Sixth Annual Hawaii International Conference on System Sciences*, 1993, pp. 102-111.

Valacich, J. S.; Dennis, A. R. and Connolly, T. "Group Versus Individual Brainstorming: A New Ending to an Old Story." *Organizational Behavior and Human Decision Processes*, Volume 57, 1994, pp. 448-467.

\*Valacich, J. S.; Paranka, D.; George, J. F.; and Nunamaker, J. F. "Communication Concurrence and the New Media." *Communication Research*, Volume 20, Number 2, 1993, pp. 249-276.

\*Valacich, J. S., and Stewing, C. "Devil's Advocacy and Dialectical Inquiry Effects on Face-to-Face and Computer-Mediated Group Decision Making." *Organizational Behavior and Group Decision Processes*, Volume 63, Number 2, 1995, pp. 158-173.

\*Wheeler, B. C. "Facilitation, GSS, and Training as Sources of Process Restrictiveness and Guidance for Structured Decision Making: An Empirical Assessment." *Information Systems Research*, in press.

\*Winniford, J. "Issues in Automated Voting." *Proceedings of the Twenty-Fourth Annual Hawaii International Conference on System Sciences*, 1991, pp. 621-630.