Experimental Studies of Group Decision Support Systems: An Assessment of Variables Studied and Methodology

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ABSTRACT

By early 1996, approximately 140 different controlled experiments had been published in 164 articles in refereed journals or conference proceedings, which examined processes and outcomes in computer- supported group decision making. This paper is a concise overview of what has been studied and how: the systems, independent and intervening variables manipulated or measured, and experimental procedures employed. A subsequent paper will examine the dependent variables and findings of the experiments. The purpose is not only to provide a comprehensive summary of past research, but also to critically assess what has been studied little or inadequately, in order to inform design choices for future experiments.

1. Introduction: The study of Group Decision Support Systems (GDSS)

In the mid-twentieth century, there were many studies of small group decision making, generally in the "Face to Face" (FtF) condition, which compared the decision making of individuals to that of groups, and which explored variables related to group effectiveness. Good reviews of this tradition in social psychology include those by Hare (1962, 1976), Shaw (1971, 1976), Steiner (1972), and McGrath (1984). Generally, it was found that small groups, left to their own devices, suffered many process losses: "The degree to which actual productivity approaches potential productivity is a function of the appropriateness of its processes relative to the task demands" (Steiner, 1972). Among the key variables which have been observed to influence the effectiveness of small group decision making are leadership and structuring of the group process. For example, imposing certain structures for interaction on small Face-to Face (FtF) groups, such as a strict agenda which forces "rational" decision making, or brainstorming (Osborn 1957) or Nominal Group Techniques (Van de Ven & Delbecq, 1971), can improve process and outcomes. Particularly during the 1970's, there were also some experiments exploring the effects of media such as the telephone (audio-only) or video plus audio ("videoconferencing") on small group decision making (e.g., Short, Williams & Christie, 1976).

Experiments on Group Decision Support Systems (GDSS) make their first explicit appearance in the literature in 1982, in the Turoff and Hiltz article entitled "Computer support for group versus individual decisions." Preliminary results of a series of controlled experiments at New Jersey Institute of Technology (NJIT) comparing the process and outcome of groups using Computer-Mediated Communication (CMC) versus FtF communication, and of unenhanced or "plain vanilla" CMC vs. CMC with the addition of various tools or structures to support group decision making, also appeared there. With the exception of some experiments on CMC at Carnegie Mellon (e.g., Keisler et al. 1985), there was relatively little other published experimental work until after the mid-80's, and one seldom saw the term, "GDSS." However, programs of research were underway at the University of Minnesota and at the University of Arizona, as well as at NJIT, which would soon produce a flow of theoretical papers, empirical results, and well-trained and productive young researchers.

DeSanctis and Gallupe's seminal paper, "A Foundation for the Study of Group Decision Support Systems" (1987) has been extremely influential in providing a common

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framework for research on GDSS. They defined GDSS as combining "communication, computer, and decision technologies to support problem formulation and solution in group meetings" (p. 589). They also presented a "contingency" theory to help explain why GDSS is not always beneficial; it would depend upon whether the nature of the technology and structuring provided was appropriate for the group size (smaller vs. larger), the type of task, and the communication mode, of which they identified two: same place (FtF, or "decision room") and different place, or dispersed. They also touched on what would later become Adaptive Structuration Theory (e.g., DeSanctis, Poole, Dickson, and Jackson, 1993), with the statement, "The effectiveness of the technology depends on its appropriate design and use by the group" (DeSanctis & Gallupe, 1987, p. 589). The Minnesota students, including Vogel, Watson, Gallupe, Zigurs, and Sambamurthy, dispersed to a variety of universities where GDSS programs of research sprung up. Simultaneously, at the University of Arizona, major research initiatives were in progress using decision room technology which was to become GroupSystems. Under the direction of Jay F. Nunamaker. The researchers from this program include: Applegate, Dennis, Jessup, and Valichich.

Some important distinctions were later added to the GDSS theoretical framework. For example, CMC can be same time (synchronous), or different-time ("asynchronous"); in many ways, these are totally different media, in terms of their effects on group communication processes. Pinsonneault & Kraemer (1990) make a related distinction between GDSS and "GCSS" or "Group Communication Support Systems," which they observed as having "similar impacts on some aspects of group processes and outcomes, but opposite impacts on other aspects" (p. 143).

In our review of the literature, we located 140 different empirical studies that met our criteria for this analysis. First, they were studies of groups, which we defined as comprising at least three members. Simmel (1902, 1950), was the first to convincingly make the case that a dyad is fundamentally different than larger groups, because the triad is the smallest size aggregation in which there can be a "majority" which stands against a minority. Secondly, they used a computer-based GDSS or GCSS with at least minimal features designed to support group communication and decision making processes. Third, the study was actually a controlled experiment: there were two or more conditions deliberately created and contrasted; other variables were controlled in some manner; and there was at least one independent and one dependent variable, which was measured and statistically analyzed. Finally, the study had to be published in a refereed journal or conference proceedings; e.g., unpublished dissertations or conference presentations or book chapters are not included.

Everything that we could locate, published in English and available by early 1996, is included. A few studies fail to meet one or more of these criteria, but are cited heavily in the literature, or seem to be significant studies, so they are included as "non-conforming studies," and identified with an asterisk in the list of studies; a footnote at the end notes how the study does not conform to our general guidelines. Undoubtedly, there are a few studies that we missed; and, of course, more are being published almost weekly, so it is impossible to ever be completely "up to date." We have recently identified seven other studies which are not included here.

There are several prior summaries of GDSS studies, of which Benbasat & Lim (1993) is the most comprehensive; others of note include Pinsonneault & Kraemer (1990), Gray, Vogel & Beauclair (1990); McLeod (1992), McGrath (1994); and Hollingshead & McGrath (1995). However, none of these prior summaries include more than about 50 studies, since they were made before the great flood of GDSS publications in the mid-1990's. In addition, none of them use as comprehensive a framework for gathering information and putting it into a common terminology so that the procedures and results can be compared and statistically analyzed.

2. The Theoretical Framework

Theoretical frameworks are designed to aid in the understanding and the design of empirical investigations. A number of representative frameworks were utilized as the core from which we originally extracted a comprehensive factors model, including DeSanctis and Gallupe (1987), Jalasi and Beauclair (1987); Dennis et. al, (1988); Pinsonneault and Kraemer (1989); Poole and DeSanctis (1990); Hiltz et al (1991);and Nunamaker et. al (1991). This integrated framework was developed to provide complete coverage of factors present in the literature as a whole and has been previously published (Fjermestad, Hiltz and Turoff, 1993). Since that time, we have refined the framework based on reviewers' suggestions about factors that could be placed differently in order to improve the logic of the model, and comparison of the initial theoretical model to the actual variables appearing in the empirical studies. The result appears as "Chart I;" it will be only briefly explained here; see Fjermestad (1997) for a complete description. This integrated theoretical framework is conceptualized as consisting of four major categories of variables: Contextual or independent variables; Intervening

variables; group Adaptation processes; and Outcomes. Of these, the Contextual and one of the Intervening variables that have been studied (methodology) will be summarized in this paper, along with the experimental methods and procedures that have been used; these are shaded in Chart I. Subsequent papers will discuss the remaining intervening and the adaptation and outcome factors and analyze which classes of hypotheses have and have not been supported.

The Contextual factors are all external or driving variables that comprise the environment or conditions for the decision making task. It is from these variables that the "independent variables" manipulated in any given experiment are generally chosen. For any one experiment, they are (relatively) fixed or controlled. These include characteristics of the particular technology (GSS) being used, of the group, task, environmental and organizational contexts.

Intervening factors, which also affect the group interaction, are derived from or added to the set of conditions created from the context of the group decision sessions. For example, the methods used by the group may vary as to session length, number of sessions, and presence and role of a facilitator. These factors can change from session to session, if the "meeting" goes on over a period of time, and thus are somewhat dynamic, rather than static. The variables we have categorized as "intervening are often treated as co-variates or moderator variables in the analysis of experimental results, but are sometimes treated as dependent variables.

The second set of dynamic factors is the Adaptation (adaptive structuration) or interaction process of the group. This includes such things as their level of effort, their attitude toward the GDSS, and participation patterns. They are the variables that are controlled by the group on an individual or collective basis.

Finally, the Outcomes are the result of the interplay of the intervening factors and adaptation of the group with the contextual factors. These results or dependent variables include efficiency measures (e.g., calendar time to decision), effectiveness measures (e.g., decision quality), usability of the system and methods used, and subjective satisfaction measures.

3. The Studies and Their Categorization

A list was compiled and copies obtained of all controlled experiments on GDSS published in English in refereed journal articles or conference proceedings. The results of some experiments were presented in more than one paper, resulting in a total of 163 papers representing 140 different studies. On the other hand, some papers presented multiple experiments; in this case, the different experiments were given notations of "experiment 1," "experiment 2," etc.

One problem in locating experimental studies of GDSS is that this is an interdisciplinary field, spanning the boundaries of Information Systems, Management, Computer Science, Social Psychology, and Communication. There are 31 different journals and five conference proceedings represented in the list of publications. The Hawaiian International Conference on Systems Sciences (HICSS) is the most frequent forum for presentation of GDSS studies; a total of 24 studies has appeared only in HICSS proceedings thus far, and another 19 were published there first, and subsequently in a journal. Thirteen papers have been published in JMIS, and eight papers each in MISQ, Information and Management, and Small Group Research.

We have previously mentioned that the "flood" of GDSS studies is a phenomenon of the 90's. This is very apparent from the following count of years of publication (journal and conference proceedings):

Table 1
GDSS Publication Years

Year	Count
1986 and Earlier	5
1987-1989	16
1990	21
1991	18
1992	16
1993	24
1994	23
1995	24
1996 (partial)	17
Total	163

These experiments represent a large investment of time and money by a large number of researchers, funders, and subjects. We suspect that the tremendous popularity of the World Wide Web and web browsers will see a new surge of interest in GDSS, particularly of the distributed and asynchronous variety, now that "user friendly" GUI's and "multi-media" can be included in the group support systems. It is very important that the research community have a complete understanding of what has been studied thus far and what has been studied little or not at all; of "what we know and what we don't know" about GDSS effectiveness, in order to design future studies that will optimally contribute to our knowledge of how to build and use these systems. That is the objective of our comprehensive analysis.

The major aspects of the methodology and findings of experiments on GDSS have been put into a data base and

organized into two large charts (Example Chart A: Methodology and Example Chart B: Results; the full charts are not included here, due to space limitations), focusing on methodology and findings. Only Summary Chart II is included here; note the order of variables in this chart matches that in Chart I.

4. What Has Been Studied: Contextual Factors

4.1 Technology

Task Support -Tools: Variations in the specific type of task support provided by a computer-based system have been studied in only nine experiments. The tools and procedures used are the fundamental cause of the expected changes in process and outcome; yet, most experiments seem to (falsely) assume that all GDSS's are a standard "package" that will have the same effect.

The most frequently used task support tool is Brainstorming (34 studies) used for idea generation, followed by ranking (18) or some other form of voting or preference rating (22 studies) for support of preference or decision making tasks. It is interesting to note that research on FtF groups suggests that Nominal Group Technique (NGT) is more effective than brainstorming for idea generation (Van de Ven & DelBecq, 1974). However, NGT and alternative structures such as Dialectical Inquiry have generally not been built into GDSS software. Though such structures for interaction can conceivably be created solely through facilitator guidance or instructions to group members, the only way to assure that they are followed is to embody them in software. It appears that there has been a tendency for the first tool tried to be accepted uncritically by subsequent system designers.

A software-supported ability for a group to build a list and an imposed agenda are described for five studies each; none of the other specific tools have been used more than four times. In many instances the basic set of tools provided with the software was available for use by the subjects. Hiltz and Turoff (1992), Nunamaker, Dennis, Martz, Valacich, and Vogel (1992) and Dickson, Poole and DeSanctis (1992) provide an excellent review of the tools available with EIES2, GroupSystems and SAMM, respectively.

Task Structure: In addition to the type of system, proximity and time dispersion were classified. Summary Chart II shows that by far the majority of studies to date (92 of the 140, or two thirds) are in the Decision Room environment. An additional 14 studies used a condition with dispersed (two or more linked) decision rooms, and 21 studies compared a Face to Face with a dispersed condition (most frequently CMC, synchronous or asynchronous). Only 9 studies utilized a fully distributed (asynchronous; different times and places) condition, plus two more that compared synchronous with asynchronous time dispersion.

Process Structure: The "level" of the GDSS or CMC system is a rough coding of its sophistication in terms of GDSS features, and follows the descriptions of "level 1" and "level 2" systems by DeSanctis & Gallupe (1987). The majority of the systems used (68%) are level 1 systems, and another 4% compare level 1 and level 2 systems. Some of the CMC systems are actually just email and are not structured to keep an organized and searchable record of the group discussion, as a conference is, but if that was what was used, it is included. However, nine of the studies use CMC systems so "poverty stricken" that we have labeled them "level 0" because they do not provide even the minimal features that would facilitate a rich group discussion. The most restrictive and limited of these are systems with fixed screens designed with fields to be filled in to support highly structured decision making for a specific task. For instance, if there were a "choice dilemma" task, the screen might have a field for the short problem description, and a field for inputting a number between 1 and 10, which is the "answer" to the choice. At the bottom of the screen of these "poverty stricken" CMC facilities there is often only a single line, or in some cases, only a half of a line, which is the entire space allowed to compose and send free text communication to other group members. "Chat" systems with split screens that allow one to view only a few lines of text, provide little or no editing, and display what everybody is typing as they type it, letter by letter, are also classified as "level 0." They give the users no control over what they see and what and when they send, nor do they support the communication of well thought out and edited contributions, or a reviewable transcript of the group discussion. Many of these "level 0" systems also send everything anonymously automatically, which is hardly conducive to responsible group discussion behavior. One wonders if these systems were designed to inhibit group discussion rather than to support it!

Process Support-Medium: by far the most frequently manipulated variable is communication mode, studied in a total of 91 experiments, or about two thirds. The most common contrast is unsupported FtF groups vs. GDSS supported FtF groups (32 studies). This is followed closely by 21 studies comparing groups communicating FtF vs. via CMC. A problem in many of these studies is that the tools or processes built into the GDSS or CMC or other type of computer-based system, are not available in any form to the FtF groups. Only six studies included a

full range of three modes: the unsupported FtF or "baseline" groups; FtF groups that are given manual versions of the tools and processes (e.g., facilitation or an agenda or a decision process); and the computer-supported condition. This is the only way to avoid confounding the tools or processes or other supports, with the mode of communication.

Process Support-Technology: The Group Support Systems used have been classified into three primary types: "DSS" (Decision Support Systems) GDSS, or "CMC" (Computer-Mediated Communication). A DSS is designed to support an individual decision maker; three of the studies employed this sort of system, generally with one terminal available to the group to look at. "GDSS" refers to a system primarily designed for a "decision "room" application or other synchronous (same time) situation, which allows communication to take place via audio and/or video media. The GDSS consists of tools to enforce structure (e.g., anonymous brainstorming) on portions of the group's communication and deliberation, or to assist decision making (e.g., voting tools). The majority of the studies (69%) used a GDSS.

CMC refers to a system designed primarily to support group discussion, such as a computer conferencing system, that may or may not have GDSS tools included. A total of 40 studies (29%) used a CMC system.

Process Support-Design: In terms of specific software, the most frequently used system has been Arizona's GroupSystems (or its predecessors, EDS/EMS/EBS, PlexCenter, and Plexsys), used in 48 studies. Minnesota's SAMM was the platform for 15 experiments, while NJIT's EIES or EIES2 was used in 7 published experiments, and unidentified or miscellaneous CMC's in 20. Though a variety of systems have been studied, almost half of the experiments used one of the three specific systems developed at three universities where extensive programs of GDSS experiments began in the mid- 80's; thus there is a very real question of whether the "weight" of the findings thus far might be unduly dependent upon the characteristics of these specific systems.

4.2 Group

The group variables (see Chart I) have been treated either as independent or as moderator variables and are labeled accordingly in Chart II.

Group Size: Thriteen studies have used group size as a manipulated variable, with small vs. medium sized groups (e.g., 6 vs. 12) as the most frequent choice. Only one study varying group size used groups larger than 12.

The modal group size is three (See Chart II, 5.1 Method); this is probably because one can obtain the largest number of groups with the smallest number of subjects, with this group size. Four is the next most popular, followed by group size five, probably for similar reasons; making a total of 45% of the experiments using group size of 4 or fewer members. Many experiments did not rigidly control group size; e.g., 17 studies reported a range of 3 to 8 subjects per group, and another 15 reported a range of 4 to 8. Altogether, only 12 studies, or 10%, used group sizes larger than 10, which might be considered a dividing line between "small" and medium to large sized groups. Yet, as we shall review near the end of this assessment, both theory and empirical evidence lead us to believe that GDSS tools and processes can be most beneficial for medium to large sized groups, rather than for very small groups such as those with only 2, 3, or 4 members.

Group composition is even more troublesome; only 5 (or 4%) of the groups were established rather than ad hoc, and over 90% use students as subjects. Twenty studies used group composition as an independent variable or co-variate. Members' degree of knowledge or skill related to the task is the most frequently studied (5 experiments). Such potentially important factors as gender composition and the use of established versus ad-hoc groups have been studied in only two experiments each.

Member Characteristics: These potentially include any attributes of individual members, such as their attitudes, personality traits, age, or previous experience with systems or tasks. Only five member characteristics have been studied, and except for leadership, each has been used only in a single experiment.

Subjects Type: Undergraduates were used as the subjects in 65% of the experiments; 7% used professionals, and only 7% used solely graduate students. Remus (1989) reported that undergraduate subjects made poorer decisions than did part-time MBA subjects (who were all professionals working on an MBA degree). This study is important because the objective of the technology is to improve effectiveness. Remus's study documents that it is the interaction of experience working with the technology that produces effective performance. The experienced managers made less costly decisions, used more effective heuristics, and were less erratic than undergraduate students.

In another study [20] retired professionals were compared with active professionals, with and without technology (CMC versus no-CMC). An interaction effect between retired and CMC treatments (retired with CMC out performed any other combination of groups) was found. CMC groups were more satisfied with the group, the process, and had higher quality decisions. The fact that there can be an interaction between type of subject/user and the effectiveness of the technology

emphasizes the need to experiment with a variety of types of subjects. The issue of the generalizability of the results of GDSS experiments, when they are so heavily based on the use of students as subjects, will also be further explored at the end of this assessment.

4.3 Task

Task is the primary reason for the group to exist. Poole et. al. (1985) suggested that it alone could account for 50% of the variance in group performance.

Type: McGrath (1984) developed a task typology which consists of eight different task types within four categories. The graphical representation of this typology differentiates tasks on two dimensions. The first dimension classifies tasks on the basis of outcome: intellectual (e.g., a decision) or behavioral (e.g., a "product" or action). The second dimension uses the type of behavior of group members (convergent or cooperative, vs. conflicting). This results in eight task types.

We re-coded task type to make the categorizations match the descriptions given by McGrath (1984) and McGrath & Hollingshead (1994), and consistent. It was interesting to note that some tasks had been described as belonging in two or three different categories, by different authors. What we see is that only 4 studies used Task type 1 (Planning), and only one used task type 6 (Mixed-motive, resolving conflicts of motive or interest). The most frequently used task type (used 74 times or 41%) is the preference or decision making task (type 4), for which the preference of the majority is taken as the correct answer because there is no objective measure of quality. The second most frequently used task type is creativity (generating ideas, brainstorming), employed in 29% of the experimental sessions. Intellective tasks were used 21% of the time. Given the "laboratory" settings of most studies, none used tasks purely in the "execute" quadrant, which includes psycho-motor behaviors and contests or battles, though one of the 30 instances with mixed task types did have a performance aspect, flying paper airplanes [3].

Task complexity has been varied in four experiments, while 14 have varied task type. The most frequent task type contrast chosen for experimental design is intellective versus decision making (preference) tasks, a contrast included in ten experiments.

4.4 Context

This includes environmental and organizational variables. Given that most studies have used students in U.S. universities, for a single session, it is not surprising to find that few context variables have been studied. Assessment of prior experience with a system was varied in eleven studies. Culture (e.g., Singaporean vs. American) has been looked at in three experiments. Obviously, this is an area of great neglect.

5.0 What Has Been Studied: Intervening Factors

The intervening category of variables constitutes the first phase of the variable interactions posited by the contingency model. The group interacts with the task, context, and technology through the set of intervening variables. The intervening variables can be treated as either independent or control variables in experimental design and analysis. Most of them have been totally ignored. This discussion will be limited to experimental methodology, which is the only set of intervening variables frequently documented or studied.

5.1 Method

Experimental Designs: Single independent variables (with 2-5 conditions) were used in 52 (36%) of the experiments. The 2 x 2 factorial design is the next most popular, accounting for 30% of the experiments, with various other factorial designs accounting for another 33%. In most studies, subjects served in only one experimental condition, but repeated measures designs were used in 25% of the experiments.

Training is the opportunity for the group to become familiar with the system itself, the tools to be used, the procedures to be followed, and the other group members, before being presented with a task to perform and generally a time limit in which to accomplish this task. Forty studies do not report on this important detail of the methodology at all. Another 52 mention that some sort of training was given, but no details are provided. A total of 11 studies gave the group a practice task as part of their training. When training is reported, it generally is of very short duration; the mode is only 5 to 10 minutes. Only twelve studies used a total of an hour or more of training before the group task was assigned.

The training variable is also notable because not a single study has specifically varied it to determine the effects of various types and amounts of training.

Number of Sessions: 72% of the experiments have involved the group members in only a single problem solving session; they thus had no opportunity to exhibit much "adaptive structuration" of their use of the system based on experience. Five studies have been longitudinal, specifically looking for possible changes over time. Our

theoretical framework posits that adaptive structuration will be an important process influencing the outcomes of technological support for group decision making; and such group learning and reshaping of the technology in use takes time to unfold. Experiments using longitudinal designs tend to show that groups require some experience in order to learn how to coordinate their interaction using technological supports, particularly if they are using spacially distributed or asynchronous modes of communication. For example, Chidambaram and colleagues [10] concluded on the basis of an early experiment using a longitudinal design that GSS groups need time to learn the system, and a later study [8] concluded that asynchronous GSS groups require more than four sessions to learn how to interact via the technology in ways that overcome its limitations. McGrath and colleagues[49] , in an experiment lasting 13 weeks, found that FtF groups significantly outperformed CMC groups for the first five weeks, but not in the last four weeks. Thus, both theoretical expectations and empirical results suggest that the results of single session studies, especially those lasting less than an hour total, will not be very generalizable to organizational use over a period of weeks to years.

Facilitation: The majority of studies (66%) did not employ a group facilitator to help coordinate the interaction. In addition to contrasting facilitated with non-facilitated groups, one can purposely vary facilitator style, e.g., a technical facilitator or "chauffeur" vs. a process facilitator or a human facilitator vs. automated facilitation. Most studies using GDSS simply confound facilitator presence and style with mode of communication. Seven experiments have examined facilitation as an explicitly manipulated factor.

Number of Subjects: Many of the experiments suffer from a low level of statistical power because of the use of an inadequate total number of subjects, groups, and/or groups per cell. For example, 17 studies use a total of less than 50 subjects and 44 (36%) use a total of under 20 groups. 23% of the experiments fail to consistently provide a groups per cell size of five or larger, which might be considered just a "minimum" to have a good chance of detecting significant differences. Only 62 (or 44%) have at least 10 groups per cell, which generally provides fairly good statistical power.

Task Implementation: This includes the specific tasks used, as well as the instructions and specific wording, and the amount of time allowed. 106 different tasks were used, but some tasks have perhaps been over-used, such as the Foundation task (14 experiments). Table 2 shows the most often used tasks. These eight tasks have been used in a total of 56 instances. The advantage of using a task that has been studied in many other experiments is that one can make some indirect comparisons of results. The disadvantage of over-use of a specific task is that the body of findings from experiments may be an artifact of a narrow range of specific tasks on which they were based.

Duration of the Experiments: Almost a fifth of the studies failed to report the length of the task, which is an important methodological detail. Of those reporting a session length or upper limit, 35% took less than half an hour. These tasks must have been extremely simple. Another 26% took between 30 and 60 minutes, and also could not be considered very complex tasks if they could be completed in such a short time. Four studies investigated task complexity [5, 36, 106, 114] and found that as task complexity increases, the decision quality and depth of analysis improve in groups using GSS. Thus, it is of concern that the majority of experiments studying the effects of GSS used short, simple tasks that are probably least likely to need or benefit from technological supports to the decision making process.

Table 2
Tasks and Usage Frequency

Task	Count
Foundation	14
Choice Dilemma	7
PC Imports	7
Tourism	7
School of Business	6
International Studies	5
PVVI	5
Parkway Drug	5

6. SUMMARY: What Needs to Be Studied?

It must be emphasized that the following conclusions are based solely on GDSS studies using controlled experiments (laboratory or field) as the methodology. We plan to do a similar survey of empirical studies using other methodologies (e.g., case studies, surveys) in the future. Undoubtedly, such data will exhibit different patterns.

6.1 Gaps in the Experimental Research

The field of GDSS is no longer new; all experiments published in the future should have strong methodology and documentation. This includes adequate cell sizes, training times, and descriptions of the specific task, system, tools, and facilitation used.

The majority (87% of 163 papers) of experimental GDSS studies have been published in 1990 or later. Unfortunately, the scope of this body of work, and its external validity/generalizability for "real" problem solving groups, is weaker than would be hoped. And despite the relative recency of this body of work, most of it was done on what is already "outmoded" technology, given the increasing pervasiveness of GUI's such as Netscape™ and of hypertext and hypermedia systems embedded in the World Wide Web. This is not necessarily the "fault" of the experimenters, given rapidly changing technology and academic equipment budgets which often do not make it possible for research facilities to stay at the "state of the art." However, this situation does suggest that perhaps some earlier experiments (particularly ones in which 'no difference" was found between FtF groups and GDSS supported groups using what would now be considered "outmoded" systems) should be replicated ;using Web-based GDSS or conferencing systems, to see if the newer systems are more effective.

The vast majority of experiments have concentrated on only a few of the potentially important variables that should be studied. Notably, though a large proportion of future use of GDSS will probably be in fully distributed (asynchronous) or mixed modes conditions, most of the experiments have been conducted in same time/same place "decision rooms."

The tasks on which research has been conducted are clustered heavily in the "preference" and "brainstorming/creativity" sectors of the McGrath (1984) typology. This makes it difficult to obtain any objective measures of decision quality so that the relative effectiveness of different modes and tools can be assessed. Very few experiments have been conducted in the "difficult" task areas of planning, negotiation, and conflict; however, if a system is to be employed for the full range of group tasks that must be accomplished in long term, complex projects, these are necessary group tasks to support.

More worrisome than task type is the apparent lack of complexity of the tasks used in most experiments. The majority (64%) of the tasks took less than an hour total for the GSS groups to learn the technology, adapt to the group, and agree on a decision or course of action. Generally, one would imagine that if an organizational group feels that it needs technology to help support decision making, it would be because the task was complex and lengthy. If not, then acquiring and/or traveling to a special computer-based facility and learning how to use it would undoubtedly seem like more trouble than it's worth!

The nature of the individual subjects and the distribution of group sizes used in most GDSS experiments are also of concern. Only 4% of the studies used established rather than ad hoc groups, and over 90% used students as the subjects. Using students has some advantages, since the relative homogeneity of the subjects removes a source of uncontrolled variance, and since most of them are familiar with computer keyboards and do not require extensive training to acquire the basic skills necessary to use a GDSS. However, their motivation to maximize effort and quality of decision is questionable, and they may also "put up" with things that "real" subjects would never tolerate, because they are used to doing as they are told by their teachers.

Group Size, Task Characteristics, and GDSS Effectiveness: In terms of group size, most experiments used groups of five or fewer subjects. Yet, we know that GDSS is generally most helpful for larger sized groups. An Arizona study [19] comparing small (size 3), medium (9), and large (18) groups showed that the larger the group using the GDSS, the better the performance and satisfaction of the group. Another pair of experiments using GroupSystems varied group size from 2 to 12 and concluded that the advantages of electronic brainstorming consistently become more pronounced as group size increases. Every other study varying group size [50, 89, 90, 91, 92] also showed larger groups out-performing smaller groups using GDSS.

One study (Valacich et al., 1993) compared homogeneous to heterogeneous knowledge. The results suggested that greater performance gains were achieved for heterogeneous, large groups.

Two studies investigated task complexity (Bui and Sivasankaran, 1990; and Gallupe et al., 1988) and found that as task complexity increases the decision quality and depth of analysis improve in groups using GSS. Thus, the limited evidence which exists suggests that complex tasks and larger groups will benefit more from GDSS, yet the experiments conducted to date have mostly used small groups with simple tasks.

6.2 What Needs to be Done

There is a need for future experiments to place more emphasis on the use of larger groups of non-student subjects, using more complex tasks than has been typical. It is also time for more experiments to use a design which explores how factors such as group size and task type and complexity interact with specific types of tools and processes that can be provided by GDSS, rather than simply comparing GDSS to baseline or "manually supported" Face to Face groups.

More importantly, there have been no published experiments utilizing "anytime/anyplace" systems: the use of combined modes used by task groups, over a period of time. Likewise, state-o-the-art multimedia and/or Web-based systems need to be compared to the prior generations of "flat" text systems. In sum, despite well over 100 experiments, there are whole domains of GSS that have been left unexplored.

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REFERENCES

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,* 24, 4, 1993, 430-462.

Dennis, A., R., George, J., F., Jessup, L., M., Nunamaker, J., F., and Vogel, D.,R., "Information Technology to Support Electronic Meetings," *MIS Quarterly, December*, 1988, 591-618.

DeSanctis, G. and Gallupe, R.B., "A Foundation for the Study of Group Decision Support Systems," *Management Science,* 33, 5 ,1987, 589- 609.

DeSanctis, G., Poole, M. S., Dickson, G., and Jackson, M. "Interpretive Analysis of Team Use of Group Technologies," *Journal of Organizational Computing, 3,1,* 1993, 1-30.

Dickson, G.W., Poole, M.S., and DeSanctis, G., "An Overview of the GDSS Research Project and the SAMM System," in Bostrom, R.P., Watson, R.T., and Kinney, S.T., (Eds.) *Computer Augmented Teamwork: A Guided Tour, 1992, Van Nostrand Reinhold,* New York.

Fjermestad, J., "An Integrated Framework for Group Support Systems," *Journal Organizational Computing and Electronic Commerce,* 1997 (accepted-pending revisions).

Fjermestad, J.L., Hiltz, S.R., and Turoff, M., "An Integrative Framework for the Study of Group Decision Support Systems," *Proceedings of the Twenty-Sixth Hawaii International Conference on Systems Science,* 1993, IV, 179-188.

Gray, P., Vogel, D., and Beauclair, R., "Assessing GDSS Empirical Research," *European Journal of Operational Research,* 46, 1990, 162-178.

Hare, A. P., *Handbook of Small Group Research*, New York: The Free Press. First ed., 1962, revised ed., 1976.

Hiltz, S. R., Dufner, D.K., Holmes, M. E., and Poole, S. M., "Distributed Group Support Systems: Social Dynamics and Design Dilemmas," *Journal of Organizational Computing* , 2, 1, 1991, 135-159.

Hollingshead, A.B. and McGrath, J.E., "Computer-Assisted Groups: A Critical Review of the Empirical Research," in Guzzo, R.A., Salas, E., and Associates, (Eds.) *Team Effectiveness and Decision Making in Organizations,* 1995. Jossey-Bass, San Francisco.

Jelassi, M. T., and Beauclair, R. A., "An Integrated Framework for Group Decision Support System Design," *Information and Management,* 13, 1987, 143-155.

Kiesler, S., Zubrow, D., Moses, A.M., and Geller, V., "Affect in computer-mediated communications: An Experiment in Synchronous Terminal-to-Terminal Discussion," *Human Computer Interaction,* 1 , 1985, 77-104.

McGrath, J.E., *Groups: Interaction and Performance*, Englewood Cliffs, NJ, Prentice-Hall, 1984.

McGrath, J.E. and Hollingshead, A. B., *Groups Interacting with Technology,* Thousand Oaks, CA: Sage Publications, 1994.

McLeod, P. , "An Assessment of the Experimental Literature on the Electronic Support of Group Work: Results of a Meta-Analysis, " *Human Computer Interaction,* 7, 3, 1992, 257-280.

Nunamaker, J.F., Dennis, A. R.. George, J.F., Martz, W.B., Valacich, J. S., and Vogel, D. R., "GroupSystems," in Bostrom, R. P., Watson, R.T., and Kinney, S.T., (Eds.) *Computer Augmented Teamwork: A Guided Tour,* 1992, Van Nostrand Reinhold, New York.

Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D.R., & George, J.F., "Electronic Meeting Systems to Support GroupWork," *Communications of the ACM,* 34, 7, 1991, 41-61.

Osborn, A. F., *Applied Imagination* (rev. ed.). New York: Scribner's, 1957.

Pinsonneault, A. and Kraemer, K. L., "The effects of electronic meetings on group processes and outcomes: An assessment of

the empirical research." *European Journal of Operational Research,* 46, 1990, 143-161.

Poole, M. S., and DeSanctis, G., "Understanding the use of group decision support systems: The theory of adaptive structuration," In Steinfield, C. and Fulk, J. (Eds.), *Organizations and communication technology*, 1990, Beverly Hills: Sage Publications.

Remus, W., "Using Students as Subjects in Experiments on Decision Support Systems," *Proceedings of the Twenty-Second Hawaii International Conference on Systems Science*, 1989, IV, 176-180.

Shaw, M. E., *Group Dynamics: The Psychology of Small Group Behavior,* New York: McGraw-Hill, 1971, 1976.

Short, J., Williams, E., and Christie, B., *The Social Psychology of Telecommunications,* London: John Wiley & Sons, 1976.

Simmel, G. Soziologie, *Untersuchungen uber die Formen der Vergesell Schaftung,* Leipzig: Duncker and Humblot, 1892, 1907.

Simmel, G., translated and edited by K.H. Wolff. *The Sociology of Georg Simmel,* New York: The Free Press, 1950.

Steiner, I .D., *Group Process and Productivity*, New York: Academic Press, 1972.

Turoff, M. and Hiltz, S.R., "Computer support for group vs. individual decisions," *IEEE Transactions on Communications COM-20* ,1, 1982, 82-91.

Van de Ven, A.H. and Delbecq, A. L., " Nominal vs. Interacting Group Processes for Committee Decision-making Effectiveness," *Academy of Management Journal,* 14 ,2, 1971, 203- 212.

The Experimental GSS Literature

1 Adrianson, L. and E. Hjelmquist, "Group Processes in Face-to -Face and Computer-Mediated Communication,"*Behavior & Information Technology,* 10,4 (1991), 281-296.

2 Aiken, M., J. Krosp, A. Shirani, and J. Martin, "Electronic Brainstorming in Small and Large Groups," *Information & Management,* 27 (1994), 141-148.

3 Anson, R., R. Bostrom, and B. Wynne, "An Experiment Assessing Group Support Systems and Facilitator Effects on Meeting Outcomes," *Management Science,* 41,2 (1995), 189-208.

4 Archer, N.P., "A Comparison of Computer Conferences with Face-To-Face Meetings for Small Group Business Decisions," *Behaviour & Information Technology,* 9, 4(1990), 307-317.

64 Austin, L.C., J.K. Liker, and P.L. McLeod, "Who Controls the Technology in Group Support Systems? Determinants and Consequences," *Human-Computer Interaction,* 8 (1993), 217-236.

124 Berdahl, J. L. and K. M. Craig, "Equality of Participation and Influences in Groups: The Effects of Communication Medium and Sex Composition," *Computer Supported Cooperative Work (CSCW),* 4, 2, 1996, 179-201.

5 Bui, T. and T.R. Sivasankaran, "Relation Between GDSS Use and Group Task Complexity: An Experimental Study," *Proceedings of the Twenty-Third Hawaii International Conference on System Sciences, III* (1990), 69-78.

6 Bui, T., T.R. Sivasankaran, Y. Fijol, and M.A. Woodbury, "Identifying Organizational Opportunities For GDSS Use: Some Experimental Evidence," *Transactions of the Seventh International Conference on Decision Support Systems,* June (1987), 68-75.

7 Burke, K. and L. Chidambaram, "Development in Electronically -Supported Groups: A Preliminary Longitudinal Study of Distributed and Face-to-Face Meetings," *Proceedings of the Twenty-Seventh Hawaii International Conference onSystem Sciences,* IV (1994), 104-113.

7 Burke, K. and L. Chidambaram, "Developmental Differences Between Distributed and Face-to-Face Groups in Electronically Supported Meeting Environments: An Exploratory Investigation, *Group Decision and Negotiation,* 4, 3 (1995), 213-234.

8 Burke, K., L. Chidambaram, and J. Lock, "Evolution of Relational Factors Over Time: A Study of Distributed and Non-Distributed Meetings," Proceedings of the Twenty-Eighth Hawaii International Conference on System Sciences, IV (1995), 14-23.

111 Burke, K. and L. Chidambaram, ADo Mediated Contexts Differ In Information Richness? A Comparison of Collocated And Dispersed Meetings,@ *Proceedings of the Twenty-Ninth Annual Hawaii International Conference on System Sciences,* III (1996), 92-101.

9 Cass, K., T.J. Heintz, and K.M. Kaiser, "Using a Voice-Synchronous GDSS In Dispersed Locations: A Preliminary Analysis of Participant Satisfaction," *Proceedings of the Twenty-Fourth Hawaii International Conference on System Sciences,* IV (1991), 554-563.

9 Cass, K., T.J. Heintz, and K.M. Kaiser, "An Investigation of Satisfaction When Using a Voice-Synchronous GDSS in Dispersed Meetings," *Information & Management,* 23 (1992), 173-182.

10 Chidambaram, L., and R.P. Bostrom, "Evolution of Group Performance of Over Time: A Repeated Measures Study of GDSS Effects," *Journal of Organizational Computing,* 3,4 (1993), 443-469.

10 Chidambaram, L., R.P. Bostrom, and B.E. Wynne, "A Longitudinal Study of the Impact of Group Decision Support Systems on Group Development," *Journal of Management Information Systems,* 7,3 (1990), 7-25.

10 Chidambaram, L., R.P. Bostrom, and B.E. Wynne, "An Empirical Investigation of the Impact of Computer Support on Group Performance," *Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences,* IV (1990), 3-12.

11 Chidambaram, L. and B. Jones, "Impact on Communication Medium and Computer Support on Group Perceptions and Performance: A Comparison of Face-o-Face and Dispersed Meetings," *MIS Quarterly,* 17,4 (1993), 465-491.

***12** Chidambaram, L. and J. A. Kautz, "Defining Common Ground: Managing Diversity Through Electronic Meeting Systems," *Proceedings of the Fourteenth International Conference on Information Systems,* (1993), 1-11.

112 Clapper, D. L. and A. P. Massey, "Predicting Group Output: Assessing the Relative Impacts of Task-Related Input and GSS Use," P*roceedings of the Sixteenth International Conference on Information Systems,* (1995), 65-80.

13 Clapper, D.L., E.R. McLean, and R.T. Watson, "An Experimental Investigation of the Effect of A Group Decision Support System on Normative Influence in Small Groups," *Proceedings of the Twelfth International Conference on Information Systems,* (1991), 273-282.

14 Connolly, T., L. Jessup, and J.S. Valacich, "Effects of Anonymity and Evaluative Tone on Idea Generation in Computer-Mediated Groups," *Management Science,* 36,6 (1990), 689-703.

***15** Connolly, T., R.L. Routhieaux, and S.K. Schneider, "On the Effectiveness of Group Brainstorming: Test of One Underlying Cognitive Mechanism," *Small Group Research,* 24, 4, (1993), 490-503.

124 Cummings, A., A. Schlosser, and H. Arrow, "Developing Complex Group Products: Idea Combination in Computer-Mediated and Face-to-Face Groups," *Computer Supported Cooperative Work (CSCW),* 4, 2, 1996, 229-251.

16 Daly, B.L., "The Influence of Face-To-Face Versus Computer-Mediated Communication Channels on Collective Induction," *Accounting Management & Information Technology,* 3, 1 (1993), 1-22.

113 Dennis, A., J. Aronson, B. Heninger, and E. Walker, ATask and Time Decomposition in Electronic Brainstorming," *Proceedings of the Twenty-Ninth Annual Hawaii International Conference on System Sciences,* III (1996), 51-59.

17 Dennis, A.R., A.C. Easton, G.K. Easton, J.F. George, and J.F. Nunamaker, "Ad Hoc versus Established Groups in an Electronic Meting Environment," *Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences,* IV (1990), 23-29.

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

126 Dennis, A., J.S. Valacich, T. Connolly and B. E. Wynne, "Process Structuring in Electronic Brainstorming," Information Systems Research, 7, 2, 1996, 268-277.

19 Dennis, A.R., J.S. Valacich, and J.F. Nunamaker, "An Experimental Investigation of Small Medium and Large Groups in an Electronic Meeting System Environment," *IEEE Transactions Systems Man Cybernetics,* 20,5 (1990), 1049-1057.

20 DeSanctis, G., M.J. D'Onofrio, V. Sambamurthy, and M.S. Poole, "Comprehensiveness and Restrictiveness in Group Decision Heuristic: Effectsof Computer Support on Consensus Decision Making," *Proceedings of the Tenth International Conference on Information Systems,*(1989), 131-40.

21 Dickson, G.W., G. DeSanctis, M.S. Poole, and M. Limayem, "Multicriteria Modeling and "What IF" Analysis as Conflict Management Tools for Group Decision Making," *DSS Transaction,* (1991), 133-141.

22 Dickson, G.W., J. Lee-Partridge, and L.H. Robinson, "Exploring Modes of Facilitative Support for GDSS Technology," *MIS Quarterly,* June (1993), 173-194.

22 Dickson, G.W., J.E. Lee, L. Robinson, and R. Heath, "Observations on GDSS Interactions: Chauffeured, Facilitated, and User-Driven Systems," *Proceedings of the Twenty-Second Hawaii International Conference on System Sciences, (*1989), 337-343.

23 Dubrovsky, V.J., S. Kiesler, and B.N. Sethna, "The Equalization Phenomenon: Status Effects in Computer-Mediated and Face-to-Face Decision Making Groups," *Human Computer Interaction,* 6 (1991), 119-146.

125 Dubrovsky, V.J., D. Clapper, and M. Ullal, "The Effects of a Distinct Window Screen Design on Computer-Mediated Group Decision Making," *Computer Supported Cooperative Work,* 4, 1996, 33-49.

24 Dufner, D.K., S.R. Hiltz, K. Johnson, and R. Czech, "Distributed Group Support Systems: The Effects of Voting Tools on Group Perceptions of Media Richness," *Group Decision and Negotiation,* 4,3 (1995), 235-250.

24 Dufner, D., S.R. Hiltz, and M. Turoff, "Distributed Group Support: A Preliminary Analysis of the Effects of the Use of Voting Tools and Sequential Procedures," *Proceedings of the Twenty-Seventh Hawaii International Conference on System Sciences,* IV, (1994), 114-123.

25 Easton, G.K., J.F. George, J.F. Nunamaker, and M.O. Pendergast, "Using Two Different Electronic Meeting System Tools for the Same Task: An Experimental Comparison," *Journal of Management Information Systems,* 7,1 (1990), 85-99.

26 Easton, A.C., D.R. Vogel, and J.F. Nunamaker, "Interactive versus Stand-Alone Group Decision Support Systems for Stakeholder Identification and Assumption Surfacing in Small Groups," *Decision Support Systems,* 8(1992), 159-168.

27 Easton, A. C., D.R. Vogel, and J.F. Nunamaker," Stakeholder Identification and Assumption Surfacing in Small Groups: An Experimental Study," Proceedings of the Twenty-Second Hawaii International Conference on System Sciences, IV(1989), 344-351.

***28** Ellis, C.A., G.L. Rein, and S.L. Jarvenpaa, "Nick Experimentation: Selected Results Concerning Effectiveness of Meeting Support Technology," *Journal of Management Information Systems,* 6,3 (1990), 7-24.

28 Ellis, C.A., G.L. Rein, and S.L. Jarvenpaa, "Nick Experimentation: Some Selected Results," *Proceedings of the Twenty-Second Hawaii International Conference on System Sciences,* IV (1989), 359-369.

***29** Eveland, J.D. and T.K. Bikson, "Work Group Structures and Computer Support: A Field Experiment," *ACM Transactions on Office Information Systems,* 6,4, (1988), 354-379.

30 Fjermestad, J., S.R. Hiltz, M. Turoff, C. Ford, K. Johnson, R.M. Czech, R. Ocker, F. Ferront, and M. Worrell, "Distributed Computer Supported Cooperative Strategic Decision Making Using Structured Conflict and Consensus Approaches," *Proceedings of the Twenty-Eight Hawaii International Conference on System Sciences,* III,(1995), 222-231.

31 Galegher, J. and R.E. Kraut, "Computer-Mediated Communication for Intellectual Teamwork: An Experiment in Group Writing," *Information Systems Research,* 5, 2, (1994), 110-138

31 Galegher, J. and R.E. Kraut, "Computer-Mediated Communication for Intellectual Teamwork: A Field Experiment in Group Writing," *Proceedings of the Conference on Computer-Supported Cooperative Work,* October(1990), 95-78.

32 Gallupe, R.B., "Suppressing the Contributions of the Group's Best Member: Is GDSS Use Appropriate for All Group Tasks," *Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences,* IV (1990), 13-22.

33 Gallupe, R.B., L.M. Bastianutti, and W.H. Cooper, "Unlocking Brainstorms," *Journal of Applied Psychology,* 76, 1(1991), 137-142.

34 Gallup, R.B., W.H. Cooper, M.L. Grise, and L.M. Bastianutti, "Blocking Electronic Brainstorms," *Journal of Applied Psychology,* 79,1 (1994), 77-86.

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

36 Gallupe, R.B., G. DeSanctis, and G.W. Dickson, "Computer-Based Support for Group Problem-Finding: An Experimental Investigation," *MIS Quarterly,* June (1988), 277-296.

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

38 George, J.F., A.R. Dennis, and J.F. Nunamaker, "An Experimental Investigation of Facilitation in an EMS Decision Room," *Group Decision and Negotiation,* 1 (1992), 57-70.

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

40 Ghani, J.A., R. Supnick, and P. Rooney, "The Experiences of Flow in Computer-Mediated and Face-To-Face Groups," *Proceedings of the Twelfth International Conference on Information Systems,* (1991), 229-237.

41 Glasson, B., D. Atkinson, V. Chang, and A. Whiteley, "Empowering Systems Developers Through Alternate Methods and Technologies: Testing the Efficacy of GDSS (Group Decision Support Systems)," *Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences,* III (1994), 224-233.

42 Gopal, A., R.P. Bostrom, and W. Chin, "Modeling the Process of GSS Use: An Adaptive Structuration Perspective," *Journal of Management Information Systems,* 9,3 (1993), 45-69.

42 Gopal, A., R.P. Bostrom, and W.Chin, "Modeling the Process of GSS Use: An Adaptive Structuration Perspective," *Proceedings of the Twenty-Fifth Annual Hawaii International Conference on System Sciences,* IV (1992), 208-219.

***43** Griffth, T.L., and G.B. Northcraft, "Distinguish Between the Forest and Trees: Media, Features, and Methodology in Electronic Communication Research," *Organizational Science,* 5,2 (1994), 272-285.

44 Herschel, R.T., "The Impact of Varying Gender Composition on Group Brainstorming Performance in a GSS Environment," *Computer in Human Behavior,* 10, 2 (1994), 209-222.

44 Herschel, R. and B.E. Wynne, "An Analysis of the Performance of Groups of Varying Gender Composition in an Electronic Meeting System Environment," T*ransactions of DSS,* (1991),156-167.

114 Hightower, R. and L. Sayeed, AThe Impact of Computer-Mediated Communication Systems on Biased Group Discussion," *Computers in Human Behavior,* 1,1 , (1995), 33-44.

45 Hiltz, S.R., K. Johnson, and M. Turoff, "Experiments in Group Decision Making: Communication Process and Outcome in Face-to-Face Versus Computerized Conferences," *Human Communications Research,* 13,2 (1986), 225-252.

46 Hiltz, S.R., K. Johnson, and M. Turoff, "Group Decision Support: The Effects of Human Leaders and Statistical Feedback in Computerized Conferences," *Journal of Management Information Systems,* 8,2 (1991), 81-108.

47 Hiltz, S.R., M. Turoff, and K. Johnson, "Experiments in Group Decision Making, 3: Disinhibition, Deindividuation, and Group Process in Pen Name and Real Name Computer Conferences," *Decision Support Systems,* 5 (1989), 217-232.

48 Ho, T.H. and K.S. Raman, "The effect of GDSS and Elected Leadership on Small Group Meetings," *Journal of Management Information Systems,* 8,2 (1991), 109-133.

49 Hollingshead, A.B., J.E. McGrath, K.M. O'Connor, " Group Task Performance and Communication Technology: A Longitudinal Study of Computer-Mediated Versus Face-to-Face Groups," *Small Group Research,* 24,3 (1993), 307-333.

50 Huang, W., K.S. Raman, and K.K. Wei, "A Process Study of Effects of GSS and Task Type on Informational and Normative Influence in Small Groups," *Proceedings of the Fourteenth International Conference on Information Systems,* (1993), 91-101.

51 Hwang, H.G. and J. Guynes, "The Effects of Group Size on Group Performance in Computer-Mediated Decision Making," *Information & Management,* 26 (1994), 189-198.

52 Hymes, C.M. and G.M. Olson, "Unblocking Brainstorming Through the Use of a Simple Group Editor," *Proceedings of the Conference on Computer-Supported Cooperative Work,* October, (1992) 99-106.

53 Iz, P.H., "An Experimental Assessment of Preference Aggregation in a Group Decision Support System Based on Multiple Criteria Optimization," *Proceedings of the Twenty-Fifth Annual Hawaii International Conference on System Sciences,* IV (1992), 185-189.

***54** Jarvenpaa, S.L., V.S. Rao, and G.P. Huber, "Computer Support for Meetings of Groups Working on Unstructured Problems: A Field Experiment," *MIS Quarterly,12,4,* (1988), 645-665.

55 Jessup, L.M., T. Connolly, and J. Galegher, "The Effects of Anonymity on GDSS Group Process With an Idea-Generating Task," *MIS Quarterly,* September, (1990), 313-321.

123 Jessup, L.M., J.L., Egbert, and T. Connolly, "Understanding Computer-Supported Group Work: The Effects of Interaction Frequency on Group Process and Outcome," Journal of Research on Computing in Education, 28,2, 1996, 190-208.

56 Jessup, L.M. and D.A. Tansik, "Decision Making in an Automated Environment: The Effects of Anonymity and Proximity with a Group Decision Support System," *Decision Sciences,* 22, (1991), 266-279.

57 Joyner, R. and K. Tunstall, "Computer Augmented Organizational Problem Solving," *Management Science,* 14, 4 (1970) 212-225.

115 Kahai, S. S., B. J. Avolio, and J. J. Sosik, "Meeting Impacts of Two Types of EMS Anonymity and Initial Differences in Opinions," P*roceedings of the Sixteenth International Conference on Information Systems,(*1995),81-92.

81 Lea, M.and R. Spears, "Computer-mediated Communication, Deindividuation, and Group Decision Making," *International Journal of Man-Machine Studies,* 34, (1991), 283-301.

124 Lebie, L., J. A. Rhoades, and J. E. McGrath, " Interaction Process in Computer-Mediated and Face-to-Face Groups," *Computer Supported Cooperative Work* , 4 , 1996, 127-152.

116 Lewe, H., AComputer Support and Facilitated Structure in Meetings-An Empirical Comparison of Their Impact,"

Proceedings of the Twenty-Ninth Annual Hawaii International Conference on System Sciences, III (1996), 24-33.

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

59 Lim, L.H., K.S. Raman, K.K. Wei, " Interacting Effects of GDSS and Leadership," *Decision Support Systems,* 12, 3, (1994),199-211.

59 Lim, L.H., K.S. Raman, and K.K. Wei, "Does GDSS Promote More Democratic Decision-Making? The Singapore Experiment," *Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences,* IV (1990), 59-68.

60 Limayem, M., J.E. Lee-Partridge, G.W. Dickson, and G. DeSanctis, "Enhancing GDSS Effectiveness: Automated versus Human Facilitation," *Proceedings of the Twenty-Sixth Hawaii International Conference on System Sciences,* IV, (1993), 95-101.

117 Losada, M., P. Sanchez, and E. E.Nobel, "Collaborative Technology and Group Process Feedback: Their Impact on Interactive Sequences in Meetings," *Proceedings of the Conference on Computer Supported Cooperative Work,* (1990), 53-64.

61 Massey, A.P., and D.L. Clapper, "Element Finding: The Impact of a Group Support Systems on a Crucial Phase of Sense Making," *Journal of Management Information Systems,* 11,4, (1995), 149-176.

48 McGrath, J., "Introduction: The JEMCO Workshop-Description of a Longitudinal Study," *Small Group Research,* 24,3, (1993), 285-306.

124 McGrath, J. E. and H. Arrow, "Introduction: The JEMCO-2 Study of Time, Technology, and Groups," *Computer Supported Cooperative Work (CSCW),* 4, 2, 1996, 107-126.

62 McGuire, T.W., S. Kiesler, and J. Siegel, "Group and Computer-Mediated Discussion Effects in Risk Decision Making," *Journal of Personality and Social Psychology,* 52, 5, (1987), 917-930.

***63** McLeod, P.L. and S.E. Elston, "Persuasive Linguistic Devices in Anonymous Vs Identified Computer Supported Groups: An Exploratory Study," *Proceedings of the Twenty-Eight Hawaii International Conference on System Sciences,* IV, (1995), 163-170.

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

118 Mejas, R., L. Lazeneo, and D. Vogel, AA Cross-Cultural Comparison of GSS and non-GSS Consensus and Satisfaction Levels Within and Between the U.S. & Mexico,@ *Proceedings of the Twenty-Ninth Annual Hawaii International Conference on System Sciences,* III (1996), 408-417.

65 Mennecke, B.E., J.A. Hoffer, and J.S. Valacich, "An Experimental Investigation of Group History and Group Support Systems Use on Information Sharing Performance and User Perceptions," *Proceedings of the Twenty-Eight Hawaii International Conference on System Sciences,* IV, (1995), 153- 162.

66 Miranda, S.M., and R.P. Bostrom, "The Impact of Group Support Systems on Group Conflict and Conflict Management," *Journal of Management Information Systems,* 10, 3, (1994), 63-95.

66 Miranda, S.M., and R.P. Bostrom, "The Impact of Group Support Systems on Group Conflict and Conflict Management: An Empirical Investigation," *Proceedings of the Twenty-Sixth Hawaii International Conference on System Sciences,* III, (1993), 83-94.

67 Ocker, R., S.R. Hiltz, M. Turoff, J. Fjermestad, "The Effects of Distributed Group Support and Process Structuring on Requirements Development Teams: Results on Creativity and Quality," *Journal of Management Information Systems,* 12, 3, (1996), 127-153..

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

119 Olson, J. S., G. M. Olson, and D. K. Meader, "What Mix of Video and Audio is Useful for Remote Real-time Work?" *Proceedings of Computer Human Interaction,* (1995), 362-368.

68 Olson, J.S., G.M. Olson, M. Storrosten, and M. Carter, "How a Group-Editor Changes the Character of a Design Meeting as Well as its Outcome," *Proceedings of the Conference on Computer-Supported Cooperative Work,* October, (1992), 91-98.

99 Poole, M.S., and G. DeSanctis, "Microlevel Structuration in Computer-Supported Group Decision Making," *Human Communication Research,* 19,1, (1992), 5-49.

99 Poole, M.S., M. Holmes and G. DeSanctis, "Conflict Management in a Computer-Supported Meeting Environment," *Management Science,* 37,8 (1991), 926-953.

99 Poole, M.S., M. Holmes, R. Watson, and G. DeSanctis, "Group Decision Support Systems and Group Communication: A Comparison of Decision Making in Computer-Supported and Non-supported Groups," *Communications Research,* 20, 2 (1993), 176-213.

69 Raman, K.S., B.C.Y. Tan, and K.K. Wei," An Empirical Study of Task Type and Communication Medium in GDSS," *Proceedings of the Twenty-Sixth Hawaii International Conference on Systems Science,* IV, (1993), 161-168.

***70** Rao, V.S., "Effects of Teleconferencing Technologies: An Evaluation Exploration of Comprehension, Feedback, Satisfaction and Role-related Differences," *Group Decision and Negotiation,* 4, (1995), 251-272.

70 Rao, V.S., "Dimensions of Satisfaction in Teleconferencing: An Exploratory Analysis," *Proceedings of the Twenty-Seventh Hawaii International Conference on System Sciences,* IV,(1994),124-133.

71 Reagan-Cirincione, P., "Improving the Accuracy of Group Judgment: A Process Intervention Combining Group Facilitation, Social Judgment Analysis, and Information Technology," *Organizational Behavior and Human Decision Processes,* 58, (1994), 246-270.

71 Reagan-Cirincione, P., "Combining Group Facilitation, Decision Modeling, and Information Technology to Improve the Accuracy of Group Judgment," *Proceedings of the Twenty-Fifth Hawaii International Conference on System Sciences,* IV, (1992),

127 Reinig, B.A., R.O. Briggs, M.M. Shepherd, J. Yen and J.F. Nunamaker, "Affective Reward and the Adoption of Group Support Systems," *Journal of Management Information Systems,* 12, 2, 1996, 171-185.

127 Reinig, B.A., R.O. Briggs, M.M. Shepherd, J. Yen and J.F. Nunamaker, "Developing and Validating an Instrument to Measure the Impact of Group Support Technology on Affective Reward," *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences,* IV (1995), 798-807.

72 Rhee, H.S., H. Pirkul, V. Jacob, and R. Barhki, "Effects of Computer-Mediated Communication on Group Negotiation: An Empirical Study," *Proceedings of the Twenty-Eighth Hawaii International Conference on System Sciences,* IV, (1995), 270-279.
73 Sambamurthy, V. and G. DeSanctis, "An Experimental Evaluation of GDSS Effects on Group Performance During Stakeholder Analysis," *Proceedings of the Twenty-Third Hawaii International Conference on System Sciences,* IV, (1990), 79-88.
73 Sambamurthy, V. and M.S. Poole, "The effects of variations in capabilities of GDSS designs on management of cognitive conflict in groups," *Information Systems Research,* 3,3 (1992), 224-251.
73 Sambamurthy, V., G. DeSanctis, and M.S. Poole, "The Effects of Alternative Computer-Based Technologies on Equivocality Reduction During Group Decision-Making," Unpublished manuscript, School of Business, Florida State University, Tallahassee, 1991.
73 Sambamurthy, V., M.S. Poole, and J. Kelly, "The Effects of Variations in GDSS Capabilities on Decision-making Processes in Groups," *Small Group Research,* 24,4 (1993), 523-546.
120 Savicki, V., M. Kelley, and D. Lingenfelter, "Gender and Group Composition in Small Task Groups Using Computer-Mediated Communication," *Computers in Human Behavior*, 12, 2, 1996, 209-224.
74 Sengupta, K. and D. Te'eni, "Cognitive Feedback in GDSS: Improving Control and Convergence, " *MIS Quarterly*, 17,1 (1993), 87-113.
74 Sengupta, K. and D. Te'eni, "Reducing Cognitive Conflict Through Feedback in GDSS: An Experiment in the Formulation of Group Preferences," *Proceedings of the Twenty-Sixth Hawaii International Conference on System Sciences,* IV, (1991) 631-640.
75 Sharda, R., Barr, S.H., and McDonnell, J.C., "Decision Support System Effectiveness: A Review and an Empirical Test," *Management Science,* 34,2, (1988), 139-157.
76 Shephard, M.M., R.O. Briggs, B.A. Reninig, J. Yen, and J.F. Nunamaker, "Social Comparison to Improve Electronic Brainstorming: Beyond Anonymity," Journal of Management Information Systems, 12, 3, 1996, 155-170.
76 Shepherd, M.M., R.O. Briggs, B.A. Reinig, and J. Yen, "Social Loafing in Electronic brainstorming: Invoking Social Comparison Through Technology and Facilitation Techniques to Improve Group Productivity," *Proceedings of the Twenty-Eight Hawaii International Conference on System Sciences*, IV, (1995), 523-532.
121 Sia, C., B. C. Y. Tan, and K. Wei, "Exploring the Effects of Some Display and Task Factors on GSS User Groups," *Information and Management*, 30, 1996, 35-41.
77 Siegel, J., V. Dubrovsky, S. Kiesler, and T.W. McGuire, "Group Processes in Computer-Mediated Communication," *Organizational Behavior and Human Decision Processes,* 37, (1986), 157-187.
78 Silver, S.D., B.J. Cohen, and J.H. Crutchfield, "Status Differentiation and Information Exchange in Face-to-Face and Computer-Mediated Idea Generation," *Social Psychology Quarterly,* 57, 2 (1994), 108-123.
***79** Smith, J.Y. and M.T. Vanecek, "Dispersed Group Decision Making Using Nonsimultaneous Computer Conferencing: A Report of Research," *Journal of Management Information Systems,* 7,2 (1990), 71-92.
79 Smith, J.Y. and M.T. Vanecek, "A Nonsimultaneous Computer Conference as a Component of Group Decision Support Systems," *Proceedings of the Twenty-Second Hawaii International Conference on System Sciences,* IV, (1989), 370-377.
80 Smith J.Y. and M.T. Vanecek, "Computer Conferencing and Task-Oriented Decisions: Implications for Group Decision Support," *Information & Management,* 14, (1988), 123-132.
81 Spears, R., M. Lea, and S. Lee, "De-Individuation and Group Polarization in Computer-Mediated Communication," *British Journal of Social Psychology,* 29, (1990), 1-14.
82 Steeb, R. and S.C. Johnston, "A Computer-Based Interactive System for Group Decision Making," *IEEE Trans. Systems Man Cybernetics,* 11,8 (1981), 544-552.
122 Straus, S., "Getting a Clue: The Effects of Communication Media and Information Distribution of Participation and Performance in Computer-Mediated and Face-to-Face Groups," *Small Group Research*, 27, 1, 1996, 115-142.
83 Straus, S.G., and J.E. McGrath, "Does the Medium Matter? The Interaction of Task Type and Technology on Group Performance and Member Reactions," *Journal of Applied Psychology,* 79, 1 (1994), 87-97.
84 Tan, B.C.Y., K.S. Raman, and K.K. Wei, "An Empirical Study of Task Dimension of Group Support Systems," *IEEE Transactions on Systems, Man, and Cybernetics,* 24, 7 (1994), 1054-1060.
84 Tan, B.C.Y., K.K. Wei, and K.S. Raman, "Effects of Supported and Task Type on Group Decision Outcome: A Study Using SAMM," *Proceedings of the Twenty-Fourth Hawaii International Conference on System Sciences,* IV, (1991), 537-546
85 Tan, B.C.Y., K.K. Wei, and R.T. Watson, "Dampening Status Influence Using A Group Support System: An Empirical Study," *Transactions of the Thirteenth International Conference on Decision Support Systems,* (1993), 77-89.
86 Toth, J.A., "The Effects of Interactive Graphics and Text on Social Influence in Computer-Mediated Small Groups," *Proceedings of the Conference on Computer Supported Cooperative Work,* October 22, (1994), 299-310.
87 Tung, L.L. and A.R. Heminger, "The Effects of Dialectical Inquiry, Devil's Advocacy, and Consensus Inquiry Methods in a GSS Environment," *Information & Management,* 25, (1993), 33-41.
***88** Tryan, C.K., J.F. George, and J.F. Nunamaker, "Group Support for Technical Review Teams: An Exploratory Investigation, *Proceedings of the Twenty-Sixth Hawaii International Conference on System Sciences,* IV, (1993), 102-111.
45,47 Turoff, M. and S.R. Hiltz, "Computer Support for Group Versus Individual Decisions," *IEEE Transactions on Communication,* 30,1 (1982), 82-90.
89 Valacich, J.S., A.R. Dennis, and T. Connolly, "Idea Generation in Computer-Based Groups: A New Ending to an Old Story," *Organizational Behavior and Human Decision Processes*, 57, (1994), 488-467.
90 Valacich, J.S., A.R. Dennis, and J.F. Nunamaker, "Anonymity and Group Size Effects in an Electronic Meeting Systems Environment," *Small Group Research,* 23,1 (1992), 49-73.
91 Valacich, J.S., J.F. George, J.F. Nunamaker, and D.R. Vogel, "Physical Proximity Effects on Computer-Mediated Group Idea Generation, *Small Group Research,* 25, 1 (1994), 83-104.
92 Valacich, J.S., B.C. Wheeler, B.E. Mennecke, R. Wachter, "The Effects of Numerical and Logical Group Size on Computer-

Mediated Idea Generation," *Organizational Behavior and Human Decision Processes,* 62, 3 (1995), 318-329.
92 Valacich, J.S., B.E. Mennecke, R. Wachter, and B.C. Wheeler, "Computer-Mediated Idea Generation: The Effects of Group Size and Group Heterogeneity," *Proceedings of the Twenty-Sixth Hawaii International Conference on Systems Science,* IV, (1993), 152-160.
93 Valacich, J.S., D. Paranka, J.F. George, J.F. Nunamaker, "Communication Concurrency and the New Media: A New Dimension for Media Richness," *Communication Research,* 20, 2 (1993), 249-276.
94 Valacich, J.S. and C. Schwenk, "Devil's Advocacy and Dialectical Inquiry Effects on Group Decision Making Using Computer-Mediated Versus Verbal Communication," *Organizational Behavior and Human Decision Processes,* 63,2 (1995), 158-173.
95 Valacich, J.S. and C. Schwenk, "Effects of Carping versus Objective Devil's Advocacy on the Decision Making of Individuals and Groups Using Verbal Versus Computer-Mediated Communication," *Decision Sciences*, 26,3, (1995) 369-394.
96 VanSchaik, F.D. and H.G. Sol, "Effectiveness of Decision Support Systems," *Proceedings of the Twenty-Third Hawaii International Conference on System Sciences, III,* (1990), 50-58.
97 Venkatesh, M. and B.E. Wynne, "Effects of Problem Formulation and Process Structures on Performance and Perception in a GDSS Environment: An Experiment," *Proceedings of the Twenty-Fourth Hawaii International Conference on System Sciences,* III, (1991), 564-572.
98 Walther, J.B., "Relational Aspect of Computer-Mediated Communication: Experimental Observations over Time," *Organizational Science,* 6, 2 (1995), 186-203.
98 Walther, J.B., "Longitudinal Experiment on Relational Tone in Computer-Mediated and Face to Face Interaction," *Proceedings of the Twenty-Fifth Hawaii International Conference on Systems Science, IV, (*1992), 220-231.
98 Walther, J.B. and J.K. Burgoon, "Relational Communication in Computer-Mediated Interaction," *Human Communications Research,* 19, 1 (1992), 50-88.
99 Watson. R.T., G. DeSanctis, and M.S. Poole, "Using a GDSS to Facilitate Group Consensus: Some Intended and Unintended Consequences," *MIS Quarterly,* September, (1988), 463-477.
100 Watson, R.T., T.H. Ho, K.S. Raman, "A Fourth Dimension of Group Support Systems," *Communications of the ACM,* 37, 10 (1994), 44-55.
101 Weisband, S.P., "Group Discussion and First Advocacy Effects in Computer-Mediated and Face-to-Face Decision Making Groups," *Organizational Behavior and Human Decision Processes,* 53, (1992), 352-380.
102 Weisband, S., "Overcoming Social Awareness in Computer-Supported Groups: Does Anonymity Really Help?" Computer Supported Cooperative Work (CSCW), 2, (1994), 285-297.
102 Weisband, S., S.K. Scheidner, T. Connolly, "Computer-Mediated Communication and Social Information: Status Salience and Status Differences," *Academy of Management Journal,* 38,4 (1995), 1124-1151.
103 Wheeler, B.C., B.E. Mennecke, and J.N. Scudder, "Restrictive Group Support Systems as a Source of Process Structure for High and Low Procedural Order Groups," *Small Group Research,* 24, 4 (1993), 504-522.
104 Wilson, J. and L.M. Jessup, "A Field Experiment on GSS Anonymity and Group Member Status," *Proceedings of the Twenty- Eighth Hawaii International Conference on System Sciences,* IV, (1995), 212-221.
105 Winniford, M., "Issues in Automated Voting," *Proceedings of the Twenty-Forth Hawaii International Conference on System Sciences, IV, (*1991), 621-630.
106 Wood, J.G. and J.T. Nosek, "Discrimination of Structure and Technology in a Group Support System: The Role of Process Complexity," *Proceedings of the International Conference on Information Systems,* III, (1994), 187-199.
107 Yellen, R.E., M. Winniford, and C.C. Sanford, "Extraversion and Introversion in Electronically-Supported Meetings," *Information & Management*, 24, (1995), 63-74.
***108** Zigurs, I., G. DeSanctis, and J. Billingsley, "Adoption Patterns and Attitudinal Development in Computer-Supported Meetings: An Exploratory Study with SAMM," *Journal of Management Information Systems,* 7,4 (1991), 51-70.
***108** Zigurs, I., G. DeSanctis, and J. Billingsley, "Exploring Attitudinal Development in Computer-Supported Groups," *Proceedings of the Twenty-Second Hawaii International Conference on System Sciences,* III (1989), 353-357.
109 Zigurs, I., M.S. Poole, and G.L. DeSanctis, "A Study of Influence in Computer-Mediated Group Decision Making," *MIS Quarterly,* December, (1988), 625-644.
110 Zigurs, I., E.V. Wilson, A.M. Sloane, R.F. Reitsma, and C. Lewis, "Simulation Models and Group Negotiation: Problems of Task Understanding and Computer Support," *Proceedings of the Twenty-Seventh Hawaii International Conference on Systems Science,* III, (1994), 306-315.

Note: An * In front: Non-conforming studies

12 Chidambaram & Kautz, 1993: One group per cell; No statistics.
15 Connolly, Routheaux, & Schneider, 1993: Individuals pooled into groups.
28 Ellis, Rein, & Jarvenpaa, 1989, 1990: One group per cell.
29 Eveland & Bikson, 1988: One group per cell; No statistics.
43 Griffith & Northcraft, 1994: Two subjects per group.
54 Jarvenpaa, Rao, Huber, 1988: One group per cell.
63 Mcleod & Elston, 1995: No Statistics.
70 Rao, 1994, 1995: No real task; discussion only.
79 Smith & Vanecek, 1988: Two subjects per group.
88 Tryan, George, & Nunamaker, 1992: No statistics.
108 Zigurs, DeSanctis, & Billingsley, 1989: No statistics-Case study.

Chart I

THEORETICAL FRAMEWORK FOR ANALYZING STUDIES OF GROUP DECISION SUPPORT SYSTEMS

CONTEXTUAL FACTORS	INTERVENING FACTORS	ADAPTATION FACTORS	OUTCOME FACTORS
1. **TECHNOLOGY:** . Tools (Task support): Electronic brain storming, voting, agenda setting, cognitive feedback, etc. . Methods (Task structure): Time, proximity, settings, procedures, degree of anonymity, control & structure; e.g. NGT, DI, DA, sequential vs. parallel process . Levels (Process structure): Levels 1, 2, and or 3, structural features-restrictiveness, comprehensiveness . Medium (Process support): Communications Mode-- text, graphics, voice, image, sound, and video; FtF, CMC, GSS, DSS . Design: Room configuration, interface, embeddability, extensibility, flexibility, functionality & usability 2. **GROUP:** . Group characteristics: Size and salience, ad-hoc, established . Composition: Heterogeneity, organizational & job tenure, shared norms, member status, history & experience, subject type(student, MBA, professional, etc) . Leadership: Formal leadership, style, attitude, skills, power, and organizational position . Member characteristics: Attitudes, values, power, personal beliefs, age, sex, preferences, self confidence, skills demographics, initial quality, & experience (systems & tasks) . Meeting structure: Clarity of objective, specific work norm . Initial levels: Cohesiveness, task understanding, consensus, and agreement . Group Structures: Styles of interacting, knowledge & experience with structures, perceptions of others knowledge, evaluative tone 3. **TASK:** . Type: Generate, choose, negotiate, and execute; gain/loss . Characteristics: . Structure: Structured to unstructured . Equivocality: High to low . Analyzability: High to low . Complexity: High to low . Importance: High to low . Enjoy ability: High to low . Predictability: High to low . Source: Internal to external . Degree of task knowledge . Degree of agreement on values 4. **CONTEXT:** . Environment: Competition, uncertainty, time pressure . Organizational: Information system, age, goals, reward structure, leadership, culture, organizational size, etc . Cultural: American, British, Chinese, Hawaiian, Singaporian, etc.	1. **METHODS:** . Experimental design . Subjects . Task implementation . Session supports . Facilitator, chauffeur, moderator or not . Session structure . Session length . Number of sessions . Order (order of treatment or task) . Training: technology, group process and task 2. **RESULTANT COMMUNICATION DIMENSIONS:** . Bandwidth . Media richness . Social presence 3. **GROUP MEMBER PERCEPTION:** . Task: importance, visibility, understanding, & commitment . Individual: Values, personal needs, level of interest, and degree of frustration 4. **INDIVIDUAL PROBLEM SOLVING:** . Psychological differences . Biases . Strategies 5. **ORGANIZING CONCEPTS** . Information processing systems . Consensus generating systems . Behavior motivation & regulation 6. **OPERATING CONDITIONS** . Degree of anonymity . Modalities available . Time pressure . Changes in task, rewards, norms & division of labor Shaded Areas are the areas presented in this paper. Adapted from Fjermestad, 1997 and Fjermestad, Hiltz, &Turoff, 1993.	1. **GROUP ADAPTATION PROCESS:** **Structuration** . Social technology . Structural features . General spirit . Faithful/Ironic . Rules, resources- use, attitude, control, and consensus . Comfort, respect **Process Variables** . Participation . Consensus generating . Normative regulation . Effectiveness . Level of effort **Process Issues** . Diffusion of responsibility . Deindividuation . Pressure to consensus . Coordination 2. **PROCESS GAINS/LOSSES:** **Process Gains** . Synergy, learning . Clarity **Process Losses** . Free riding . Evaluation apprehension . Attenuation blocking . Information overload . Flaming . Dominance 3. **INTERMEDIATE ROLE OUTCOMES** . Role assumption by technology . Actual roles of participants Task-related & group-building: recorder, gatekeeper,follower, information/opinion seeker, information/opinion giver, proceduralist, motivator, explainer, evaluator . Values	1. **EFFICIENCY MEASURES:** . Decision time . Number of decision cycles . Time spent in activities . Time spent waiting for responses . Time to consensus 2. **EFFECTIVENESS MEASURES:** . Communication . Number of comments . Idea Quality . Decision quality . Decision confidence . Process quality . Creativity/Innovation . Level of understanding . Task Focus . Depth of Evaluation . Commitment to results 3. **SATISFACTION MEASURES:** . Participation . Cohesiveness . Conflict management . Influence . Confidence . Attitude . General satisfaction . Decision Satisfaction 4. **CONSENSUS:** . Decision agreement . Commitment 5. **USABILITY MEASURES:** . Learning time . Willingness to work together again . System utilization . Number of errors . Design Preference

Summary Chart II
FACTORS MODEL
CONTEXTUAL FACTORS

4.1 TECHNOLOGY

Task Support (I)

Task Tools (General).....3
Cognitive Feedback.7

Task Structure (I)

Anonymity.....11
Process.....14
Proximity.....7

Process Structure (I)

Levels.....3
Comprehensiveness..2
Restrictiveness....3

Process Support (I)

Communication Mode...91
FtF/CMC other.....13
FtF/CMC.....21
FtF/EBS.....5
FtF/DSS.....3
FtF/GSS.....32
FtF/EBB/EWS....2
FtF/GSS/D-GSS/A-GSS.6
FtF/Audio.....3
GSS/Manual/Baseline.6

Task Support: Tools

Agenda.....5
Alternative Generator.....3
Group Outliner.....2
Group Writer.....3
HyperCard.....1
Idea Generator.....4
Topic Commentor....4
Lists.....5
Ranking.....18
EBS.....34
EDS.....3
Voting.....22
Issue Analyzer.....3
SIAS.....2
SAST.....1
STA.....1
Standard Package..12
ShareEditor.....3
MCDM.....3
Other.....23
None.....23

Task Structure

Group Proximity

Dispersed..... 13
Decision Room..92
FtF/Dispersed..21
DR/Dispersed...14

Time Dispersion

Synchronous...129
Asynchronous....9
Synch/Asynch....2

Anonymity

Anonymity (A)..36
Identified (I).95
A/I.....9

Process Structure

Levels

Level 0.....9
Level 1.....95
Level 2.....30

Level 1 vs 2.....6

Note: The "/" means there is a comparison between both sides of the /.

Process Support

Technology

DSS.....3
CMC.....40
GSS.....97

I: Independent Variable
The rest are Moderator Variables

Design-GSS System

CMC-General.....20
COSY.....3
CaptureLab.....3
Co-Op.....2
Converse.....4
DECAID.....3
DSS-General.....3
EDS/EMS/EBS.....6
EIES/EIES2.....7
GroupLink..... 3
GroupSystems....34
GSS-General.....10
Nick.....2
OptionLink.....3
Perceptronics....1
PlexCenter.....2
Plexsys.....6
Sage.....3
SAMM.....15
Shr-Edit.....3
VisionQuest.....7

Summary Chart II
FACTORS MODEL
CONTEXTUAL FACTORS

4.2 GROUP

Group Size (I)

2,4,6 1
3,9 2
3,9,18 1
4,8 1
4,8,12 1
5,10 1
5,6,7,8,9,10 1
6,12 4
Other 1

Group Composition (I)

Gender 2
Established/Ad-hoc 2
Member Status 3
Knowledge/Skill 5
Structure 2
Type 1
Other 7

Member Characteristics (I)

Attitudes 1
Personality 1
Preferences 1
Other 1
Leadership 4

Moderator Variables

Group Type

Ad Hoc 135
Established 5

Group Composition (Subject Type)

Professionals 11
Graduate Students 4
Under graduates 98
MBA Students 7
Grad/Under grads/MBA 18
Grads/Under grads 10
High School/Local 2

Leadership

Assigned Leader 2
Elected Leader 2
Group Leader (GL) 2
Moderator 1
GL/NL 1
Leader/NL 1
No Leader (NL) 131

I: Independent Variable
M: Moderator Variable

4.3 TASK

Task Characteristics (I)

Complexity 4
Task 13
Task Type 14

Task Type (M)

Type 0 1
Type 1 4
Type 2 53
Type 3 37
Type 4 74
Type 5 10
Type 6 1

Mixed 30
(Double Counted)

4.3 CONTEXT

Environment (I)

Culture 3
Evaluative Tone 2
Experience 11
Time Pressure 1
Organizational 1

Summary Chart II
FACTORS MODEL
INTERVENING FACTORS

5.1 METHOD

Method (I)

Facilitation.....5
Open/Blocked.....1
Order.....4
Sessions.....11
(Same as experience)

Facilitation

Facilitator.....41
No Facilitator....93
M/F.....3
F/C.....1
F/AF.....1
F/U.....1
NF/F.....1

Automated F (AF)
Chauffeur C
Facilitator (F)
Moderator (M)
No Facilitator (NF)
User Driven (U)

Number of Sessions

1...101 7....2
2....18 8....1
3.....7 13....2
4.....7
Not Reported 2

Training

Not Reported.....40
Training
Mentioned.....52
None.....3
5 to 10 min.....14
11 to 20 min.....9
21 to 50 min.....9
60 to 90 min.....10
120+ min.....2

Duration of Experiment

< 15 min.....13
15 < 30 min.....23
30 < 60 min.....27
1 < 2 hr.....26
2 < 3 hr.....5
1 year..... 1
1 week.....1
2 weeks.....4
5 weeks.....1
Not Reported.....25
No Limit.....2

Experimental Design

1 X 2..30 2 X 4..4
1 X 3..19 2 X 6..1
1 X 4...1 2 X 7..1
1 X 5...2 2 X 8..1
2 X 2..43 3 X 3..5
2 X 3..15 3 X 4..2

2 X 2 X 2.....10
2 X 2 X 7.....1
3 X 2 X 2.....2
4 X 2 X 3.....1
4 X 4 X 4.....1
2 X 2 X 3 X 2.....1
2 X 2 X 4X 2X 13...1

Case.....1

Design Type

Anova.....51
Factorial.....46
Repeated Measures.34
Quasi Factorial....3
Counter Balanced...1
Repeated Measures
Latin Square.....4

Groups per Cell

1.....6 12-5...11
2-3.....4 15-20...19
3-4....10 20+.....7
4-5....12 Mixed....3
5-6....12
7-10....6
8-10...25
10.....11
10-12..14

Group Size

2.....3 8.....3
3.....37 9.....4
3-8...17 10.....2
4.....23 12.....4
4-8...15 6-16/17..2
5.....21 18..... 1
5-10...3 20..... 1
6.....8 41..... 2
6-7....2 50..... 1
7.....2 63..... 1
7-10...3
Not Reported.....1

I: Independent Variable; The rest are Moderator Variables

Total Number of Groups

3- 4.....7
8-12.....19
14-19.....24
20-30.....33
31-40.....30
41-60.....16
60-90.....9
100+.....2

Total Subjects

17- 50.....18
51- 80.....34
81-100.....16
101-120.....18
121-160.....17
161-220.....11
221-300.....17
301-400.....5
500+.....2
Not Reported.1

Example CHART A
An Empirical Analysis of Group Support Systems: Methodology

AUTHORS	TECHNOLOGY	EXPERIMENTAL DESIGN	GROUP & SUBJECT Variables	TASK TYPE	NUMBER of SESSIONS/ SESSION LENGTH
1 Adrianson & Hjelmquist, 1991	CMC: COM, Level 1, Decision room, distributed, Tools: Ranking; Training?	2 X 2 X 2 Repeated measures Communication Mode: FtF, CMC Problem Type: Human relations Technical ranking Experience Experienced, Inexperienced	16 groups; 4 groups per cell; 4 subjects per group; 65 total subjects; Professional.	Forest Ranger & Lost in the Arctic, Decision-making, Intellective, Type 4,3	2 sessions, one F-t-F and 1 CMC. FR FtF 75 min FR CMC 80 min LA FtF 60 min LA CMC 90 min.
2 Aiken, Krosp, Shirani, & Martin, 1994	GSS: GroupForum, Level 2 decision room, anonymous, facilitator, Tools: brainstorming, Training: 5 min.	2 x 2 quasi factorial Communication: Verbal, GSS Group size: Small, Large	10 groups; 2 or 3 groups per cell; 6 small groups of 7 to 9 subjects and 4 large groups (size 50 & 63 for verbal and two size 41 for GSS); 243 total subjects; Undergraduates.	Tourism Task & Parking problem, Idea generation, Type 2	1 session, 15 minutes.
3 Anson, Bostrom, & Wynne, 1995	GSS: GroupSystems, Level 2, Decision room, Facilitator, Tools: issue consolidation, topic commentor; Training: practice task &systems demo.	2 X 2 Factorial Technology: GSS, No-GSS Facilitation: Facilitator, No Facilitator	48 groups; 12 groups per cell; 6 or 7 subjects per group; 319 total subjects; Undergraduates.	Strategy Design and Implementation (paper planes), Planning & performance, Type 1 & 8	1 session, training plus 90 minutes planning task and 5 minutes execution.
4 Archer, 1990	CMC: CoSy, Level 2, asynchronous, Group Moderator/Leader; Distributed, Tools: None Training: yes	4 X 4 X 4 Repeated Measures Communication Mode: FtF, FtF-NGT, CC-Asynch, CC-NGT Cases: 4 cases Order: 4 order	4 groups; 2 groups per cell; 4 or 5 subjects per group; 18 total subjects; MBA Students.	Case studies on IS, Decision-making, Type 4	4 Asynch sessions, each 2 weeks long.
5 Bui & Sivasankaran, 1990	GSS: Co-Op, Level 1, Decision Room, Laboratory, Facilitator, Tools: MCDM; Training ?	2 X 2 Repeated Measures GSS Type: GSS, No GSS Task Complexity: High vs Low	24 groups; 12 groups per cell, 4 cells, 3 subjects per group, 72 total subjects; Graduates.	Al Kohbari & Energy International, Intellective, Type 3	1 session.
6 Bui, Sivasankaran, Fijol, & Woodbury, 1987	GSS: Co-Op, Level 1, Decision room, Laboratory, Facilitator, Tools: MCDM; Training ?	2 x 1 GSS Type: FtF Shared system Distributed system	12 groups; 6 groups per cell; 3 subjects per group; 36 total subjects; Graduates.	Case Study: Generate criteria & select best manager, Idea generation & Intellective, Type 2,3	1 session length not reported.

Example Chart B
An Analysis of Group Support Systems: Results

AUTHORS	DEPENDENT MEASURES - OUTCOMES	COMMENTS - GROUP PROCESS ADAPTATION	CONCLUSIONS
1 Adrianson & Hjelmquist, 1991	**CommMode / Task / Experience** Attitude: FtF > CMC / Ns / Ns Satisfaction: FtF > CMC / Ns / Ns Consensus: FtF > CMC / Ns / Ns Quality: Ns / Ns / Ns Participation-Equ. Ns / Ns / E > I Dominance: Ns / Ns / Ns Opinion shift: FtF > CMC / Ns / Ns Decision Satis: FtF > CMC / Ns / Ns Personality Type: Ns / Ns / Ns E: Experienced; I: Inexperienced	Experienced users were as active in the CMC as they were in the FtF condition. Interactions: Experience and CommMode Mode with Consensus: Task Type 4 FtF > CMC Task Type 3 Ns Quality: Task Type 4 E > I Task Type 3 Ns	No difference in problem solving between FtF and CMC. Task difference between FtF and CMC; in human relations problem- FtF has greater conformity and opinion change.
2 Aiken, Krosp, Shirani, & Martin, 1994	**CommMode / Group Size** Production Blocking: FtF > GSS / Large > Small Evaluation Apprehension: FtF > GSS / Large > Small Satisfaction: GSS > FtF / Small > Large	There are several interaction effects: apprehension greatest in large verbal groups; large GSS groups were the most satisfied. Anonymity and mode were confounded, also analysis was at the individual as unit instead of group. Group size was not controlled.	Electronic brainstorming is superior to verbal communication in large groups for idea generation. There were no significant differences between the technologies in the smaller groups.
3 Anson, Bostrom, & Wynne, 1995	**CommMode** Performance: Ns Cohesion: GSS-F, FtF-F, GSS > FtF Process Perceptions: GSS-F, FtF-F, GSS > FtF GSS-F; Facilitated GSS FtF-F: Facilitated FtF;	All GSS groups appropriated the more restrictive "generate" tool faithfully. However, 14 of 24 groups faithfully appropriated the consolidate tool; 5 groups discarded the tool. Facilitator attitudes and training/skills may have been a moderating factor. 6 of 11 facilitators expressed negative attitudes toward facilitating in the GSS setting. High group variability was reported.	Both the GSS and facilitation interventions were found to improve cohesion and process outcomes compared to baseline groups. The results suggest that a high quality facilitator could significantly improve outcomes compared to no facilitator at all.
4 Archer, 1990	**CommMode** Decision Quality: Ns Num. Alternatives: NG > FtF, CMC Perceived Satisfaction: Ns Interaction effects Decision Time: CMC > FtF (observation) NG: Nominal Group	Assignment to groups was based upon high intra-group heterogeneity and low inter-group differences in educational characteristics. Participants were also observed to adopt a coping mechanism for dealing with the large numbers of alternatives to the complex problems (AST).	Decision quality did not depend on the meeting methodology used. It is suggested that business decision quality will not degrade if CMC is used. Groups varied widely in their satisfaction with meeting technique and communications mode.
5 Bui & Sivasankaran, 1990	**CommMode / TaskComp / Interaction** Decision Quality : Ns / Ns / H-GSS > H-FtF Decision Time: GSS > FtF / H > L / L-GSS > L-FtF Satisfaction: Ns / Ns / L-FtF > L-GSS Note: Hypotheses were on the interaction effects	The results can be interpreted as a Structuration effect. The higher the complexity the more time it took to reach a decision and the better the decision; satisfaction went from low to equal. GSS reduced influence of dominant members: more equal participation.	GSS enhances decision quality as complexity increases.