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The Minnesota GDSS Research Project: Group Support Systems, Group Processes, and Outcomes*

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Abstract

The Minnesota GDSS Research Project is a 20-year program of interdisciplinary research that has generated more than 80 articles, chapters, dissertations, and proceedings publications and has influenced other researchers who developed their own niches. Grounded in Adaptive Structuration Theory, which emerged and evolved as the research unfolded, the project studied the impact of technology characteristics (level of support, restrictiveness) and other support (training, heuristics, facilitation) on group processes and outcomes for a range of tasks (problem definition, decision making, planning). The project entailed a complex tapestry of a series of laboratory experiments and two major field studies. The basic theoretical framework, experimental strategy and design, field study design, and results are summarized, along with a discussion of the significance and implications of the project for contemporary theory and practice.

Keywords: *Group decision support; Structuration theory; Collaboration technology; Decision support; Group communication*

* Jonathon Cummings was the accepting guest editor.

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The Minnesota GDSS Research Project: Group Support Systems, Group Processes, and Outcomes

1.0 Introduction

In 1985 a group of scholars at the University of Minnesota undertook an extended program of research on group decision support systems (GDSSs), also known as group support systems (GSSs).[1] A GDSS is a computer-based technology designed to help committees, project teams, and other small groups with activities such as problem identification and analysis, decision making, planning, creativity, conflict management, negotiation, and meeting management (Gray, 1987; Bostrom, Watson, and Kinney, 1992; Jessup and Valacich, 1992; Poole, 2002). GDSSs combine communication, information, and decision support technologies in an integrated environment. Depending on their specific features, GDSSs can support face-to-face or distributed groups and single session or long-term groups (DeSanctis and Gallupe, 1987).

In the late 1980s, driven by advances in computer and telecommunications technology, there was an upsurge of interest in groupware, ranging from presentation software to computer conferencing, to GDSSs (Johansen, 1987). The rise of interest in teams and networked organizations led academics and managers alike to search for novel tools that could make group processes more effective. Today this phenomenon is evidenced in interest in collaboration technologies, virtual teams, and online communities. GDSSs are an important part of the mix of collaborative technologies, as noted in a Gartner report that argued such systems will be critical to the effectiveness of web-based conferencing and collaboration tools (Austin, Drakos and Mann, 2006).

This article analyzes and describes the evolution and results of the Minnesota GDSS Research Project 20 years after its conception. During this period, the project produced 29 refereed articles, 34 book chapters and proceedings publications, 11 doctoral dissertations, and 19 unpublished reports (see http://hdl.handle.net/2142/5350 for a complete listing of these). The project influenced subsequent research not only as doctoral students graduated and established their own lines of inquiry but in other venues as researchers built on the ideas that came out of the project. It is useful to integrate findings across the various studies, because these findings provide an in-depth exploration of a theoretical model that specifies key dimensions of GDSS design and effects and the group processes that mediate these effects. Many of the findings included in this summary have not been previously published, offering additional illumination to the published studies. The process by which the project evolved is also worthy of examination, as an example of how the interplay among people and ideas in an interdisciplinary team drives a programmatic effort.

Several extensive reviews of research on GDSS and groupware exist, most notably Fjermestad and Hiltz (1998-99); see also McLeod (1996) and Scott (1999). This article is not a broad review in those traditions, but rather a deep consideration of one line of research organized around a unified theoretical framework, similar and comparable GDSS technology, and a uniform experimental protocol. The studies in the Minnesota GDSS program built on one another, and their results were cumulative because constructs were consistently defined and operationalized. The program developed through an extended "conversation" among researchers in which questions raised by earlier studies became the focus of subsequent research. GDSSs are complex technologies, and using the same system over numerous studies in the lab and field also facilitated studying many aspects of the system and replication of various features, which enhanced the likelihood of meaningful results that informed theory and practice. In advocating the advantages of a unified theoretical model and a consistent technology, it is also important to acknowledge their limitations, which we consider in the discussion.

The article is structured as follows: Section 2 lays out the conceptual framework for the project, recounting the motivation for the project and the theoretical model of Adaptive Structuration Theory that emerged from it. Section 3 describes the GDSS laboratory and the GDSS technology used in the studies, Software Aided Meeting Management. Section 4 then summarizes a series of laboratory investigations that tested and developed the model. Section 5 reviews two major field studies undertaken to test the lab results in business settings and to further develop the theoretical model.

The article concludes with a discussion of the project, a consideration of its strengths and weaknesses, and an outline of future directions for research. The article is organized primarily around the theoretical model and the key questions driving the research. For a more detailed account of the history of this project, how it was organized and developed over time, factors that contributed to its success, and challenges it faced, see Poole and DeSanctis (in press).

2.0 Conceptual Framework

2.1 Motivation for the Project

DeSanctis and Poole met as assistant professors at the University of Minnesota in 1986. Though they were from different disciplines, they realized that they had complementary interests and trajectories of research. Along with Gary Dickson, Gallupe, Watson, Zigurs, and Sambamurthy, DeSanctis and Poole began to formulate a theoretical and empirical framework.

At the time, information systems scholars were trying to develop decision support systems to structure group problem solving, with the goal of improving decision efficiency and effectiveness. Classical behavioral decision theory posited that if decision makers were given tools and techniques to overcome known biases and dysfunctions in human decision processes—such as the tendency to make decisions on the basis of anecdotal examples rather than thorough analysis—decision making might be improved (Simon, 1997). In the group context, this leap was proving extraordinarily difficult due to (a) the challenge of developing technology that could accommodate multiparty participation in the decision process and (b) the inadequacy of existing theory to predict or explain technology effects. In many arenas, information technology (IT) was not providing the advantages for which technologists hoped.

Starting in the early 1980s, DeSanctis, Gallupe, and Dickson (DeSanctis and Gallupe, 1985; 1987) began developing a theoretical basis for group decision support. A key issue they faced was that early on in the study of group decision support, researchers realized that GDSS technology would not necessarily bring about the advantages intended by designers. Fresh theoretical perspectives were needed to spur innovative technology design, as well as to understand the technology implementation process. They had already explored the literature on groups in social psychology and communication and were incorporating some of its insights into their conceptualization of GDSSs.

Poole had moved to the University of Minnesota in 1985 and began working with DeSanctis and her information systems colleagues in 1986. A central question of Poole's previous research was how to explain variations in group decision processes and resultant outcomes, even when groups had similar resources and attempted to utilize the same decision techniques. Poole's early research had shown that the then-dominant "stage theories" of group decision making, in which task groups were said to pass through a set series of stages in making decisions—for example, orientation, problem definition, solution generation, and choice—generally did not apply, even in controlled laboratory settings. More complex and dynamic theoretical approaches were needed to advance understanding of basic group communication processes. Structuration theory, developed in sociology to explain the evolution of large-scale social phenomena (Giddens, 1979), was being developed and refined by Poole, Seibold, McPhee (1985, 1986) and their colleagues in order to illuminate small group phenomena, such as the development of decisions and argumentation and influence in groups. Research conducted within this framework emphasized direct observation of group interaction as the best way to map group processes and to determine the influences upon it.

Effective group decision support was a significant issue in contemporary society in the mid-1980s. Driven by advances in computer and telecommunications technology, there was an explosion of interest in "groupware," ranging from presentation software to computer conferencing to group support systems (Johansen, 1988). The growth of the team-based quality movement and interest in team-oriented management practices led academics and organizational leaders alike to search for novel tools that could make these processes more effective. The emergence of local and wide-area network technologies and the Internet, and the need for integration of information within and across organizational boundaries as joint ventures and alliances proliferated, also made it possible and necessary for distributed groups to work over networks and emphasized the need for tools to help these groups to work effectively. Thus, organizations had a significant interest in implementing advanced IT and making it successful.

An integration of the information systems and communication approaches promised to yield insights into several important questions, and DeSanctis and Gallupe (1987) developed a conceptual paper crystallize some of the early concepts and helped to set the agenda for the first phases of the research. The key questions at this point included:

- *What effects do GDSSs have on group processes and outcomes?* The hypothesis that technology would improve outcomes had received uneven support in early GDSS studies. DeSanctis and Gallupe (1987) articulated several avenues through which GDSSs should improve group outcomes. Comparisons of groups using a GDSS to similar groups without a GDSS were designed to test the impacts of GDSSs on outcomes. Analysis of whether the avenues defined by DeSanctis and Gallupe were actually taken by groups as they used the GDSS attempted to identify mediating group processes that led to effective and ineffective use of the GDSS.

- *What meaningful dimensions underlie the design of GDSSs and how do these dimensions affect group processes and outcomes?* Answering this question required going beyond lists of GDSS features to more fundamental constructs in the design of GDSSs and groupware. DeSanctis and Gallupe had defined different levels of support that could be designed into GDSSs. Research by Poole and colleagues suggested some additional features of group procedures that might underlie GDSS effects. Studies of GDSSs varying along these dimensions attempted to determine differences due to their designs.

- *What additional types of support can facilitate GDSS use?* As with any information system or group procedure, using a GDSS is a learned skill. Training, assistance from facilitators or leaders, and other interventions may be used to assist groups to learn how to use the GDSS for best effect and to encourage them to utilize available tools. Studies of various types of interventions sought to clarify which ones made a difference and how best to deliver them.

- *How does the process of using a GDSS mediate its impacts on group processes and outcomes?* The mixed results of GDSS studies strongly implied that GDSSs did not have deterministic effects. The researchers sought to develop a model of the emergent impacts of GDSSs along the lines defined by Markus and Robey (1988). This theory was designed to take human agency into account as a source of variation in groups.

These questions reflected both scholarly and practical aspirations. The project attempted to develop a theory and empirical evidence that addressed the four questions. The researchers suspected that the research would bridge causal and interpretive approaches, and so they set out to develop a theory that stretched the bounds of current social scientific work in information systems and communication by combining causal and social constructionist accounts in a common model. This was done by layering functional and constitutive explanations (Poole and DeSanctis, 2004), and the research reported here shows the layered, incremental analysis that was required to do this. The researchers hoped to be able to get past the either-or thinking that characterized—and still does characterize—much social scientific research. The development of Adaptive Structuration Theory and subsequent analyses were central to bridging these perspectives.

On the practical side, the project was designed to develop tools that could help groups function more effectively. Research on decision support, group processes, and information systems has much to offer practitioners, and embodying this research in a system that directly engages groups was an appealing way to move from scholarship to practice.

2.2 Theoretical Framework: Adaptive Structuration Theory

Figure 1 portrayed the basic model that ultimately guided the project. The main components of the model are represented by the boxes. The specific dimensions or factors within the model, listed within each box, evolved over the course of the project. The essentials of the model were worked out in 1986, but the model did not explicitly guide research design until 1988. Studies by Gallupe, DeSanctis and Dickson (1988) and Watson, DeSanctis and Poole (1988) were not based on this framework, although videotapes from Watson et al. (1988) were used in later structuration-based analyses. The model was originally developed for a grant proposal to the National Science Foundation in 1987 and was largely fleshed out by 1990 (Poole and DeSanctis, 1989; Poole and DeSanctis, 1990). Its fullest statement was in DeSanctis and Poole (1994).

The model represents a specific instantiation of structuration theory in the context of technology use in groups and organizations that was termed *Adaptive Structuration Theory (AST)* (Poole and DeSanctis, 1990; DeSanctis and Poole, 1994). AST argues that the effects of GDSSs on group processes and outcomes depend on the design of technology structures and on the emergent (adaptive) structures that form in the group as members interact with the technology over time. Thus, from the design perspective, one can identify and develop structural capabilities that are likely to bring about desired group interaction processes. But outcomes of GDSS use depend on how these structures are brought into interaction, how they blend with other available structures in the work environment, and how the structures are effectively "redesigned" by the group in the course of their use for specific purposes. AST provides a dynamic view of GDSS technology and group interaction, focusing on the emergence of new social orders through active use of technology structures.

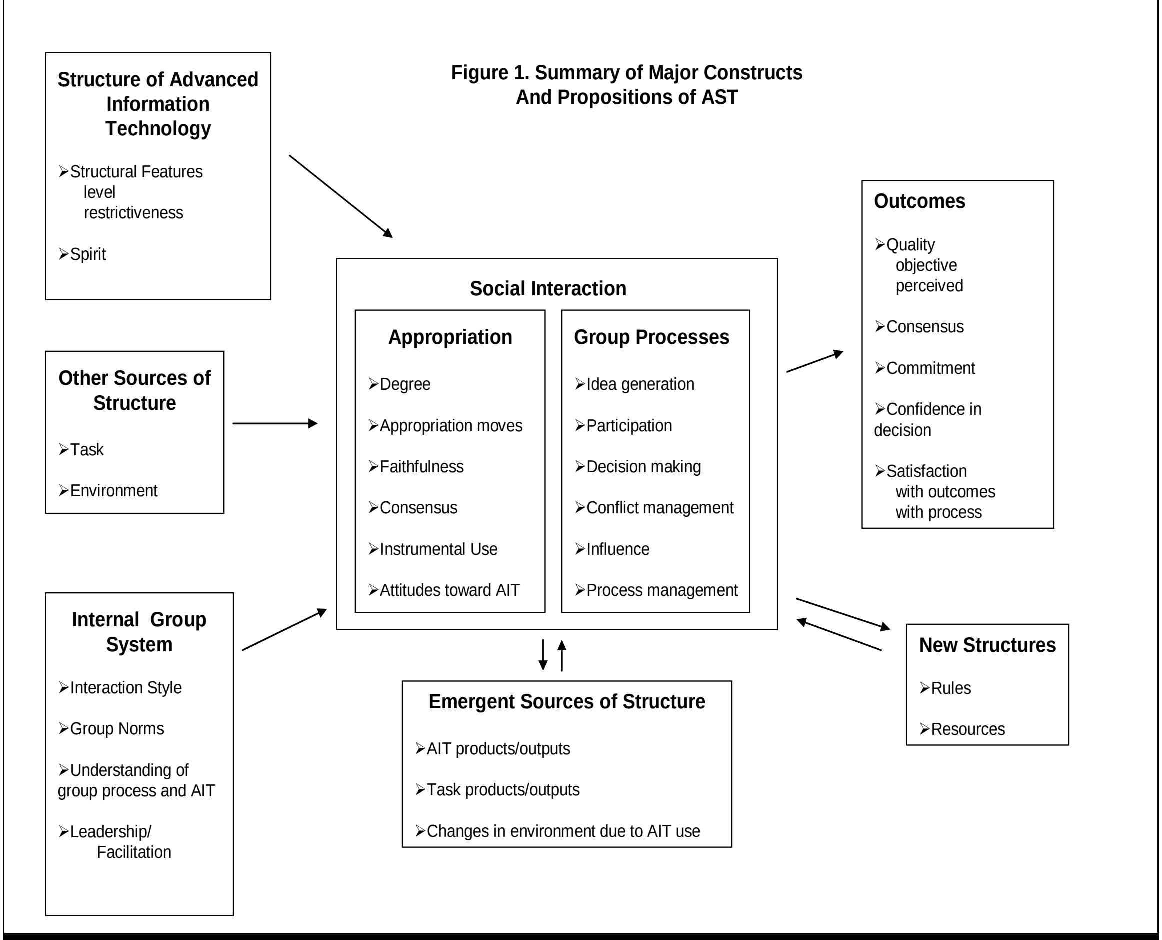

Figure 1. Summary of Major Constructs and Propositions of AST

Procedures and GDSS features embody what Giddens (1979) termed structures, rules and resources that actors use to generate, organize, and sustain social systems such as groups or organizations. A GDSS presents a group with an array of potential structures to draw down into its work. The research (DeSanctis and Poole, 1994; Poole and DeSanctis, 1990 and 1992) distinguished two aspects of technological structures: the *spirit*, the general values and attitudes the technology is built around (such as democratic decision making) and the specific *features* built into the system (such as anonymous input of ideas or a stakeholder analysis procedure).

The spirit is the principle of coherence that holds a set of rules and resources together, the general intent of the GDSS as reflected in its design and how it is implemented. Spirit can be described in terms of a general set of values or principles for the system, and it suggests general patterns or strategies for using the GDSS, how to interpret its features, and how to fill in gaps in procedure that are not explicitly specified.

The features of a GDSS are designed to promote its spirit, but they are functionally independent and may be used in ways contrary to the spirit. Usually the features of an information technology like a group decision support system are designed to promote its spirit, although in some cases features may be inconsistent due to sloppy design. Information technologies also differ in the degree to which their spirit is coherent; lack of reflection by designers, changes in designers over the course of the technology's development, and misunderstanding of the spirit by implementers may all result in an ambiguous or less coherent spirit.

Structuration is a process through which groups select, adapt, and develop their working structures from among those provided by the GDSS. In general terms, structuration can be defined as the process by which systems are produced and reproduced through group members' use of rules and resources (Giddens, 1979; Poole, Seibold and McPhee, 1985). This definition is founded on several additional assumptions and distinctions. First, structures are dualities; they are used to produce and reproduce the group system and to do the group's work, but the structures themselves are produced and reproduced through the group's activities. Structures have no reality independent of the social practices they constitute. Hence, when a group utilizes a GDSS voting procedure, it is employing the rules embodied in the GDSS features and putting them into action—hence constituting structures in the system of action—but it is also reminding itself that these rules exist, working out a way of using the rules, perhaps creating a special version of them—in short, the group is producing and reproducing its own version of the procedure for present and future use. When the group uses the features the next time, it is likely to constitute the structures based on its previous experience. So it is really somewhat misleading to regard structures as static entities or to presume that the structural potential embodied in a GDSS is equivalent to the structures that are used or usable by the group. A voting feature does not, for all practical purposes, exist for a group if the group never considers or employs it. A voting feature may, however, have salience if the group considers it and deliberately chooses not to use it, since that deliberation may affect subsequent experience.

Central to the structuration of group processes through GDSSs is the interplay between the spirit of the technology and the specific features members use. A group develops a reading of the spirit of the GDSS that is an important aspect of the meaning of the GDSS to the group. Their initial take on spirit is shaped by how the system is explained, members' prior beliefs about GDSSs and what they regard as similar systems, and the group's sense of itself and its context. The group's reading of the spirit of the GDSS influences its mode of appropriation of GDSS features. For example, if the group perceives that the GDSS is intended to speed up its decision processes, members might apply voting procedures in such a way that they rush on to their next agenda item after taking a vote. In some cases, a group's reading of spirit may not be consistent with how the designers and implementers of the GDSS present the GDSS. For example, the designers and implementers may have attempted to stress the GDSS as a vehicle for rational and careful decision making. However, some members of the group may want the GDSS to be a tool to cut down on meeting time and add an emphasis on speed. This new emphasis may be inconsistent with the structure of a system set up to support rational and careful decision making, setting up tensions between system capacities and the uses to which they are put. Such cases are called *ironic* appropriations of the GDSS because they turn its structures in ways contradictory to its intended spirit.

As Figure 1 shows, the group's interaction process is influenced by the group's appropriation of structural elements embodied in the GDSS and other external sources. Three types of inputs influence group processes: technological structures, other sources of structure, and the group's internal interaction system. Technological structures provided by the GDSS can be characterized in terms of feature configurations and the spirit of the technology. Features delimit the specific structures embodied in the GDSS, such as idea listing, voting, multi-criteria decision analysis, or note taking. The entire ensemble or configuration of features can also be described in terms of two dimensions:

- *Level of support*. DeSanctis and Gallupe (1987) distinguished three levels of support provided by GDSSs. *Level 1* features provide support for enhanced communication among group members. These features include idea listing, evaluation techniques such as voting or rating, and comment recording. *Level 2* features provide decision support tools such as multi-criteria decision making, stakeholder analysis, and problem formulation. A *Level 2* GDSS supports activities that members could not undertake on their own in a reasonable amount of time and enables members to utilize advanced decision models and techniques. *Level 3* features provide guidance for the group through such tools as automated facilitation and expert systems that advise the group on strategies and approaches for making the decision. They are intended to help members determine which Level 1 and Level 2 procedures to use and to take the burden of learning how to use the GDSS off members' shoulders.

- *Restrictiveness* of the system is the degree of freedom the user has in applying the technology (Silver, 1988; Wheeler, 1996). Restrictiveness influences appropriation of the GDSS: a very restrictive system must be used in a formulaic manner, which tends to result in faithful use of the GDSS, but may be inflexible and difficult to adapt to the situation. A less restrictive system leaves more room for users to improvise and adapt, but it may also be used ironically.

In addition to information technology, groups can draw on the structural potential offered by other sources. One important source of rules and resources is the group's task or work. Strategies for making decisions or work procedures often must be melded with the procedures built into the GDSS in order to adapt it to the task. Other aspects of work, such as looming deadlines or specific types of information required to make the decision, also shape structuration of the group decision process by placing constraints on how (and how much) the GDSS can be used. A second source of rules and resources is the general environment of the group, particularly the encompassing organization and members' previous experiences with similar work, as well as the organization's culture — an important source of norms that can be used to guide group work: General social norms such as reciprocity or equity can also be imported into the group's interaction.

The internal system of the group, which refers to the nature of relationships among members, typical interaction patterns, and individual and shared knowledge, is the third influence on adaptive structuration after technological structure and other sources of structure mentioned above. Specific aspects of the internal system that influence appropriation include:

- *Interaction styles*, either those characteristics of the group as a whole, such as group conflict management style (Kuhn and Poole, 2000), or of key members, such as individual conflict management style, that will influence appropriations through their impact on decisions about task strategies and employing the GDSS. For example, a group that tends to engage in a lot of socializing will use the GDSS differently than one that is mostly task-focused.

- Group *norms* that have been developed prior to using the GDSS will influence how the system is appropriated and used. A group that has norms favoring very structured meetings will most likely welcome the GDSS, whereas one whose norms favor low structure may resist the GDSS. Often, preexisting norms must be melded with the structural elements drawn from the GDSS. For example, Parliamentary Procedure might be combined with the decision processes built into the GDSS.

- Members' *degree of understanding* of the technological features and structures will affect how they use them. A member who knows the GDSS very well will use it differently from a novice; he or she may educate the group or, alternatively, use the technology to manipulate other members.

- *Leadership* will obviously influence how the GDSS is used. A directive leader will have more influence on how the GDSS is appropriated than will a more laissez-faire leader. In addition to the group's leadership, facilitators helping the group use the technology will also exert an influence on GDSS use. In some cases, the facilitator will be a critical source of leadership, especially when the group has hired an outside facilitator to assist its deliberations.

As noted, the GDSS is appropriated into the group's interaction. Dimensions to characterize appropriation of the GDSS include:

- *Degree of appropriation* — in terms of amount of use of the GDSS, where use is appropriated and the number of structures appropriated.

- *Appropriation moves* — how the GDSS is appropriated, how members make sense of the GDSS and its operations and potential, and how the GDSS is combined with other structures.

- *Faithfulness of appropriation* — overall, how consistent the appropriation of the GDSS is with its spirit.

- *Consensus on appropriation* — the degree of agreement among members concerning how the GDSS should be used and how it fits with the group's work.

- *Instrumental use of the GDSS* — the particular uses to which the group puts the GDSS, including task, process, power, social, individualistic, and exploratory uses.

- *Attitudes toward the technology* — members' comfort with the GDSS, their respect for the GDSS as useful, and the challenge the system poses for the group to work hard and excel.

How the system is appropriated then influences the decision process, including the number and quality of ideas generated, the level and balance in member participation, how the group manages conflict, how members influence one another, and how the group organizes its decision process.

The outcomes of the interaction process include results such as objective and perceived quality of the decision, consensus on the decision, commitment to the decision, confidence in the decision, satisfaction with the decision, and satisfaction with the process by which the decision was made. New structures may also result, which influence subsequent interaction. For example, following use of a brainstorming tool in a GDSS, a group might decide to add a rule that it should generate multiple options before all decisions, changing prior procedures. And outcomes of using the GDSS, such as a list of priorities, can be resources that will be consulted in future decision making.

The theoretical model just described began as a looser framework that had all the major components in Figure 1, but much less detail on specific constructs. As the team applied for grants and conducted successive studies, the model was specified and modified until it assumed its (more or less) final form.

3.0 The GDSS Laboratory

The GDSS system and lab evolved gradually over a number of years (see Dickson, Poole and DeSanctis, 1992, for a more detailed summary). Groups met around a rectangular table—and later around a specially built horseshoe-shaped conference table—with a terminal and keyboard for each group member. Chairs swiveled and had rolling feet, so users could move about comfortably to face one another. A large monitor—later a projector and screen—at the front of the room displayed group information (such as vote tallies or idea lists generated during the meeting). Two video cameras recorded group interaction during GDSS sessions on a split screen. Cameras were backed up by a stereo audio recording system in case the cameras malfunctioned. Figure 2 shows the final configuration of the Software Aided Meeting Management (SAMM) laboratory for a 10-person group.

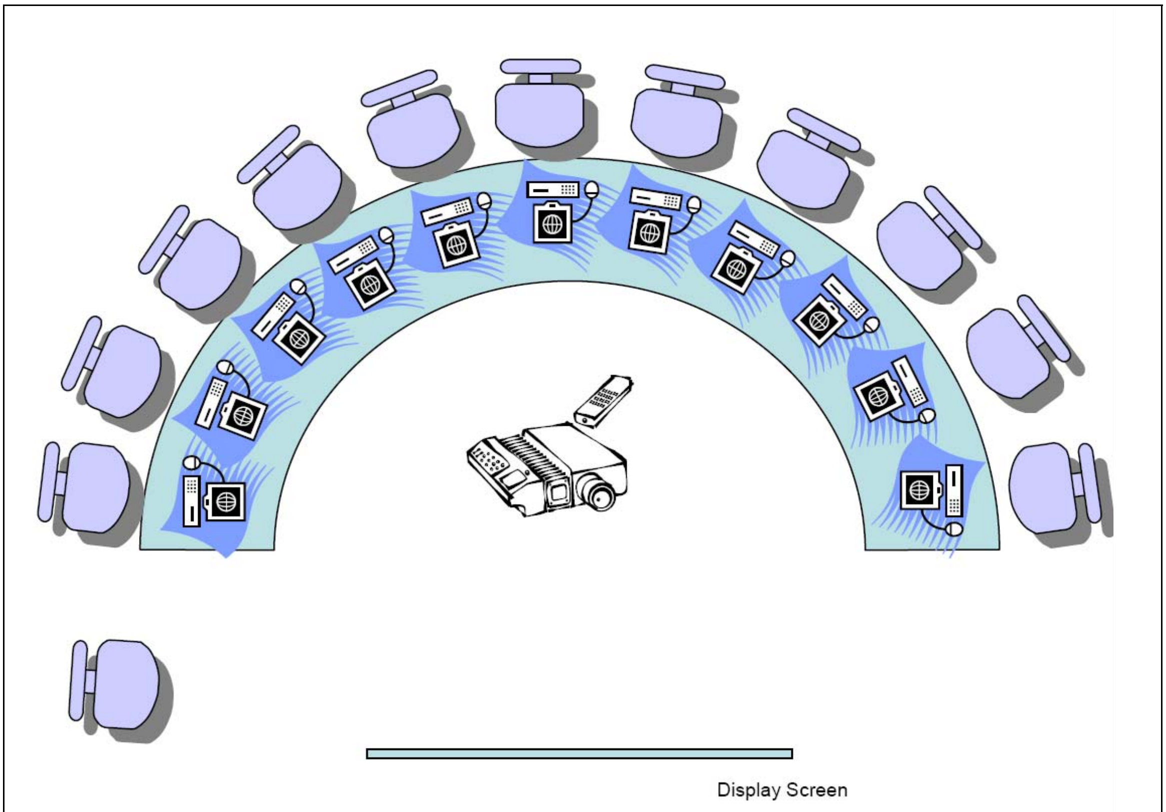

Figure 2. A GDSS room for eleven users

The GDSS developed for this research, SAMM, was designed to be used by groups meeting synchronously in a decision room (DeSanctis, Sambamurthy, and Watson, 1987; Dickson, Poole and DeSanctis, 1992). A menu-driven system, SAMM provided a group with a range of procedural control options: members could control the system themselves, or a facilitator or technician could help. SAMM used the UNIX operating system.

SAMM was designed to support participatory, democratic decision-making in three to 16 person groups). The final set of SAMM features can be diagrammed as shown in Figure 3.

The SAMM system was purposely designed to fulfill a specific spirit, embodying the following set of values: (a) participatory decision making guided by rational discussion; (b) democratic, shared leadership; (c) efficient use of group resources; (d) confrontive, constructive conflict management; and (e) an informal, safe climate for the group. To assess whether the specific set of features that was developed did indeed reflect these values, DeSanctis, Snyder and Poole (1994) conducted a functional evaluation of SAMM that asked novice users to describe SAMM. Their responses indicated that the design of SAMM and its features reflected the intended spirit to a good degree.

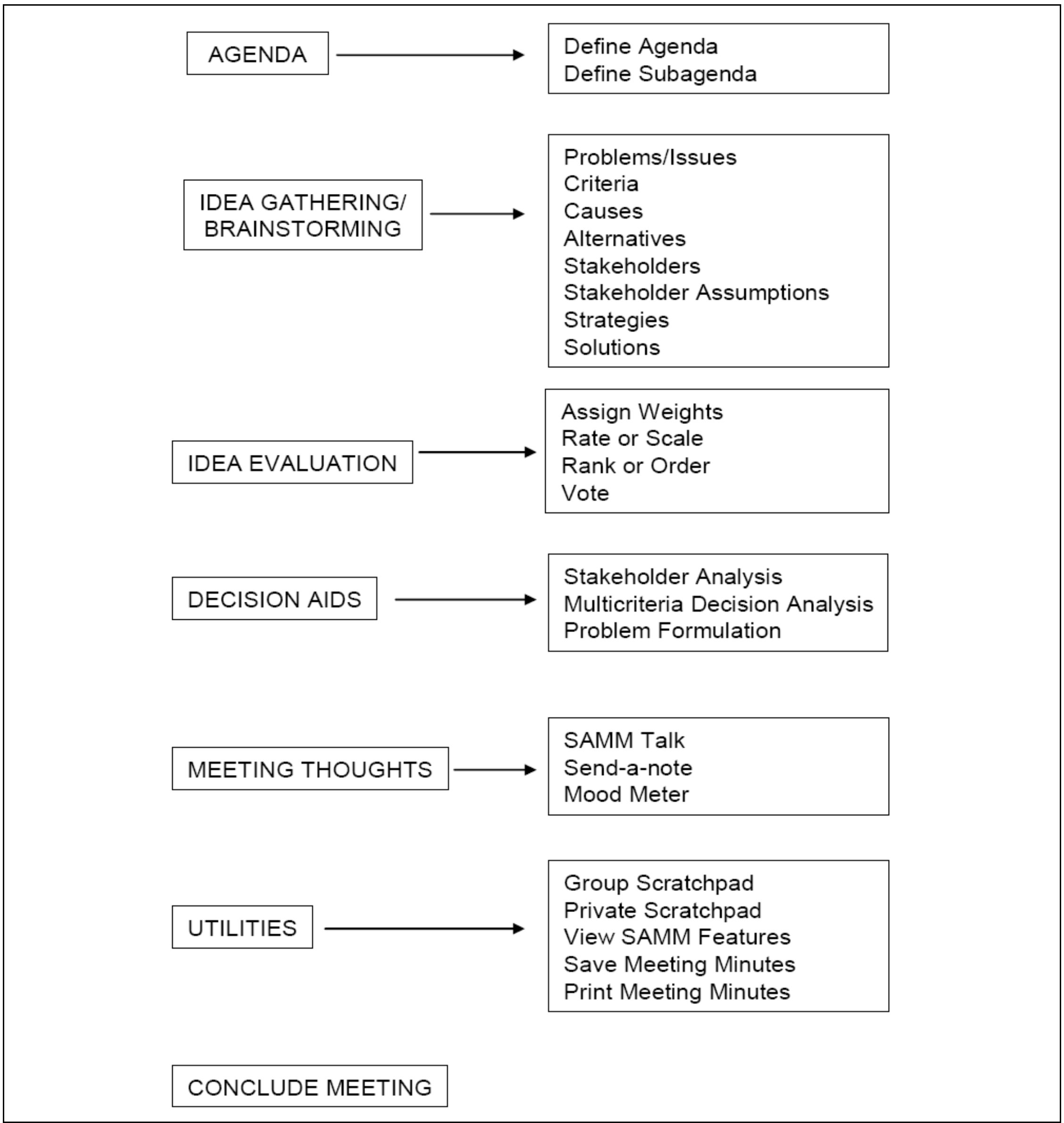

Figure 3. Features of SAMM (Software Aided Meeting Management) System

4.0 Laboratory Studies

Commencing in 1986, the research team conducted a series of experiments to investigate the impacts of GDSSs on decision making, problem identification, and conflict management processes and outcomes. These experiments manipulated features of the GDSS, facilitation, and training and measured effects on a number of objective and subjective process and outcome variables. The experiments utilized groups of three to seven individuals in order to assess the effects of group size, which generally were negligible. Unlike many experiments, there was no attempt to control or tightly script the behavior of group members. Participants were granted a measure of freedom to use the GDSS (or not use it) as they saw fit. The logic of AST proposed differences in appropriation of the technology and procedures across groups, and the experimental groups were given some leeway so that these differences would emerge. This approach enabled the study of appropriation process and the factors that shaped it. All sessions were videotaped for future analysis.

Analytical approach was as important to the project as the experimental design. The researchers conducted three layers of analysis. First, a traditional causal analysis focused on factors that influenced measurable outcomes. Outcomes were measured objectively—for example, by assessing degree of consensus on the final decision through the use of multiple coders and assessments of inter-coder reliability—and subjectively via questionnaires that measured perceived quality of the decision and overall satisfaction with the decision process. This analysis enabled the assessment of the causal effects of the manipulated factors.

The second layer was analysis of the group process and assessment of how the manipulated factors influenced processes and how processes affected outcomes. The theoretical framework was based on the assumption that group interaction processes mediated the effects of input factors on outputs. This assumption required the identification of elements of group processes that specifically mediated GDSS effects. These elements were measured objectively, by systematically coding the interaction using several classification schemes, and subjectively via questionnaires that asked participants for their perceptions of interaction. The coded data required secondary processing to generate three types of meaningful information about the interaction process: (1) distributional structure, the total number of acts in particular categories, for example, the total number of statements that suggested or elaborated solutions; (2) phase structure, which mapped the sequence of holistic episodes of activity in which the group as a whole engaged, for example, orientation followed by idea generation followed by idea evaluation; and (3) critical events, particular acts or occurrences in the interaction that represented important points in the group process, for example, open conflict or using the GDSS to take a vote. Each of these types of data was used to investigate specific hypotheses or research questions about the group process and the mediating effects of process on outcomes.

The third layer of analysis focused on the structuring process. AST assumed that structuring processes influenced and were influenced by other aspects of the group interaction process and also that structuration mediated the impact of the GDSS on outcomes. To get a structuring process required identification of indicators in the use of the technology in interaction, since structuration was not directly observable. These processes were identified through coding appropriation of the GDSS features with classification schemes described in DeSanctis and Poole (1994). One of these schemes coded specific “appropriation moves,” ways in which individual members applied a feature in the group’s work, and a second coded “instrumental uses,” the specific aspects of the group process (task, process, power) for which the GDSS was appropriated. These codes were subjected to secondary analysis similar to that described in the previous paragraph to characterize structuration of the technology. In addition, a system was developed to code faithfulness of appropriation of the GDSS. The coding system scored whether participants were using the features in a way consistent with the spirit of the GDSS, yielding an overall faithfulness profile for each group. Finally, subjective data on structuration were gathered through measuring participants’ attitudes toward the GDSS in terms of their perceived respect for, comfort with, and challenge posed by the GDSS.

In going from the first to third layer of analysis, the focus moved to “deeper” levels of the group process. Relationships among data gathered at each layer and between objective and subjective data brought different domains of data together, increasing confidence that results were not due to common method effects or experimental artifact.

4.1 Experimental Procedures

Although each experiment varied in the purpose and variables involved, the procedures were generally consistent across the studies. Table 1 describes a typical experiment in terms of sequence and nature of activities.

The researchers developed a script for each experiment, with detailed instructions for each condition. The script ensured consistent administration of procedures across experimenters and provided a documented record of the process for follow-up analysis.

Table 1. Typical Steps in Laboratory Experimental Design

Step	Description
1. Background to the study	Experimenter introduces the study with a background statement designed to stimulate interest and commitment of participants
2. Pre-treatment questionnaire	Participants sign consent form, provide demographic information, answer any questions designed for pre-treatment
3. Pre-session individual decision	For some tasks that involve comparison of individual to group decision, a pre-session individual decision may be made
4. Training on structure and/or GDSS	Participants practice any task and/or technology procedures that require training, with different conditions having different training requirements
5. Treatment task	Participants follow experimenter instructions in carrying out the task process and developing required deliverables as a group
6. Post-treatment questionnaire	Participants individually fill out the post-treatment questionnaire about process and outcome perceptions

All experiments were videotaped, which added video data to the questionnaire and computer log data that was available. The set-up of the GDSS room varied from one experiment to another as the technology and laboratory facilities evolved. One constant in the set-up was that all participants had individual control over their access to the GDSS, so that everyone had an equal opportunity to participate.

4.2 Tasks

A major advantage of a program of research is the ability to develop a set of experimental tasks that can be refined and reused. Researchers developed several tasks over the course of the laboratory studies, each of which had specific characteristics that allowed for testing of different aspects of group process and outcomes. The tasks can be characterized in the following broad categories: (a) problem identification and formulation, (b) decision making with no verifiable solution; (c) decision making with a verifiable solution; (d) creativity; (e) negotiation; and (f) planning. This diverse array of tasks enabled us to sort out the influence of task on GDSS process and outcomes. More detailed task descriptions are available in DeSanctis, Poole, Limayem, and Johnson (1990).

Two different *problem identification and formulation* tasks were developed: the Marketing Business Case and the Minnesota Merchandising Case. The Marketing Business Case had two levels of difficulty, high and low. Group members had to identify problems in the business case, and outcomes were measured in terms of quality of problem identification and number of problem statements. The Minnesota Merchandising Case involved a company that had a problem with the use of sensitive data, with issues ranging across legal, ethical, strategic, personnel, and technical concerns. Group members were required to discuss different points of view to come to a common formulation of the problem. Outcomes measures were information search and equivocality reduction, coverage of critical issues, group member reactions, and time – all of which formed a general assessment of perceived problem formulation quality.

The Foundation Task was developed as a *decision making task with no verifiable solution*. Groups were asked to allocate a given sum of money among six projects, each of which represented different values. This task had high potential for conflict because value differences were built into the choices, and the task had no verifiable outcome. Researchers measured the outcome in terms of shift in consensus from pre-meeting to post-meeting and satisfaction with decision outcome and process. This task was used repeatedly across the studies, as it represented the most difficult type of real world task for which the GDSS would be used.

DeSanctis and her colleagues developed two tasks as *decision making tasks with a verifiable solution*: the Student Admissions Task and the Security Measures Task. The Student Admissions Task required groups to decide among different candidates for admission to a university. Each candidate was described on certain criteria, which group members were told to use as the basis for their decision. Prior to group discussion, participants were trained individually on the relationship between the criteria and success of the university. Thus, the task had a verifiable outcome, and the decision criteria were provided to group members in advance. Performance was the key outcome measure. The second task in this category – the Security Measures Task – required subjects to rank alternative methods for improving campus security. The verifiable solution was based on the expert opinion of campus security officers.

SAMM Lab researchers employed several *creativity* tasks, requiring brainstorming of ideas about parking, tourism, cultural diversity, and campus security. All of the creativity tasks had the same general format, namely, for each topic, group members were asked to generate ideas about how that specific issue could be improved. Some issues were in the context of a university (e.g., parking, campus security), while others were in the context of the larger geographic region in which people lived (e.g., tourism), but the format was consistent across issues. In all cases, groups were prompted to develop ideas of both high quality and high quantity.

Finally, the Tidewater College Task served as the *planning* task, which involved stakeholder analysis and option identification. The steps of this task required groups to identify key stakeholders for a proposed project, identify their concerns and assumptions, evaluate those concerns and assumptions in terms of their importance to stakeholders and project success, analyze the concerns and assumptions to identify the most important issues for planning, and then select an appropriate strategic option. A planning task is especially relevant for Level 2 functionality within a GDSS, since these types of functions can perform the complex calculations that are required to combine individual members' evaluations in representations of group opinion.

4.3 Measurement

Two types of data were gathered for the lab studies: (1) objective and subjective measures and (2) observational data through interaction coding. Details and scales for many of these measures can be found in DeSanctis et al. (1990).

Constructs and Scales. Researchers employed a core set of scales across most studies, adding special measures when appropriate for a given study. The constructs and how they were measured are listed in Table 2, along with the source from which they were developed.

Observation. Videotapes of experimental sessions allowed analysis of group interaction processes. These analyses were useful in that they provided insight into how the GDSS produced observed effects. Group process is the vehicle through which members enact decisions, engage in conflicts, plan, and identify problems, among other things, and observing how members used the GDSS and manual procedures gave insight into how the technology was influencing group operations.

These studies of group process took both functional and constitutive approaches. Some analyses focused on the functions of group interaction such as the task functions involved in decision making (e.g., defining the decision problem, analyzing the problem, or defining criteria). The results of these studies fit in with mainstream studies of decision making, problem solving, and conflict management processes. A second group of analyses focused on adaptive structuration in the constitution of decisions, plans, and other group activities. These studies required methods for studying structuration processes in interaction. The researchers developed methods to analyze structuration at the micro level (act-to-act), the meso level (interaction episodes, phases), and the global level (entire meetings, series of meetings). These methods were somewhat involved, and we leave description of them for the section on structuration studies below.

Table 2. Measures Used in the Experiments

Construct (Type of variable)	How Measured	Source
Challenge (Process)	5-item Scale	Sambamurthy (1989)
Comfort (Process)	4-item Scale	Sambamurthy (1989)
Comfort with Multiple Roles (Outcome)	Nominal and ordinal measures	Vician (1994)
Comfort with Specific Meeting Role (Outcome)	4-item Scale	Vician (1994)
Commitment to Implement (Outcome)	1 Item	Niederman (1990)
Confidence in Decision (Outcome)	7-item Scale	Gallupe (1986); Sambamurthy (1989)
Consensus (Outcome)	Fuzzy measure of agreement	Spillman, Spillman and Bezdek (1980)
Coorientation (Outcome)	Deviation of prediction of other members rankings from actual rankings	Lee-Partridge (1992)
Decision Scheme Satisfaction (Outcome)	8-item Scale	Green and Taber (1980)
Learning: Ability of members to understand the GDSS and its outputs (Outcome)	Objective measure: 15 question quiz on system, features, and outputs	Lee-Partridge (1992)
Number of Items Generated (Ideas, Criteria, etc.) (Outcome)	Objective measure: Count of items in item list	Created for each study
Orientation Time	Objective: timing on concerns, questions, problems on GDSS	Vician (1994)
Perceived Conflict (Process)	Multiple-item Scale	Gallupe (1987)
Perceived Coverage of Key Issues	Multiple-item Scale	Niederman (1990)
Perceived Depth of Analysis (Process)	2-item Scale	Sambamurthy (1989)
Perceived Quality (Outcome)	13-item Scale	Gouran, Brown, and Henry (1978)
Perceived Role Ambiguity (Outcome)	5-item Scale	Rizzo, House and Lirtzman (1970) adapted in Vician (1994)
Perceived Understanding of Other Members' Perspective (Outcome)	2-item Scale	Sambamurthy (1989)
Quality of Ideas, Solutions, etc. (Outcome)	Objective measure: Rating of items by external judges	Created for each study
Respect (Process)	4-item Scale	Sambamurthy (1989)
Satisfaction with Facilitator	5-item Scale	Lee-Partridge (1992)
Satisfaction with Solution	5-item Scale	Green and Taber (1980)
Time on Task	Objective: Timing of session	Done for each study
Understanding of Multiple Roles	Nominal and ordinal measures	Vician (1994)
Understanding of Specific Meeting Role (Outcome)	3-item Scale	Vician (1994)

Due to the intensive work involved in interaction analysis, we were only able to analyze a subset of groups from each experiment. We selected 10-15 groups per condition in a way that reflected the mean and range of outcomes in the original samples for each condition in the design. We prepared and coded transcripts of the meetings in multiple passes with various coding systems. What was coded was determined by expectations regarding the impacts of GDSSs on group processes. For example, GDSSs were expected to foster more organized decision processes, greater equality of influence, and the consideration of more ideas. We developed a list of more than 15 possible effects that the GDSS might have on the group interaction process and worked out ways to identify them through interaction analysis. In some cases, we used established coding systems, such as Putnam's (1981) Procedural Order coding system and Poole's (1981) Decision Functions Coding System. In other cases, special procedures for coding indicators of possible GDSS effects were developed. For example, to assess whether GDSSs helped groups generate and consider a greater number of ideas than manual systems, we developed rules for counting ideas. Table 3 lists the various indicators of group process.

Table 3. Indicators Derived from Observational Measures

Construct	Indicator	Source
Linkage of Criteria to Alternatives	Number of statements in which criteria are applied to solution	Poole, Holmes, Watson, and DeSanctis (1993)
Use of Formal Idea Evaluation	Number of times group uses evaluation tool	Poole, Holmes, Watson, and DeSanctis (1993)
Influence Behavior	Procedural Coding System	Putnam (1981)
Start-up Friction	Number of problems with system during first 15 minutes of the session	Poole, Holmes, Watson, and DeSanctis (1993)
Reliance on Written Material	Number of times members refer to written forms or GDSS outputs	Poole, Holmes and DeSanctis (1991)
Organization of Decision Process	Inverse of complexity of phase structure	Poole, Holmes, Watson and DeSanctis (1993)

4.4 Results

Previous sections identified experimental procedures, tasks, and measurement that were used for the laboratory studies. This section summarizes general findings of the laboratory studies. We group results according to the core questions introduced previously and present them in synoptic form. Of necessity, the results are summarized at a high level of abstraction. The Appendices display more specific findings in tabular format, and a detailed narrative of the studies and findings can be found online at https://www.ideals.uiuc.edu/handle/2142/5349.

4.4.1 What Effects Do GDSSs Have on Group Processes and Outcomes?

The initial studies focused on differences between groups using the GDSS and groups employing more traditional modes of operation. Normatively, the studies were focused on the question of whether there was any net improvement in decision outcomes such as quality, satisfaction, and commitment due to GDSSs. To address these questions, we compared three conditions: (1) groups with no support that were given a task and left to their own devices (Baseline groups), (2) groups with a manual version of the procedures built into the GDSS (Manual groups), and (3) groups with a GDSS (GDSS groups). The contrast of conditions 1 and 2 with condition 3 identified the effects due to computerization, while the contrast of condition 1 with conditions 2 and 3 identified the effects due to structured procedures, whether automated or not. These comparisons enabled the sorting out of impacts due to procedures, which could be employed manually as well as with the GDSS, from impacts due to computerization.

Laboratory experiments by Gallupe (1985), Watson, DeSanctis and Poole (1988), Zigurs (1987; Zigurs, Poole, and DeSanctis, 1988), Sambamurthy and DeSanctis (1990), and Niderman and DeSanctis (1995), and a field experiment by Niederman and Bryson (1998) compared GDSS with Manual and Baseline groups in terms of various outcome variables that included objective quality, consensus change, satisfaction with the solution and the decision process, and confidence in and commitment to the decision. Studies by Zigurs et al. (1988), Poole, Holmes and DeSanctis (1991), Sambamurthy and Poole (1992), Poole, Holmes, Watson, and DeSanctis (1993), and Poole and Holmes (1995) analyzed the interaction in subsets of groups drawn from the three conditions in the Watson et al. (1988), Zigurs et al. (1988), and Sambamurthy and DeSanctis (1990) studies. These follow-up studies compared GDSS, Manual, and Baseline groups in terms of amount and types of communication, nature of the decision process, quality of discussion and analysis, and conflict management.

Table 1 in the Appendix presents the results of studies that compared GDSS groups to traditional groups. Key findings include:

- Groups using a Level 1 GDSS generated higher quality solutions than Manual groups on a task with an objective performance measure when the task was high in complexity, but not necessarily when the task was low in complexity.

- Groups using a Level 1 GDSS generated more ideas than Manual groups when the task was open-ended, but not when the task was closed and most options were already on the table.

- Computerization made procedures easier to apply when the procedure did not easily map onto the task. Manual groups had difficulty carrying out a procedure that was not a good fit to the task, whereas GDSS-supported groups were able to carry out the procedure and work around it to achieve higher quality results.

- Both Level 1 GDSS and Manual groups attained higher levels of consensus change than Baseline groups. GDSS groups achieved higher consensus than Manual groups when preexisting disagreement was high, but not when it was low.

- In general, groups using a GDSS had lower levels of perceived quality, satisfaction with the decision process, and (to some degree) confidence in the decision than groups using Manual procedures. This finding held for two studies conducted in the lab, but not for a field experiment (Niederman, 1990), which also found that groups using a Level 2 GDSS had greater confidence and commitment to their problem formulation than did Manual groups.

- Groups using a GDSS devoted a large proportion of their time to procedural messages, suggesting that understanding the system, deciding how to use it, addressing problems, and coordinating use occupied a great deal of members' time. This represented "friction" that detracted from immediate focus on the task. There was also evidence that use of a GDSS created a higher level of understanding of procedures than was attained in Baseline or Manual groups.

- Groups using Manual procedures devoted less time to discussing and organizing procedures and more time to goal emphasis and substantive and critical discussion of ideas than GDSS groups.

- There were mixed results in terms of perceptions of control over the process and influence in GDSS compared to Manual and Baseline groups.

- Groups using a procedure had more organized and less complex decision processes than did Baseline groups.

- Groups using a Level 1 GDSS deviated more from a normative problem-solution decision sequence than did groups using the same agenda manually.

- Members of GDSS groups reported higher levels of conflict than did members of groups using manual procedures. Consistent with this perception, groups using a GDSS engaged in more open conflict than groups using Manual procedures. Level 2 GDSS groups confronted conflict and managed it in a more integrative fashion than did Manual groups.

- Groups differed in how they used the GDSS. When groups used the GDSS to promote open discussion and participation, confronted conflict in a constructive manner, and actively adapted it to the task, groups could achieve levels of consensus, perceived quality, and decision scheme satisfaction comparable to or better than effective Manual and Baseline groups. When they let the GDSS drive their activities and used it mechanically or when they had problems with the GDSS, they achieved lower levels of consensus, perceived quality, and decision scheme satisfaction.

Zigurs, DeSanctis and Billingsley (1991) conducted a longitudinal study of user acceptance of the SAMM GDSS that shed some light on overall reactions to this system and to GDSSs as a whole. They measured users' perceptions across eight meetings of eight groups conducting class projects that had the potential to impact how a university department marketed itself to students. The study measured users' perceptions of the quality of the meeting, level of personal participation, negative socio-emotional behavior, and informal leadership, as well as overall evaluation of group behavior, satisfaction with the meeting, and satisfaction with the decision process. Three of these groups (adopters) enthusiastically adopted the GDSS, while four (discarders) initially adopted but greatly reduced their use after the third or fourth meeting, and one group rejected the GDSS from the outset. There did not seem to be any differences in the patterns of attitudes over time between the adopter and discarder groups, but the rejecter group had less positive attitudes overall.

These findings suggested an interesting irony: GDSSs can improve group decision making, but groups often do not like to use them. This was suggested in the first studies by Gallupe (1985) and Watson et al. (1988), and this possibility was explored in several subsequent studies. That GDSS groups had more friction and less critical examination of ideas than Manual groups offered an explanation for the finding of lower levels of satisfaction with the decision process for GDSS groups compared to Manual groups.

It seemed possible that some of these results were due to the fact that the GDSS required members to relearn how to conduct procedures that are natural to them—such as idea listing and voting—via the computer, making the operations seem awkward and imposing a learning curve. There was also more conflict in the GDSS groups than the Manual groups, which was probably a result of the display of ratings, which tends to highlight differences among members, thereby steering the discussion toward points of disagreement.

The investigators speculated that GDSSs might not evoke such a negative reaction when they embody procedures that would be difficult for groups to do manually or with a Level 1 system, such as multi-criteria decision analysis. In such a case, the value added by the GDSS support should be more evident. Hence, for this type of Level 2 procedure the GDSS might outperform Manual procedures. This observation motivated a set of studies dedicated to addressing a second question.

4.4.2 What Meaningful Dimensions Underlie the Design of GDSSs, and How Do These Dimensions Affect Group Processes and Outcomes?

To address this question, researchers conducted studies that compared groups using three Level 2 procedures—Multi-criteria Decision Analysis, Stakeholder Analysis, and Problem Formulation based on principles from Synectics—to groups working on the same task using the problem solving agenda employed in the first set of studies. The groups worked on tasks appropriate to the procedures. The one exception was that they did not include a manual control group, because it would have taken members too long to conduct the same operations, and it seemed to be an inappropriate comparison.

Sambamurthy and DeSanctis (1990; Sambamurthy and Chin, 1994) studied Stakeholder Analysis implemented in a Level 2 GDSS; Dickson, DeSanctis, Poole, and Limayem, (1991) focused on Multi-criteria Decision Analysis, and Niederman (1990; Niederman and DeSanctis, 1995) investigated Level 2 Problem Formulation procedures. Follow-up studies by Sambamurthy, Poole, and Kelly (1993) and Sambamurthy and Poole (1992) examined the interaction in Level 1 and Level 2 Stakeholder Analysis groups, while additional observations regarding group interaction were reported by Niederman and Bryson (1998) and Dickson et al. (1990).

Table 2 in the Appendix summarizes results of these studies. Key findings include:

- Groups using Level 2 GDSS tools could achieve higher levels of consensus on decision-making tasks than groups using a Level 1 GDSS when the groups had a high degree of initial disagreement. This effect did not hold when there was a low degree of initial disagreement among members.

- Level 2 GDSS procedures were more complex and challenging to use than Level 1 procedures and could require additional external support such as training and facilitation to achieve their benefits.

- There were mixed results in terms of subjective reactions to the Level 2 GDSS. In some cases reactions were more favorable than those to the Level 1 GDSS, but in other cases, there were no differences.

- Level 2 GDSS groups engaged in deeper and more thorough analysis of solution options than Level 1 groups.

- Groups using a Level 2 GDSS were more effective in managing conflict than groups using a Level 1 GDSS. Both types of GDSSs surfaced disagreements, but groups using the Level 2 GDSS were able to resolve disagreements more effectively than groups with a Level 1 GDSS.

- Groups using a Level 2 GDSS managed conflict differently from groups using manual procedures. A Level 2 GDSS enabled groups to surface disagreements and manage them effectively. Groups using Manual procedures tended to avoid open conflict; they used low-key critical discussion to work out disagreements and make a final decision.

- Groups using Manual procedures managed conflict more effectively than the average group with a Level 1 GDSS, but groups that employed the GDSS to foster discussion of ideas and explore options could be just as effective as Manual groups in conflict management.

- Control over and management of procedures tended to be less equal in GDSS groups than in groups using Manual procedures.

The interesting result that Level 2 GDSS *may* lead to superior outcomes—but only under the right conditions—suggested exploration of several measures that might be used to create these "right conditions." This led to the third set of studies.

4.4.3 What Additional Types of Support Facilitate GDSS Use?

Various avenues of additional support were a logical concern with a complex technology like GDSS. The project investigated the impact of altering the internal group system by utilizing external interventions of heuristics, role training, facilitation, and Level 3 guidance. The studies in this series parallel in an interesting way Dennis, Wixom, and Vandenberg's (2001) appropriation support tools.

DeSanctis, D'Onofrio, Sambamurthy, and Poole (1989) investigated the impact of *heuristics*—guides to making decisions—on GDSS use and outcomes. Vician (1994, Vician and DeSanctis, 2000) studied the delivery of *GDSS role training* within self-managed groups for repetitive and changed task situations. Lee-Partridge (1992; Dickson, Lee-Partridge and Robinson, 1993) focused on the effects of *facilitation styles* for level 2 GDSS sessions. Limayem (1992, Limayem and DeSanctis, 2000) investigated the automation of facilitation within the GDSS itself, leading to the development of a *Level 3* GDSS.

Table 3 in the Appendix summarizes results of these studies. Key findings include:

- Groups required training and guidance to use the GDSS effectively. If this was provided, members understood the GDSS better, and better outcomes ensued.

- Heuristics to guide use of GDSSs led to better outcomes if the heuristics were not overly complex and gave groups a set of guidelines organized around a small set of consistent principles.

- Heuristics that described a general approach to decision making (such as the consensus approach) led to better outcomes than more specific heuristics that described the use of the system in detail or that combined the general approach with specific descriptions of how to carry it out. (Specific instructions on how to use the system were useful in terms of implementation, however.)

- There was no difference due to training members of GDSS groups in fixed or rotating roles vs. training in simply using the GDSS.

- Facilitated Level 2 GDSS groups had superior outcomes to Level 2 GDSS groups without facilitators.

- Flexible Facilitation, which gave members some control over how the GDSS was used, was more effective than Firm Facilitation, which compelled members to use the GDSS as the facilitator specified. Both types of facilitation yielded better results than no facilitation when the GDSS features were complex.

- A Level 3 GDSS enabled groups to achieve outcomes superior to those obtained with a Level 2 GDSS through increasing members' understanding of the GDSS, which had a positive impact on outcomes.

A key premise of the Minnesota GDSS project was that the impacts of GDSSs—positive and negative—would be mediated by the ways in which they were structured by the groups that used them. Hence, the next step was to study structuration in the GDSS sessions.

4.4.4 How Does the Process of Using a GDSS Mediate Its Impacts on Group Processes and Outcomes?: Adaptive Structuration of GDSS

A central aspect of the experimental design in these studies was that groups were not marched "lockstep" through the procedures, but instead were given some leeway to use the GDSS as they saw best. Even in the studies of guidance and facilitation, groups were given room to vary their use of the GDSS. This practice created variation in how the GDSS was appropriated by the groups and enabled the study of how groups structured their process using the GDSS and how, in turn, outcomes were affected.

A negative side effect of this variation was that the positive impacts of the GDSS on group process and outcomes were likely to be understated due to the fact that some groups were left free to "misuse" or "underutilize" the system. However, the benefits of being able to study how groups structured the system on their own outweighed this loss.

Structuration processes were studied in several of the experiments summarized in previous sections. The Minnesota researcher employed to analyze structuration: (1) tests of within-cell variation in processes and outcomes; (2) direct analysis of structuration; and (3) analysis of user attitudes related to structuration (challenge, comfort, respect). We discuss each of these strategies in turn.

4.4.4.1 Within-Cell Variation

If the impacts of the GDSS (and of manual procedures) on group outcomes were mediated by their structuration during the group decision process, then groups should vary in how they appropriated the GDSS, and these variations should relate to outcomes. In terms of Analysis of Variance, this involved a test for within-cell variation in effects, with the inference that these would be due to different appropriations. These analyses were conducted by Poole, Holmes and DeSanctis (1991), Zigurs et al. (1989), Sambamurthy and Poole (1992), Armstrong, Perez and Sambamurthy (1993), and Limayem and DeSanctis (2000).

4.4.4.2 Direct Analysis of Structuration

Methods to study structuration directly focused primarily on group interaction, since structuration is a collective process in which members work out appropriations as they interact. Thus, it is a public process in which members must share. Structuration was investigated at two levels. First, microlevel structuration was tracked through analysis of interaction moves that appropriated, produced, and reproduced structures (see, e.g., Poole and DeSanctis, 1992). Second, global patterns of structuration that characterized the process across an entire decision or series of decisions were identified through analysis of the phase sequences or general patterns of structuration (e.g., Poole, DeSanctis, Kirsch, and Jackson, 1994). It is important to note also that at least one more level influences structuration: macrolevel organizational and societal discourse concerning appropriation of various structures that are commonly shared across a population of groups or organizations. This level could not be investigated in the laboratory studies, but some insights emerged from later field studies. The researchers expected all three levels to interpenetrate and influence each other.

DeSanctis and her colleague developed three schemes for coding micro-level appropriations, each of which yielded coded data that could be processed to generate global characterization of patterns of structuration. The first scheme was an *Appropriation Checklist* of actions that groups had to complete to carry out the agenda for a given experiment. This checklist consisted of a list of the GDSS features that corresponded to steps in the agenda and the correct way to carry out steps to enact the spirit of the SAMM GDSS. For example, for the step "Evaluate Ideas," members would have to rate, rank, or vote on

Coded by: ____________________ Transcript: ________________

Problem Definition	1	2	3	4
Enter into problem definition list correctly				
Post several definitions				
Discuss before posting				
Discuss after posting				
Choose one based on discussion				

Criteria Definition				
Enter into criteria list correctly				
Post several criteria				
Discuss before posting				
Weight correctly				
Discuss results of weighting				
Wait to view until all entered				

Alternative Evaluation				
Enter solutions into list correctly				
Use tool (rate/rank/vote)				
Evaluate with tool				
Discuss alternatives before evaluating				
Discuss results of evaluation				
Wait to view until all entered				

Apply criteria				
Explicit reference to criteria				

Figure 4. Coding Sheet for Faithfulness of Use (Reflective Thinking Agenda)

Table 4. Appropriation Move Classification Scheme

1.Direct Appropriation
- a. Explicit appropriation--openly use and refer to
- b. Implicit appropriation--use, but do not refer to the structure
- c. Appropriation bid--suggest or ask group use structure

2. Substitution
- a. Synechdoche-substitute part for whole
- b. Metonymy-substitute related structure, e.g., voting for polling
- c. Catechresis-substitute unrelated structure in place of structure named

3. Combination
- a. Composition-combine two structures in a way consistent with the spirit of both
- b. Paradox (Synocoesis) combine contrary structures with no acknowledgement they are contrary
- c. Antagogue-adopt one structure as a corrective for another

4. Enlargement
- a. Metaphor-relation of two structures in which one is used to gain an under-standing of the structure in use. This includes allusion also. One structure remains on the floor throughout.

5. Constraint
- a. Definition-states what the structure is or specifies what some element of the structure means. Explains the structure directly.
- b. Command-define system by giving directions on its use or ordering people to use it.
- c. Diagnosis-identify problem in use of structure or comment on how it is working
- d. Ordering-specify ordering among components.
- e. Query-ask question about structure or its meaning.
- f. Closing-show how use of system feature has been completed.
- g. Status report-state what has been or is being done with the structure.
- h. Status request-question about what has been done with structure.

6. Contrast
- a. Litotes-express structure by denying contrary
- b. Antithesis-explicit contrast of structures, with one favored.
- c. Criticism-criticism of structure.

7. Affirmation
- a. Agree with appropriation of structure
- b. Bid-agree--suggest or ask for agreement with structure.

8. Negation
- a. Direct-directly reject structure.
- b. Indirect-reject structure by ignoring it.
- c. Bid-reject--suggest or ask for rejection of structure.

Summary Measures Based on Appropriation Moves

1. References to the system as a whole rather than just its parts (ratio).

2. Degree of faithful versus ironic use of the system.

3. Amount of structural change during the discussion. (a) Simple amount and magnitude. (b) Amount of turbulent change in the structure (changes in opposite directions, which suggest struggle over structure).

4. Members' understanding of how and why they use the system.

5. Is control over appropriations concentrated?

6. Do they use whole system or omit parts?

the ideas as prescribed by the SAMM system and then discuss the results of the evaluation prior to moving toward a decision. A checklist of the use of Level 1 SAMM for the Reflective Thinking Process is shown in Figure 4. Groups were scored on how many of the correct actions they took for each feature of SAMM they used. These scores were then converted to a proportion of correct steps they took over the total number of correct actions they should have taken to yield a score for faithfulness of appropriation that ranged from 0.0 to 1.0. This numerical appropriation score could then be used in quantitative analyses. This checklist was employed in studies by Poole, Lind, Watson and DeSanctis (1992) and Sambamurthy and Poole (1992). Limayem et al. (2006) used the Chin, Gopal and Salisbury (1997) measure of faithfulness of appropriation in a complementary study.

The second scheme drew on the systems of tropes used by rhetorical scholars to devise an *Appropriation Move Coding System* (Poole and DeSanctis, 1992; DeSanctis and Poole, 1994). Tropes describe ways in which speakers or writers can use the structures of language to achieve various effects and so suggest a variety of structuring "moves" through which technology can be employed by users and groups. Based on lists of tropes and analysis of the groups, researchers developed a typology of 37 appropriation moves, organized into nine general categories. These categories were based on the following distinctions: (1) Did the move involve a single structure or more than one structure? and (2) Did the move consist of an active use of the structure, an attempt to understand or clarify the structure, or a response to another member's appropriation move? The category system is shown in Table 4.

Two categories coded moves that involved a single structure: *direct appropriation* represented active use of the structure, while *constraint* represented an attempt to interpret and understand the structure. For example, a direct appropriation of a GDSS involved simply using some feature of the GDSS, while explaining how to use the GDSS would be a constraint move, because the explanation would focus members' attention on a particular interpretation of what the feature meant and how it should be used. Four categories coded moves involving more than one structure. For example, *combination* coded active uses of two or more structures. In a combination move, two structures were melded in various ways, as when a group decided to use parliamentary procedure to run meetings in which it used the GDSS; in this case, the rules of parliamentary procedure were combined with those for using the GDSS. The *enlargement* category was used to code moves in which two structures were likened to each other. In one study, members of quality teams likened the GDSS they were using to a "secretary" and "coach," which added to the meaning of the GDSS and probably created expectations in members' minds about what the GDSS could do for them.

Each of these appropriation moves had to be accepted by other members to influence structuration of the GDSS, so responses to the moves were also coded. *Affirmation* and *negation* represented the positive and negative modes of response to others' appropriations, while *ambiguity* represented uncertainty and confusion in response to some structure. Ironic appropriations could occur in constraint, enlargement, or contrast moves that imposed definitions on the structure that were inconsistent with its features (e.g., "the voting procedure in this GDSS can be used to determine who agrees with the leader"), or substitution or combination moves that put structures inconsistent with the spirit together (e.g., the secretary metaphor created false expectations that the GDSS had artificial intelligence, leading some members to reject the system when it did not provide active suggestions).

In addition to coding the specific appropriation moves, the scheme also identified the sources of structures, including the technology, the task, and outside norms. So a technology structure might be combined with a task structure, resulting in an appropriation of the GDSS that served to adapt the system to the group's task.

This scheme identified basic structuring moves and responses in group interaction. Several analyses were generated from these codings: (1) profiles of the general types of appropriations made by groups as well as which members made and controlled them, (2) the phases of appropriation that occurred in the groups, (3) critical junctures at which appropriation of the GDSS changed, (4) conflicts in the structuring process, and (5) ironic (nonfaithful) uses of the GDSS.

Poole and DeSanctis (1992) conducted a follow-up study in which they used the Appropriation Move

Coding System to study structuration in 18 groups drawn from the Watson and D'Onofrio studies. They sampled groups that varied in level of Restrictiveness of structures and in terms of effectiveness, as measured by consensus change during the discussion. Armstrong, Perez and Sambamurthy (1993) applied the system to study appropriation in Sambamurthy's (1989) groups.

The third coding scheme, an *Instrumental Use Coding Scheme* identified the function that the GDSS was appropriated to serve, divided into task, process, power, social, individualistic, and exploratory uses. These uses were coded as a second track along with the appropriation moves. This system was used to some degree in the lab research, but served a more prominent role in the field studies that are summarized in the next major section.

4.4.4.3 User Attitudes Related to Structuration

Researchers also developed scales for measuring attitudes related to appropriation. These scales measured the group members' level of comfort with the technology, their respect for the GDSS as a useful technology, and the degree to which they felt challenged to do their best by the GDSS. Studies by Zigurs, Poole and DeSanctis (1988), Lee-Partridge (1992), Limayem (1992), Vician (1994), DeSanctis et al. (1994), and Sambamurthy, DeSanctis, and Poole (1995) utilized these scales.

Table 4 in the Appendix presents results from the various studies and modes of analysis. Key findings include:

- There were differences in how groups appropriated the GDSS. Groups varied in terms of degree of appropriation, how faithfully they appropriated the GDSS, the degree of consensus on appropriation, how many members guided appropriation, and their attitudes toward the technology.

- Faithful appropriation of the GDSS was positively related to consensus change. The relationship between faithfulness and consensus change was mediated by group interaction; to the extent that appropriation fostered interaction consistent with the requirements of the task, it had a positive effect on consensus change.

- There was mixed evidence on the impact of appropriation on perceived quality, decision scheme satisfaction, and confidence in the decision.

- On average, Level 2 groups appropriated the GDSS with greater faithfulness and had less conflict over appropriations than Level 1 groups, though there was variability of appropriation within each set of groups.

- A High Restrictiveness GDSS led to greater faithfulness than did a Low Restrictiveness GDSS. A High Restrictiveness GDSS increased appropriations of the GDSS related to substantive discussion. Groups using a Low Restrictive GDSS focused more on organizing their decision process and use of the GDSS than groups with restrictive GDSSs.

- A group that effectively appropriated the GDSS:

  (a) Used the GDSS only for components of the task that fit GDSS structures embodied in its features and procedures;
  (b) Organized ill-defined tasks around the GDSS structures, provided this did not entail "force fitting" the task to the GDSS in such a way that goals or requirements of the task were compromised;
  (c) Clearly delegated a few members or a facilitator to guide appropriation of the GDSS and use of its features and procedures;
  (d) Focused on critical discussion and sense-making related to GDSS outputs rather than simply accepting them as final results;
  (e) Focused less on understanding and interpreting GDSS structures than on GDSS outputs and the task; and

(f) Cultivated positive attitudes (comfort, respect, challenge) toward the GDSS among members, but also encouraged members to take a critical approach to application of the GDSS.

- Key junctures such as problems with the GDSS, conflicts, and transitions between tasks or steps within tasks were particularly important occasions for structuration, resulting in changes in the appropriation of the technology or confirmation of current appropriations.

- Level 3 support helped groups deal with junctures and manage breakpoints. Groups with Level 3 GDSSs typically had more positive attitudes toward the GDSS than did groups using Level 2 GDSSs.

These results complemented and enlarged upon the studies of group process functions. In particular, the results suggest that how the group appropriated the GDSS influenced outcomes independent of group interactions that occurred while using the GDSS. These group interactions had a strong direct influence on outcomes, but appropriation influenced the nature of group interactions and had modest direct effects on outcomes.

These lab studies divulged some important generalizations about the impacts that GDSSs could have. However, the Minnesota researchers believed it was necessary to examine GDSS use in organizations to determine which of these impacts actually held in practice and how strongly they held.

5.0 Field Studies

Field studies began in the third and fourth years of the program. Two major field sites were involved: the Internal Revenue Service (IRS) and Texaco Inc. Collaborators at the field sites were interested in applying GDSSs in their organizations, which provided the opportunity for longitudinal analysis of a variety of team processes and activities. In both cases, the field sites provided the hardware and room facilities, while the Minnesota group provided licensing and free support for the SAMM software. In return, the field site gave researchers significant access to the teams, with the opportunity to videotape team meetings and assess team member perceptions through interviews and questionnaires.

The primary interest was in observing natural use of a GDSS over time, that is, to examining the extent and nature of voluntary use of a GDSS in different types of task and organizational contexts. Researchers worked with the field sites to implement SAMM in areas where they identified a need. To the extent possible, they also made improvements to the system based on on-going feedback from participants.

The initial study at the IRS consisted of an analysis of team member attitudes and uses of the system, based on questionnaires and interviews (DeSanctis, Poole, Desharnais, and Lewis, 1991). Subsequently, the research team analyzed videotapes to identify structuration moves and patterns in the teams (DeSanctis, Poole, Lewis, and Desharnais, 1991-1992) and conducted an in-depth study of four teams over an extended period of time (Poole, DeSanctis, Kirsch, and Jackson, 1994). Also examined were differences in brainstorming sessions in teams that used the technology vs. those that did not (Jackson and Poole, 2003).

The Texaco study also varied the type of analysis to bring out differences in the teams' processes and use of technology. Appropriation analysis of one group of teams identified differences in how well SAMM supported team processes (DeSanctis, Poole, Dickson, and Jackson, 1993). An in-depth study of a single team that had surprising success with SAMM provided insight into the role of the team leader, a continuous learning process, and the use of different functions of the system (Vician, DeSanctis, Poole, and Jackson, 1992). Finally, a longitudinal study of a larger number of teams showed how teams and their technology use changed as the organization changed (DeSanctis, Poole, and Dickson, 2000; DeSanctis and Jackson, 1994).

Finally, the researchers conducted some analysis across the two field sites that resulted in the identification of global appropriation types and patterns of alignment of task with technology (Poole, Jackson, Kirsch, and DeSanctis, 1998).

The sections that follow describe the field studies as a whole in terms of data gathering procedures used, the different task contexts, the measures used, and the overall results. In line with the research program, we applied a complex but consistent analytic method throughout the field studies across a variety of teams and situations.

5.1 Data Gathering Procedures

researchers collected four main types of data: video, computer system use log, survey, and interview data. Most team meetings were videotaped, and the videotapes were used for analysis of appropriation moves. For example, to analyze structuration from the videotapes of the team meetings, the researchers viewed a sample of the tapes for the teams being studied. For each tape, they created a protocol of the sequence of events, including a detailed description of meeting activities and observations about specific interaction processes followed by the team. These protocols were used in conjunction with the other data to develop an analysis of appropriation.

Computer system log data captured the features of SAMM that were used in each meeting. This data allowed for a global measure of system use, as well as a characterization of the level of use as Level 1 or Level 2 (DeSanctis and Gallupe, 1987).

Team members also agreed to fill out surveys on a periodic basis. In most cases, team members filled out two surveys at the end of a meeting. The first survey measured team members' perception of systematic process, openness of communication, and sense of accomplishment. The second survey measured comfort with the GDSS technology and perceived impact of the technology.

In addition, researchers conducted unstructured interviews with team leaders and selected individual team members. The interviews typically included such topics as individual roles and responsibilities, the nature of the team's tasks, perceptions of the team's decision processes and overall progress, and reactions to the SAMM technology.

5.2 Task Context

The IRS site was designed as a natural experiment in which teams would meet in the GDSS room for all their meetings, but they could choose to use or not use the software as they felt appropriate. The SAMM researchers studied 10 teams involved in organizational quality processes over time, with team size varying from five to 10 members. Each team had a facilitator who assisted in the application of both the quality process and the GDSS. The task for these teams was to identify and solve problems that reduced the quality of the agency's functioning and services. The researchers provided a specialized agenda of quality techniques to the teams, including formats to support problem definition, cause-effect analysis, and solution development. Multiple meetings of the 10 teams were recorded. In addition, the sample included a number of staff teams who conducted one to three meetings with the system.

The Texaco site consisted of two different sets of teams. The first set was three teams that met over a period of eight months. The teams varied widely in their composition, organizational level, and task. One team was composed of 14 high-level managers charged with organizational planning. The second team had eight medium-level personnel who provided support for computer users. The third team had seven lower-level personnel who were designing a procedure for automating database operations at night.

The second set of teams at Texaco consisted of 47 technical and administrative teams who participated for a three-year period and were on-going teams involved in a variety of tasks. Technical teams were likely to have more focus and less diffuse work tasks than the administrative teams.

5.3 Measurement

Appropriation was assessed in some cases via the coding scheme that DeSanctis and Poole (1994) had developed previously for use in the laboratory studies and that continued to evolve as the studies were conducted. In other cases, appropriation was assessed by survey questions. Table 5 shows appropriation measures that were used in the field studies.

Table 5. Appropriation Measures for Field Studies

Construct Measured	Source	Validated in
Initiation of use	Transcript from video	DeSanctis, Poole, Lewis, and Desharnais, 1991-1992
Instrumental use	Transcript from video	
Use sentiments	Transcript from video	
Amount of appropriation	Interview, transcript from video	DeSanctis, Poole, Dickson, and Jackson, 1993
Distribution of appropriation	Interview, transcript from video	
Attitude toward appropriation	Interview, transcript from video	
Advanced technology use	Survey	DeSanctis, Poole, and Dickson, 2000
Comfort with technology	Survey	
Technology adaptation (creative and routine uses of technology)	Survey	
Power/domination (use of technology for power and dominance rather than collaboration)	Survey	

Outcome measures also varied across studies. Table 6 shows the outcome measures that were used across the field studies, along with the source and validation of each measure.

Table 6. Outcome Measures for Field Studies

Construct Measured	Source	Validated in
Satisfaction with GDSS (comfort and enjoyment; provides right support; adequate training)	Survey	Sambamurthy, 1989
Satisfaction with meeting process and outcomes (systematic process, openness of communication, sense of accomplishment)	Survey	DeSanctis, Poole, Dickson, and Jackson, 1993
Team coordination	Interview, open-ended	
Group effectiveness	Interview, scale	DeSanctis, Poole, and Dickson, 2000

5. 4 Results

Key findings from the field studies include:

- There was more and better use of the GDSS when it was introduced in a newly formed group, rather than an already established one. Existing problems or conflicts in a group tended to carry over into its use of the GDSS, lessening the benefits groups could derive from the GDSS.

- Use of Level 2 GDSS tools was higher among groups that had the GDSS introduced early on than in those where it was introduced midstream. A Level 2 GDSS increased group effectiveness when the group faced complex tasks and when there were disagreements among members.

- Effective use of the GDSS depended on effective alignment among the system, the group's tasks, and group norms and other structures. Alignment required a continuous process of adjustment.

- Too much emphasis on internal group processes to the exclusion of work could lead to ineffective appropriation of the GDSS.

- The GDSS facilitated more balanced participation by members, especially by quiet or low power members.

- Groups using the GDSS did not generate more ideas than non-supported groups using either a flipchart or paper to record ideas. All groups in the field, GDSS and non-GDSS, generated fewer ideas than did laboratory groups. Idea generation was more limited in the field groups in part because some topics naturally had limits on the number of ideas that could be generated and also because the meeting served other purposes than generating ideas, e.g., as a ritual signaling that the group was being creative.

- Conflict over the use of the GDSS did not necessarily reduce team effectiveness or positive impacts of the GDSS on group processes and outcomes.

- Effective appropriation of the GDSS depended on emphasizing task and process uses and on constraining power-related uses of the system to those that moved the group toward its goals.

- Facilitation improved the effectiveness of GDSS use at all levels.

- Effective appropriation of the GDSS depended on a continuous learning process on the part of all (or most) members. The leader could play an important role in guiding the GDSS and encouraging members to use the system during the learning process.

- Effective use of the GDSS was most likely if the group became independent in the use of the system, either functionally autonomous and able to manage the system itself, or able to determine the procedures it wanted to use and to direct the facilitator or resident expert as to how it wished to use them. The GDSS was used more and more effectively when members initiated use themselves, rather than relying heavily on the facilitator.

- It was important to maintain a balance between task and process orientation. Too much emphasis on internal group process led to less effective use of the GDSS.

- Just as in the lab studies, key junctures in system use were very important. These critical events could be negative, such as a group crisis or technology failure, or they could be positive, such as success with the GDSS. At these junctures, members engaged in interchanges that determined subsequent appropriation.

One example of a key juncture was provided by a facilitator (summarized):

> A team was floundering for direction and decided to do a stakeholder analysis. There was no facilitator who knew how to use the system. They followed instructions from the user's guide and had no problems employing the procedure. The facilitator, who had been tacitly anti-SAMM up to that point, told us that SAMM had turned the meeting around.

Most of these conclusions are consistent with findings from the laboratory studies, but at least one was not. Whereas the GDSS did not equalize participation in lab studies, it did in the field studies.

This difference probably stems from measurement. In the lab, measures were based on coded behaviors and tended to treat every act as though it had equal weight in tapping participation, whereas the field studies tended to yield critical incidents in which participation was increased.

5.5 GDSSs and Other Collaborative Technologies in the Organizational Context

Studies of SAMM use in organizational settings stimulated interest in the impacts of groupware in the larger organizational context. The emergence of new forms of organization, such as networked organizations and post-bureaucratic organizations, had been described by many scholars (e.g., Fulk and DeSanctis, 1999). These forms have evolved in response to rapid technological and economic changes that require organizations to adapt and innovate much more quickly than they had to in the past. DeSanctis and Poole (1997) hypothesized changes in the nature of teams in networked organizations. They argued that in networked organizations there would be more teams and that these teams would be more geographically dispersed, more diverse, and exhibit a greater variety of structures than would teams in hierarchical organizations. Moreover, teams in networked organizations would have more open boundaries, and their structures would change more rapidly than those in hierarchical organizations. These teams would be very communication intensive, relying less on formal structures and more on information retrieval and information sharing systems in doing their work. DeSanctis and Poole (1997) further hypothesized that participation would replace hierarchy as the key mode of decision making, planning, and management. They believed that processes in teams in networked organizations would also be much more dynamic and changeable than group processes in hierarchical organizations.

DeSanctis and Colleagues found that information and communication technologies (ICTs) are key enablers of the changes in teams that networked organization fosters. Dispersed, diverse, open, participative, virtual teams must supplement face-to-face communications with technologies such as email, teleconferencing, instant messaging, GDSSs, and computer conferencing to maintain cohesion and manage their work. Utilizing a mix of these technologies with face-to-face communication enables networked teams to respond to conflicting pressures for integration of information flow and member inputs, on the one hand, and fragmentation due to increased workload, diverse perspectives, complex team structures, and multiple team memberships on the other. The more complex the team's work and structure, the greater the benefit from "higher end" ICTs such as GDSSs, which structure the work and facilitate negotiation and conflict management, compared to "lower end" technologies such as e-mail or paper memos.

DeSanctis, Poole, and Dickson (2000) conducted a longitudinal study of 47 teams in Texaco. Texaco was moving toward a hybrid organizational structure in which the networked form was overlaid on the organization's existing hierarchy. DeSanctis et al.'s study focused on how teams changed as the organization changed by assessing team use of technologies and team characteristics at three points in time over a year and a half. They found that use of groupware ("higher end" ICTs, including teleconferencing, computer conferencing, and GDSSs) increased over the course of the study, while email and traditional modes of communication (face-to-face meetings, telephone, fax, memos) remained constant (see also DeSanctis and Jackson, 1994). This finding is consistent with the hypothesis that teams in networked organizations will be more communication intensive. They assessed the impact of structural variables—team size, geographical dispersion—on appropriation of the technology—measured by use of ICTs, comfort with the technology, adaptation of the technology to the team's work, and use of ICTs for power/control purposes. They also assessed the impact of structural and appropriation variables on two outcomes: perceived group effectiveness and perceived strengths of the group, a measure of coordination quality.

DeSanctis et al. found that smaller teams that met often preferred advanced ICTs more than did larger teams, which was surprising. The structural variables did not predict technology use over time, but prior technology use did, suggesting that use builds on itself. Appropriation variables, particularly adaptation and power uses, were stronger predictors of coordination quality than the structural variables. For technically-oriented teams, at time 2, both adaptation and power uses were negatively related to coordination quality, while at time 3, adaptation was positively related to coordination quality; and power uses were negatively related. This change in sign suggests a learning effect; at first, adapting to ICTs is a burden, but as teams get used to ICTs, adapting to them is easier and helps the group. None of the variables predicted perceived effectiveness.

6.0 Discussion

The Minnesota GDSS Project was a complicated tapestry of laboratory and field studies conducted by an interdisciplinary team of researchers. The goal of the project was to use a common, robust technological platform to conduct an interlocking set of lab and field studies that would develop and test theoretical explanations for the impacts of GDSSs.

The very complexity of the phenomenon shaped the project. GDSSs are quite complex systems and group interaction is a many-layered phenomenon. Add in the impacts of organizational and societal context, and the possible effects are truly multifaceted. This context necessitated a graduated, programmatic approach to the research. For each line of research in the project, the initial focus was on effects studies, with the rationale that only if interesting effects were found would further research be warranted. The focus then shifted to studies of interaction processes to ascertain how the GDSS had its impacts and the mediating role of interaction process on GDSS effects. Once, the researchers elucidated the interaction processes, the focus shifted to articulating the nature of structuration processes in GDSS use. The initial studies were conducted in a lab environment that provided a high degree of experimental control. Subsequent field studies enabled assessment of the degree to which lab findings transferred to settings of organizational use. The result was a “layering” of overlapping studies each of which took a smaller part of the complex whole and, together, gave some idea of the larger picture.

Several tensions helped to drive this research program. First was the tension between theory and empirical research. An important principle of this project has been the importance of theory. Developing a detailed theoretical framework at the outset provided a reference point that clarified the larger implications of individual studies and helped structure a systematic program. In the beginning, the framework was rather general, and the empirical studies informed it both by showing where expectations were wrong and by suggesting additions. The theoretical framework was articulated over a 10-year period, in response to successive waves of findings that supported some aspects and challenged others.

The interplay of lab and field research also shaped the project. GDSS research has been more academically driven than much research in information systems, which tends to pick its subjects from current practice and often lags somewhat behind industry. By contrast, GDSSs were largely designed in university settings and so were idealized versions built around what academics believed would be useful for practitioners. Practitioners interested in groupware looked to universities for ideas and extrapolated the results of laboratory research to the field based on their sense of its potential. Results from the field served as essential tests of concepts and ideas developed in the bell jar of academia. The field research, in turn, spurred further development of the SAMM system and suggested additional laboratory experiments. For example, the studies on Level 3 systems were motivated in part by feedback from the field studies that suggested that complex systems required effective facilitation, but that good facilitators were hard to find. Automated guidance built into the GDSS was one way of overcoming this barrier.

Finally, the interplay of theory and practice greatly enriched the project. The impetus to develop theories that could explain how the GDSS could help groups improve their functioning was an important normative influence on this project. Such theories could guide design of GDSSs and other groupware and would, thus, be eminently practical. However, much of the theory for this project was developed “for theory’s sake,” and initially failed to inform practice (though it was gratifying to academics!). Practitioners’ questions often brought the researchers “up shot” and encouraged articulation of theories so that they had traction for organizational groups.

A few observations about the findings are in order. First, the results of lab and field studies point to the benefits of higher-order Level 2 features such as stakeholder analysis or problem formulation procedures, which may be substantially greater than those resulting from Level 1 tools. However, the same studies also show that Level 2 features are often somewhat difficult for groups to understand and use properly and may take time to master. Facilitation, training, and other support are necessary for groups to capitalize on Level 2 features. It is also important to stress that while learning to use and interpret the results of Level 2 features requires an investment of time and resources, over the long term it can reduce the time and effort required to conduct a sound analysis and come to consensus.

The benefits of Level 2 GDSSs underscore an irony in current information systems, particularly Web 2.0 applications, which reflect a new generation of the Web that provides for greater social interaction and collaboration. Most systems currently being offered to support groups and teams, especially virtual teams, primarily provide Level 1 features, such as threaded messaging, videoconferencing, file sharing, and shared applications of drawing or word processing tools. However, the lab studies showed clearly that groups using Level 1 tools tend to underperform or at best equal groups using Manual versions of the same tools, have higher levels of conflict than Manual groups, and have difficulty managing these conflicts. It is only through use of Level 2 features that GDSS groups have more constructive conflict management and better outcomes than groups using Manual procedures. A key challenge to those wishing to benefit from GDSSs is finding systems that incorporate Level 2 tools and then motivating groups to use them. The results from these studies help to inform how one might provide better process structure in dispersed team environments to address these issues. Recall that the report by Gartner cited earlier predicted that GDSS tools would need to be incorporated into conferencing and other Internet spaces in the near future.

Second, the importance of facilitation—particularly flexible facilitation—and guidance in the effectiveness of Level 2 systems was noteworthy. As a sidebar of the field study—and in subsequent discussions with industry users—one of the barriers to the adoption of GDSSs is the overhead connected with facilitation. Organizations often do not have—or are not willing to commit—the resources to employ specially trained facilitators. Even when facilitators are available, team leaders must spend time working with them to select procedures and plan meetings, as well as spend “social capital” convincing reluctant members to use the GDSS. Members must learn to use the system. This overhead, combined with the dissatisfaction that GDSS users typically experience until they get accustomed to the system and have some successes, is a disincentive to use GDSSs. To successfully implement GDSSs, organizations must be willing to commit the necessary resources and encourage employees to take the time to master the technology and its application. Level 3 GDSSs, which build guidance into the system, can potentially reduce the overhead involved in implementing GDSSs. The growth in sophistication of agent-based advisory systems promises Level 3 systems that can learn and adapt to the particular requirements of teams.

A major theme of the Minnesota GDSS research project was to encourage faithful use of the system, that is, use in line with the spirit built into the system. A second theme was the need to create groups that are capable of taking charge of the GDSS themselves. The presumption has been that the GDSS should be both a tool and an opportunity for the group to learn how to function better, and that achieving the latter means that groups should become functionally independent in using the GDSS. However, as groups become more independent and achieve greater facility in adapting the GDSS to their work (and vice versa), they also are likely to embark on ironic uses of the GDSS that violate the spirit of the technology. Ironic appropriations are not necessarily a bad thing; many represent creative new ways to apply the system that go beyond what designers and implementers envision. However, some ironic appropriations do work against the values that designers and implementers of GDSSs want to promote. Use of a voting feature to impose the majority’s will on the group, for example, is inconsistent both with rational deliberation and with participative decision making, two norms most GDSS experts wish to promote. And if the resident experts in the GDSS choose to use it in ways that manipulate the outcome, the group will be “shortchanged” by the system, getting a predetermined result rather than benefiting from true collaboration among members. Insuring that the values and processes built into the system are honored is a continuous process. This is particularly the case because GDSSs must be melded with existing organizational norms, which are often at odds with norms underlying GDSS procedures.

Finally, the findings of the studies suggest that it is important to put some thought into the selection of groups that will use the GDSS. The groups best situated to benefit from a GDSS are those with complex tasks, fair or good relationships among members, open communication, and some degree of comfort with information technology. Bringing in a GDSS to solve problems that a group already has is unlikely to work. The studies suggest that the group will simply transfer its problems into its appropriation of the GDSS. GDSSs may benefit "troubled" groups when combined with other interventions, such as strong facilitation that helps the group address its problems.

Adaptive Structuration Theory continues to develop, with more than 250 citations found in a recent search. It has been used by researchers in several other fields, including geography (Nyerges and Jankowski, 1997), management (Browning, Beyer, and Shetler, 1995), applied psychology (Kahai, Sosik, and Avolio, (1997), and communication (Sunwolf and Seibold, 1998). In addition to information systems it has been used to study interorganizational ventures, development of industries and communities, leadership, and implementation of innovations. However, it has not been without controversy, as several critiques suggest (Jones, 1999; Orlikowski, 2000).

6.1 Strengths and Limitations

The approach taken in the Minnesota program of research has several advantages. The studies utilized a consistent technological platform built around a coherent spirit with a consistent look and feel, which enabled us to rule out effects due to different technologies or interfaces. As a result, the results of different studies were cumulative over the entire program. Utilizing multiple tasks that were often employed across multiple studies also has advantages. Comparing results across multiple tasks, as in the studies of Level 2 support, tested generalizability. It also facilitated discovery of inconsistencies in results that led to additional research on facilitation and guidance. Because the Minnesota researchers used the same task across several studies that varied level of support, heuristics, and other factors, we were able to compare processes and outcomes and, hence, to tease out the impacts of technological and procedural variations. The laboratory and field studies provided useful complements; consistencies in results across venues provided reassurance that substantive results and inconsistencies posed interesting puzzles. Finally, we used a consistent theoretical model throughout the program, which provided a compass to guide the planning of studies and interpretation of results.

The GDSS research program also has its limitations. Using a single technological platform opens the project to the charge that results are idiosyncratic to that platform. The same can be said for the experimental strategy and design and for the instruments employed to measure key constructs. While these objections cannot be ruled out on the basis of the evidence provided by the project alone, there are some mitigating observations. First, a number of results are consistent with those from research using other GDSSs, tasks, and designs, as indicated by a comprehensive review of the GDSS literature by Fjermestad and Hiltz (1998-1999). Second, there is reason to believe that, although the SAMM design is only one of many possible designs, it was a reasonably effective technology. Many subjects in the lab and users in the field expressed positive reactions to SAMM. In the case of the lab studies that purposely left many groups to their own resources and allowed them to flounder and fail in order to get variation in processes and outcomes, the researchers were surprised by the number of subjects who were very positive about SAMM and understood its potential. In the studies that offered support and guidance, satisfaction with the system was high. In the field, groups using SAMM for multiple sessions had about a 50 percent success rate, which is respectable for IS implementations.

Another limitation stems from an inherent tension in research on experimental IS in the field. For the purposes of research, it is important to observe unsuccessful as well as successful uses of the system. No information technology works perfectly when it is first installed, and the researcher and the system developer learn as much when problems and issues arise or when people use it wrongly as when the system works perfectly. This is particularly true for research informed by AST, because testing this theory requires observations of ironic as well as faithful uses of the GDSS. Helping the groups use the system perfectly would reduce the type of variation needed to study its impacts on group processes and outcomes. However, on the practical side, it was critical that SAMM work well and generate clear benefits for participating organizations. If the system had too many problems and bugs or if it did not deliver benefits, there would be no incentive for the organization to continue to use it. There was in some cases, then, a potential conflict between the requirements for good research and what would foster a good long-term collaboration. The researchers walked a fine line between these issues throughout the project.

6.2 Future Directions

One promising set of directions extends along the trajectory already laid out by the project. It includes research on systems for automated guidance of GDSSs, study of processes such as group argumentation that play a major role in the impacts of GDSSs, and studies of the social construction of group technologies.

A second direction points toward connecting the study of GDSS more closely to collaboration technology generally. GDSS is just one of a suite of such technologies, and enthusiasm for newer collaboration technologies such as portals, avatars, and blogs has eclipsed GDSSs in some venues. However, research on GDSSs holds important insights for newer collaboration technologies. Newer technologies also promise to enrich GDSSs. While research shows clear benefits from GDSSs, they have not been very successful applications. It may indeed be the case that newer, more successful collaboration technologies can inform the design and implementation of GDSSs, making them more palatable to the large mass of users.

A third direction moves beyond GDSSs and extends AST and the research strategy employed in this project to new venues. DeSanctis and colleagues pursued study of virtual organizations and online communities using many of the concepts and techniques developed in this project (Fulk and DeSanctis, 1999).

7.0 Conclusion

In its 20 years, the Minnesota GDSS Research Project has made several significant contributions. Adaptive Structuration Theory offers a general model of information and communication technology use and impacts that have proven its utility beyond the GDSS context. The theory has become recognized as a central theory for the information systems domain and it has been applied in a variety of areas. Within the GDSS context, research guided by AST has clarified the processes by which users incorporate information technology into their work and how they realize and restructure it in so doing, which has implications for the implementation of IS. The project's systematic study of levels of group decision support has clarified the impacts and contributions of the different levels, which has implications for the design and utilization of a wide variety of collaboration technologies. The project also has yielded significant findings relevant to facilitation and the use of heuristics and other structures in concert with GDSSs. These fundamental topics continue to be important as new developments in technology create opportunities for new ways to support groups. The theory, findings, instruments, tasks, and techniques that issued from this project continue to find application in new areas. Though its participants have for the most part gone on to pursue other lines of research, further analyses drawing on its data continue to appear, providing evidence of the solid value of long-term programs of research.

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APPENDIX

A more detailed narrative of the results summarized here is available at http://hdl.handle.net/2142/5349

Table 1. GDSS Groups Versus Traditional Groups

Concept Studied*	GDSS Outperforms Traditional	Traditional Outperforms GDSS	Other Findings/Issues/ Qualifications	Reference
Quality of production (Outcome)	Level 1 GDSS groups identified higher quality problems than Baseline groups in a marketing case with high complexity.		Task moderated the impact of GDSS: there was no difference in performance for low complexity task.	Gallupe, 1987; Gallupe, 1988
	Level 1 GDSS groups improved their performance compared to average member performance.		Baseline groups also improved their performance compared to average member performance.	Zigurs, 1988; Zigurs et al., 1989
Quantity of production (Outcome)	Level 1 GDSS groups generated more problem statements than Baseline groups.		Marketing task was relatively open-ended.	Gallupe, 1988
		Manual groups generated more ideas than Level 1 GDSS groups or Baseline groups	Foundation task was relatively closed-ended.	Poole, Holmes, Watson and DeSanctis, 1993

Concept Studied*	GDSS Outperforms Traditional	Traditional Outperforms GDSS	Other Findings/Issues/ Qualifications	Reference
Consensus Change (Outcome)	GDSS groups achieved higher levels of consensus change than Baseline groups		Although GDSS groups were better than Baseline, Manual groups outperformed GDSS in terms of consensus change; Foundation task used.	Watson et al., 1988
	When preexisting disagreement was high, GDSS groups achieved higher consensus than Manual groups.	Manual groups achieved higher levels of consensus than GDSS groups.	Pre-existing levels of consensus was a moderator; Planning task used.	Sambamurthy and DeSanctis, 1990
Time (Outcome)		Baseline groups took less time than GDSS and Manual groups.	Foundation task used, with closed-ended alternatives.	Watson et al., 1988
			No difference between Baseline and Level 1 GDSS groups; Marketing case used.	Gallupe et al., 1988
Subjective Outcomes (Outcome)		Perceived quality of decision and decision scheme satisfaction were less for Level 1 GDSS groups; Manual groups had greater decision confidence.		Watson et al., 1988
		Members' satisfaction with decision was less for Level 1 GDSS groups than Baseline groups.	No difference in confidence in the decision in Level 1 GDSS and Baseline groups.	Gallupe et al., 1988

Concept Studied*	**GDSS Outperforms Traditional**	**Traditional Outperforms GDSS**	**Other Findings/Issues/ Qualifications**	**Reference**
	Level 2 GDSS groups had higher confidence in decision and greater commitment to implement decisions than Manual groups.		No difference in perceived quality between Level 2 GDSS and manual groups in field experiment; no difference in decision scheme satisfaction between Level 2 GDSS and Baseline groups.	Niederman, 1990
Amount of Communication (Group Process)	Level 1 GDSS groups had more communication than Baseline groups.		Manual groups also had more communication than Baseline groups.	Watson et al., 1988; Zigurs et al., 1989
Quality of Discussion and Analysis (Group Process)		Manual groups spent more time discussing criteria for decision than Level 1 GDSS groups. Baseline groups elaborated on solution s more than manual, which did more than GDSS groups.	No differences in degree to which members of GDSS, Manual, or Baseline groups connected solutions to criteria.	Poole, Holmes, Watson, and DeSanctis, 1993
	Members of Level 2 GDSS groups perceived greater depth of analysis than Baseline groups.		Field experiment.	Niederman, 1990

Concept Studied*	GDSS Outperforms Traditional	Traditional Outperforms GDSS	Other Findings/Issues/ Qualifications	Reference
		GDSS groups were more likely to use formal evaluation to degrade discussion, while Manual groups used formal evaluations to promote discussion and analysis. Manual groups more closely approximated ideal task-communication fit profile than GDSS groups.	GDSS groups that used the GDSS productively—using rating/voting as a stimulus for further discussion, balancing participation, clarifying roles and process—had higher levels of consensus change than GDSS groups that did not. Nonproductive uses of evaluation were negatively correlated with consensus, perceived quality, and decision scheme satisfaction. Task-communication fit was positively correlated with consensus, perceived quality, and decision scheme satisfaction.	Poole et al., 1991, 1993
Decision Process (Group Process)	Level 1 GDSS groups were more equal than Manual groups on perceptions of control of the group and group process.		Level 1 GDSS groups had more influence behavior and were more focused on procedures than in manual. Manual groups had more integration and goal-oriented statements than GDSS or baseline, but this was negatively correlated with performance.	Zigurs et al., 1989
	Level 1 GDSS groups had higher levels of procedural insight than Manual or Baseline groups.	Level 1 GDSS groups had more difficulty than Manual groups in using procedures initially, had more problems and disagreements with procedures, and rated process as more confusing.	Problems with using the GDSS were negatively correlated with decision scheme satisfaction	Poole et al., 1993

Concept Studied*	GDSS Outperforms Traditional	Traditional Outperforms GDSS	Other Findings/Issues/ Qualifications	Reference
		Manual groups had decision paths more similar to normative sequence than Level 1 GDSS or baseline groups. Paths that resembled the normative sequence led to more consensus change and satisfaction with the decision.	Progression through the normative sequence did not have to be highly orderly; more complex paths in which groups recycled to early phases (e.g., going back to reconsider the problem during solution development) for brief periods seemed to be useful, so long as the overall decision path largely followed the normative sequence.	Poole and Holmes, 1995
		Level 1 GDSS groups (3-person) perceived less equality of influence than manual or baseline. GDSS groups perceived less clear leadership than baseline.	4-person groups had no differences in perception of equality of influence.	Watson et al., 1988
Conflict Management (Group Process)		Baseline groups had less conflict than Level 1 GDSS groups.		Gallupe et al., 1988
	Level 1 GDSS groups had more integration behavior during conflict.		Manual groups managed disagreement by low key debate while baseline and Level 1 GDSS groups used open discussion.	Poole, Holmes and DeSanctis, 1991
	Level 2 GDSS groups had more open confrontation of conflict and integrative conflict management than Manual groups.		Manual groups managed disagreement by low key debate.	Sambamurthy and Poole, 1992

*Concept in parentheses indicates the component of the conceptual model (see Figure 1) to which the results relate.

Table 2. Level 1 Versus Level 2 Groups

Concept Studied*	Level 2 Outperforms Level 1	Level 1 Outperforms Level 2	Other Findings/Issues/ Qualifications	Reference
Consensus (Outcome)	In group with high levels of initial disagreement, Level 2 groups had higher consensus than Level 1.		No difference between Level 1 and 2 in groups with low levels of initial disagreement. Planning task. Groups were carefully monitored and problems were addressed during sessions.	Sambamurthy and DeSanctis, 1990
		Level 2 groups had problems using system.	No difference between Level 1 and 2; Foundation task. Groups had problems using the Level 2 GDSS.	Dickson, DeSanctis, Poole, and Limayem, 1990
		Some evidence that Level 2 groups had problems using system.	No difference between Level 1 and 2; Problem identification task. Some evidence that groups had problems using the Level 2 GDSS.	Niederman, 1990
Time (Outcome)			No difference in length of meeting between Level 1 and 2.	Niederman, 1990
Subjective Outcomes (Outcome)	Level 2 groups had higher confidence in decision than Level 1.		No difference between Level 1 and 2 in perceived quality and decision scheme satisfaction; planning task.	Sambamurthy and DeSanctis, 1990
	Level 2 groups had higher decision scheme satisfaction and commitment to implement decision than Level 1.		No difference between Level 1 and 2 in perceived quality and confidence; Problem identification task.	Niederman, 1990; Niederman and DeSanctis, 1995

Concept Studied*	Level 2 Outperforms Level 1	Level 1 Outperforms Level 2	Other Findings/Issues/ Qualifications	Reference
			Perceived ease of use and usefulness mediated subjective reactions to the GDSS. In the short run perceived ease of use was positively related to positive reactions; in the long run, perceived usefulness was positively related to positive reactions	Sambamurthy and Chin, 1994
Quality of Discussion and Analysis (Group Process)	Level 2 groups had more statements linking criteria and solutions, correlating positively with perceived quality, consensus, and confidence.	Level 1 groups had greater proportion of solution elaboration statements.	No difference between Level 1 and 2 in perceived task focus.	Sambamurthy, Poole, and Kelly, 1993
	Level 2 groups had fewer assumptions in final decisions, suggesting more thorough discrimination, and less nonproductive use of formal evaluation.		No difference in perceived understanding of other members.	Sambamurthy et al., 1993
	Level 2 groups perceived more coverage of significant issues.		No difference in perceived depth of analysis and understanding of other members.	Niederman, 1990
	Level 2 groups used formal evaluation procedures productively (and more) than Level 1 groups			Sambamurthy et al., 1993

Concept Studied*	Level 2 Outperforms Level 1	Level 1 Outperforms Level 2	Other Findings/Issues/ Qualifications	Reference
Decision Process (Group Process)	Level 2 groups had more information search and equivocality reducing statements, correlated positively with consensus and perceived coverage of important issues.			Niederman, 1990
	Level 2 groups had fewer problems getting started and more procedural insight.		Once Level 1 groups got started, there was no difference in problems between Level 1 and Level 2 groups	Sambamurthy et al., 1993
			There was no difference how the decision process unfolded in terms of phases of group decision-making; there was no difference in degree of organization of the decision process between Level 1 and Level 2 groups	Sambamurthy et al., 1993

Concept Studied*	Level 2 Outperforms Level 1	Level 1 Outperforms Level 2	Other Findings/Issues/ Qualifications	Reference
			In a comparison between high and low performing Level 2 groups, and Level 1 groups, high performing groups in all conditions: (1) Had a member or facilitator who knew and took charge of the process; (2) Engaged the task seriously and in-depth; (3) Tried several different combinations of weights in the allocate step and discussed the ratings thoroughly; (4) When conflicts arose, groups engaged in constructive conflict management discussion rather than negotiation/bargaining/tradeoffs in making their decision.	Dickson et al., 1993
Conflict Management (Group Process)	Level 2 groups had more open confrontation and integrative resolution of conflict. Level 1 groups surfaced conflict, but were not able to manage it effectively.			Sambamurthy and Poole, 1992

*Concept in parentheses indicates the component of the conceptual model (see Figure 1) to which the results relate.

Table 3. Effects of Altering the Internal Group System by Adding External Support

Type of Support	Positive Effects	Negative Effects	Other Findings/Issues/ Qualifications	Reference
Heuristics	Coupled Heuristic had higher consensus change than Specific or Integrated Heuristic. Consensus Guidelines alone had higher consensus change than Coupled Heuristic.	Integrated Heuristic took longer than Coupled or Specific.	Restrictiveness had no effect on consensus.	DeSanctis, D'Onofrio, Sambamurthy, and Poole, 1989; Poole & Lee-Partridge (1992)
	Integrated Heuristic led groups to define criteria for a good decision and link them to deliberation more than Coupled or Specific Heuristics. Integrated Heuristic groups had better task-communication fit than Coupled or Specific Heuristic groups Coupled Heuristic led to greater adherence to Consensus Guidelines than Integrated Heuristic. Restrictive Groups had clearer emergence of leadership than Nonrestrictive groups.	Restrictive Groups were less equal in participation than Nonrestrictive Groups	High Restrictiveness resulted in more use of formal idea evaluation but no difference in how productively evaluation was used, compared to low Restrictiveness.	Poole & Lee-Partridge (1992)

Type of Support	Positive Effects	Negative Effects	Other Findings/Issues/ Qualifications	Reference
GDSS Role Training			No differences across outcomes for rotated roles, fixed roles, and no roles for repetitive tasks. Under novel task condition, role training showed promise for reducing amount of start-up friction encountered by group.	Vician and DeSanctis, 2000
Facilitation	Facilitated groups had higher levels of consensus change than non-facilitated groups with Level 2 GDSS. Flexible Facilitation groups had higher consensus than firm facilitation groups, and higher perceived quality and decision scheme satisfaction than Firm and No-Facilitation groups. Facilitated groups achieved higher levels of understanding of the GDSS and its outputs than Non-Facilitated groups. Facilitated groups generated more criteria and used them in evaluating ideas more than Non-Facilitated groups.	Non-facilitated groups had higher confidence than Firm Facilitator groups. Facilitated groups took longer to make decisions than Non-Facilitated groups.		Dickson, Lee-Partridge, and Robinson, 1993, 1996
	Highest performing groups had a member or facilitator who knew and took charge of the process.			Dickson et al., 1993

Type of Support	Positive Effects	Negative Effects	Other Findings/Issues/ Qualifications	Reference
Level 3 Guidance	Level 3 groups had higher consensus, perceived quality, decision scheme satisfaction, perceived depth of analysis, and better understanding of procedure than Level 2.		No difference in decision confidence between Level 3 and 2. Level 3 took more time.	Limayem, 1994 & 2006; Limayem, Banerjee, and Ma, 2006

Table 4. Adaptive Structuration Findings

Structuration Aspect	Positive Finding	Negative Finding	Other Findings/Issues/ Qualifications	Reference
Overall evidence that structuration process has effect on outcomes	Groups that used the GDSS in ways that enacted productive conflict management behavior had higher levels of consensus change than those that did not.			Poole, Holmes, and DeSanctis, 1991
	Groups use of influence strategies via the GDSS and its outputs was related to group performance			Zigurs et al., 1989
	Sequence of conflict management activities differed within GDSS conditions and sequences in which the groups openly confronted conflict and discussed possible resolutions had higher levels of consensus change than groups that did not confront their conflict.			Sambamurthy and Poole, 1992
	Learning of system mediated impact of system level on outcomes within Level 2 and 3 conditions			Limayem and DeSanctis, 2000
Faithfulness of appropriation	Faithful appropriation was related to higher consensus change.			Poole and DeSanctis, 1992
	Faithfulness increased task-communication fit, which was positively related to consensus change, perceived quality, and decision scheme satisfaction.			Poole, Lind, Watson, and DeSanctis, 1992

Structuration Aspect	Positive Finding	Negative Finding	Other Findings/Issues/ Qualifications	Reference
	Faithfulness was higher with a High Restrictive GDSS than with a Low Restrictive GDSS			Poole and Lee Partridge, 1992
	Faithful appropriation of the GDSS positively influenced amount of conflict in discussions, which was positively related to consensus change.	Faithfulness positively influence amount of conflict in discussion, which was negatively related to confidence in group's recommendation. Faithfulness had direct negative relationships with consensus change and confidence		Sambamurthy and Poole, 1994
	Level 3 groups had higher levels of faithful appropriation than Level 2 groups, and faithfulness was positively related to higher levels of consensus, perceived quality, and decision scheme satisfaction.			Limayem, Banerjee, and Ma, 2006
			No difference in automated versus human facilitation in enhancing faithfulness of appropriation of GDSS	Limayem, 2006

Structuration Aspect	Positive Finding	Negative Finding	Other Findings/Issues/ Qualifications	Reference
Microlevel appropriation	High Consensus Change groups used structures to guide their work and actively worked to match GDSS features to task features.		Effective appropriation of GDSS depended on being able to use the system in a discriminating fashion that adapted to the task. Continuous process of production and reproduction of structures creates a momentum toward stabilization. Junctures or breakpoints can be identified, in which groups made major choices on which structural features to appropriate.	Poole and DeSanctis, 1992
	Level 3 support can help groups deal with junctures and manage breakpoints.			Limayem, 1995; Limayem and DeSanctis, 2000
	Level 2 groups had more direct appropriation with non-problematic use of GDSS than Level 1.		Overall proportion of GDSS structure use was negatively correlated with consensus change; proportion of external structure use was positively correlated with consensus change.	Armstrong, Perez, and Sambamurthy, 1993
Attitudes toward GDSS	Attitude toward GDSS was positively related to confidence in group's recommendation, perceived quality of decision, and decision scheme satisfaction.			Sambamurthy, DeSanctis, and Poole, 1995

Structuration Aspect	Positive Finding	Negative Finding	Other Findings/Issues/ Qualifications	Reference
			No difference in comfort, challenge, or respect toward GDSS in different training modes.	Vician, 1994
	Facilitated groups showed more challenge, comfort, and respect toward GDSS than non-facilitated groups.			LeePartridge, 1992
	Level 3 groups had more challenge, comfort, and respect toward GDSS than Level 2 groups.			Limayem, 1992
	Groups that had positive approaches to their technology/ procedures had more productive discussions.			Zigurs, Poole, and DeSanctis, 1988
			Users of Level 2 features chose action-oriented descriptive terms for the GDSS, while users of Level 1 features chose trait-like descriptive terms.	DeSanctis et al., 1994

Table 5. Field Studies

Aspect of Field Study	Positive Finding	Negative Finding	Other Findings/Issues/ Qualifications	Reference
Overall impact of GDSS	GDSS team members had favorable attitudes toward the system. Voluntary use of system was high. Polling feature helped team to understand differences.		GDSS had better results and was used more when introduced soon after team formation rather than mid-stream. Extent of match of task with technology contributed to success.	DeSanctis, Poole, Lewis, and DeSharnais, 1991
		Existing conflicts carried over into use of GDSS, lessening benefit to be derived from system.		Poole, DeSanctis, Kirsch, and Jackson, 1994
	Effective use was dependent on alignment among system, team tasks, group norms, and other structures.		A poor fit of task with technology can be overcome with continuous learning process.	Vician, DeSanctis, Poole, and Jackson, 1992
		GDSS groups generated fewer ideas than manual groups. GDSS groups spent more time managing brainstorming process than elaborating on ideas.	Quantity of ideas was less important in the field groups than other functions that idea generation served, e.g., ritual.	Jackson and Poole, 2003

Aspect of Field Study	Positive Finding	Negative Finding	Other Findings/Issues/ Qualifications	Reference
Impact of more sophisticated support	Level 2 features required more support from facilitators, but had powerful effects when used, increasing group effectiveness in complex tasks and disagreements, enabling teams to handle multiple viewpoints, providing structure for complex tasks, and enhancing efficiency of meetings.		Level 1 features were used more frequently than Level 2. Teams that started using GDSS early in their life as a team used Level 2 features more often.	DeSanctis et al., 1991; DeSanctis et al., 1991-1992
Impact of facilitation	Facilitation helped groups make progress.			Poole, DeSanctis, Kirsch, and Jackson, 1995
	Leadership in promoting learning of the GDSS enabled team to appropriate the system in ways that facilitated its work.			Vician et al., 1992
Patterns of appropriation	Patterns reveal that effective use of GDSS is most likely if team becomes independent in use of system. Effective appropriation depends on emphasizing task and process uses and constraining power-related uses of GDSS.	Too much emphasis on internal process to exclusion of work lead to ineffective appropriation of GDSS.	Different patterns of alignment can be identified, among GDSS structure, team task, internal member relations, and pre-existing structures other than task.	Poole, Jackson, Kirsch, and DeSanctis, 1998
	Team member initiation of use of GDSS was positively related to team's comfort with the systems, adequacy of the system, and adequacy of training.			DeSanctis et al., 1991
Trends in GDSS and other collaborative technology use	At first, adapting groupware use is a burden, but over time, it becomes easier and helps the group.		Groupware use increased over time while email and traditional collaboration stayed constant.	DeSanctis, Poole, and Dickson, 2000

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