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ABHIJIT GOPAL, ROBERT P. BOSTROM, AND WYNNE W. CHIN

ABHIJIT GOPAL is Assistant Professor in the Management Information Systems Area at the University of Calgary. He received his doctorate in information systems at the University of Georgia. He has a degree in economics from the University of Madras, India, a degree in law from the University of Bombay, India, and an M.B.A. from Bowling Green State University. He has worked several years in the advertising industry. His current research is in the implementation of group support systems in organizations.

ROBERT P. BOSTROM is Associate Professor of MIS at the Department of Management, University of Georgia. He holds a B.A. and an M.B.A. from Michigan State University, an M.S. in computer science from SUNY at Albany, and a Ph.D. in MIS from the University of Minnesota. Besides numerous publications in leading academic and practitioner journals, he has extensive consulting and training experience in the areas of MIS management, MIS design, group support systems, organizational development, and high-performing MIS professionals. His current research interests are focused on high-performing individuals, user–designer relationships, group support systems, end-user computing, and effective design of organizations via integrating human/social and technological dimensions.

WYNNE W. CHIN is Associate Professor of MIS in the Faculty of Management at the University of Calgary. He previously taught at Wayne State University and at the University of Michigan, where he received his Ph.D. in information systems. In 1989, he was honored with a doctoral fellowship from the Society of Information Management. His background includes academic degrees in biophysics from the University of California, Berkeley, bioengineering from Northwestern University, and an M.B.A. from the University of Michigan. His primary research interests include user acceptance of new information technology, group support systems, methodological issues in information systems research, the use of social network analysis and latent structural analysis, office automation, and end-user computing.

ABSTRACT: Adaptive structuration theory (AST) provides a sound basis from which to study the use of group support systems (GSS). The need for a theoretical approach such as AST is especially urgent because it helps explain the process of GSS use, thereby providing insights into the reasons for inconsistent research results. This paper

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illustrates the development of a research model based on AST, and reports the results of a study conducted on the basis of this model. The independent variables in the study were task and technology. The model's process component was represented by the attitudes of group members toward the technology they used. The six attitude dimensions were obtained from AST as well as from other information technology researchers. The model was tested using the partial least squares (PLS) technique.

KEY WORDS AND PHRASES: adaptive structuration theory, group decision process, group decision support systems.

1. Introduction

A RECENT TREND IN THE GROUP SUPPORT SYSTEMS (GSS) literature has been the attempt to understand the *process* of GSS use. This trend follows on the heels of early GSS research efforts that sought to understand the effects of GSS use primarily through the outcomes of such use. This early approach resulted in conflicting research results, as the influence of the process of GSS use was often not considered. This transition can be characterized as a movement from an *object-centered* approach, in which a technology itself is the object of interest, to a *social-actor-centered* approach, in which the focus shifts to the use of the technology by members of a social system [23].

The bid to understand the GSS process has been led by researchers incorporating theoretical frameworks from reference disciplines into their toolkits [27, 28, 33]. The most clearly articulated of the different approaches appears to be adaptive structuration theory (AST), outlined by Poole and DeSanctis [27, 28]. This approach provides a cogent framework for the study of GSS, and is used to frame the research reported in this paper.

The purpose of this paper is to demonstrate the use of AST to develop and test a research model, and to evaluate the use of AST in the context of the results of the research. The objective of this endeavor is to address the problem of inconsistent findings by focusing on some of the variables that may help explain them, and by attempting to understand the variables that impact the process of GSS use. The remainder of this paper is arranged in five sections. The next section describes AST and initiates the development of the research model. Section 3 outlines the methods and procedures used in the research, and completes the definition of the research model. Section 4 presents the results of a causal modeling approach to testing the model. The fifth section evaluates the results of the analysis and discusses the use of AST and its constructs in this context. The concluding section summarizes the paper and discusses the potential for the use of AST in the larger context of ongoing GSS research.

2. AST and the Research Model

IN ARTICULATING AST, POOLE AND DESANCTIS [27, 28] point out that group outcomes, rather than resulting directly from the effects of variables such as technology and task, reflect the manner in which groups *appropriate* the structures of the technology and the context of its use. Appropriation refers to the manner in which structures are adapted by a group for its own use through a process called *structuration*, wherein structures are continuously produced and reproduced (or confirmed) as the group's interaction process occurs.

Poole and DeSanctis [27, 28] explain structures by making the following distinction:

> A *system* is a social entity such as a group, pursuing various practices that give rise to observable patterns of relations, such as the pecking order often seen in groups or organizations. *Structures* are the rules and resources actors use to generate and support this system [28, p. 179].

Structures consist of a *spirit*, the "general goals and attitudes the technology aims to promote" [27], and specific *structural features* that implement the spirit promoted by the structure or the system.

AST further posits that the mode in which structures are appropriated is determined along three dimensions: the *faithfulness* of that appropriation, the group's *attitudes* toward the GSS, and the group's *level of consensus* on the appropriation. Faithfulness refers to the extent to which a group uses a GSS in keeping with the spirit in which it is meant to be used. A *faithful* appropriation involves adhering to the spirit, while an *ironic* appropriation entails violation of the spirit. Attitudes include the *level of comfort* that group members feel with the use of the GSS, and the *degree of respect* they have for it. Level of consensus refers to the extent to which group members agree on how a GSS should be appropriated.

Poole and DeSanctis [27, 28] suggest that for a GSS to have its intended effects (improved outcome quality, etc.), its structures should be appropriated in a *stable* manner. For an appropriation to be stable, the GSS should be faithfully appropriated, there should be a high level of consensus on appropriation, and the group's attitudes toward the technology should be positive.

It should be noted that the concept of stability is not necessarily associated with a positive or negative connotation concerning GSS use. However, the proponents of AST appear to assume implicitly that stable appropriation is more likely to reflect a positive rather than a negative experience for a group, because the intended effects of the use of most GSS are positive in nature. However, it is conceivable that an ironic (and therefore "unstable") appropriation of a GSS could still lead to positive and productive GSS outcomes, especially in situations where groups are able to overcome poor design features to achieve their goals.

Thus, in an AST context, the use of a GSS can be depicted as an input-process-output framework. Given certain input conditions such as technology and contextual factors, groups create and experience the use process, which is characterized by their modes of appropriation, and in turn leads to certain outcomes, the predictability of which is based on the stability of appropriation.

Many of the input conditions can be culled from the comprehensive list of group work dimensions provided by McGrath [21]. Based on these dimensions and those suggested by Poole and DeSanctis [28], several dimensions of relevance to the GSS environment were identified for this study. These dimensions, referred to here as input variables, are categorized based on the scheme used by McGrath [21]. This scheme classifies variables as being related to the individual (individual/trait differences, background of individual), the standing group (group size, group history), the task (task type based on McGrath's typology), and the environment (technology, physical environment, facilitation).

The process can be characterized by the modes of appropriation defined in AST: faithfulness of appropriation, attitudes toward the GSS, and level of consensus on appropriation.

While GSS use can be expected to impact a wide variety of outcome variables, the output segment of the framework can be characterized by some of the more widely used dependent variables in GSS research, including perceived outcome quality [32], satisfaction with outcome [2, 32], and satisfaction with process [31, 32]. The resultant input-process-output framework is presented in figure 1.

In view of the inconsistencies prevalent in GSS research results, interest in this study was centered on two variables that have been identified as having considerable potential to explain such inconsistencies: technology and task [28]. In addition, there was interest in investigating the task-technology fit.

The choice of technology as an independent variable was prompted by three factors. First, GSS studies have been conducted using a wide variety of GSS technologies. Yet, their results have been considered comparable, in spite of the ensuing inconsistencies between these results. Second, several different forms of information technology (IT) support for groups have emerged in recent years [11, 26]. Consequently, it is becoming increasingly inappropriate to classify all these systems under the single label of GSS. Rather, distinctions should be made between *types* of GSS, with attention paid to the dimensions along which these systems differ. Third, Poole and DeSanctis [28] suggest that "some [GSS] designs are more conducive to stable appropriation than others." Thus, it is considered important to investigate the effects of technology from an AST perspective.

Three factors led to an interest in studying task as a variable. First, as with technology, GSS researchers have used a variety of tasks in their studies, but only a few [7] have accounted for differences in tasks as a potential reason for inconsistent results. Second, organizational groups engage in a wide range of tasks, which suggests the need to study GSS use in multiple task environments [19]. Third, different forms of GSS can be expected to support different tasks in distinctive ways. In an AST context, it is proposed that the stability of appropriation of a technology can differ on the basis of the task being conducted. Thus, it was expected that the incorporation of task as an independent variable would further inform the investigation of the nature of the appropriation process.

The interest in the task-technology fit was prompted in part by the fact that GSS have often been imposed on tasks that may have been better served by alternative modes of completion, resulting in negative effects of GSS use. While such negative effects are rarely recorded in the literature, their existence is verified through anecdotal evidence provided by GSS facilitators, who recognize that an important component of their facilitation skills is the ability to effectively match the technology to the tasks

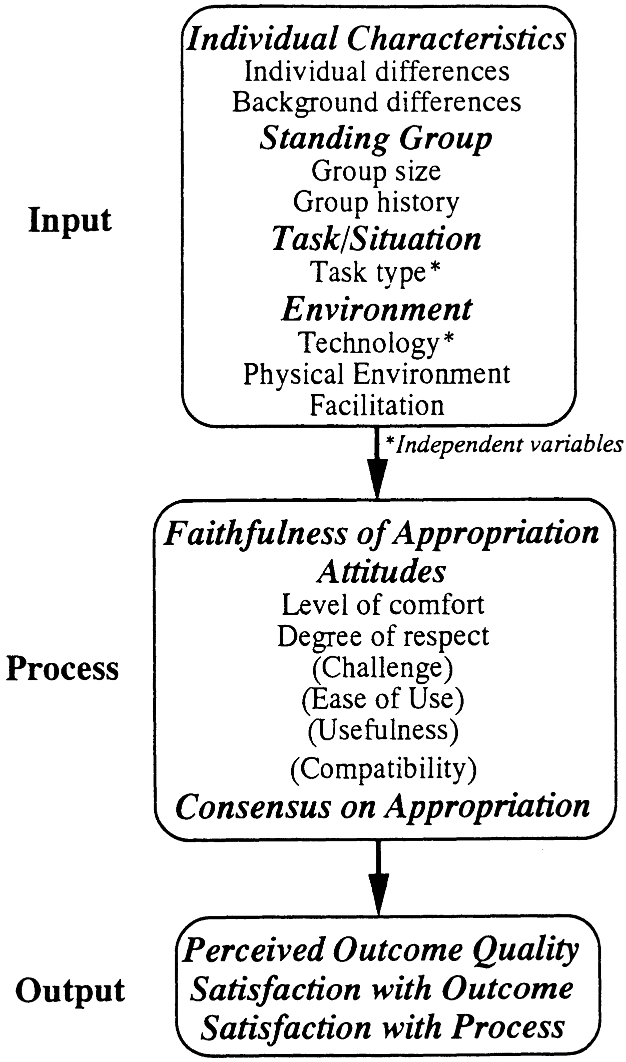

Figure 1. Research Framework

at hand. Clearly, a case exists for the application of the appropriate GSS technologies to a range of different tasks, and for research into the best fits between tasks and technology.

Based on AST and the research framework presented in figure 1, technology and task were assumed to affect attitudes when the other process factors were controlled, which in turn affected outcomes. However, a case existed for the inclusion of direct paths from the input to the outcome variables for two reasons. First, such direct causality had been implicitly assumed in previous GSS research, thereby calling for an evaluation of whether such links did indeed exist.

Second, primarily because of the perceptual nature of the outcome variables, both input variables could arguably be viewed as directly influencing outcomes. For example, a difficult task could result in the perception that the outcomes of the group process were poor because of the group's lack of experience with the task domain, even though attitudes toward the GSS were positive. Similarly, it could be argued that even when group members had high opinions concerning the technology used (attitude), there may have been differences between technologies in perceptions concerning the extent of its influence on their outcomes. Thus, causal linkages between the input and outcome variables were included in the model. The development of the research model (depicted in figures 2 through 7) is completed in the next section, following a description of the study method.

3. Method of Study

BOTH TECHNOLOGY AND TASK CAN BE CHARACTERIZED on a large number of dimensions. In this section, these two variables and their operationalization are discussed in detail, as are the controlled variables, the experimental procedures used, and the measures of the attitude and outcome variables.

3.1. The Technology Construct

For simplicity, and due to the fact that an established technology model was unavailable, two existing GSS were chosen, and five dimensions on which they differed, drawn from two sources [10, 15], were noted. One system, OptionFinder, involved the use of keypads for evaluative responses, while the other system, GroupSystems, had group members using microcomputers. Profiles of the two technologies in the five dimensions of interest are presented in Table 1. It should be noted that the differences on each dimension, while wide enough to be easily distinguishable, are relative to each other rather than to absolute standards. For example, the learning required for GroupSystems is considerably higher than for OptionFinder, by the very nature of the media involved—computers and keypads. However, in an absolute sense, it is not difficult to learn to use either system.

The two GSS used are among the few systems of their kind that have enjoyed some commercial success. OptionFinder, developed and marketed by Option Technologies, has been widely adopted by major corporations around the world [25], and is also extensively used in the consulting industry for applications such as marketing research and personnel evaluation. GroupSystems, developed at the University of Arizona and marketed by IBM and Ventana Corporation, has been installed and is extensively used at several corporate and university sites.

3.2 The Task Construct

The tasks were selected such that they differed primarily in terms of their fundamental activities. The predominant activity on one task, which called for the development of a strategy to tackle a campus parking problem [3, 12], was alternative generation. The second task, involving residence hall misconduct [2, 16], was mainly concerned with

Table 1 Technology Differences

Dimension	GS	OF
Degree of IT support	High	Low
Effort to use	High	Low
Skill required	Moderate	Low
Learning required	High	Low
Face-to-face communication	Moderate	High
User interface	Computer	Keypad

alternative evaluation. These activities correspond to the *generate* and *choose* quadrants of McGrath's [21] task circumplex. Table 2 summarizes the differences between the tasks on other dimensions.

On the parking problem task, subjects were asked to consider the difficulties experienced by the university community in parking their vehicles on campus, and to develop a solution strategy that met the needs of the community. Their solution was to be based on criteria generated by the group. On the misconduct case task, considerable information was provided on the circumstances surrounding a residence hall dispute. The transcript of a disciplinary committee meeting was provided, and basic alternatives were suggested to the group. Decision-making criteria were also provided. The group's task was to determine the most equitable course of action to take based on the information provided.

Both tasks were expected to be adequately supported by each technology. GroupSystems was expected to provide extensive support for both idea generation and evaluation. OptionFinder was expected to provide considerable evaluation support as well as a measure of generation support, in the form of group members' ideas recorded by the facilitator for viewing on the public screen.

3.3. Controlled Variables

All input variables other than task and technology were designed to be controlled. Individual characteristics were controlled by the random allocation of subjects to groups and groups to treatments. Group size was set at nine, to gain a balance between the different group sizes used in GSS research, and to reflect the size of organizational groups that could be expected to benefit from the use of a GSS [12]. Groups without any history were used, due to the greater availability of such groups, and because histories were deemed impossible to control at any given level. The physical environment within which groups worked was exactly the same for every group, irrespective of technology or task assignment. Facilitation was controlled by completely balancing facilitator assignments, and assigning facilitators randomly across groups. No facilitator worked with the same group twice.

It was assumed that two of the three process variables, faithfulness of appropriation and level of consensus on appropriation, could be held constant. Faithfulness was regarded as controllable through the adequate communication of the *spirit* associated with the GSS [8]. The spirit was communicated through the experimental materials

Table 2 Task Differences

Dimension	Parking	Misconduct
Primary activity	Generate	Choose
Information provided	Low	High
Evaluation criteria	Generated by group	Provided
Impact of decision	On community	On two individuals

provided to subjects, as well as through the facilitators, who emphasized the intended spirit on several occasions to each group. Level of consensus was deemed to be controlled because the instructions communicated to group members emphasized that they had little discretion in how they chose to utilize the GSS structures. Facilitators were asked to ensure that groups follow the procedures specified, and were asked to discourage attempts to alter the way in which groups used the GSS. Thus, in this context, consensus was assumed to reflect the behavior of the individuals in the group in actually appropriating the technology, rather than their opinions about how the technology ought to have been appropriated.

3.4. Attitude and Outcome Measures

Attitude was considered to be the vehicle that reflected the stability of each group's appropriation process. The two attitude constructs defined by Poole and DeSanctis [27, 28], *level of comfort* and *degree of respect*, as operationalized by Sambamurthy [30], were measured. A third attitude variable incorporated by Sambamurthy [30] into the AST framework, *challenge*, was also measured.

While attitude is clearly a multidimensional construct, and is recognized as such by Poole and DeSanctis [27, 28], several other dimensions of attitude have been incorporated into IT research. Notable among these dimensions are Davis's [5] perceived usefulness and perceived ease of use, and Moore's [22] perceived characteristics of innovating. Both sets of attitudes have been drawn in large part from the work of Rogers [29]. As Davis's two dimensions are definitionally very close to the definitions of level of comfort and degree of respect, these dimensions were also measured, because of their more extensive use in the past, and to determine whether their scales did indeed converge with the two AST attitudes. Inspection of Moore's [22] perceived characteristics of innovating showed that most of these characteristics were either similar to Davis's formulations, or not appropriate to GSS. One exception that could be used to augment the attitudinal dimensions used by Sambamurthy [30] was perceived compatibility. Thus, the perceived compatibility scale constructed by Moore [22] was included. Definitions of all six attitude constructs are presented in Table 3.

The three outcome variables were measured by means of scales used in previous small group and GSS research [31, 32]. Perceived outcome quality was measured through the scale items proposed by Gouran, Brown, and Henry [17], while satisfaction with process and satisfaction with outcome were measured through scales contained in the questionnaire used by Green and Taber [18]. An objective measure

Table 3 Definitions and Reliability

Construct	Definition	AR
Level of comfort	A group's confidence and ease in use of system [30]	0.82
Degree of respect	The value groups place on the structures provided by a technology [30]	0.82
Challenge	Sense of accomplishment from technology use [30]	0.78
Perceived ease of use	Degree to which the use of a method is seen to be free of effort [5]	0.95
Perceived usefulness	Degree to which method is perceived to enhance one's performance [5]	0.94
Perceived compatibility	Degree to which method is perceived as consistent with one's existing values and past experiences [22]	0.92
Perceived outcome quality	How well or poorly a decision-making discussion is perceived [16]	0.91
Satisfaction with outcome	Members' satisfaction with group solution [18]	0.85
Satisfaction with process	Members' satisfaction with decision scheme used [18]	0.91

of outcome quality, based on the scores of expert judges, was also recorded, but was not included in the model because of unacceptably low inter-rater reliability [15]. As the tasks were designed to reflect actual organizational decision making where correct answers are rarely available, the value of the supposedly objective measure of quality was not considered to be any greater than the self-reported outcome measures that were included in the model.

Scores on each of the attitude and outcome variables were aggregated from their original scales. Each scale was analyzed for reliability by calculating Cronbach's [4] alpha. Reliability scores were calculated for each task, and then averaged to yield an average reliability score (labeled *AR* in Table 3). Nunnally's [24] recommendation concerning a threshold reliability score of $\alpha = 0.80$ was adopted to ascertain whether a scale could be considered reliable. The average reliability scores are also presented in Table 3. These scores indicate that all the measured variables fall within the threshold of reliability except challenge, which was close enough to the threshold to be considered marginally reliable.

3.5. Participants

The subjects for the study were 258 business school undergraduates drawn from different sections of an introductory management course. The subjects were divided into thirty-three groups, which varied in size from five to nine members. This variation in group size, in spite of a fixed planned size of nine, was unavoidable due to variations in attendance patterns. Diagnostic analysis revealed that this difference in group sizes did not significantly affect the results. However, the lack of difference due to group size does not necessarily suggest that such differences do not actually exist. Because the data analysis conducted was at group level, the relatively low sample size of thirty-three groups may have been inadequate to detect any differences had they existed. Power analysis revealed that for most of the variables in the model, the probability of finding differences based on group size, if they existed, was less than 35 percent. The highest power level observed was only 58 percent.

Most subjects had never used the GSS technology prior to the study. Approximately 12 percent of subjects using GroupSystems had previously used some form of GSS technology, while only 4 percent of OptionFinder subjects had experience with GSS technology. Approximately 3 percent of all subjects had used some form of GSS technology on more than one occasion. Subjects' experience with computers in general was considerably higher. On a seven-point Likert scale, a mean score of 4.41 was obtained for frequency of computer use.

3.6. Experimental Procedure

Each group was asked to complete both tasks using a single technology. The order of task presentation was completely balanced between groups. The two meetings for each group were separated by two weeks. Treatments were balanced by having half the groups start with the Parking Problem, and the other half with the Misconduct Case. All but two groups, whose results were discarded, used the same technology both times. Thus, 31 groups, 16 of which used OptionFinder while 15 used GroupSystems, were included in the final analysis. The groups consisted of 234 subjects that attended both group meetings.

At their first meeting, group members began by completing a questionnaire designed to collect background information on each subject. They were subsequently introduced to the technology they were to use by means of a practice task. This task, which called for subjects to identify and evaluate alternative uses of the material used in tea bags, involved all the steps that would be required to complete both experimental tasks. A short break followed the practice task, after which groups completed the first experimental task. Each subject filled out a questionnaire after the task was completed. At the second meeting, subjects proceeded directly to the experimental task, and completed the same questionnaire after completing the task. Groups spent an average time of 63.2 minutes on the experimental task at their first meeting, and an average of 57.9 minutes on the task at their second meeting.

All facilitators received prior training in the facilitation process, and were also trained in the use of each of the two technologies to the extent that they could explain how the tools could be used by the subjects, and could perform simple troubleshooting such as recovering after hardware or network failure. Facilitators were given instruction documents that identified their roles and responsibilities. These documents, while explicit, stopped short of scripting what each facilitator was expected to say. The reason for this omission was to allow facilitators the leeway necessary to interact in a natural manner with their groups. Facilitators were clearly instructed to help groups with the meeting *process*, including operation of the GSS technology, but to completely avoid any involvement in the *content* of the meeting. To ensure that facilitators adhered to this rule, subjects were asked, in their questionnaires, whether their facilitators had been neutral concerning the task content, and had only regulated the meeting process. Analysis of the results indicated no differences among the eight facilitators used on the control questions or on any of the other measured variables.

In an attempt to maximize experimental control, steps were taken to ensure that the procedures used were equivalent for both technologies. Thus, every step used in a GroupSystems meeting was paralleled in each OptionFinder meeting. Toward this end, a standard agenda was developed for each task. Barring specific task-based differences, each agenda involved problem definition, idea generation, idea evaluation, decision making, and decision recording. The amount of time spent on each phase also differed by task.

3.7. Two Forms of the Research Model

The research model discussed in the previous section is shown in figures 2, 4, and 6. This model, however, was considered appropriate only for a group's first meeting. However, due to the potential effect of learning and previous results, it was assumed that at the second group meeting, there could be two additional influences on attitude. These influences were prevailing attitude, operationalized by the attitude from the previous meeting, and expectations concerning outcomes, operationalized by outcomes from the previous meeting. The adjusted model for the second meeting is shown in figures 3, 5, and 7.

4. Results

GROUP MEETINGS WERE USED TO REPRESENT ALL THE MEASURED VARIABLES, because these rather than the individual scores were in keeping with the fundamental premise of AST that *groups* appropriate a GSS in different ways. The matrix of correlations between the measured variables and the two independent variables is presented in Table 4. For each of the two models developed in the previous section, three separate analyses were conducted. These analyses differed on the basis of the dimensions used to represent the attitude construct. The first analysis used all six attitude dimensions that were measured. The second analysis used the three AST dimensions used by Sambamurthy [30]. The third analysis used the two dimensions developed by Davis [5] and the dimension constructed by Moore [22]. The reason for conducting three

Table 4 Correlation Matrix

TECHNOLOGY	**.3**																			
TASK	.01	**.3**																		
LEVEL OF COMFORT (MTG 1)	.08	.19	**7.8**																	
LEVEL OF COMFORT (MTG 2)	.09	.00	*.49*	**9.5**																
DEGREE OF RESPECT (MTG 1)	.06	.05	*.67*	*.42*	**21.8**															
DEGREE OF RESPECT (MTG 2)	.03	.01	*.45*	*.64*	*.66*	**31.2**														
CHALLENGE (MTG 1)	.14	.01	*.49*	*.42*	*.57*	*.42*	**14.9**													
CHALLENGE (MTG 2)	.14	-.01	*.32*	*.66*	*.37*	*.56*	*.62*	**16.4**												
PERCEIVED EASE OF USE (MTG 1)	-.00	.08	*.63*	*.38*	*.47*	*.38*	*.29*	*.22*	**8.6**											
PERCEIVED EASE OF USE (MTG 2)	.10	-.00	*.43*	*.62*	*.44*	*.56*	*.38*	*.48*	*.54*	**12.0**										
PERCEIVED USEFULNESS (MTG 1)	.03	-.09	*.50*	*.40*	*.65*	*.52*	*.61*	*.45*	*.42*	*.43*	**45.1**									
PERCEIVED USEFULNESS (MTG 2)	.05	-.09	*.38*	*.59*	*.52*	*.71*	*.49*	*.63*	*.33*	*.54*	*.68*	**66.4**								
PERCEIVED COMPATIBILITY (MTG 1)	.04	-.02	*.50*	*.43*	*.61*	*.54*	*.51*	*.47*	*.31*	*.41*	*.65*	*.67*	**23.4**							
PERCEIVED COMPATIBILITY (MTG 2)	.00	-.04	*.32*	*.50*	*.47*	*.65*	*.43*	*.59*	*.30*	*.50*	*.58*	*.80*	*.72*	**35.6**						
PERCEIVED OUTCOME QUALITY (MTG 1)	.11	.18	*.46*	*.30*	*.43*	*.26*	*.60*	*.37*	*.29*	*.30*	*.40*	*.26*	*.37*	*.26*	**29.1**					
PERCEIVED OUTCOME QUALITY (MTG 2)	.10	-.02	.19	*.50*	.20	*.36*	*.32*	*.63*	*.22*	*.37*	*.25*	*.40*	*.27*	*.39*	*.34*	**37.5**				
SATISFACTION WITH OUTCOME (MTG 1)	.10	.20	*.38*	*.23*	*.35*	.21	*.52*	*.30*	*.23*	.20	*.30*	.15	*.22*	.14	*.73*	*.24*	**4.8**			
SATISFACTION WITH OUTCOME (MTG 2)	.11	-.10	.11	*.38*	.17	*.28*	*.24*	*.48*	.13	*.26*	.21	*.31*	.20	*.30*	*.25*	*.65*	*.30*	**7.3**		
SATISFACTION WITH PROCESS (MTG 1)	.11	*.27*	*.42*	*.28*	*.33*	*.22*	*.46*	*.30*	*.29*	*.27*	*.32*	.18	*.29*	.15	*.72*	*.30*	*.64*	.15	**7.0**	
SATISFACTION WITH PROCESS (MTG 2)	.09	-.04	*.23*	*.43*	*.25*	*.35*	*.35*	*.52*	*.23*	*.31*	*.29*	*.37*	*.31*	*.35*	*.38*	*.70*	*.30*	*.62*	*.38*	**12.9**

Italicized numeric entries indicate correlations significant at α=.001.
Diagonal entries represent variances.

separate analyses was to facilitate the comparison of results based on different operationalizations of attitude.

The causal modeling approach used to test the research model was partial least squares (PLS). PLS [20, 35] is a powerful method of analysis because of the minimal demands it places on measurement scales, sample size, and residual distributions. It is appropriate for use when theory is weak or tentative, or, as in this case, is untested in an application domain.

PLS is a latent structural equations modeling technique used to analyze research models that contain variables that are not directly observed, such as attitude and outcome. It is a component-based approach that is, at times, considered superior to the better-known factor-based covariance fitting approaches embodied in systems such as LISREL, EQS, COSAN, and EZPATH, because it avoids two problems: inadmissible solutions and factor indeterminacy [14]. PLS estimates the latent variables as exact linear combinations of the observed measures, thereby avoiding the indeterminacy problem and providing an exact definition of component scores. Using a fixed point estimation technique [34], PLS provides a general model that encompasses, among other techniques, canonical correlation, redundancy analysis, multiple regression, multivariate analysis of variance, and principal components. As a consequence of using an iterative algorithm consisting of a series of ordinary least squares analyses, identification is not a problem for recursive models, and no distributional form is presumed for measured variables. Furthermore, sample sizes can be as small as five times the number of items on the scale with the most items (six items, in the case of this study). In fact, Wold [36] provides the example of an extreme case in which ten cases are used to create a PLS model with two latent variables, in which there are twenty-seven exogenous variables and one endogenous variable, and which is shown to have predictive relevance.

The results of the PLS analysis for the first meeting, using all six attitude dimensions, are shown in figure 2. The multiple coefficients of determination (R^2) for the attitude and outcome constructs on all six analysis configurations (three sets of attitude dimensions on each of two meetings) are shown in Table 5. An R^2 value may be interpreted in a manner similar to the way it is in traditional regression analysis, as indicative of the proportion of variation in a variable that is explained by its relationship with the variables that are assumed to impact it. Also, as in traditional regression analysis, the R^2 value does not show causal direction. Rather, causal ordering is specified in the research model, and is based on theoretical expectations. The path coefficients can also be interpreted within a regression context. They are equivalent to the standardized beta weights in a multiple regression model. Using the blindfolding method of resampling, all paths in the model were found to be statistically significant at $\alpha = 0.01$.

Figure 2 indicates the existence of a strong causal link between attitude and outcome, as well as a moderately strong direct relationship between task and outcome. The other path coefficients in the model are weaker, and the low R^2 value associated with attitude indicates that task and technology account for little, if any, of the variation in attitude. However, over 50 percent of the variation in outcome is accounted for by attitude, task, and technology, with attitude clearly explaining the bulk of the variation.

Table 5 Multiple R^2 for Endogenous Constructs

	Attitudes used in analysis					
	All		AST		Non-AST	
Const.	Meeting 1	Meeting 2	Meeting 1	Meeting 2	Meeting 1	Meeting 2
Attitude	0.06	0.61	0.13	0.42	0.01	0.69
Outcome	0.50	0.15	0.54	0.22	0.41	0.09

The path model for the second meeting (see figure 3), however, shows a very different pattern from the first. Not surprisingly, a strong causal linkage exists between attitude during the first meeting and attitude during the second meeting. Interestingly, there is a reasonably strong *negative* relationship between the outcome at the previous meeting and the attitude at the second meeting. The paths from tasks to attitude and outcome are negligible, in contrast to the results at the first meeting. The paths from technology to attitude and outcome are also negligible, much like those during the first meeting. Inspection of the coefficients of determination shows that the mix of variables introduced to model the second meeting explain over 61 percent of the variability in attitude (considerably more than the first meeting), but explain significantly less of the variability in outcome (15 percent) than during the first meeting.

Inspection of the loadings of the six attitude dimensions on the attitude construct reveals the relatively poor association between ease of use and attitude, although the strength of the association is greater during the second meeting. This result suggests that ease of use may not be at the same level of specificity as the other dimensions, as it may be an antecedent construct, as modeled by Davis, Bagozzi, and Warshaw [6]. All three outcome variables load high on the outcome construct at both meetings.

The use of the attitude dimensions proposed in AST to represent the attitude construct provides slightly different, though interesting, results (see figures 4 and 5). Of special significance is the rearrangement of the path coefficients associated with task in the first meeting. The direct effect of task on outcome is somewhat reduced (compared to the use of all six attitude dimensions in figures 2 and 3), while the effect of task on attitude is considerably increased. Further, the percentage of explained variation in attitude is greater (13 percent).

During the second meeting there is a somewhat weaker link between previous attitude and current attitude, although the link is still very strong. The reduced strength of association is reflected in the multiple R^2 associated with attitude, which indicates that only 42 percent of the variation in attitude is explained, compared with 61 percent when all six attitudes are used. However, it is interesting to note that the link between attitude and outcome, although weaker than in the first meeting, is stronger when only the AST attitudes are used.

All the AST attitudes load well on the attitude construct during both meetings. The same is true for the loadings of the outcome variables on the outcome construct.

Finally, to facilitate comparison between the use of different attitude dimensions, figures 6 and 7 show the effects on the path coefficients of using the three attitude

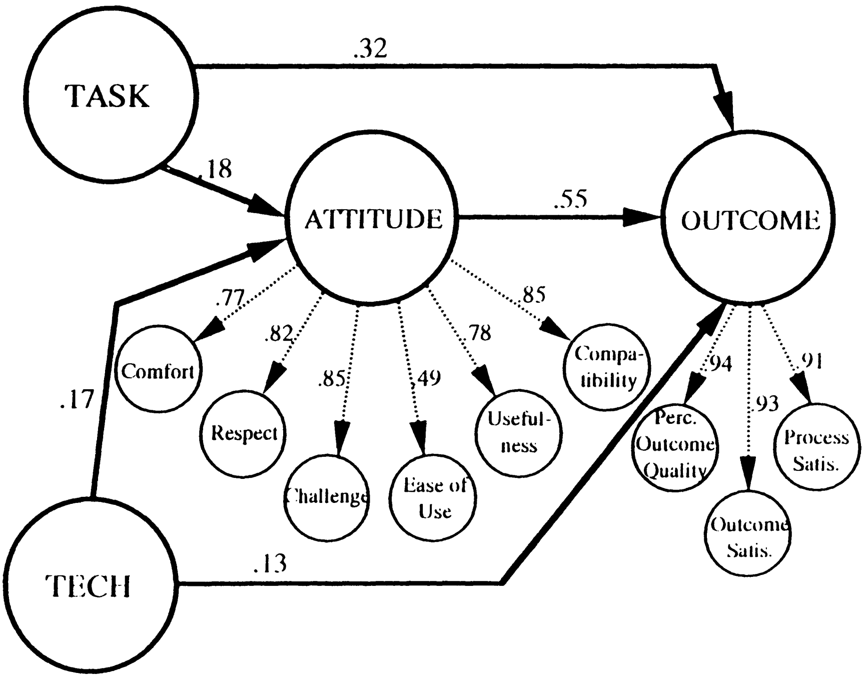

Figure 2. All Attitudes, Meeting 1

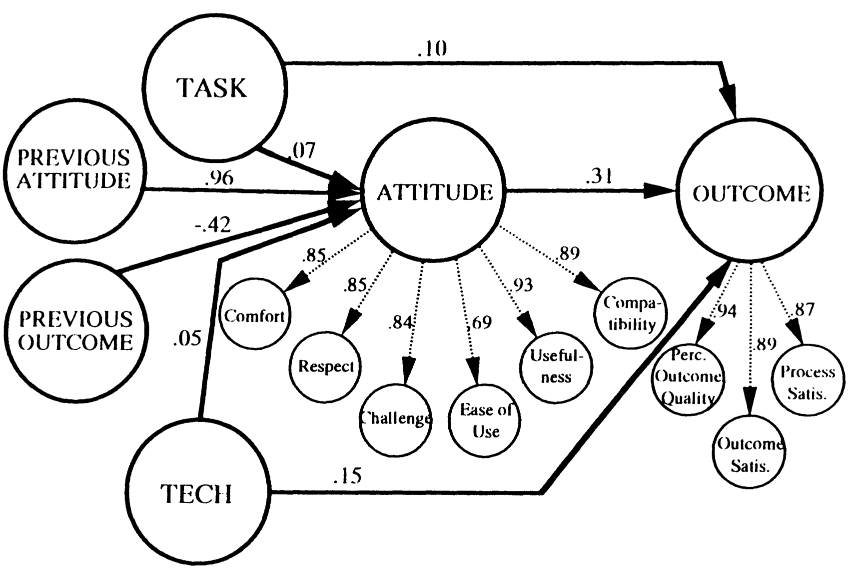

Figure 3. All Attitudes, Meeting 2

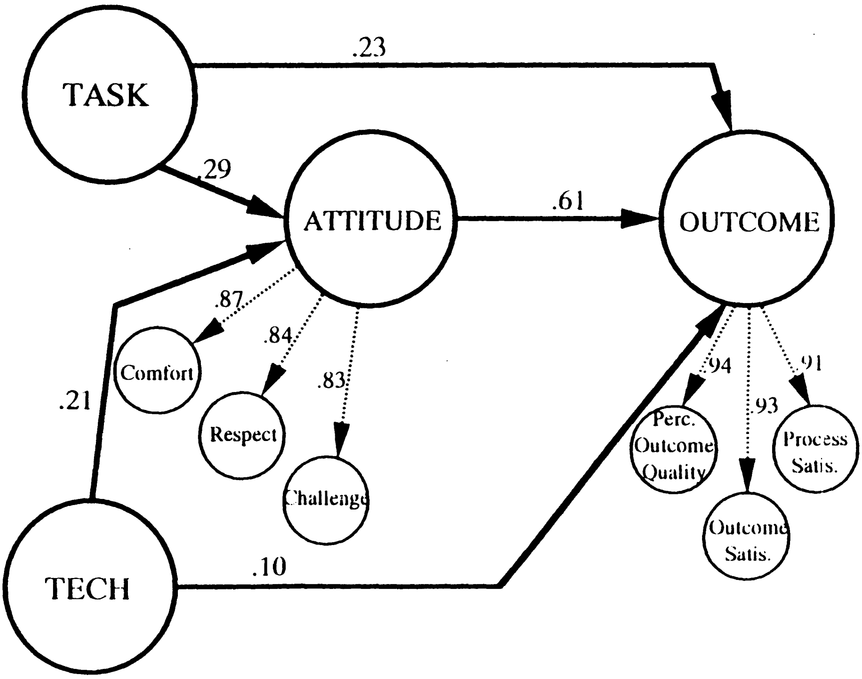

Figure 4. AST Attitudes, Meeting 1

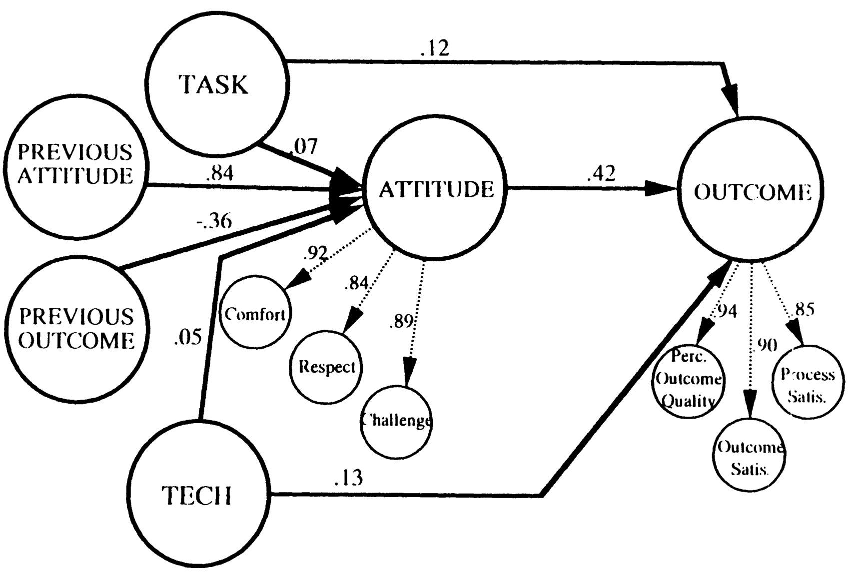

Figure 5. AST Attitudes, Meeting 2

formulations that are borrowed from previous IT literature. As expected, the major differences (compared to using only the AST attitude dimensions) during the first meeting are in the strengths of the path coefficients associated with task, and in the strength of association between attitude and outcome. During the second meeting, the primary differences are in the percentage of variation in attitude that is explained, and in the reduced strength of association between attitude and outcome.

It is interesting to note that perceived ease of use, as was noted in figures 4 and 5, loads relatively poorly on attitude during the first meeting, but has a considerably higher loading during the second meeting.

5. Implications of Results

SEVERAL FACTORS THAT ARE REFLECTED IN ALL THREE ANALYSES are worth noting. First, the sizable effect of previous attitude on current attitude during the second meeting, and the magnitude of the associated R^2, suggest that a major proportion of the attitudes that influence appropriation may be brought into a meeting by participants, in the form of preconceptions concerning the GSS and its associated processes, as well as attitudes formed through prior use. This possibility implies that a relatively smaller proportion of these attitudes is formed during the meeting.

In this study, attitudinal dimensions were not measured prior to the study. Consequently, attitudes that prevailed before the first meeting could not be entered in the model. However, if the hypothesis stated in the previous paragraph does indeed hold true, the relatively small proportion of variation in attitudes that is currently explained may well be increased considerably through the inclusion of prevailing attitude as an effect on current attitude.

Formulated in AST terms, this interpretation suggests that some participants enter a meeting "willing to believe" in the new process, while others are strongly skeptical at the outset. In large part, these attitudes guide the formation of their attitudes during the meeting, which affects stability of appropriation more than do differences in task and technology. The strong relationship between attitude and outcome suggests that stability of appropriation then has a strong effect on whether or not the intended effects of GSS use (i.e., positive outcomes) are achieved, especially during the first meeting.

Second, a smaller proportion of variation in outcome is explained during the second meeting than during the first. This finding appears to indicate that perceptions concerning outcomes may be strongly anchored in attitudes and tasks only during the first meeting. At this time, participants have little experience with the technology, and most of their cognitive effort is devoted to learning the technology and the process (the learning referred to here is considerably more complex than learning how to use the GroupSystems or OptionFinder software, as it involves learning about a way of conducting meetings with which the participants are not familiar). However, during the second meeting, experience with the new way of meeting may increase the effects of the specific behaviors promoted by the GSS, thereby decoupling attitudes and outcomes to some extent. This effect would appear to be consonant with the AST concept of reproduction of structures, wherein a GSS is incorporated into the group's

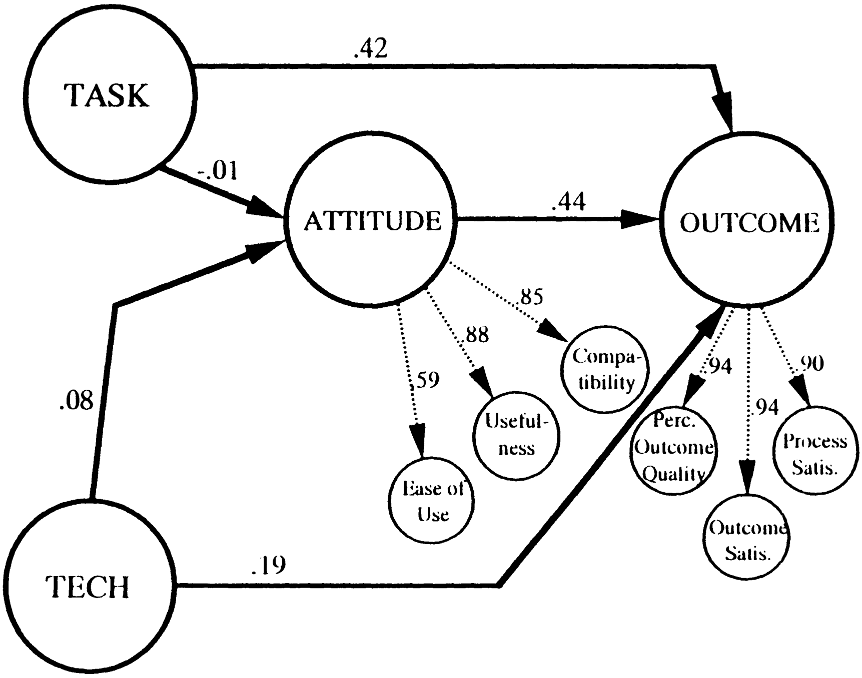

Figure 6. Non-AST Attitudes, Meeting 1

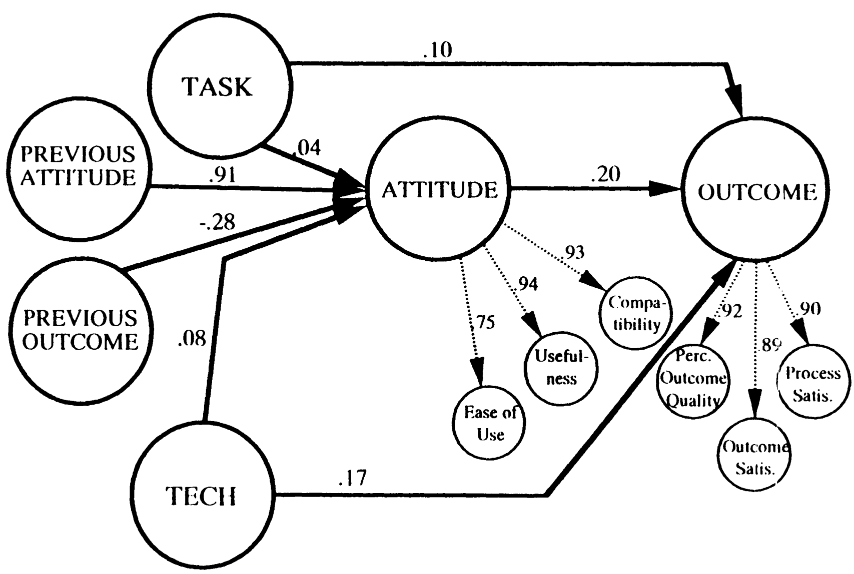

Figure 7. Non-AST Attitudes, Meeting 2

way of working. At this point, the outcomes of GSS use may depend more on the behaviors the GSS promotes than on people's attitudes toward the technology itself.

An alternative, though complementary, explanation for the reduced effect of attitude on outcome during the second meeting is that attitude does not fully represent stability of appropriation during the second meeting. Instead, faithfulness of appropriation, which was assumed to be controlled may come into play once participants understand the technology better. Indeed, several groups were observed to wrest control of their second meetings from their facilitators, and often deviated from the faithful use of the structures provided. For example, one group chose to avoid evaluating its final list of alternative solutions, and selected all the items on the list it had generated as elements of the final solution. Another group used a show of hands to decide the final list of selected alternatives, rather than the more anonymous and efficient method made available through the technology. Thus, even though attitudes may have been positive during the second meeting, their effect on outcome may have been limited by the negative effect of *ironic* appropriations [28].

Third, the limited effects of technology and, to some extent, task on attitude may have been an artifact of the experimental conditions, spawned in part by the quest for rigor in experimental research. In order to factor out the effects of all but the relevant dimensions of task and technology, the processes created for both technologies and, to a large extent, for both tasks, were exactly alike. Thus, if a process was used for a GroupSystems meeting, it was also used for an OptionFinder meeting. However, the structural feature that enabled the process may have differed. For example, on the Parking Problem, all participants generated alternative solutions. GroupSystems supported this activity by allowing participants to enter ideas through their keyboards, while OptionFinder required participants to voice their ideas for the facilitator to enter.

It is conceivable that the similarities in processes may have obscured the differences between technologies, characterized by their different delivery mechanisms for structural features. Similarly, the fact that the two tasks called for participants to follow essentially the same procedures may have reduced the "distance" between the tasks. However, key differences, such as the greater structure in the Misconduct Case, may have contributed to the minor task-based effects that were observed.

This finding points to an important possibility. While Poole and DeSanctis [28] expect different GSS designs to result in differences in appropriation, it may be more appropriate to reformulate the design differences as differences in *process* design. Thus, the collection of structures used, which may be similar between different technologies (e.g., both technologies used rating scales), may be more important than the specific structural sources that deliver these structures (e.g., one GSS provides idea generation through keyboard entry by each participant, while another GSS calls for verbal idea generation). It appears, therefore, that even though two GSS are designed differently, it is possible to equate the stability of their appropriations by designing the process of their use similarly. Alternatively, the same GSS, given exactly similar contextual conditions such as task and setting, may be appropriated differently if the processes of their use are dissimilarly designed. Intuitive verification of this conclusion may be found by comparing the results of well-planned and poorly planned meetings.

The final factor reflected in all three analyses was the negative path coefficients between outcome at the first meeting and attitude at the second meeting. There is no clear explanation for this result. In view of the values of the other path coefficients and the expectations stated in a previous section, this result is counterintuitive. One possible, though admittedly far-fetched, reason for this finding has to do with the locus of causality associated with the outcome construct. It is conceivable that groups that perceived their first outcome as positive attributed their success to themselves, rather than to the manner in which they were empowered by the GSS. Therefore, they might have felt that the technology did not really help. Consequently, their attitude toward the GSS at the second meeting was lower than at the first. Indeed, it is possible that these groups were influenced by individuals who had, at the first meeting, started with a less than positive attitude toward the GSS.

On the other hand, groups that did not have very high opinions concerning the outcomes of their first meetings may have felt that they, as a group, had failed to use the GSS appropriately, thereby resulting in their willingness to give the GSS a second chance. Thus, their attitudes the second time around differed from their perceptions concerning the previous outcome. While the plausibility of this explanation is certainly questionable, it reflects the fact that groups' final outcomes were developed and written *after* they had completed interacting with the GSS. Thus, it is possible that they viewed their outcome as a product of the group interaction that was separate from their interaction with the technology.

The use of three different sets of attitude dimensions in the causal analysis provided interesting results. First, using only the attitudes associated with AST provided some of the strongest causal linkages and multiple R^2 values. Analysis using these attitudes indicated the existence of a link between task and attitude during the first meeting, which would be consistent with the expectations of AST. The variation in attitude explained by differences in task and technology in the first meeting was the highest, although the absolute value of the multiple R^2 was relatively low (13 percent).

These patterns suggest that the attitude dimensions proposed in AST [27, 28, 30] do indeed reflect appropriation patterns better than attitude dimensions borrowed from other IT literature. However, certain paths on which the AST dimensions performed comparatively poorly should be noted. One such path is the link between attitude in the first meeting and attitude during the second meeting (see figures 3, 5, and 7). Clearly, the linkages are strong using all three attitude formulations, but appear to be significantly stronger when perceptions concerning ease of use, usefulness, and compatibility are included in the model, especially when they are used in conjunction with the AST dimensions. The multiple R^2 values associated with attitude during the second meeting show that a greater proportion of variance is explained with the inclusion of the additional attitudes.

At the same time, the use of these three dimensions considerably reduces the explanatory power of attitude as a predictor of outcome in both meetings. These findings suggest an interesting and potentially important implication. The AST dimensions appear to best reflect the formation of attitudes *during* a meeting. On the other hand, there might be a different set of attitude dimensions that come into play prior to the meeting, when participants have not actually used a GSS, but have started to develop opinions about it based on what they have heard. These prior dimensions could have an important influence on attitudes during a meeting, and therefore should be investigated further.

Given the nature of the six attitude dimensions, and the fact that perceived ease of use loaded poorly on attitude, it is possible to conclude that, *prior to* a meeting, the important dimensions are perceived usefulness and perceived compatibility, which have to do with *on the job* expectations of the GSS. *During* the meeting, the important dimensions appear to be comfort, respect, and challenge, which deal with the actual perceived performance of the GSS during the actual meeting.

A second finding of interest is that use of the AST dimensions appears to dampen the direct effect of task on outcome during the first meeting, while simultaneously accentuating the effect of task on attitude. These results seem consistent with the previous conclusion, that AST attitudes appear more salient to the meeting process, while perceived usefulness and perceived compatibility appear more directly applicable to job performance.

One other result of the analyses merits attention. There appears to be a notable difference among the reliability scores associated with the AST dimensions and the other three attitude variables. The AST attitudes appear to be at the threshold of acceptable reliability, while the other attitudes, as well as the outcome variables, have higher scores. Had the two sets of attitudes overlapped, there would have been a case for the use of one or more of the other three attitude scales to represent the AST dimensions. However, because the two sets of attitudes seem to tap into different constructs, it is important to develop the scales further, and test them both for reliability and validity. In fact, inspection of the items associated with challenge appears to suggest the existence of two different constructs (sense of accomplishment after the meeting, and degree of challenge posed by the GSS during the meeting).

6. Conclusions

THE RESULTS DISCUSSED IN THE PREVIOUS SECTION POINT TO TWO CONCLUSIONS concerning the use of AST as a theoretical foundation for research in GSS. First, based on the limited testing of the theoretical assertions in AST via the research model developed for this study, it appears that AST does indeed provide a convincing description of GSS process.

The fact that the path coefficients often fell short of achieving magnitudes that clearly supported AST can be attributed to shortcomings in the study and the research model, rather than in AST. One shortcoming was that attitudes prior to the first meeting were not measured, thereby precluding the possibility of establishing baseline measures. Another shortcoming was that modes of appropriation other than attitude were assumed to be controlled, whereas in fact they may well have varied, as evidenced in the relative independence exhibited by groups during their second meetings.

The second conclusion is that, because GSS process appears to be influenced by attitudes prevailing prior to use, other theoretical explanations of GSS use may be needed to complement AST. These descriptions should address the effects of influences external to the process of group work. Promising theories in this respect are Rogers's [29] work concerning organizational diffusion of innovations such as GSS, and the theory of reasoned action [13], which focuses on the effects of attitudes, intentions, behavior, and peer influences. Both theoretical perspectives have already been incorporated in other IT areas [1, 5, 22], and their incorporation in the GSS domain should be relatively straightforward.

The very availability of a theoretical framework such as AST within which GSS research can be couched has two important implications beyond the mere legitimization of the field through the application of theory. First, it provides researchers with a viable means of opening the black box of GSS process and understanding the complexities of interaction between technology, groups, and tasks that make the varied outcomes of GSS use so hard to understand. Toward this end, DeSanctis and Poole [9] have developed a means of coding and modeling GSS use, which is viewed as an appropriation process.

A related advantage is that researchers can use AST to model the process of GSS use within the specific contexts of interest to them. An example of such a use of AST is presented in this paper. AST was used to frame the investigation of the roles of differences in task and technology in GSS use, and to develop an appropriate research model.

Second, it is the opinion of the authors that the true value of the structuration approach will be seen in the years to come, as GSS moves out of the synchronous meeting environment into an "any time, any place" mode of operation. Beyond explaining how a GSS is used in a meeting environment, the structuration approach will help us understand how the power of technology and group interaction can empower organizations and their members in innovative new ways.

A limitation associated with the PLS method bears mention, even though the method provides a powerful means of investigating the causal linkages between constructs. The value of PLS use is dependent on the correct specification of the causal model. The path coefficients may be considered artifacts of the constructs and linkages specified. In the event that the model is incorrectly specified, confidence in the coefficients may be considerably reduced. The model specified in this paper is assumed to be representative of the process of GSS use, especially considering that it is altered to incorporate additional constructs during the second meeting. However, considerably more testing of the research model is necessary before confidence can be expressed in it. Also, there appears to be a case for the inclusion of prevailing attitude as an influence on attitudes formed during the first meeting. Further, the model does not acknowledge the influence of variables external to the experiment, such as classroom interaction among subjects. Thus, the results of the foregoing analysis should be interpreted with caution.

Another issue that deserves consideration is that of the external validity of the study. The use of student subjects and contrived tasks are certainly causes for concern with respect to the generalizability of the study's results. However, the negative effects of these factors were mitigated in two ways. First, the tasks used were of direct relevance to the subject population. Consequently, a measure of problem domain understanding existed, as might be expected of groups tackling real managerial tasks. Second, subjects were provided with performance incentives, in the form of cash awards. These incentives were expected to raise the motivation level of subjects to perform the tasks as real managers would (though such motivation would admittedly fall short of what might be observed among real managers). Thus, efforts were made to avoid compromising the external validity of the study, even though experimental studies, by their very nature, sacrifice some external validity for increased control.

There are several implications for future research, many of which have already been mentioned in the paper. Two other implications deserve attention. First, attitudes clearly play an important part in GSS use, both during the process of use, and in the context of this process. For organizational members to *adopt* a GSS in their work environments, they must have attitudes toward it that promote such adoption. The attitudes proposed in AST, and the other attitudes measured in this study, provide a useful starting point for the investigation of the role of attitudes in GSS. However, a wider range of attitudes should be identified and studied in the AST context, in order to identify the specific attitudes that can be manipulated or influenced to promote GSS adoption in organizations. It is encouraging to note that efforts in this area have already been initiated [37].

Second, there appears to be a strong case for the study of GSS in a longitudinal mode. The value of this form of research is implied by the results of this study, which show that effects of certain variables appear to differ from the first to the second meeting. The importance of studying GSS in this manner is also suggested by the fact that groups often need more than a single exposure to the technology to start incorporating the new methods into the way they normally work, and by the fact that real groups are ongoing, and can rarely be completely characterized by their behavior at a single meeting.

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