

Predicting Strength of Consensus in Small Groups

by

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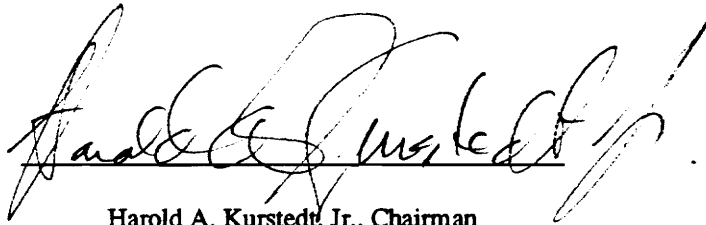
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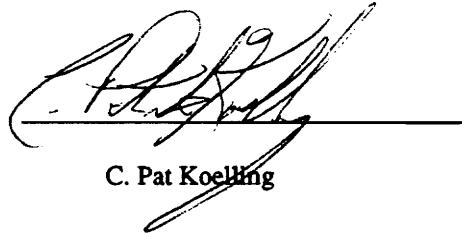
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Industrial and Systems Engineering

(ABSTRACT)

This study was conducted to determine if the strength of consensus in small groups could be predicted from group members' perceptions of information usefulness and shared understanding. Eight groups of five and two groups of four subjects participated in a group consensus exercise designed to allow mathematical measurement of the consensus achieved. The subjects also completed questionnaires designed to measure their perceptions of information usefulness, shared understanding, and strength of consensus. The findings of this study suggest that shared understanding is a strong predictor of the strength of consensus while information usefulness is only slightly predictive.

This study is the first step toward development of management tools to measure consensus in small groups when no mathematical algorithm is possible. The goal of this and further research is to provide managers with a way to know how strongly workers support actions they have agreed to take in order to make participatory management more effective. Tools such as these can also be used in the public policy arena. When groups of concerned citizens are brought together, these tools can be used to see if the consensus achieved is really representative of everyone's views.

Acknowledgments

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INTRODUCTION

Problem Statement

With this research I aim to characterize and study two constructs, individuals' perceptions of information usefulness and shared understanding, and to investigate the effect they have on strength of consensus in small group interaction.

Relevance of the Study

Many different aspects of consensus have been researched, yet few measurements of the construct have been developed. I have only found one perceived consensus measurement instrument *for decisions not yielding a ranked list* (Knutson & Holdridge, 1974). Today, most management decisions do not require ranking alternatives. Examples of other types of decisions include resource allocation, alternative selection, and compliance decisions. To gain acceptance, agreement, and a willingness to help implement decisions, managers need to involve stakeholders in decision making. Knutson's instrument doesn't include all the constructs I believe affect consensus. His instrument was specific to his study exploring the relationship between group orientation and consensus. With my research, I hypothesize that the constructs of perceived information usefulness and perceived shared understanding have a positive effect on an individual's perceived strength of consensus. I hope to develop the instruments I've designed for this study to the point where a manager can use the questions to determine what is necessary to strengthen consensus (either

provide more information or change the process to increase perceived shared understanding). (I leave determination of how to do this for future research.) I include a more detailed review of the literature relating to the background and relevance of my study in Appendix A.

One of the major premises of my research is that the level of perceived information usefulness and perceived shared understanding predict consensus strength. I investigate the nature of this relationship so managers responsible for bringing consensus groups together can know how to evaluate and change the two variables I investigated to affect the strength of consensus. Someday, I hope to provide managers with tools, composed of questions modified from this study, to predict and measure the strength of consensus in small groups. (This paragraph summarizes the research questions, purpose, and objective. The full text is in Appendix B.)

Premises/Delimitations

The important premises/delimitations in my research deal with implications related to how I've defined the variables representing my constructs, and the process my subjects went through. The premises/delimitations are:

For this research, consensus is considered a state, not a process.

Consensus is not a binary state; there exist degrees of strength.

The strength of consensus can't be measured directly and is not independent of participants' feelings. Because consensus strength is closely linked with how people feel, perceived strength of consensus is as important as an independent measure of consensus strength.

Although many factors influence consensus, I considered two in this research; perceived shared understanding and perceived information usefulness.

I consider facilitation a moderating variable and didn't consider its effects with this research. No formal facilitation was provided to the groups.

A group consists of two or more people.

Some type of group interaction is necessary for consensus.

My research focused on specific consensus decisions, not general societal or organizational consensus.

Any effects of the task problem were held constant over all groups by having all groups solve the same problem.

I minimized the effect of participants' differing cognitive styles by randomly assigning subjects to groups.

Research Assumptions

The assumptions I made for this research deal mainly with relationships which have not been proven, but which are necessary to assume in order to delimit this research into something manageable. I made assumptions about my variables and the conditions under which I conducted my experiment. The research assumptions are:

Although there are many attributes of perceived information usefulness, investigating two main attributes, importance and usability, was sufficient to investigate my hypotheses.

Although there are many attributes of shared understanding, investigating two main attributes, constructive controversy and the ability of group members to express their individual views, was sufficient to investigate my hypotheses.

Individual perceptions of information usefulness contain enough variation so manipulating the usefulness of the information provided to different groups was not necessary to investigate the hypothesized relationship between information usefulness and consensus strength.

Individual perceptions of shared understanding contain enough variation so manipulating discussion in different groups wasn't necessary to investigate the hypothesized relationship between perceived shared understanding and consensus strength.

A non-facilitated group can achieve consensus.

Decision environment did not affect the results of this research because it affected all groups equally. (It may, however, affect the generalizability of the results.)

Conceptual Model

Figure 1 places my conceptual model within Management Systems Laboratories' conceptual model for the grant funding this research.

The grant conceptual model consists of six parts; precipitator, problem, purpose, participation, people, process and product. The **precipitator** is what motivates the convener to call a meeting; the issue at hand; the issue to be solved or avoided. You must understand the characteristics of the issue you need to solve before you can decide what to do next. The order of the next four parts of the model depend on the precipitator characteristics. You must decide the **purpose** of bringing a group together. The purpose is what you want the output/outcome of the meeting to be. Do you want a recommendation, a report, actions carried out or do you simply want the group members to feel involved? You must also decide what type of **participation** you want. Participation is the type of involvement you want the group members to have in solving the problem. Do you want consensus? Do you want individual viewpoints? Are you only sharing information? Vroom's (1973) decision process flow chart is an example of a taxonomy for choosing the type of participation you want. You must determine what

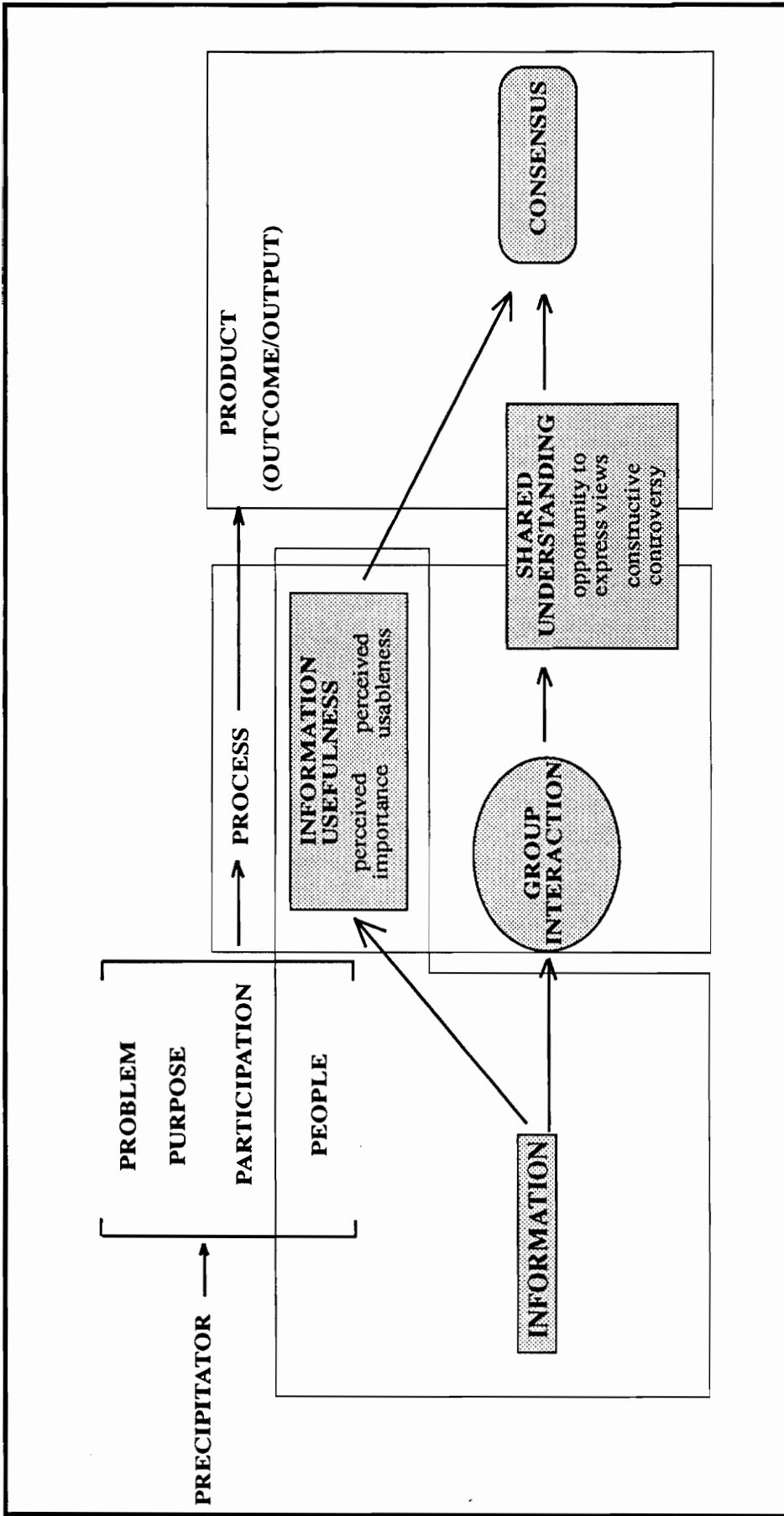


Figure 1. My conceptual model applied to the grant's conceptual model.

people you want to participate. Participants in decision making should be the stakeholders in the issue being discussed. Other people include facilitators, moderators, information suppliers and/or experts. Finally, you must choose the **problem** or task; what you want the people to do to accomplish your purpose. Once these first five parts have been determined, you are ready to determine a **process**. The process is the way the participation will be coordinated to support the purpose with the people chosen to solve the problem to resolve the issue. There are many different group processes for facilitating meetings for many different types of participation. The final part of the model is the **product**. The product can be either an outcome, an output, or both. An output is something tangible like a report, a decision or a proposal. An outcome is not easily measured. Outcomes can include consensus, decision quality, acceptance, shared understanding among the participants, etc.

My research focused on consensus as the desired outcome. In the summer of 1989, an MSL team did historical research to determine what was important to successful consensus decisions. They prepared a document called *Consensus Case Studies*. My conceptual model reflects the findings of this study: the most influential factors on a successful consensus were shared understanding, information, and a strong facilitator. **Shared understanding** is an outcome of group interaction in which all participants understand the positions and values each individual brings to the group. **Information** is an input to group interaction brought by the convener, experts, or other group members offering independent testimony. The **facilitator** is another input to group interaction that I consider a moderating variable. The facilitator influences group interaction so the members will make the best use of the information provided and develop shared understanding to make the consensus stronger. In this research, I concentrated on

showing the relationship between consensus and the constructs of information usefulness and shared understanding. Once this relationship is demonstrated, managers can investigate the strength of consensus by looking at perceived information usefulness and perceived shared understanding.

My specific conceptual model fits into the grant conceptual model in the following way. Information is an input having characteristics of perceived importance and perceived usability. I believe information affects the strength of consensus through group interaction. Perceived information importance and usability [two characteristics of perceived information usefulness (Larker and Lessig, 1980)] will determine if the group can discuss the problem to the point of reaching consensus. If the information input to the group is not useful, the only consensus worth achieving will be a consensus not to make a decision until appropriate information is available. Information comes to the group through people; either the people directly involved, the convener, or people not directly involved (possibly experts). The perceived importance and usability of the information are determined by the participants during group interaction. There are other inputs such as cognitive style, decision environment, task characteristics, and facilitation which I didn't consider. (They are addressed in the premises and assumptions.) These inputs lead to group interaction fitting under the process component in the grant conceptual model. Within this process, controversy needs to be resolved in a constructive way and each group member must feel they have freedom to express their individual views to persuade others. Group interaction leads to a quasi-outcome of shared understanding. (In this model I refer to shared understanding as a quasi-outcome because, while it could be the final outcome in a different situation, in this case the final

desired outcome is consensus.) Consensus fits under product (product being either an outcome or an output).

Sub-problems

According to Leedy (1985), sub-problems are a way to break the problem statement into researchable units. The sub-problems must add up to the totality of the problem statement and can include nothing extra. The sub-problems should be in the form of questions and, if the problem statement is written correctly, will number between two and six. My sub-problems are:

What are some of the distinctive characteristics of information usefulness which may affect consensus in small groups?

What are some of the distinctive characteristics of shared understanding which may affect consensus in small groups?

What is the relationship between perceived information usefulness, perceived shared understanding, and consensus?

Will a combination of questions based on perceived information usefulness and perceived shared understanding predict the strength of consensus?

Outputs

An output is a tangible product of the research effort. There were a number of outputs from my research which can prompt further research. The outputs were:

A better understanding of information characteristics crucial to consensus in small groups and a list of questions to measure how they affect consensus. (I explain in my literature review what information characteristics affect consensus. The questions I used to measure the effect of information on strength of consensus are given in the first section of the questionnaire in Appendix C.)

An understanding of what leads to or enhances shared understanding in small groups and a list of questions to measure their relationship with consensus. (I explain in my literature review how shared understanding affects consensus. The questions I used to measure the effect of perceived shared understanding on strength of consensus are given in the second section of the questionnaire in Appendix C.)

A determination of the relationship between perceived information usefulness, perceived shared understanding, and strength of consensus. (This output is given in the results section where I discuss my findings that perceived shared understanding had a significant effect on strength of consensus but perceived information usefulness didn't.)

An instrument to predict strength of consensus based on the constructs of perceived information usefulness and perceived shared understanding. (This instrument is the one I used for this study and can be found in Appendix C.)

Research Hypotheses

The research hypotheses are general statements about the relationships I investigated.

The research hypotheses are not meant to be testable, they serve as a reference point around which the research is oriented in searching for relevant data (Leedy, 1985). My research hypotheses are:

The greater an individual's perception of shared understanding among participants in a group process the greater an individual's perceived strength of consensus produced as an outcome will be.

An increase in an individual's perception of information usefulness affects group interaction positively, thereby indirectly increasing an individual's perceived strength of consensus produced as an outcome.

Perceived information usefulness and perceived shared understanding, together, affect the strength of consensus to a greater degree than either alone.

LITERATURE REVIEW

The literature on consensus is very broad, reflecting numerous ways the construct has been defined. Consensus has also been researched many different ways depending on how it is defined. In this research effort, I also define consensus and design my research around my definition. In this section, I present a review of the literature which is specific to my conceptual model and my definition of consensus. A more general review of the literature related to the broader context of consensus is given in Appendix A.

Consensus

The literature on consensus can be classified into two major categories. The first category, macro-consensus, deals with the politics of society. Sociologists like Schelling, Durkheim and Dewey are prominent in the first category (Scheff, 1984). The second category, micro-consensus, deals with consensus between individuals and on the small-group level. Within micro-level consensus, the term has been used to refer to both an ideal situation in groups (state) and the ideal means to achieve group goals (process) (Dess & Origer, 1987, Gentry, 1984, Rawlins, 1984). Authors like Holder (1972), Janis (1972), Hare (1980), Gentry (1984), Rawlins (1984), and Tjosvold and Field (1985) have researched consensus as a group process issue. They've looked at consensus as a process to achieve group goals. Numerous other authors have defined consensus as a group decision, attitude and/or action. I considered this subcategory of the literature, consensus defined as a state, for this thesis. Within this subcategory there are two further issues I dealt with. These were 1) how consensus has been defined within this subcategory and

2) how consensus has been operationalized and measured within this subcategory. Figure 2 outlines the body of knowledge on consensus and where my research fits.

Consensus has been defined in many different ways. Most include some form of agreement. Kaprzyk and Fedrizzi (1988) define consensus relating to the influence of the most dynamic group members. Some researchers include expression of views and acceptance of the decision (English & English, 1958, Tjosvold & Field, 1985, Wood, 1985). Others define consensus as some form of agreement among a critical number of group members (Beck & Lin, 1983, DeStephen, 1983, Holder, 1972, Price, 1972, Scheff, 1984) while some deem it necessary for there to be unanimity among all group members before consensus is possible (Hirokawa, 1985, Knutson & Holdridge, 1974, Rawlins, 1985). A list of consensus definitions found in the literature is given in Appendix D.

I was interested in researching what is consensus, how do we know when we have it, and how do we know how strong it is? The need to study consensus isn't new. Consensus was the main concept in a 1921 book by Park and Burgess (Scheff, 1984). In 1958, Gross et al. suggested that sociologists transform consensus into a variable to study the degree to which it occurs. Yet, over thirty years later no clear definition of consensus or operationalization of consensus exists in the literature.

I participated in a research effort to determine what variables are crucial for a successful consensus. We defined successful consensus as a combination of two things. One, the quality of the consensus decision, which, through hindsight, has been historically judged as high or low. Two, the strength of the consensus which we determined as a function of the extent the participants to the decision supported it, whether the results were good or

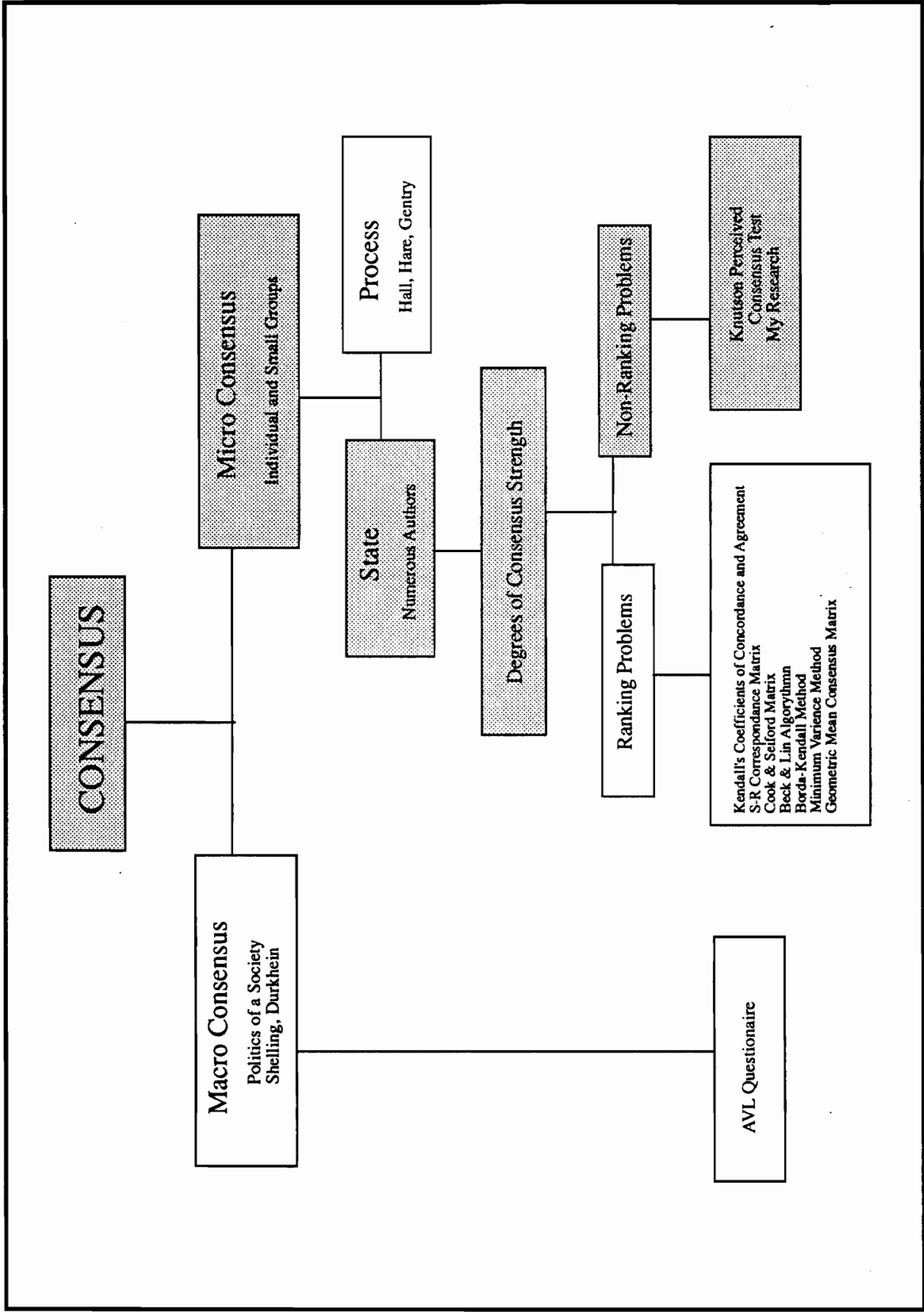


Figure 2. The existing consensus literature and where my research contributes.

bad. We found three common variables in successful consensus decisions: information, shared understanding, and a strong facilitator (Doss, Brubaker, & Kurstedt, 1990). I wanted to build on this by considering the effects of information and shared understanding on the strength of consensus. I didn't consider facilitation because, while I think it is necessary for a successful consensus, I don't think it is necessary for a strong consensus. (Successful consensus includes a quality decision as well as strength of consensus.)

Information Characteristics

In his review of information characteristics important to usefulness, Hill (1989) found that the most common attributes of information studied have been accuracy, timeliness, and relevance. In this research, I controlled for timeliness and investigated the other two. The construct of information usefulness refers to "the usefulness attributed to an information item by a decision maker for a specific decision making process" (Larker & Lessig, 1980, p. 122). Estes (1968) and Chandra (1974) used three and five point scales to have people rate the usefulness of different information sets. A different way to measure usefulness was suggested by Swanson (1974) who used a 16-item instrument to measure characteristics of usefulness. Gallagher (1974) did the same with a 15-item instrument. Larker and Lessig (1980) developed a measurement instrument for the other two attributes. Combined, they refer to the attributes as information usefulness and individually refer to them as information importance and usability. I considered the effects of importance (relevance) and usability (accuracy) on consensus.

Cognitive style and decision environment are two other variables affecting the usefulness of information. Many studies have shown that people with different cognitive styles prefer different information (Grochow, 1973, Killman & Mitroff, 1976, Mock, 1973, Zmud, 1979). Gorry and Scott-Morton (1971) set up a framework of decision environments and argued that the information requirements were different for each environment. I limited the effects of these variables by randomly assigning subjects to groups and keeping the decision environment constant across groups.

Shared Understanding

I was concerned with two attributes of shared understanding: constructive controversy (a type of conflict) and opportunity to express views. Conflict exists when incompatible activities occur (Deutsch, 1980). There are two kinds of conflict: controversy and conflict of interests. Controversy occurs when "one person's ideas, opinions, conclusions, theories, and information are incompatible with another's when they discuss problems and make decisions" (Tjosvold, 1985). Conflict of interest occurs when the actions of one person prevent, block, or interfere with the interests of another (Deutsch, 1973). Conflict of interest is present in labor-management negotiations where labor's demands for higher wages interfere with management's interest in reducing costs and staying profitable. The difference in input between conflict of interest and controversy is that, in conflict of interest, people have different goals while in controversy it is possible for two people to have the same goals but disagree about the right course of action. The difference in output is that conflict of interest is usually resolved through negotiation and compromise not completely satisfying any of the participants, while controversy is resolved with a decision often more effective for all (Tjosvold, 1985).

Measures of Consensus

Knutsen, Lee, and Danes Instrument. In 1973, Knutson, Lee, and Danes constructed a Perceived Consensus Test consisting of six questions (Knutson & Holdridge, 1974). The following items, measured on a 7-point scale from completely agree to completely disagree, are supposed to "contribute to the identification of differences in perceived consensus between agreement and non-agreement groups" (Knutson & Holdridge, 1974).

1. Your group reached moderate agreement on the topic you were discussing.
2. There was a relatively warm, easy going atmosphere during your discussion.
3. Even if you had continued, your group probably would not have reached agreement on the topic you were discussing.
4. In general, the members in your group discussed the topic in an understanding and orderly manner.
5. Most of the members in your group did not make any helpful suggestions on the topic you were discussing.
6. Some of the participants in your group discussion were more close-minded and opinionated than open-minded and non-opinionated.

I believe this instrument is too narrow in scope. It doesn't consider the construct of information nor does it completely cover the construct of shared understanding. While it may have been able to distinguish between non-agreement and agreement groups, I don't think it can be used to measure differing strength of consensus. I wanted to build upon

this instrument to create a better one I could use to show the relationship of perceived information usefulness and perceived shared understanding with strength of consensus.

Hall's Exercise. Hall developed an exercise he called the "Lost on the Moon Exercise" (Hall & Watson, 1970). In it he outlined a scenario where the group using the exercise imagines they are the crew of a space ship that has crash landed on the moon. The crew has 15 items left from the crash and has to use them to get to the main space ship. The participants in this exercise are instructed to rank the 15 items in order of importance for survival during the trip across the moon. After this is done individually, the group is instructed to come to a consensus ranking. Hall used this consensus ranking to measure the quality of the consensus decision by comparing it to the theoretically correct answer supplied by NASA. He showed that groups making consensus decisions came to higher quality decisions than the average individual can make alone.

Tjosvold (1983) used Hall's exercise and had the group members do individual rankings after they had supplied him with their consensus ranking. He then used the difference between each individual ranking and the group consensus as a measure of individual commitment to the group decision. I used this method and called the measure individual agreement with the group decision. I used this as a measure for strength of consensus on an individual basis.

Allport, Vernon, Lindzey Questionnaire. In 1960, Allport, Vernon and Lindzey published a *Manual for the Study of Values* in which they developed an instrument for the measurement of values among a group of people. This instrument has since been named for them. The questionnaire is designed so there is a total of 240 points

distributed by the person filling out the questionnaire over six value categories (theoretical, social, economic, aesthetic, political and religious). The difference between these distributions is used to measure the person's relative values and compare them to the values of the other participants. Between 1960 and 1964, Tagiuri used the Allport, Vernon, Lindzey questionnaire to measure the amount of difference in value orientation of 995 American businessmen, research managers, and scientists attending various classes at Harvard University. He computed means and standard deviations for each of the six values for the three groups. In 1972, Price, in his book *Handbook of Organizational Measurement*, used this study by Tagiuri as a measurement of consensus. Tagiuri's study was used as an example of how consensus in an organization could be measured. Price considers Tagiuri's differences in values as corresponding to consensus and uses standard deviations from Tagiuri's measurements as a measure of consensus. The smaller the standard deviations for each of the six values on the Allport, Vernon, Lindzey questionnaire, the greater the consensus of the organization (Price, 1972).

DeStephen's Questionnaire. In 1983, DeStephen measured consensus in groups to classify them as either high or low consensus groups and to determine if there is any significant interaction differences between the two classes of groups. He used the following four questions to classify the groups as either high or low consensus groups.

1. To what degree do you support the group's solution to the problem you investigated?
2. To what degree do you support the group's selection of the problem you investigated?

3. How satisfied were you with the division of labor in completing your group project?
4. In general, how satisfied are you with your group right now?

DeStephen had group members respond to each of the previous questions on a scale of one to five. He then took the average of all the responses for the group and used these averages to classify each group as having achieved high or low consensus. After this he did an interaction analysis (using RELCOM and FIAS) on each of the group discussions to see if there were any differences in the discussions of the high consensus groups versus the low consensus groups. He found clarification and equivalence statements more prevalent in high consensus groups.

Kendall's Coefficients. In 1974, van Gigch used Kendall's coefficients of concordance and agreement to measure consensus in ranking situations. Each of these coefficients has a maximum value of 1.0; the closer the score is to the maximum, the stronger the consensus. He also developed what he called the S-R correspondence matrix and used it with Kendall's coefficient of concordance to measure consensus.

Mathematical Algorithms. In 1978, Cook and Seiford treated the ordinal rankings of individuals as vectors and combined them to minimize the differences in an overall consensus ranking. To do this they treated each individual ranking of a number of objects as a vector. They then created a distance matrix made up of the sum of the deviations between an individual ranking of a single object and the rankings of that object by all group members. The distance matrix includes the sum of these deviations for each object and each member. They then used an assignment algorithm to rank the

objects by minimizing the sum of the deviations between the rankings of the individual members.

Beck and Lin (1983) also created a consensus ranking algorithm. Their method is good for both ordinal and cardinal rankings. They created an agreement matrix and used the column and row vectors to determine the positive and negative preferences for each object. They created the agreement matrix by determining the number of raters preferring each object (i) over each of the other objects (j). The sum for each object (i) across all columns produces a column vector representing the number of times each object (j) isn't preferred over all the other objects. This is called the negative preference vector N. The procedure for then creating the consensus ranking is an iterative one where you create the agreement matrix and take any objects with a zero entry in the negative preference vector and place them in the next highest available position in the consensus ranking. Likewise, you take any object with a zero entry in the positive preference vector and place it in the next lowest available position in the consensus ranking. If no zeros occur in the vectors, take the object with the highest negative preference vector and place it in the next highest available position. Once an object(s) is (are) removed, recalculate the agreement matrix and start the assignment procedure over. This procedure maximizes agreement.

The preceding procedures by van Gigh, Cook and Seiford, and Beck and Lin are used to create mathematically a consensus out of a number of individual rankings of n objects. These procedures measure the consensus present at the outset or at the end of discussion depending on when you have the individuals create their rankings. These are mathematical combinations, they don't take into account any group dynamics and do not

require the individuals to ever meet. Other mathematical methods are reviewed by Jenson (1986). He looked at and compared the Borda-Kendall method (BK), the Minimum-Variance method (MV), and the geometric-mean consensus matrix (GM).

RESEARCH METHODOLOGY

Variables

Dependent variable. The dependent variable for this study was strength of consensus. Because of a lack in the literature of any clear way to measure strength of consensus, I measured this variable in two ways. The first and most direct measure of the variable was as perceived consensus of the participants in a small group setting. I measured this with a questionnaire I developed based on the literature.

The second way I operationalized strength of consensus was as individual agreement with the consensus decision. I measured this in a ranked list exercise by statistically determining the distance of each individual ranking, following group discussion, from the consensus ranking. I then statistically determined if changes in this variable can be predicted by changes in the predictor variables, perceived information usefulness and perceived shared understanding.

Predictor variables. I had two predictor variables: perceived information usefulness and perceived shared understanding. Perceived information usefulness was operationalized as perceived information importance and perceived information usability. This variable was measured with a questionnaire I modified from one used by Larker and Lessig in 1980.

The other predictor variable, perceived shared understanding, was operationalized as the opportunity of each person to express his or her own views and the amount of constructive controversy. This variable was measured with a questionnaire I modified from one used by Tjosvold and Field in 1985.

Moderating variables. The most important moderating variables affecting the relationship of the predictor variables to the dependent variable are facilitation, task characteristics, individual characteristics of participants, and decision environment. Facilitation and task characteristic effects were kept constant by having no facilitators and giving all groups the same task with the same directions and supporting information. I controlled decision environment by conducting all exercises under the same conditions. I limited the effects of participants' personal characteristics by making random group assignments.

Exact definitions of my variables and related terms are given in Appendix E.

Research Model

The research model depicts the relationships I studied between the predictor variables and the dependent variable. Also included in the model are the moderating variables which I either controlled or assumed the effects to be consistent across groups. (See Figure 3.)

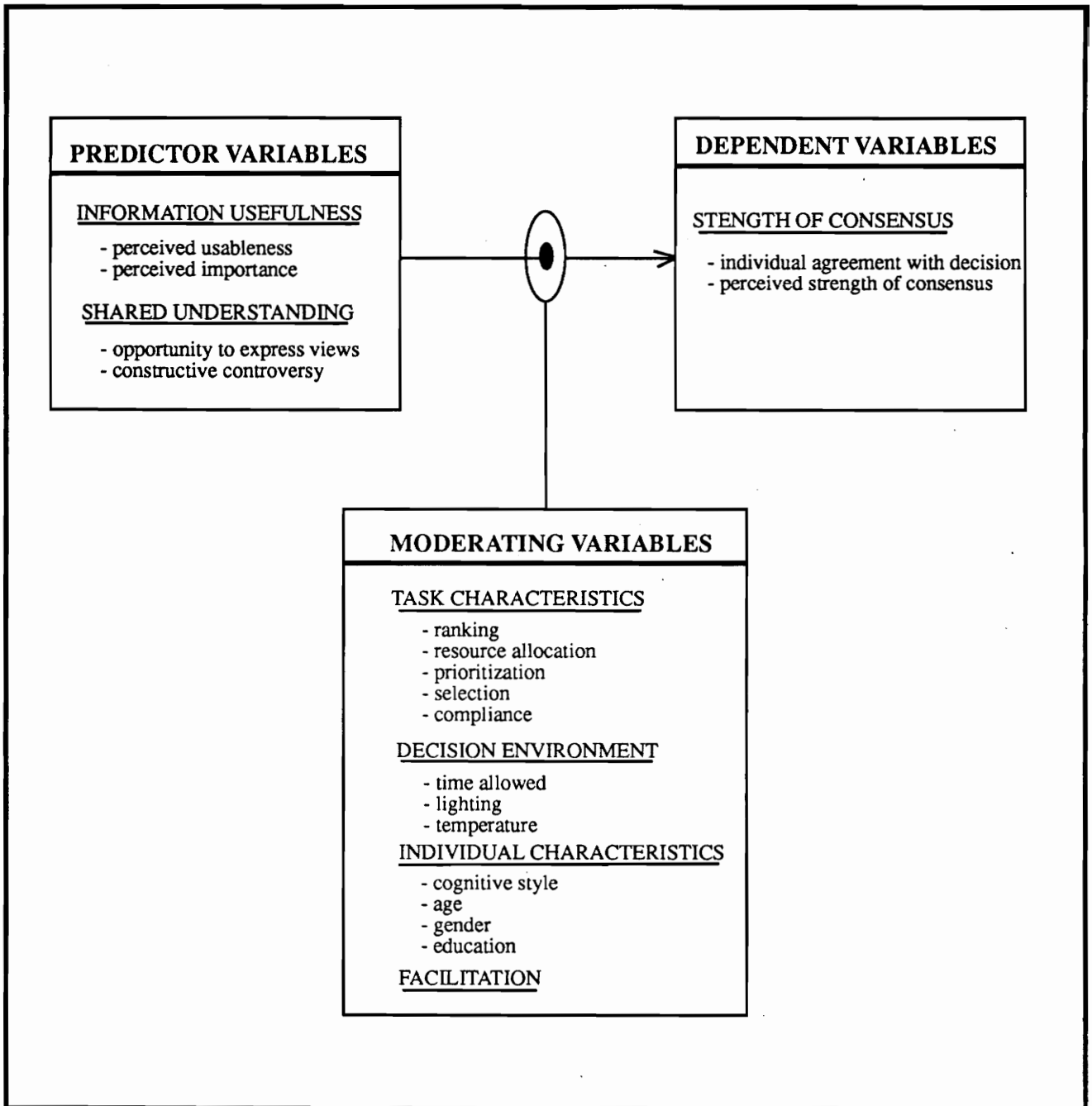


Figure 3. My research model and the hypothesized variable relationships.

Specific Hypotheses

Specific hypotheses are narrower in scope than the research hypotheses. They lay out the scope of the research by specifically stating what is going to be tested. My specific hypotheses are:

- 1) The greater the perceived usefulness of information, the greater will be the perceived strength of consensus and the individual agreement scores.
- 2) The greater the perceived shared understanding, the greater will be the perceived strength of consensus and the individual agreement scores.
- 3) The perceived strength of consensus and the individual agreement scores will be significantly correlated ($p < .05$).
- 4) The amount of variation in strength of consensus predicted by the combination of perceived information usefulness and perceived shared understanding will be significantly greater than the amount predicted by either predictor variable alone.

Method

Exercise. I used the Lost on the Moon exercise (Hall, 1970). This exercise is described in my literature review (p. 18). The exercise, information, and instructions I provided are in Appendix F. I modified Hall's procedure for the exercise by having the subjects fill

out individual rankings of the 15 items after the group reached consensus in addition to ranking the items prior to group interaction as the exercise was originally used. This allowed me to determine individual agreement as a measure for strength of consensus.

Procedure. The procedure is outlined in the flow chart on Figure 4. I brought the subjects together in one room where they received the test exercise and verbal instructions about what they were supposed to do. (They also read and signed the consent forms at this time.) The subjects then individually ranked the items in the exercise. (This was done to give the subjects a point of individual reference about their own thoughts before the group derived a consensus ranking.)

Before handing out the individual ranking sheets, I had coded each sheet to assign subjects randomly to groups of five. When all the individual rankings were completed, the subjects moved into their groups and left with a proctor to go to a separate room to complete the exercise. The groups were separated so they couldn't hear the discussion of other groups. After arriving at their separate rooms, the proctors collected the individual rankings and distributed one copy of the information and instructions to each subject and one clean test exercise to each group. (These handouts are presented in Appendix F.) The groups received verbal instruction about how to complete the exercise. The groups weren't given any instructions about consensus or how to achieve it because I didn't want to bias the groups' interaction. The groups were given as much time as necessary to discuss the scenario and derive a group consensus ranking on the importance of the items.

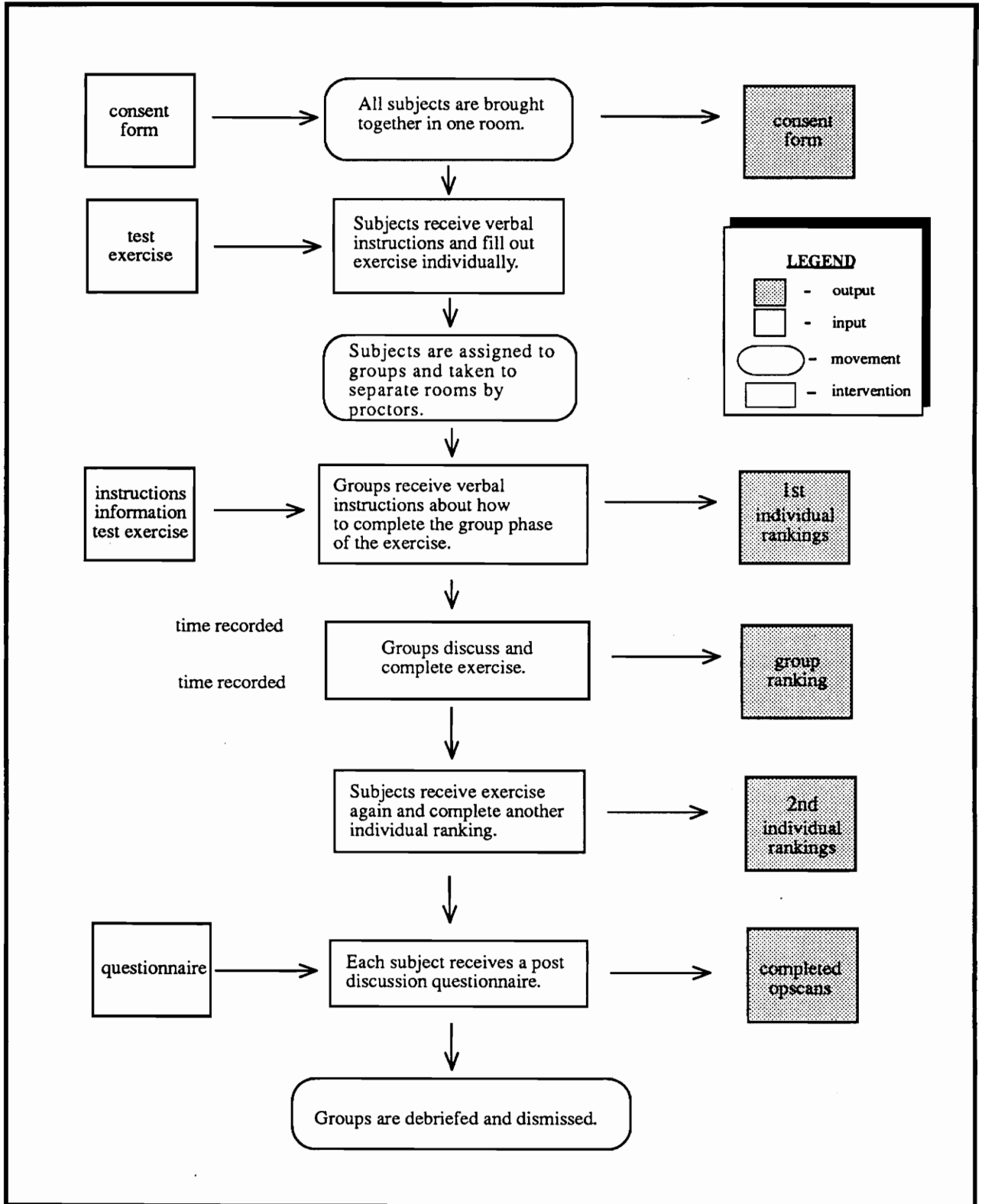


Figure 4. I followed the procedure in this flow chart.

After each group finished deriving their consensus, they gave their group consensus to the proctor. The proctor then gave each subject another copy of the test exercise and asked them to rank the items again, individually, as if the group consensus didn't matter. They were asked for their own individual ranking and were told that their ranking didn't have to agree with their group's consensus. When this was finished, the proctors collected the rankings and distributed the questionnaire containing the three measurement instruments. (The questionnaire is presented in Appendix C.) The questions were printed on an opscan form upon which the subjects recorded their responses. The subjects were instructed not to talk while the group was filling out the questionnaire. When the group members finished the questionnaire, the proctors debriefed them by telling them NASA's ranking and the reasons for the ranking (see Appendix G). The exercise was then complete. (If they didn't want to wait for NASA's answers, the subjects were free to go after completing the questionnaire.) The proctors then returned all materials to me.

Subjects. The subjects were students at Virginia Polytechnic Institute and State University. They were taken from an introductory psychology class and participated as volunteers for class credit. The 48 subjects were randomly assigned to eight groups of five and two groups of four.

I used a multiple regression analysis with two predictor variables. A rough rule of thumb for sample size in regression analysis is to have at least 15 subjects for each predictor variable in the model (Borg & Gall, 1989). This means I should have had at least 30 subjects. I chose to have as many subjects as I could get to volunteer. (The final total number of subjects was 48.)

I chose to use groups of five because larger groups might have limited interaction and resulted in some subjects not being able to participate fully. As group size increases, two negative effects have been found: members have fewer chances to speak and therefore are less satisfied, and members feel their individual opinions are not important and worth presenting to the group (Hare, 1952).

Instruments. I used three instruments. They measured perceived information usefulness, perceived shared understanding, and perceived strength of consensus. The three instruments were printed on one opscan form and administered following completion of the exercise.

The instrument used to measure perceived information usefulness was modified from one designed by Larker and Lessig (1980). Their original instrument is presented in Appendix H. The original instrument was designed by interviewing faculty and graduate students on the probable characteristics of information usefulness and usability. The authors then generated thirteen statements from these interviews. These statements were further refined by having three faculty members and three graduate members examine them and indicate which statements applied to importance and which applied to usability. The authors then kept the six statements that the judges classified unanimously as relating to information importance and usability. The instrument was then validated in a capital budgeting exercise. In this study, construct validity, the extent to which an instrument can be shown to measure a hypothetical construct, was shown for the instrument through factor analysis. Factor analysis shows whether or not the set of

items can be reduced to a smaller set or if the items are measuring more than one construct. Factor analysis was used to show there actually were two distinct dimensions of information usefulness measured by Larker and Lessig's instrument.

The instrument used to measure perceived shared understanding was modified from one designed by Tjosvold and Field (1985) to measure constructive controversy. Their original instrument is presented in Appendix H. I have no information about how Tjosvold and Field derived the questions for their instrument. It was used to investigate the effect of constructive controversy on effective decision making. They used factor analysis to show construct validity. For this instrument all the items loaded on one factor and reliability was 0.88. The elimination of any question reduced the reliability by at least 0.04.

I designed my instrument measuring perceived strength of consensus by modifying an instrument used by Knutson, Lee, and Danes (Knutson and Holdridge, 1975) and adding two questions from an instrument used by DeStephen (1983). Their two original instruments are presented in Appendix H. The instrument designed by Knutson, et. al. was derived through several Q-sorts. The items kept were those identified as contributing the most to the identification of differences in perceived consensus between agreement groups and non-agreement groups.

All questions for my three instruments had a seven point Likert scale for subject response. To make sure the questions were worded clearly and asked what I intended them to, I had five people from a research laboratory on campus read over them. I

recorded their responses and changed the questions accordingly. As a result, I anchored every point on the scale and randomly reversed the direction of some of the questions.

Data Analysis. My data analysis is outlined in the flow chart on Figure 5. For each subject, I had four sources of data: three sources from the responses to the three measurement instruments and one source from individual agreement scores representing the amount of agreement between each individuals' post discussion ranking and their group consensus. The responses to the three instruments were recorded by the subjects on op-scan sheets and entered into a data file by the Learning Resources Center of Virginia Polytechnic Institute and State University. The data entered into my regression models were the summations of the responses to each scale (corrected for reversals). The individual agreement score was computed by subtracting the individual rank for each item from the group rank for each item. I summed the absolute value of these differences for each individual to get their individual agreement score. The lower the score, the more the individual agreed with the group consensus. This measure was used by Tjosvold (1983) to measure individual commitment with the group decision. I also collected demographic data, which can be used for future analysis but was not analyzed in this study. Finally, I had the proctors record the discussion time each group took to reach consensus. Although I made no hypotheses about time affecting consensus, these data were collected for future research.

The four sources of data, the individual agreement score and the responses to the three instruments, were analyzed through multiple regression analysis in SAS to investigate the specific hypotheses. I chose regression analysis because it "is used for determining the

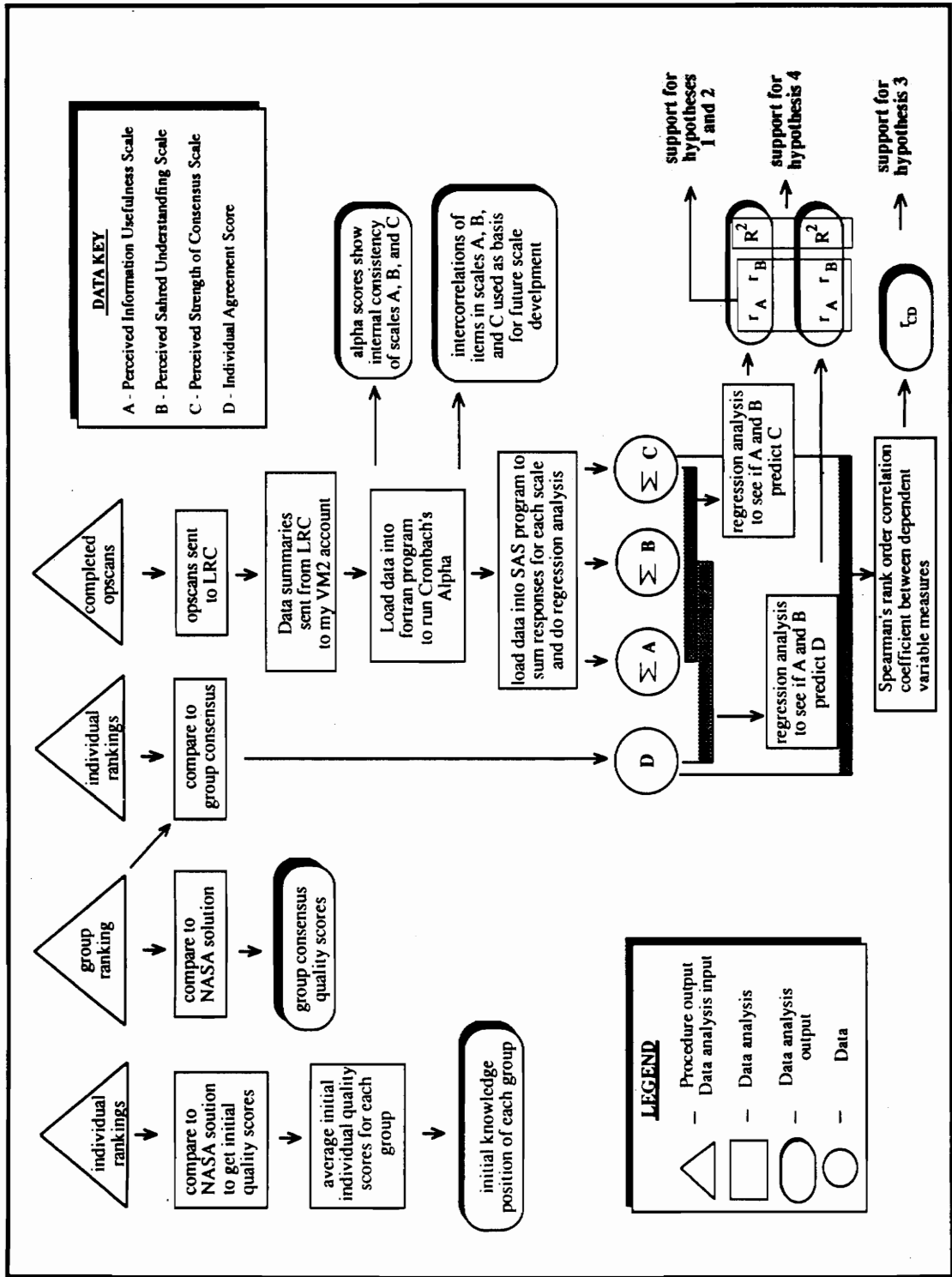


Figure 5. I show my data analysis with this flow chart.

correlation between a [dependent] variable and a combination of two or more predictor variables" (Borg & Gall, 1989). The two measures of my dependent variable are the perceived strength of consensus scale and the individual agreement score. I did two multiple regression analyses; one for each measure of the dependent variable. Two predictor variables were entered into each analysis for the dependent variable; the summation of responses to the perceived information usefulness and perceived shared understanding scales. The multiple regression analyses indicated, from the multiple correlation coefficient (R), the best predictor of the dependent variable. The multiple correlation coefficient offered support for the first two specific hypotheses, showing the magnitude of the relationship between the predictor variables and the dependent variable. For the first two hypotheses to be supported, the multiple correlation coefficient for each of the predictors had to be significant at the .05 level.

To investigate the third specific hypothesis, that the two dependent variable measures would be highly correlated, I calculated both the Pearson and Spearman correlation coefficients. I calculated Pearson correlation coefficients for all combinations of my variables. Because of a question of independence associated with the individual agreement scores, I also calculated the Spearman correlation coefficient for the two measures of my dependent variable (strength of consensus) because the Spearman coefficient is a non-parametric measure for ordered data. (The individual agreement scores were calculated by subtracting individual scores from group scores and thus one can argue the data lacked independence.)

To investigate the fourth specific hypothesis, that the combination of the two predictor variables would predict the strength of consensus better than either alone, I entered each

predictor variable into the regression models singly. The coefficient of determination (R^2) showed whether or not each variable predicted a significant amount of the variation in the dependent variable. To support hypothesis four, each predictor, singly, had to predict a significant amount of the variation in the dependent variable and the R^2 value had to be greater when both predictors were entered than for either predictor alone.

As a check on the internal consistency of the measures, I computed Cronbach's alpha for each of the three instruments. Cronbach's alpha is an indicator of internal consistency, that is, for each instrument, whether all the questions measured the same thing.

Pilot Study

Exercise. I used the same exercise (Lost on the Moon Test) for my pilot and for my main study.

Procedure. For my pilot study, I followed the procedure outlined in the procedure flow chart (Figure 4) except for the following modifications. I ran each group separately at different times instead of bringing them all together at one time. Also, two of the three groups in my pilot study contained members familiar with each other; not randomly assigned strangers. Finally, one group contained six people instead of five because I had six available and wanted to get as many data points as possible for my pilot study data analysis.

Subjects. The subjects for the pilot study were 16 students from Virginia Polytechnic Institute and State University. They were split into two groups of 5 and one group of 6. The first group consisted of five people who work together and know each other very well. The second group consisted of five people who know each other but were not as close as the first group. The subjects in the third group didn't know each other.

Data Analysis. For the pilot study, I calculated Cronbach's alpha for the three different measurement scales. A high alpha suggests that the questions are all measuring the same thing. Although I only had 16 data points, I expected this preliminary investigation of the internal consistency of the instruments to show any major internal deficiencies in my scales.

I didn't run a multiple regression analysis on the pilot study data. The number of data points was too small to obtain meaningful results. (For individual data, see Appendix I, Table 1.)

Results. The average quality of the individual rankings done before group discussion showed that the first two groups started from approximately the same knowledge base but the third group was significantly more knowledgeable. The first two groups, however, used the information given and their knowledge to derive a high quality consensus. The third group, which started with a greater knowledge base, but were not familiar with each other, derived a lower quality consensus than the first two groups. (See Appendix I, Table 2, for these data.)

Groups two and three took the same amount of time to derive their consensus ranking while the first group took slightly less time. This was not surprising since the first group knew and worked with each other. The time taken to complete the consensus ranking was consistent across groups. (These data are given in Appendix I, Table 2.)

The Cronbach's alphas for the three scales were all high enough to support a preliminary finding of internal consistency. Cronbach's alpha for the perceived information usefulness, perceived shared understanding, and perceived strength of consensus scales were .68, .88, and .92 respectively. (See Appendix I, Table 3.) The alphas for the perceived shared understanding and perceived strength of consensus scales were very high. The alpha for the perceived information usefulness scale was lower than the other two but still high enough to continue with my study without making changes.

The procedure, although slightly modified from the one I used in my study, allowed me to see if I had any problems I had to change. The pilot groups went through the procedure smoothly. I only noticed one thing I decided to change. There was confusion in every group as to whether they were on the lighted or dark side of the moon. The wording on the test exercise was not clear about this. I changed the test exercise to clearly state that the group is on the lighted side of the moon. Other than changing the wording of the exercise, I found no problems I needed to take care of before my study.

RESULTS

Introduction

In this chapter I present the results of my study. Only hypothesis 3 was supported. Hypotheses 1 and 4 were not supported while hypothesis 2 was partially supported. Shared understanding was important for achieving a strong consensus while information usefulness was not. Although not studied in this research, time seemed to affect quality of group decisions. I include data pertaining to gender and discussion time at the end of this section. This data is interpreted in the discussion section.

Individual Descriptive Statistics

The data used to calculate Spearman rank order and Pearson correlation coefficients and entered into the regression models are presented in Appendix J, Table 1. This table shows the summation of the responses to the three parts of my questionnaire (information usefulness, shared understanding, and strength of consensus) and the individual agreement scores (the difference between an individual's post discussion ranking and the group consensus ranking) for each subject. Descriptive statistics for each of these variables are in Appendix J, Table 2.

Variable Correlations

Pearson correlation coefficients between all variables are presented in Table 1. Four correlations were significant. Perceived shared understanding and information usefulness with perceived strength of consensus ($r=.82$, $p<.001$ and $r=.31$, $p<.05$ respectively) and perceived shared understanding and strength of consensus with the individual agreement scores ($r=.32$, $p<.05$ and $r=.43$, $p<.01$ respectively). To investigate the relationship between my two measures for strength of consensus, I also calculated a Spearman rank order correlation coefficient. I calculated the Spearman coefficient in addition to the Pearson because it's a non-parametric statistic. The way the agreement score is calculated (subtracting individual scores from group scores) causes a question of whether the individual agreement scores are independent. Non-independence would cause these scores to violate the assumption of a normal distribution necessary for parametric statistics like the Pearson correlation. The results of this statistic ($r=.46$, $p<.001$) were almost identical to the Pearson correlation and also showed a significant correlation between the two measures of consensus strength.

Regression Analysis

I used two regression analyses to see if my measurements of perceived information usefulness and perceived shared understanding would predict the strength of consensus. Since I measured my dependent variable in two different ways, I ran individual regression models to see if the predictor variables would predict each of the dependent variable measurements. The results of the first model with perceived

Table 1. Pearson correlations between my variables.

	Perceived Information Usefulness	Perceived Shared Understanding	Perceived Strength of Consensus	Individual Agreement Scores
Perceived Information Usefulness	1.00	0.21	0.32 *	0.02
Perceived Shared Understanding		1.00	0.82 ***	0.32 *
Perceived Strength of Consensus			1.00	0.43 **
Individual Agreement Scores				1.00

*** p<.001. ** p<.01. * p<.05.

information usefulness and perceived shared understanding as the predictor variables and the perceived strength of consensus questionnaire as the dependent variable, are presented in Table 2. Each predictor variable was entered singly and then the two were entered together. Based on this analysis ($R^2=.70$, $p<.0001$), 70 percent of the perceived strength of consensus variance is predictable by this model when both predictors are entered together. If each predictor is entered alone, perceived shared understanding predicts 67 percent ($R^2=.67$, $p<.0001$) of the variance in the perceived strength of consensus while perceived information usefulness predicts 10 percent ($R^2=.1$, $p<.08$) of the variance in the dependent variable.

The results of the second model, with the same predictor variables and with the individual agreement scores as the dependent variable measure, are presented in Table 3. When both predictor variables are entered together, the model does not significantly predict the variance in individual agreement scores ($R^2=.1$, $p<.09$). When entered alone, perceived shared understanding significantly predicted 10 percent of the variance in the dependent variable ($R^2=.1$, $p<.03$). Alone, perceived information usefulness was not a significant predictor of the variance in the dependent variable ($R^2=.00$, $p<.8$).

Internal Consistency of Instruments

In this study, I used three measurement instruments which, although based on former studies, were modified for my research. I computed Cronbach's alpha for each of the three instruments to check internal consistency. The alpha coefficients for the perceived

Table 2. Regression analysis with strength of consensus scale as dependent variable.

<u>Analysis of Variance</u>					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	4021	2010	51.543	0.001
Error	45	1755	39		
C Total	47	5776			
Root MSE	6.3		R-Square	0.7	
Dep Mean	91.9		Adj R-Sq	0.7	
C.V.	6.8				
<u>Parameter Estimates</u>					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob>T
Intercept	1	-3.30	10.00	-0.33	0.74
Perceived Information Usefulness	1	0.24	0.13	1.80	0.08
Perceived Shared Understanding	1	0.70	0.07	9.4	0.00

Table 3. Regression analysis with agreement scores as dependent variable.

<u>Analysis of Variance</u>					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	175	87	2.603	0.0851
Error	45	1520	33		
C Total	47	1695			
Root MSE	5.8		R-Square	0.10	
Dep Mean	13.5		Adj R-Sq	0.07	
C.V.	43.2				
<u>Parameter Estimates</u>					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob>T
Intercept	1	30.21	9.31	3.24	0.00
Perceived Information Usefulness	1	0.04	0.12	0.30	0.76
Perceived Shared Understanding	1	-0.16	0.07	-2.28	0.03

information usefulness, perceived shared understanding, and perceived strength of consensus scales were .67, .81, and .92 respectively. (See Appendix J, Table 3.) The results show that each instrument's questions are internally consistent; they are measuring the same thing.

Results Applied to Hypotheses

Hypothesis 1, that the greater the perceived usefulness of information, the greater the perceived strength of consensus and individual agreement scores would be, was not supported. In both regression models, perceived information usefulness didn't significantly predict the variation in the two dependent variable measures. The perceived information usefulness R^2 values for the models with perceived strength of consensus and individual agreement scores as the dependent variable were .10 ($p < .08$) and .00 ($p < .8$) respectively.

Hypothesis 2, that the greater the perceived shared understanding, the greater the perceived strength of consensus and the individual agreement scores would be, was partially supported. In both regression models, perceived shared understanding predicted a statistically significant portion of the dependent variable variance. The perceived shared understanding R^2 values for the models with perceived strength of consensus and individual agreement scores as the dependent variable were .67 ($p < .0001$) and .10 ($p < .03$) respectively. While statistically significant, an R^2 of such a low value is not considered significant in this study. Therefore, this hypothesis was only supported partially.

The third hypothesis, that the perceived strength of consensus and the individual agreement scores (the two dependent variable measures) would be significantly correlated was supported. The Spearman rank order correlation coefficient between the two dependent variable measures was lower than expected ($r=.46$, $p<.001$) but was still significant.

Hypothesis four, that the combination of perceived information usefulness and perceived shared understanding would predict the strength of consensus better than either predictor alone, was not supported. In both regression models, the amount of variance in the dependent variable predicted by the predictor variables increased when perceived information usefulness was added to the model with perceived shared understanding. However, the increase in the amount of dependent variable variation predicted when information usefulness was entered into the models was not significant ($p < .05$).

Group Descriptive Statistics

The average quality of the initial individual rankings, the quality score for the group consensus ranking, the gender breakdown for each group, and the discussion time for each group are presented in Appendix J, Table 4. Two groups had four members and eight groups had five members. This occurred because two subjects left after the initial ranking exercise while the groups were forming and moving to individual rooms to continue the study as a group. (See procedure flow chart on Figure 4.)

The average knowledge of group members and the group quality scores held no surprises. I expected, based on previous research, that each group ranking would be of higher quality than the average of their initial individual scores. This held true for all groups.

The time taken to complete the exercise was shorter than expected. Seven of the groups completed their discussion in seven minutes or less. One plausible explanation is that the information I supplied answered enough questions that little discussion was needed about the uses and relative worth of the different objects. Another explanation is that the subjects I used had no real stake in achieving the correct answers and, therefore, had no incentive to spend their time trying to achieve the best possible results.

DISCUSSION - CONCLUSIONS - RECOMMENDATIONS

Introduction

I conducted this study to see if people's perceptions of information usefulness and shared understanding can be used to predict the strength of consensus they achieve. The results are inconclusive. I discuss possible reasons for these findings and also draw conclusions about the group discussions based on data not related to my hypotheses. Despite the inconclusive results, I believe this study has important implications for management, not the least of which is the fact that consensus is not an unmeasurable construct in non-ranking situations. This section concludes with recommendations for future studies and ways this study could be improved.

Discussion

My findings showed that shared understanding is a significant predictor of consensus strength. For this research, I used two measures of the dependent variable strength of consensus; one based on agreement and only applicable to ranking-type problems, and one based on participants' perceptions which can be used with non-ranking problems. My shared understanding scale significantly predicted the variation in both these measures of consensus strength.

The significant correlation achieved between the two measures of consensus strength is very important. Although the Spearman correlation was not as high as I would have liked, it was significant ($r=.46, p<.001$). This means that the instrument I used for perceived strength of consensus measured, to some extent, the same construct as measured by the individual agreement scores. Because of the nature of the construct I measured, strength of consensus, a low correlation wasn't unexpected. It seems that peoples' perceptions often differ from reality by a great extent. The individual agreement scores have been used in the past, by myself and other authors, as a means of measuring strength of consensus in ranking situations. The fact that my perceived strength of consensus scale correlated significantly with the individual agreement scores, indicates that my instrument has potential for giving managers an insight into the actual consensus strength in a small group based on the group's perception of the strength of consensus. More work has to be done in this area to develop this instrument to the point where the correlation is higher and managers can have more confidence in the instrument's ability to measure actual strength of consensus in non-ranking situations based on perceived strength of consensus.

The results pertaining to information usefulness as a predictor of consensus strength were disappointing. Information usefulness did not predict any significant portion of the variance in the dependent variable measures. An interesting result, however, was that the responses to the information usefulness instrument averaged 5.1 on a scale of 1 to 7 with 7 representing the strongest form of agreement. This indicates that the subjects found the information given them to be useful but they still didn't achieve strong consensus. The data show that useful information isn't sufficient to achieve a strong consensus.

However, I still believe the converse is true, a strong consensus can't be achieved without high perceptions of information usefulness.

An interesting factor seemed to affect the group interactions. (This was observed by the proctors.) All groups were given a single group ranking sheet to fill out with their consensus ranking. There was no defined procedure for determining who physically received the group ranking sheet. In most of the groups, the person who was given, or took, the group ranking sheet was seen as a leader and seemed to hold positional power over the rest of the group because he or she controlled what went down on the paper as the group ranking. I don't believe this adversely affected my results since I was trying to predict the strength of consensus, whether weak or strong.

Although I wasn't concerned with decision quality, discussion time, or gender, I still collected these data. (See Appendix J, Table 4.) The shortest discussion time was only 3 minutes while three groups discussed the exercise for over 10 minutes. (The longest discussion took 20 minutes). The other six groups discussed the exercise for approximately 6 minutes. It is interesting that the two groups which discussed the exercise the longest had the worst mean individual quality scores at the beginning. (In other words, these two groups had the least amount of knowledge about the subject.) The long discussion times did not help both groups however. The group that took 16 minutes generated an average quality decision compared to the other groups. The group that took the longest (20 minutes) still generated the second worst quality decision. The worst quality decision was generated by the group that took the least amount of time (3 minutes). The group generating the best quality decision took 10 minutes followed closely by the rest of the groups.

There doesn't seem to be a very strong correlation between discussion time and quality decisions. The group taking the longest time had the worst quality decision. The decision quality scores of the other groups were very close and the order of the scores didn't suggest any correlation with discussion time.

Gender was also recorded. There doesn't appear to be any correlation between this factor and decision quality. There were no single gender groups because I didn't want gender to be a factor in this study. There were some groups, however, which were predominantly one gender. (These are groups with only one male or female member.) Predominantly female groups had the best decision quality and the second worst decision quality. There was only one group with more males than females and they had the worst decision quality. (This group also took the least amount of time.)

If future studies are to build upon my work, or my results are to be applied in real management situations, the instruments used must be scrutinized closely. In this study, I provide a good first step toward developing, validating, and investigating the psychometric properties of these instruments. The Cronbach's alpha for the shared understanding and strength of consensus instruments were high for a study where instrument development wasn't the prime focus. The Cronbach's alpha for the information usefulness instrument was lower, but still fairly good for a study of this type. Inter-item correlations of the questions in each instrument can be analyzed in the future to see which questions are candidates for removal to increase internal consistencies.

Conclusions

I draw a number of conclusions from the results of this study. Of the two predictor variables, shared understanding is much more important to achieving a strong consensus than information usefulness. This makes sense. The information can be extremely useful but if the people involved in discussion don't understand each other and each other's views, the consensus achieved won't be very strong. A good example of this is the 1972 negotiations between the United Steelworkers Union and the major steelmakers. Information was available and presented to both sides about the chances for a major increase in the price of oil and how this would affect the United States steelmakers competitive situation. The union, however, pressed for, and the owners gave them, large guaranteed wage increases for the next five years. When the Arab oil embargo caused the price of oil to sky-rocket, this agreement caused the demise of the steel industry as a major industrial power in this country and the world (Hoerr, 1989).

Based on the significant correlation between the questions designed to measure strength of consensus and the individual agreement scores which have been previously used to measure strength of consensus in ranking situations, I believe that I now have a set of questions which can be further developed and tested in non-ranking situations to develop eventually an instrument to measure consensus strength in non-ranking situations.

I also conclude, based on the results of the regression analyses, that I can use my questions measuring shared understanding to predict partially if the consensus a group achieves is strong or not. This questionnaire however, needs further revision and testing to strengthen my confidence in its ability to predict strength of consensus.

Implications

World business conditions are changing rapidly and managers have to manage change within their organizations to remain competitive. Change, however, isn't usually accepted unless precipitated by a crisis. Change is even harder to implement if it is forced upon employees. Today, managers need to move toward a culture of employee empowerment and involvement in decisions in which they are stakeholders. This means managers are going to have to learn effective use of consensus management.

I believe you can't manage something unless you can measure it. Proponents of management by consensus tell managers to use employee consensus techniques but no way exists to measure the consensus they espouse. We can measure changes in organizations and attribute them to consensus management techniques, but there exist no measures of the consensus on which change is based. We're measuring reactions, not pro-actively measuring the construct we're interested in.

The idea that strength of consensus can be measured in non-ranking situations has important implications for management. Previous research offers numerous suggestions for techniques to increase strength of consensus without providing any means to evaluate if these techniques work or if they are necessary in the first place. This research provides a first step toward being able to define and understand a problem, namely weak consensus, before applying solutions randomly. Further development of these instruments should allow managers to not only measure the strength of the consensus a group achieves, but also to predict the strength of consensus which will be achieved based on the shared understanding present in the group during discussion. (This probably

will never be developed to the point where strength of consensus can be predicted in meetings with a time duration of hours, but I feel the instrument can be developed to the point where consensus strength can be predicted during meetings which are run over a couple of days.)

The results of this study have important implications for managers involved in groups where consensus is desirable. An important implication is the relationship between shared understanding and strength of consensus. The results of this study indicate managers' interested in consensus must make sure the participants involved have an opportunity to understand each other's views. This can be done formally with round robin techniques in which every participant gets to say where they're coming from and what makes them hold the opinions they do. This can also be done informally by utilizing informal get-togethers and social functions. This worked extremely well with a group of state and Indian tribal representatives Management Systems Laboratories at Virginia Tech brought together to discuss issues related to environmental restoration and waste management (Imholz, Hindman, & Brubaker, 1990).

A final implication for management is the seeming unimportance of information usefulness. If a manager's goal for a group is to reap the benefits of the good "feeling" consensus can bring to a group, then he or she needs to be more concerned with finding ways to increase shared understanding than with making sure the information provided is useful. (If the manager's goal for the group is to achieve a high quality decision, information usefulness becomes more important. Decision quality wasn't considered in this study.)

Recommendations for Future Study

The results of this study are promising for achieving a way to measure and predict strength of consensus in non-ranking situations. Future studies should be done with these instruments where the subjects actually solve a non-ranking problem.

Future studies should also be done on the psychometric properties of these instruments. The portion of the variance in strength of consensus which these instruments will predict can be increased by investigating psychometric properties and modifying the questions based upon the results.

If this study is repeated, or a similar study is done, the group should be given enough group ranking sheets so everyone can have one. This will eliminate the perception of power the person with the ranking sheet has.

Researchers doing studies involving students should pay attention to activities happening on the scheduled exercise night. Experiments shouldn't be scheduled on nights where the students will be in a hurry to be otherwise preoccupied (e.g., the night of a major sporting event or the night before a major exam).

A procedural mistake in this study involved the class credit sheets the students had to have signed. I removed motivation to complete the exercise by signing these sheets before the exercise was complete. This naive belief in human integrity resulted in two students leaving in the middle of the experiment.

Once the validity of these instruments is established and there is confidence they measure what they're claimed to be measuring, a whole new area of study can be started to determine empirically what techniques are best in specific situations to increase the strength of consensus.

References

- Barzilai, J., Cook, W. D., & Kress, M. (1986). A generalized network formulation of the pairwise comparison consensus ranking model. *Management Science*, 32(8), 1007-1014.
- Beck, M. P., & Lin, B. W. (1983). Some heuristics for the consensus ranking problem. *Computing and Operations Research*, 10(1), 1-7.
- Borg, W. R., & Gall, M. D. (1989). *Educational research: An introduction*. White Plains, NY: Longman.
- Bourgeois, L. J. (1980, July-September). Performance and consensus. *Strategic Management Journal*, 1, 227-248.
- Bourgeois, L. J. & Singh, J. (1983). Organization slack and political behavior within top management teams. *Academy of Management Proceedings*, pp. 43-47.
- Chandra, G. (1974). A study of the consensus on disclosure among public accountants and security analysts. *The Accounting Review*, 49(4), 733-742.
- Cook, W. D. & Seiford, L. M. (1978). Priority ranking and consensus formation. *Management Science*, 24(16), 1721-1732.
- Dess, G. G. & Origer, N. K. (1987). Environment, structure, and consensus in strategy formulation: A conceptual integration. *Academy of Management Review*, 12(2), 313-330.
- DeStephen, R. S. (1983, May). High and low consensus groups - a content and relational interaction analysis. *Small Group Behavior*, pp. 141-162.
- Deutsch, M. (1973). *The resolution of conflict*. New Haven, CT: Yale.
- Deutsch, M. (1980). Over fifty years of conflict research. In L. Festinger (Ed.), *Four Decades of Social Psychology* (pp. 46-77). New York: Oxford University Press.
- Doss, A. R., Brubaker, D. M., & Kurstedt, H. A. Jr. (1990). To understand consensus, we must know what the elements are. *Proceedings of the Twenty-Sixth Annual Conference of the Southeastern Chapter of The Institute of Management Sciences* (in press).
- Durkheim, E. (1963). Sociology and Philosophy. In G. Simpson (Ed.), *Emile Durkheim* (pp. 18-21). New York: Thomas Y. Crowell.
- English, H. B., & English, A. C. (1958). *A comprehensive dictionary of psychological and psychoanalytical terms*. New York: Longmans, Green, & Company.

- Estes, R. W. (1968). An assessment of the usefulness of current cost and price-level information by financial statement users. *Journal of Accounting Research*, 6(2), 200-207.
- Gallagher, C. A. (1974). Perceptions of the value of a management information system. *Academy of Management Journal*, 17(1), 46-55.
- Gentry, M. E. (1982). Consensus as a form of decision making. *Journal of Sociology and Social Welfare*, 9(2), 233-244.
- Gorry, G. A. & Scott-Morton, M. S. (1971, Fall). A framework for management information systems. *Sloan Management Review*, pp. 55-70.
- Grochow, J. (1973). *Cognitive style as a factor in the design of interactive decision support systems*. Unpublished Ph.D. Dissertation, Massachusetts Institute of Technology.
- Gross, N. (1958). *Explorations in role analysis*. New York: Wiley.
- Hall, J. & Watson, W. H. (1970). The effects of a normative intervention on group decision making performance. *Human Relations*, 23(4), 299-317.
- Hare, A. P. (1952, June). A study of interaction and consensus in different sized groups. *American Sociological Review*, 17(3), 261 - 267.
- Hare, A. P. (1980). Consensus versus majority vote - a laboratory experiment. *Small Group Behavior*, 2(2), 131-143.
- Harvey, J. B. (1978). The Abilene paradox: The management of agreement. *Organizational Dynamics*, pp. 17-43.
- Hill, D. T. (1989). *Measuring information oriented productivity and performance*. Unpublished Master's Thesis: Virginia Polytechnic Institute and State University.
- Hirokawa, R. Y. (1985). Does consensus really result in higher quality group decisions? In G. M. Phillips & J. T. Wood (Eds.), *Emergent Issues in Human Decision Making*. Carbondale: Southern Illinois University Press.
- Holder, J. J. (1972). Decision making by consensus. *Business Horizons*, pp. 47-54.
- Hoerr, J. P. (1989). *And the wolf finally came: The decline of the american steel industry*. Pittsburgh, PA: University of Pittsburgh Press.
- Imholz, R. M., Hindman, T. B., & Brubaker, D. M. (1990). Lessons learned from applying external input to DOE policy decision making. *Proceedings of the International Topical Meeting on Nuclear and Hazardous Waste Management Spectrum '90* (pp. 12-15). Lagrange Park, Illinois: American Nuclear Society.
- Jenson, R. E. (1986). Comparison of consensus methods for priority ranking problems. *Decision Sciences*, 17, 195-211.

- Kaprzyk, J. & Fedrizzi, M. (1988). A soft measure of consensus in the setting of partial (fuzzy) preferences. *European Journal of Operational Research*, 34, 316-325.
- Killman, R. H. & Mitroff, I. I. (1976). Qualitative versus quantitative analysis for management science: Different forms for different psychological types. *Interfaces*, 6, 17-27.
- Klapp, O. E. (1957). The concept of consensus and its importance. *Sociology and Social Research*, 41, 336-342.
- Knutson, T. J. & Holdridge, W. E. (1975). Orientation behavior, leadership and consensus: A possible functional relationship. *Speech Monographs*, 42(1), 107-114.
- Knutson, T. J. & Kowitz, A. C. (1977, Spring). Effects of information type and level of orientation on consensus achievement in substantive and affective small-group conflict. *Central States Speech Journal*, 28, 54-63.
- Larker, D. F. & Lessig, V. P. (1980). Perceived usefulness of information: A psychometric examination. *Decisions Sciences*, 11, 121-134.
- Leedy, P. D. (1985). *Practical research; Planning and design*. New York: Macmillan Publishing Company.
- Mock, T. J. (1973). A longitudinal study of some information structure alternatives. *Data Base*, 5, 40-45.
- Ouchi, W. (1981). *Theory Z - How the American business can meet the Japanese challenge*. Reading, MA: Addison-Wesley.
- Price, J. L. (1972). *Handbook of organizational measurement*. Lexington, MA: D. C. Heath & Company.
- Rawlins, W. K. (1985). Consensus in decision making groups. In G. M. Phillips & J. T. Wood (Eds.), *Emergent Issues in Human Decision Making* (pp. 19-39). Carbondale: Southern Illinois University Press.
- Scheff, T. J. (1984). Towards a sociological model of consensus. *American Sociological Review*, pp. 32-46.
- Shils, E. (1968). Consensus. In D. L. Sills (Ed.), *International Encyclopedia of the Social Sciences* (Vol. 3, pp. 260-266). New York: The Macmillan Company & The Free Press.
- Swanson, E. B. (1974). Management information systems: Appreciation and involvement. *Management Science*, 21(2), 178-188.
- Tjosvold, D. (1985). Implications of Controversy Research for Management. *Journal of Management*, 11(3), 21-37.

- Tjosvold, D. & Field, R. H. G. (1983). Effects of social context on consensus and majority vote decision making. *Academy of Management Journal*, 26(3), 500-506.
- Tjosvold, D. & Field, R. H. G. (1985). Effect of concurrence, controversy, and consensus on group decision making. *The Journal of Social Psychology*, 125(3), 355-363.
- van Gigch, J. P. (1974). *Applied general systems theory*. New York: Harper & Row Publishers.
- Wood, J. T. (1985). Alternate methods of group decision making. In G. M. Phillips & J. T. Wood (Eds.), *Emergent Issues in Human Decision Making*. Carbondale: Southern Illinois University Press.
- Zahedi, F. (1986). Group consensus function estimation when preferences are uncertain. *Operations Research*, 34(6), 883-894.
- Zmud, R. W. (1979). Individual differences in MIS success: A review of the empirical literature. *Management Science*, 25, 966-979.

Appendix A. Review of Consensus Literature not Related to Conceptual Model

Macro-Level Consensus

Macro level consensus deals with the belief system of society. Schelling's work on tacit coordination proposes that the necessity of social coordination gives rise to the seeking of consensus and that consensus, in turn, is a product of communication (Scheff, 1984).

Emile Durkheim (1963) writes of the collective consciousness of society. Durkheim writes that the collective consciousness is more than the sum of the individual consciousness, but he gives no explanation of how the individual consciousness becomes group consciousness (Scheff, 1984). Schelling tries to explain this phenomena with his "higher orders of mutual understanding." Under this theory, collective representations serve as powerful constraints because each individual agrees and recognizes his neighbors agree, his neighbors each recognize that he agrees, he recognizes they recognize and so on indefinitely (Scheff, 1984). Consensus is then a result of these endless mirror reflections of each other's recognitions.

Shils (1968) defines consensus as a state of the belief system of a society. He writes, "It [consensus] exists when a large proportion of the adult members of a society, more particularly a large proportion of those concerned with decisions regarding the allocations of authority, status, rights, wealth and income, and other important and scarce values about which conflict might occur, are in approximate agreement in their beliefs about what decisions should be made and have some feeling of unity with each other and with the society as a whole." Shils also deals with degrees of consensus by explaining

that no society will universally share any consensus. The adults who share consensus will do so with very different degrees of intensity or concern.

This idea of consensus has held a very important place in sociology. In 1957, Klapp wrote: "consensus should have an importance in sociology comparable to that of energy in physics - namely, as a unifying concept, an abstraction that will include and relate more specific concepts and data. Light, heat, sound, and electromagnetism are forms of energy; so, I think, culture, structure, norm, role, symbol, and so on, should be treated as forms of consensus."

Micro-Level Consensus

Consensus Process. Even though I'm interested in the state of consensus and do not define consensus as a process, a review of the work of those who define consensus as a process is important. To me, the process moves a group from one state to another - - a state of stronger or weaker consensus. A review of this literature is important because I need to consider how the state of consensus is achieved. Consensus is an hypothetical construct I can't measure directly. Given this, I need to be aware of those process issues necessary for the achievement of the state. The work of those defining consensus as a process provides valuable insight into this problem.

Jay Hall (1971) considered consensus the ideal means to achieve group goals and defined consensus as "a decision process for making full use of available resources and for

resolving conflicts creatively." Hall listed guidelines for the consensus process (Figure 1). I see these as guidelines for achieving a state of stronger consensus.

In his best-seller *Theory Z*, Ouchi also talked about consensus as a process when he wrote "consensus is a process which permeates all hierarchical levels in major Japanese corporations." Hare (1980) studied the consensus process in comparison to a majority vote in making decisions. Hare found that group members were significantly more satisfied with the group process when consensus was used. His guidelines for the consensus process are listed in Figure 2.

Consensus as a process is used when it is necessary to develop a decision having the widest possible common acceptance (Gentry, 1982). Stopping short of providing guidelines for the group in a consensus process, Gentry (1982) provided a list of statements about consensus to be used by both group members and facilitators for understanding the process better (Figure 3).

Gentry's definition of consensus is "a decision participated in by all members of a group and representing the maximum area of common acceptance." Indeed, most of the authors who consider consensus as a process, eventually define consensus as some kind of state reached at the conclusion of the process. It is hard to separate the process used to achieve a certain state or group condition from the actual state or group decision made as an outcome. I propose to research this state, attitude, group frame of mind or decision. I will leave the research of the process to achieve this state to others.

Consensus as a State. This is covered in my conceptual model literature review.

Consensus Definitions. I believe the definitions of consensus as a state fit within two theories of consensus outlined by Scheff (1984). He outlined the theories of individual agreement and co-orientation. Under the individual agreement theory, the consensus would simply be the extent to which individuals in a group agree. The other theory, co-orientation, stresses the co-orientation of individuals in a group toward a position rather than the individual orientations of group members. Complete consensus then occurs in a group when there exists an infinite series of reciprocating understandings between the members of the group concerning the issue. (I know that you know that I know, and so on.)

The major problem with the agreement theory is the assumption that consensus somehow affects behavior. This assumption isn't hard to invalidate under the agreement theory. It isn't hard to find examples of groups of people where the individuals all agree something should be done and then nobody does it. Either everyone didn't feel strongly enough or each person thinks someone else will take the action and nothing gets done. Then there is the other extreme where people think they are in consensus and wind up doing something each individual didn't want to do. Harvey (1984) named this phenomenon the Abilene Paradox. These problems are eliminated in the co-orientation theory because consensus isn't achieved until each individual not only understands all other positions but knows that their position is understood by everyone else.

Hall's Consensus Guidelines

1. Avoid arguing for your own rankings. Present your position as lucidly and logically as possible, but listen to the other members reaction and consider them carefully before you press your point.
2. Do not assume that someone must win and someone must lose when discussion reaches a stalemate. Instead, look for the next-most-acceptable alternative for all parties.
3. Do not change your mind simply to avoid conflict and to reach agreement and harmony. When agreement seems to come too quickly and easily, be suspicious. Explore the reasons and be sure everyone accepts the solution for basically similar or complimentary reasons. Yield only to positions that have objective and logically sound foundations.
4. Avoid conflict-reducing techniques such as majority vote, averages, coin flips, and bargaining. When a dissenting member finally agrees, don't feel that he must be rewarded by having his own way on some later point.
5. Differences of opinion are natural and expected. Seek them out and try to involve everyone in the decision process. Disagreements can help the group's decision because, with a wide range of information and opinions, there is a greater chance that the group will hit upon more adequate solutions.

Figure 1. Hall provides guidelines for the consensus process.

Hare's Consensus Guidelines

1. **Do:** Secure agreement to follow rules for consensus, i.e., look for a solution that incorporates all points of view or is best for the group at this time.
Avoid: A zero-sum solution or using majority vote, averaging, or trading as conflict reduction devices.
2. **Do:** Give your own opinions on the issue. Approach the task on the basis of logic. Seek out differences of opinion to obtain more facts, especially from low status members.
Avoid: Arguing for your own opinions.
3. **Do:** Address remarks to the group as a whole. Show concern for each individual opinion.
Avoid: Confrontation and criticism.
4. **Do:** Although the main function of the group coordinator is to help the group formulate a consensus and the main function of the group recorder is to record each decision as it is reached, all members should help formulate statements about solutions to which all can agree. Even if there appears to be initial agreement, explore the basis of the agreement to make sure there is agreement at a fundamental level.
Avoid: Changing your mind only to reach agreement.
5. **Do:** If consensus is reached, make it clear that each group member is responsible to apply the principle in new situations.
Avoid: Pressing for a solution because the time for the meeting is over. If consensus is not reached, postpone the decision until another meeting and do more homework on the problem.

Figure 2. Hare provides guidelines for the consensus process.

1. The consensus process is time consuming.
2. The decision reached is likely to be supported and implemented.
3. The process works best if members have been taught how to do it.
4. Repeated use of the process improves performance.
5. The process works best when members approach a decision task with intent to agree.
6. Communication skills of verbal facility and listening are important personal characteristics for members to possess.
7. Shared ideology appears necessary for the process to work.
8. Particular skills are needed for the person in the role position of leader.
9. Members must be open to different views and information, seek all sides of an issue.
10. Members must be willing to give up personal power.
11. Members must be committed to participation by all.
12. Members should view conflict, expressed as differences of opinion, as natural and helpful rather than a hindrance.
13. Members should not seek early and quick agreement and should guard against premature strain for convergence.
14. Structural arrangements, for example, use of committees for further study and deferral procedures to a later meeting, should be provided when it becomes apparent that the group is not yet ready to reach consensus.

Figure 3. Gentry's comments about the consensus process.

Degree of Consensus

The idea of consensus being a state with different degrees of strength can be understood better if compared to the phases which occur in nature and are studied in thermodynamics. Considering water for instance, there are three phases (solid, liquid, and vapor). When water is in any of these phases, the variables affecting the state of the liquid (like temperature) can be changing without any recognizable outward change until the critical points are reached. Likewise, if we consider consensus as a phase, once it is achieved (continuing the analogy, say that the critical point for moving from information sharing to consensus is reached), the variables affecting consensus can be changing to either strengthen or weaken the consensus without any recognizable sign being given by the participants in a consensus decision. (If one wished to take this analogy further, they could theoretically develop phase diagrams and equations of state relating the variables affecting consensus.)

In the literature, a number of researchers have looked at degrees of consensus. Scheff (1984) defined degrees of partial consensus dependent on the level of co-orientation. (This theory was discussed in the section on consensus as a state.) The zero level of co-orientation is agreement and not consensus. The first level of co-orientation (perceived consensus) would be first-degree consensus, the second level of co-orientation (we recognized that they recognized that we recognized) second-degree consensus and so on. Scheff then operationalized his definition of consensus by combining agreement with understanding to define different degrees of consensus operationally. Monolithic consensus occurs when the majority agrees and understands there is agreement. When the majority agrees but thinks there is disagreement, there is pluralistic ignorance. There

is dissensus when the majority doesn't agree and understands they don't agree and there is false consensus when the majority doesn't agree and thinks they agree.

In *Consent and Consensus*, Partridge (1971) writes of consensus as the conforming behavior of individuals who each have different attitudes. These attitudes are important for determining the degree of consensus but Partridge discounts the importance of doing this. He writes: "conforming behavior may be the expression of very different attitudes and it is these attitudes which are significant for determining whether there is consensus or not. And of course, attitudes may vary greatly in intensity. It is not important to draw sharp lines between what counts as consensus and what does not in cases that fall near the margin; what is important is that we should agree that consensus contains at its core a positive agreement with, or adherence to, whatever the consensus is said to be about."

Other authors have operationalized consensus in a manner to be able to measure the degree of consensus. DeStephen (1983) operationalized consensus as an outcome of group discussion to test the hypothesis that the degree of consensus is proportional to the quality of the group product. He split consensus in two levels. High consensus was characterized by statements supporting or explaining the group's decision and expressing agreement with those explanations. Low consensus was characterized by disagreement, non-substantiated statements of opinion, and expressions of personal commitment to the group.

A number of authors have researched the effects of consensus on strategy among top management for success in organizations. These authors (Bourgeois, 1980, Bourgeois and Singh, 1983, Dess and Origer, 1987, Woolridge and Floyd, 1989) operationalize

consensus by asking top managers to describe the organization goals and strategies. They then measure the degree of consensus by measuring the extent to which these descriptions agree.

Appendix B. Research Questions, Purpose, and Objective

Research Question

What is the nature of the relationship between perceived information usefulness, perceived shared understanding, and strength of consensus?

Operational Research Question

If I were a manager responsible for bringing a group of people together to achieve consensus, what can I do to determine what factors are affecting the consensus and what I need to do to strengthen the consensus?

Research Purpose

Managers need to know what they can do to affect the strength of consensus. To manage effectively, managers need to consider the viewpoints of all stakeholders when making decisions. This often calls for participative management with consensus as the goal. Managers need to know if the relationships proposed affect the outcome of participative consensus management so they can know how to improve it.

Research Objective

The objective of this research is to show the relationship between perceived information usefulness and perceived shared understanding and strength of consensus. If the relationship is demonstrated, a secondary objective is to provide managers with an instrument, composed of the questions used in this study, to predict the strength of consensus in small groups and allow a manager to know which factor is weak and needs to be improved to strengthen the consensus.

Appendix C. Post Session Questions Asked on Op-Scan

Items 1 through 10 concern your perceptions of the information you were provided. Please read each statement carefully and use a No. 2 pencil to mark your responses in the answer column according to the following scale:

- | | |
|--------------------------------------|----------------------------|
| 1) Strongly disagree | 5) Moderately agree |
| 2) Disagree | 6) Agree |
| 3) Moderately disagree | 7) Strongly agree |
| 4) Neither Agree nor Disagree | |

1. The information provided was in a usable, logical format that didn't create any ambiguity about how to use it.
2. The information provided was easily understood without major discussion of its meaning.
3. I feel I needed more information to complete this exercise.
4. The information provided was pertinent to the problem under consideration.
5. I didn't need the information provided to complete this exercise.
6. My group didn't need all the information provided.
7. The information provided was sufficient to complete the exercise.
8. To use the information provided, my group had to make complex interpretations of the information meaning.
9. The information provided was in the correct form to complete the exercise.
10. All the information provided was essential to complete the exercise.

Questions 11 through 28 concern your perceptions of the way your group worked together. Please continue to respond according to the scale given above.

11. My group first tried to understand the problem fully.
12. My group members understood my opinions.
13. My group members did not listen to what I had to say.
14. My group members accepted what I had to say.
15. My group sought a good, acceptable, solution to our problem.
16. Opposing views aided in the full consideration of all the issues.
17. I don't feel my group fully understood the problem before we sought a solution.
18. My views were given full consideration by all group members.
19. I had sufficient opportunity to make my views known.
20. Disagreeing with another group member's ideas was not a rejection of that person.
21. Some members in my group tried to blame others when disagreements occurred.
22. All ideas were expressed before we began to evaluate them.
23. Group members influenced each other to reach a decision.
24. The final ranking my group derived adequately reflects my concerns.
25. I am satisfied with the way my group interacted to reach this decision.
26. No one tried to 'win' by pushing and keeping his or her own original views.
27. No group member tried to control the other group members.
28. I know more about the individual group members now than I did before we worked together.
29. Everyone's views were listened to, even if the person's view was in a minority.
30. My group had a 'we are in it together' attitude.
31. There was a lot of 'give and take'.
32. I don't feel all group members expressed their own views fully.

Questions 33 through 42 concern your perceptions of the outcome of your group's discussion. Please continue to respond using the following scale:

- | | |
|-------------------------------|----------------------------|
| 1) Strongly disagree | 4) Moderately agree |
| 2) Disagree | 5) Agree |
| 3) Moderately disagree | 6) Strongly agree |

33. If asked to defend my group's solution, I would be willing to do so.
34. In general, the members of my group discussed the exercise in an orderly manner.
35. In general, I am satisfied with my group.
36. I don't think my group arrived at a good solution.
37. Given the choice, I would work with this group again.
38. Members in my group made helpful suggestions on the topic we were discussing.
39. The members in my group were close minded; not open to new ideas.
40. I disagree with the group's decision.
41. There was a relatively warm, easygoing atmosphere during our discussion.
42. My group reached agreement on the topic we discussed.
43. The final group ranking represents the preferences of everyone in my group.
44. I am willing to accept the group's solution as my own.
45. The final group ranking was the best decision we could make.
46. My group's ranking is correct.
47. If asked to defend the group's solution, I believe the other group members would do
so.
48. I am satisfied with the decision my group reached.

Age _____ Major _____ Class _____ Gender M F

Thanks for your time and effort! Please turn the opscan form in when you are finished.

Appendix D. Definitions of Consensus

Barzilai, Cook and Kress (1986): a combination of individual preferences to form a compromise.

Beck and Lin (1983): collective agreement or opinion.

Cook and Seiford (1978): the minimization of the summation of distances between each members' individual preferences and the decision made.

Dess and Origer (1987): the agreement of all parties to a group decision

DeStephen (1983): satisfaction and agreement with decisions made.

Gentry (1982): a decision participated in by all members of a group and representing the maximum area of common acceptance.

Hirokawa (1984): unanimous agreement regarding a group decision or solution.

Holder (1972): agreement by all parties involved in some group decision or action after discussion of pros and cons of the issues, and when all (not a majority) of the members are in agreement. Each member must be satisfied as to the ultimate course of action to be taken.

Kacprzyk and Fedrizzi (1988): the degree to which most of the important individuals agree on almost all the relevant options.

Knutson and Kowitz (1977): a group member's perception of the level of agreement that exists among group members. (This is qualified as perceived consensus.)

Price (1972): the degree of agreement on values, beliefs, and sentiments among the members of a social system.

Random House College Dictionary: 1. general agreement or concord; harmony. 2. majority of opinion.

Rawlins (1986): a method used in small groups whereby group members discuss a problematic situation until they arrive at a unanimous agreement regarding the group's decision or solution.

Scheff (1984): a composite of freely given endorsements of a decision based upon each individual's understanding that the decision represents a satisfactory degree of (1) agreement regarding pertinent normative issues, (2) cooperation among group members, (3) integration of differing perspectives.

Shils (1968): a particular state of the belief system of a society.

Tjosvold and Field (1985): a situation where all group members are encouraged to speak their own opinion and arrive at a decision everyone can support.

Tjosvold and Field (1983): all group members express their opinions, discuss the issue, and then choose an alternative they can all agree to, at least in part.

Wood (1985): a state where the views of all members are reflected in the decision(s) and the decision(s) have the acquiescence and, ideally, the support of all the group members.

Zahedi (1986): a combination of the preference responses of group members.

Appendix E. Definition of Terms

Accuracy - a measure of how close the group's consensus position is to any pre-determined position. This pre-determined position can be the absolute correct solution or the expectation of the convener.

Conflict of Interests - a special kind of conflict occurring when the actions of one person pursuing his or her own benefits interfere, prevent, or block the action of another pursuing his or her own interests (Deutsch, 1980).

Consensus - a state where a common judgment has been reached by most of those concerned. Consensus exists when a group makes and supports a decision.

Consensus Quality - some combination of the success of consensus, strength of consensus, and decision quality. (The exact combination isn't known and was not determined in this thesis.)

Controversy - a special kind of conflict when one person's ideas, opinions, conclusions, theories, and information are incompatible with another's when they discuss problems and make decisions (Tjosvold, 1985).

Convener - a person who brings a group together for a purpose. In this thesis the purpose is to achieve consensus.

Decision Quality - measured by the accuracy of the group's consensus position compared to the "correct" objective solution.

Perceived Information Importance - whether the information is relevant, informative, meaningful, important, helpful, or significant (Larker & Lessig, 1980).

Perceived Information Usableness - whether the information is unambiguous, clear, or readable (Larker & Lessig, 1980).

Perceived Information Usefulness - the usefulness attributed to an information item by a decision maker; a combination of perceived usableness and perceived importance (Larker and Lessig, 1980).

Perceived Consensus - the perception of all group members of the consensus achieved.

Precision - a measure of the correlation between individual positions.

Strength of Consensus - measured by the precision compared to the group's consensus position.

Success of Consensus - measured by the accuracy of the group consensus position compared to the expectations of the convener.

Appendix F. Exercise and Information Provided

A Test

Your spaceship has just crash-landed on the lighted surface of the moon. You were scheduled to rendezvous with a mother ship 200 miles away. The rough landing has ruined your ship and destroyed all the equipment on board, except for the 15 items listed below.

Your crew's survival depends on reaching the mother ship, so you must choose the most critical items available for the 200 mile trip. Your task is to rank the 15 items in terms of their importance for survival and their necessity to your crew in reaching the rendezvous point. Place number 1 by the most crucial item, the number 2 by the second most crucial, and so on through number 15, the least important.

- _____ Box of matches
- _____ Food concentrate
- _____ Fifty feet of nylon rope
- _____ Parachute silk
- _____ Solar-powered portable heating unit
- _____ Two .45 caliber pistols
- _____ One case of dehydrated Pet milk
- _____ Two 100 pound tanks of oxygen
- _____ Stellar map (of the moon's constellation)
- _____ Self-inflating life raft
- _____ Magnetic compass
- _____ Five gallons of water
- _____ Signal flares
- _____ First-aid kit, including injection needles
- _____ Solar-powered FM receiver-transmitter

Instructions and Information

Your group is charged with determining the relative importance of each of the 15 items so that you will know which items to take on your 200 mile trip to the mother ship. Your survival depends on making the correct choices. As a group, discuss the importance of each item and reach a consensus on the rankings of each item from one through fifteen.

The moon has many craters and cliffs you will have to navigate. It has no atmosphere, minimal gravity, and a non-polarized magnetic field. The temperature on the lighted side of the moon is extremely hot and the sun's rays can have very harmful effects. Your space suits are equipped with special apertures allowing intake of necessities. FM radio transmission works over short ranges.

Appendix G. Exercise Answers with NASA Rationale

Answers to Lost on the Moon Test

Rank	Item	NASA Rationale
1	Two 100-pound tanks of oxygen	Most pressing survival need
2	Five gallons of water	Replacement for tremendous liquid loss on lighted side
3	Stellar map (of moon's constellation)	Primary means of navigation
4	Food concentrate	Efficient means of supplying energy requirements
5	Solar FM receiver-transmitter	For communication with mother ship, but requires line-of-sight transmission and short ranges
6	Fifty feet of nylon rope	Useful in scaling cliffs, tying injured together
7	First-aid kit / injection needles	Needles for vitamins, medicines, etc. will fit special aperture in NASA space suits
8	Parachute silk	Protection from sun's rays
9	Self-inflating life raft	CO bottle in military raft may be used for propulsion
10	Signal flares	Distress signal when mother ship is sighted
11	Two .45 caliber pistols	Possible means of self-propulsion
12	One case of dehydrated milk	Bulkier duplication of food concentrate
13	Solar-powered portable heating unit	Not needed unless on dark side
14	Magnetic compass	Magnetic field on moon is not polarized, worthless for navigation
15	Box of matches	No oxygen on moon to sustain flame, virtually worthless

Appendix H. Original Instruments I Modified to Develop My Questionnaire

Larker and Lessig's (1980) Information Usefulness Instrument:

1	2	3	4	5	6	7
completely disagree			neutral			strongly agree

- A. It would be extremely difficult to complete a specification decision without at least the information presented.
- B. Extremely complex recalculations or adjustments are necessary in order to use the information presented to complete a specific decision.
- C. The information presented is sufficient to complete a specific decision.

1	2	3	4	5	6	7
none			about half			all

- D. What portion of the information presented is in the correct form for completion of a specific decision?
- E. What portion of the information presented is interpretable, without any recalculation or adjustment for the completion of a specific decision?
- F. What portion of the information presented is essential for or instrumental in completing a specific decision?

Tjosvold and Field's (1985) Constructive Controversy Instrument:

1. We had a 'we are in it together' attitude.
2. Persons expressed their own views fully.
3. Persons felt understood and accepted by each other.
4. We all influenced each other.
5. We first tried to understand the problem fully.
6. Persons tried to win by pushing and keeping their own original views. (Reverse)
7. Everyone's view was listened to even if it was in a minority.
8. Disagreeing with another's ideas was not a rejection of that person.
9. Person's tried to control each other. (Reverse)
10. We understood the problem before we sought a solution.
11. We sought a solution good and acceptable to all.
12. Opposing views aided in the full consideration of all the issues.
13. We tried to blame each other. (Reverse)
14. There was a lot of give and take.
15. All ideas were expressed before we began to evaluate them.

Knutson, Lee, and Danes' Perceived Consensus Test**(Knutson and Holdridge, 1975):**

1	2	3	4	5
completely agree				completely disagree

1. Your group reached moderate agreement on the topic you were discussing.
2. There was a relatively warm, easygoing atmosphere during your discussion.
3. Even if you had continued, your group probably would not have reached agreement on the topic you were discussing.
4. In general, the members in your group discussed the topic in an understanding and orderly manner.
5. Most of the members in your group did not make any helpful suggestions on the topic you were discussing.
6. Some of the participants in your group discussion were more close-minded and opinionated than open minded and non-opinionated.

DeStephen's Perceived Consensus Instrument (1983):

All four questions were used with a scale of one to five.

- (1) To what degree do you support the group's solution to the problem you investigated?
- (2) To what degree do you support the group's selection of the problem you investigated?
- (3) How satisfied were you with the division of labor in completing your group project?
- (4) In general, how satisfied are you with your group right now?

Appendix I. Pilot Study Data

Table 1. Individual data from my pilot study.

Subject	Quality of Initial Rank	Sum of Scale A	Sum of Scale B	Sum of Scale C	Agreement Score
1-1	68	42	68	33	24
1-2	38	55	95	50	10
1-3	56	51	78	45	12
1-4	50	57	92	58	14
1-5	46	45	88	51	14
2-1	36	55	90	49	14
2-2	72	50	113	62	4
2-3	50	50	70	36	16
2-4	62	46	76	45	8
2-5	44	48	94	59	9
3-1	30	41	92	60	8
3-2	33	49	103	64	10
3-3	28	49	106	58	10
3-4	50	52	108	62	14
3-5	26	43	108	59	6
3-6	45	34	103	61	14

The lower the number under quality of initial rank, the closer the rank was to NASA.

For scales A, B, and C, higher scores represent a higher individual perception of information usefulness, shared understanding, and strength of consensus respectively.

The lower the agreement score, the closer the individual's post discussion ranking was to the group consensus.

Table 2. Group data from my pilot study.

<u>Group</u>	<u>Average Quality of initial rank</u>	<u>Quality of Group Consensus</u>	<u>Discussion Time</u>
1	51.6	20	10 min.
2	52.8	18	14 min.
3	35.3	26	14 min.

Table 3. Cronbach's alpha scores from my pilot study.

Scale	A	B	C
N of Obs.	16	16	16
Mean	47.9	92.7	53.2
Std. Dev.	5.77	13.10	9.22
Max	57	108	64
Min	34	68	33
COEF. ALPHA	0.68	0.88	0.92

Scale A - Perceived Information Usefulness

Scale B - Perceived Shared Understanding

Scale C - Perceived Strength of Consensus

Appendix J. Main Study Data

Table 1. Individual data used for analyses.

Subject	Information* Usefulness	Shared** Understanding	Strength*** of Consensus	Individual# Agreement Score
1-1	60	127	111	0
1-2	59	116	89	16
1-3	59	119	94	14
1-4	46	78	52	22
1-5	56	105	91	8
2-1	49	119	95	14
2-2	45	105	76	22
2-3	53	121	84	14
2-4	51	123	87	18
2-5	47	120	95	14
3-2	52	115	93	15
3-3	47	100	69	18
3-4	43	97	77	4
3-5	55	126	92	10
4-1	46	116	91	4
4-2	36	105	76	16
4-3	45	103	90	12
4-4	60	99	78	16
4-5	62	121	93	14
5-1	57	140	104	10
5-2	44	147	106	8
5-3	57	103	77	18
5-4	55	137	108	2
5-5	44	128	94	22
6-1	47	127	97	12
6-2	43	112	95	18
6-3	62	127	95	30
6-4	49	116	86	8
7-1	55	113	94	28
7-2	48	122	96	14
7-3	51	123	96	14
7-4	56	118	78	18
7-5	50	130	97	16

* Summation of responses to 10 questions on a 1 - 7 scale, corrected for reversals.
 ** Summation of responses to 18 questions on a 1 - 7 scale, corrected for reversals.
 *** Summation of responses to 11 questions on a 1 - 7 scale, corrected for reversals.
 # Summation of the absolute differences between each individually ranked item and the consensus ranking.

Table 1 (continued). Individual data used for analyses.

Subject	Information* Usefulness	Shared** Understanding	Strength*** of Consensus	Individual# Agreement Score
8-1	61	116	96	13
8-2	54	121	93	16
8-3	47	99	86	12
8-4	65	130	100	8
8-5	59	126	111	12
9-1	52	111	91	16
9-2	44	111	90	20
9-3	68	121	108	10
9-4	46	129	94	6
9-5	45	121	92	12
10-1	52	133	106	8
10-2	48	128	94	14
10-3	38	121	97	12
10-4	48	124	96	6
10-5	49	124	101	12

* Summation of responses to 10 questions on a 1 - 7 scale, corrected for reversals.
** Summation of responses to 18 questions on a 1 - 7 scale, corrected for reversals.
*** Summation of responses to 11 questions on a 1 - 7 scale, corrected for reversals.
Summation of the absolute differences between each individually ranked item and the consensus ranking.

Table 2. Descriptive statistics about the independent and dependent variables.

<u>Variable</u>	<u>No. of Questions</u>	<u>M</u>	<u>SD</u>
<u>Independent Variables</u>			
Perceived Information Usefulness	10	51.4	7.0
Perceived Shared Understanding	22	118.2	12.5
<u>Dependent Variable Measures</u>			
Perceived Strength of Consensus	16	91.9	11.1
Agreement Scores		13.5	6.1

Table 3. Cronbach's alpha for each measurement instrument.

	Number of Observations	M	SD	Range	Coef. alpha
Information Usefulness	48	51.4	6.9	32	0.66
Shared Understanding	48	118.2	12.4	69	0.81
Strength of Consensus	48	91.9	10.9	59	0.92

Table 4. Group mean quality scores and discussion times.

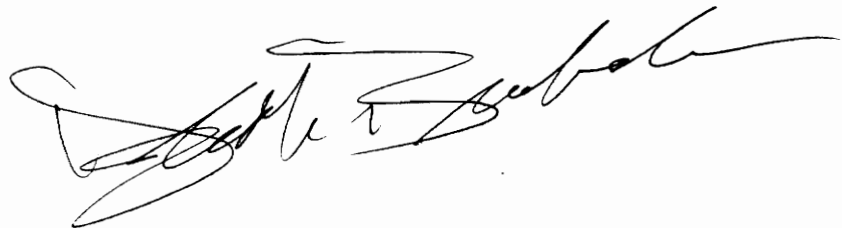
Group	n		Quality of Rankings*		Group	Discussion Time (min.)
	M	F	Mean	Std. Dev.		
1	1	4	52.4	10.71	26	7
2	1	4	50.2	11.14	14	10
3	2	2	43.0	6.22	18	6
4	2	3	43.6	15.65	22	5
5	2	3	52.4	6.69	20	16
6	3	1	40.0	6.93	32	3
7	2	3	45.8	8.67	20	5
8	2	3	37.4	9.79	20	5
9	1	4	41.4	5.55	18	5
10	1	3	56.4	14.72	30	20

* Quality is calculated by summing the differences between each item ranking for an individual or group and the ranking supplied by NASA. A lower score represents higher quality.

Vita

I, Dale Mark Brubaker, was born in Lebanon County, Pennsylvania on October 20, 1964. I grew up in Richland, Pennsylvania and graduated from Eastern Lebanon County High School in 1983. I attended Virginia Polytechnic Institute and State University (Virginia Tech), participated in the Co-Operative Education Program and graduated cum laude with a Bachelors Degree in Industrial Engineering and Operations Research in 1988. As an intern in the Industrial Engineering Department at Carpenter Technology Steel Corporation in Reading, Pennsylvania, I gained 36 months of valuable work experience.

Following graduation in 1988, I stayed at Virginia Tech and enrolled in the graduate program in Industrial and Systems Engineering. It was during this time that I decided to enroll in dual majors and completed a thesis and received a Master of Science degree in the Sports Management option of Health and Physical Education in the College of Education. With the completion of this Master of Science degree in the Management Systems option of Industrial and Systems Engineering I have accepted a Research Associate position with Management Systems Laboratories (MSL) in the Industrial and Systems Engineering Department at Virginia Tech.

A handwritten signature in black ink, appearing to read "Dale M. Brubaker", written in a cursive style.