1981


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DECISION-MAKING FORMATS: A COMPARISON ON AN EVALUATIVE TASK OF INTERACTING GROUPS, CONSENSUS GROUPS, THE NOMINAL GROUP TECHNIQUE, AND THE DELPHI TECHNIQUE

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DECISION-MAKING FORMATS: A COMPARISON ON AN EVALUATIVE TASK
OF INTERACTING GROUPS, CONSENSUS GROUPS, THE NOMINAL
GROUP TECHNIQUE, AND THE DELPHI TECHNIQUE

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Psychology

by

Robert Charles Erffmeyer
B.A., Knox College, 1976
M.A., Louisiana State University, 1979
May 1981
To
Betsy
and
My Parents
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DECISION-MAKING FORMATS: A COMPARISON ON AN EVALUATIVE TASK OF INTERACTING GROUPS, CONSENSUS GROUPS, THE NOMINAL GROUP TECHNIQUE, AND THE DELPHI TECHNIQUE

ABSTRACT

Using Steiner's (1972) model of group process and productivity, four decision-making formats: the interacting method, the consensus method, the nominal group technique, and the Delphi technique, were compared on two dimensions of an effective decision, quality and acceptance. A literature review indicated that a comparison of the effectiveness of the decision-making formats is difficult because of the prevalence of idiosyncratic modifications made to the formats. To preserve the integrity of the findings of the present study, no modifications were made in the intervention techniques.

A total of 144 male undergraduate students, working in four-person, ad hoc groups solved the NASA Lost on the Moon evaluative task. An unbiased quality measure was obtained by using the LSU scoring algorithm. Both self-report and behavioral measures of acceptance were determined.

The results indicated that as predicted, groups using the Delphi method produced significantly better quality decisions than did the groups using the interacting method. There was a significant main effect for decision-making formats on the behavioral measure of acceptance. Post-ANOVA tests revealed that, as predicted, groups using the consensus method fostered more acceptance than did groups using the interacting method, and that groups using the nominal group technique fostered more acceptance than did groups using the Delphi technique.
In addition, eight of the sixteen self-report measures of acceptance reached significance. Examination of these results indicated that the consensus method fostered the largest amount of self-reported acceptance, followed by the interacting method and the nominal group technique, while the Delphi technique fostered the least amount of acceptance.

The findings of this study add support to the claims that the results of research using modified intervention techniques may be suspect. Implications for future research using quality and acceptance measures were discussed. It was concluded that the results of this study may be of assistance to the practitioner interested in selecting the appropriate decision-making format for evaluative problem-solving situations.
INTRODUCTION

The need for effective methods of group decision making has never been greater than it is today. More and more, administrators are being faced with solving problems which require pooled judgments from people with varied backgrounds. Increasingly, important organizational decisions are being assigned to groups or committees for evaluation and recommendation. In response to this need, research in group problem solving has grown extensively. Specifically, there has been a growing effort directed at introducing new decision-making techniques and improving previously existing ones. Unfortunately, the present knowledge concerning decision-making techniques is unbalanced and poorly integrated, lacking both a uniform consideration of the techniques and an underlying conceptual framework. Data is available indicating the "better technique" of a given pair of techniques; however, the results of studies are contradictory and the studies seldom measure the same variables. In addition, the studies are plagued with idiosyncratic modifications of each technique and this only adds to the confusion as to which technique is truly more effective.

Operating without a unifying theory, present research efforts have produced a plethora of results, each claiming the superiority of one technique over the other. The net result is a practitioner
overwhelmed by conflicting reports. If the full potential of facilitative interventions is to be realized, efforts are needed to delineate further the efficacy of currently available techniques. The present research addressed these concerns by comparing the four most widely used methods for group decision making: interacting, consensus, nominal group technique and Delphi groups, in an effort to discern the effectiveness of each technique. In an attempt to bring order to the current state of confusion, Steiner's (1972) conceptual framework of group process and productivity was employed in reviewing the literature concerned with facilitative interventions.

**Group Process and Productivity**

Steiner has identified three classes of variables, 1) task demands, 2) resources, and 3) process, which determine how effectively a group can accomplish a task.

A **task demand** is a detailed description delineating the combination of resources required and the prescribed procedure which must be followed by the group if maximum productivity is to be achieved in solving the problem. In actual work situations, task demands are not presented as a written description, but consist of the understood expectancies and presumptions of the group members concerning the required resources and procedures needed to accomplish the task. A misunderstanding of the task demands would necessarily result in less than maximum productivity.

The **resource variables** include the types and amounts of the relevant (task-related) abilities, skills, knowledge, and tools actually
possessed by the group members.

Steiner states that it is possible to evaluate task demands and resources before a group begins to work. In a research setting it is possible to, not only identify these variables, but to manipulate them in studying their effect on group decision making. This is accomplished through the determination of the features of the problem to be solved and the selection of the subjects which will form the group.

Task demands and participants' resources combined determine the maximum level of productivity that can be achieved by the group. If the group possesses the full complement of resources needed to meet the task demands, it has the potential to solve the problem. However, should the resources fall short of those set forth in the task demands, the group still may possess a satisfactory level of productivity (to solve the problem), although it will not be as efficient in terms of time and quality.

Steiner has coined the term "potential productivity" to refer to the maximum level of productivity that can be achieved by a group as determined by their allotment of resources and the demands of the given task. Potential productivity is determined solely by the task demands and the resources of the participants.

Steiner has introduced another term "actual productivity" which refers to the true level of productivity that is achieved by the group. Actual productivity seldom attains the level of potential productivity. The deficit in output levels between actual and potential productivity is due to the less than maximally efficient manner in which the group may operate. Although guided by the task demands in the implementation
of their resources, a group may choose to follow a different course of action. Members may fail to allocate their resources properly or may alter from the most productive course of action to a more convenient or interesting one. Based on the past experience of the individual participants, opinions may differ as to the correct procedure to follow in certain situations, thereby leading to an uncoordinated effort in following the prescribed procedure.

Both the behaviors exhibited by a group as they organize themselves to solve a problem and those exhibited as they solve it comprise Steiner's third class of variables, the process variables. Process variables reveal the (inner) workings of the group in terms of who does what, when, and how. Steiner describes process as including members' thoughts and actions, individually and while interacting as a group, that not only serve a facilitative function, but also those that serve to frustrate or hinder the group.

The process variables, unlike task demands and resources, cannot be measured before the group begins to work. The behaviors considered in process are interdependent, i.e., the occurrence of one behavior may be influenced by the preceding behavior, and it in turn, may influence the following behavior. The closer the process behaviors follow the dictates of the task demands, the closer the actual productivity will be to the potential productivity. Should the process variables deviate from those required by the task demands the difference between actual and potential productivity will increase.

To reiterate, task demands dictate what resources will be needed and how they should be utilized. Task demands are seldom
specified in concrete detail and may be misunderstood or unclear to group members, thereby reducing the effectiveness of the group. Combined, the task demands and available resources determine the maximum level of productivity, or the potential productivity. Anything less than maximum productivity may be attributed to the manner in which the group solved the problem, or process losses. The more appropriate the group's process is to that detailed in the task demands, the closer actual productivity corresponds to potential productivity. Steiner has presented the following equation to summarize his position.

\[ \text{Potential Productivity} - \text{Losses due to faulty process} = \text{Actual Productivity} \]

**Types of Tasks**

Steiner notes that whether or not a group can perform a task and how well the group can perform it is dependent upon the nature of the task it is to perform. The nature of the task dictates the type of resources required, be it knowledge, abilities or tools, and how much of each type of resource is necessary to produce a high level of success. Task demands often specify the specific process members of a group must employ in order to produce the highest quality product possible from their available resources.

Tasks used in problem-solving studies can be categorized on the basis of the requirements they impose on groups. Problem solving can be defined as the restructuring of a problem into two sequential subproblems, 1) a fact finding phase, and 2) an evaluative phase (Bales and Strodbeck, 1951; Simon and Newell, 1958). Each subproblem or phase
requires different resources and task demands. Bales and Strodbeck (1951) found that groups begin in the fact finding stage of the problem-solving process with problems that have an emphasis on the generation of information; they then shift their emphasis to problems of evaluation and the recombination of ideas into problem-solving strategies.

The first type of problem, generative problems, poses a group with a question to which they must generate as many solutions as possible. Examples of this type of problem are "Define the specific activities that should be included in a dormitory counselor's job description," (Van de Ven, 1974; Van de Ven and Delbecq, 1974), or "List the barriers to achieve total highway safety," (Carr, Green, and Hughes, 1977). Other investigators who have used this type of problem in comparing procedural formats include Bouchard (1972 (a); 1972 (b)), Bouchard, Barsaloux, and Drauden (1974), Bouchard and Hare (1970), Geren (1978), Green (1975), and Stumpf, Freeman, and Zand (1979).

The second type of problem, evaluative problems, requires a specific answer or set of answers for a problem having a predetermined correct solution. Examples of this type of problem include exercises such as the NASA Lost on the Moon exercise (Hall and Watson, 1970), the Lost at Sea exercise (Nemiroff and Pasmore, 1974), Twelve Angry Men (Hall, Blake, and Mouton, 1963), and estimating the subjective likelihood of a known condition (Gustafson, Shulka, Delbecq, and Webster, 1973). A few researchers have used problems that combine both the generation phase and evaluation phase of decision making into a single problem (Maier, 1952; Miner, 1979; Vroom, Grant, and Cotton, 1969).
Such a variety of problems has produced a wide array of assessment measures for judging decision effectiveness, which has not made for ready comparisons. Generative problems have usually been scored in one of two ways: 1) a count is made of the number of unique responses, or 2) this count is combined with a judgment on the quality of the responses as determined by a panel of judges. In evaluative problems the effectiveness of a decision is determined by comparing the group's response with the problem's "correct" solution. With problems using the combined generative and evaluative format, decisions have been evaluated in the same fashion as with generative problems, quantity and merit are determined by judges. Some studies have gone beyond an objective quality measurement and have included a subjective measure such as acceptance (Hoffman, 1979; Hoffman, Burke, and Maier, 1965; Lane, Mathews, Chaney, Erffmeyer, Reber, and Teddlie, 1980; Mathews, Lane, Reber, Buco, Chaney, and Erffmeyer, 1980; Miner, 1979), perceived satisfaction (Geren, 1978; Van de Ven, 1974; Van de Ven and Delbecq, 1974), or an attitude measure (Nemiroff and King, 1975; Nemiroff, Pasmore, and Ford, 1976).

**Decision Properties**

In describing the properties of a decision, Maier (1952; 1963), has identified two dimensions of effective decision making, quality and acceptance of decisions. Hoffman (1979) and Vroom and Yetton (1973) have also noted this distinction between the quality and acceptance of decisions. Maier's first dimension, quality, is defined as the degree of closeness to the objectively correct solution to a problem. The
second, the acceptance dimension, represents the degree to which the members of the group support the decision. Effective decisions must contain a high degree of the quality and the acceptance components. A decision that is high in quality but low in acceptance may never be implemented by group members. Conversely, a low quality, high acceptance solution may have no difficulties in being implemented, but may not adequately solve the problem. Maier, in his research, has persuasively demonstrated these principles throughout his productive career in problem-solving research (Solem and McKeachie, 1979).

Research comparing the effects of facilitative formats on generative problems has concentrated primarily on a different dependent variable, quantity. While some studies secondarily examined a quality measure (e.g., Carr, Green, and Hughes, 1977; Green, 1975; Stumpf, Freeman, and Zand, 1979), only one (Van de Ven, 1974; Van de Ven and Delbecq, 1974) has reported a measure of satisfaction (perceived satisfaction) and all have virtually ignored an acceptance measure.

The explanation given for the use of quantity variables is that unless a sufficient number of ideas are generated in the first phase of the problem-solving task, there will be a shortage of ideas to be considered in the evaluative stage, thereby limiting the potential quality of the decision making (Van de Ven, 1974). However, some researchers have criticized this type of measurement. Springborn (1963) found a negative correlation between the number of alternative solutions suggested by a group and the quality of its final product. Stumpf, Freeman, and Zand (1979) argued that counting the number of unique ideas was a limited criterion. Quantity measures fail to
consider both the quality and acceptability of a solution to a group, in addition to creating a negative bias toward groups that spend time improving these dimensions rather than developing additional novel solutions.

The second phase in problem solving, idea evaluation, is relatively immune from the criticisms associated with quantity measures. In addition, it should be noted that inferences from generative problem-solving studies are not considered valid when made in reference to evaluative problems (Van de Ven, 1974).

The majority of the studies comparing the effects of different procedural formats on evaluative tasks have used a quality measure, with a portion of these studies using some type of an additional measure of acceptance. Thus, the following review of the literature outlines the development of four decision-making formats, interacting, consensus, the nominal group technique, and the Delphi technique, focusing on their effectiveness on evaluative tasks. Only the quality and acceptance measures were highlighted. Steiner's conceptual model of group process and productivity was used in an attempt to structure a coherent review.

Decision Formats

Steiner notes that not all decision formats are equal; some promote higher levels of productivity than others. A group may have a procedural format imposed upon it by the environment or by an outside body, as is often the case in many organizational committees. Should a group have a format imposed upon it, the group is relieved of the
responsibility of structuring or organizing itself, which is part of the process variables. Since some formats dictate what the potential productivity of the group may be, the actual productivity may, in turn, be dictated by the appropriateness of the imposed format in matching the group's resources.

Whether imposed or selected, the format the group operates under is subject to certain process losses which decrease the actual productivity, or effectiveness. This review of the decision-making literature shall compare the effectiveness of the four different decision-making formats in an effort to determine which formats tend to promote higher levels of productivity.

A group without an imposed structure or format must, consciously or not, develop some form of organization before beginning work. Unstructured groups such as these, referred to as interacting groups, comprise the first category of interest in this study.

**Interacting Groups**

The interacting group is the most commonly used format for decision-making groups. Typically, a leader presents a problem and the group discusses it; there is no prearranged structural format and group members are permitted to interact in any manner. Decisions are often based on a majority rule vote. Many decision-making studies investigating facilitative intervention techniques include an interacting group as a control, or no treatment group, as a basis for comparison. The studies that have demonstrated a particular intervention technique to be more effective than an unstructured interacting group will not be elaborated upon at this time, rather they will be
included in the discussion of the studies dealing with that particular intervention technique. However, the process losses associated with the interacting group will be discussed at this time.

Based on previous research, Maier (1967) outlined what he considered to be the liabilities, or process losses of problem-solving groups using an interacting format.

1) Social Pressure. Social pressure is a major force that tends to produce conformity. The desire to be a good group member and to be accepted tends to silence disagreement and favors consensus.

2) Individual Domination. In most leaderless groups a dominant individual emerges and captures more than his share of influence on the outcome. He can achieve this end through a greater degree of participation (valence), persuasive ability, or stubborn persistence (fatiguing the opposition).

3) Conflicting Secondary Goal: Winning the Argument. When faced with several feasible alternative solutions, members often develop preferences; once these emerge the desire to support a position is created. More and more the goal becomes that of winning the decision rather than finding the best solution.

Maier (1967) also contended that, depending upon the organization and integration of a group, certain factors could be perceived as either advantageous or disadvantageous to the group's functioning. The skill of the group's discussion leader was noted by Maier to be the key to whether the following factors served as an asset or liability for the group.

1) Disagreement. The fact that discussion may lead to disagreement can serve either to create hard feelings among members or lead to a resolution of conflict.

2) Conflicting Interests versus Mutual Interests. Some problems are stated in a manner that reveals several separate problems. If discussion is not synchronized to a certain part of the problem, each member may be engaged in discussing a different aspect.
3) **Risk Taking.** Groups are more willing than individuals to reach decisions involving risks which may lead to a gain or loss.

4) **Time Requirements.** Generally more time is required for a group to reach a decision than for a single individual to reach one. However, the practice of hastening a meeting can prevent full discussion of the problem.

5) **Who Changes.** Social pressures may cause the member with the most constructive views to change and as a result the end-product suffers; however, if persons with the least constructive points of view change, the end-product is upgraded.

In addition to Maier (1967), other researchers have documented the process losses which operate in interacting groups (Campbell, 1968; Collins and Guetzkow, 1964; Collaros and Anderson, 1969; Dunnette, Campbell, and Jaastad, 1963; Hall and Williams, 1970). However, one of the most exhaustive compilations of process losses in interacting groups is by Delbecq, Van de Ven, and Gustafson (1975), Van de Ven (1974), and Ven de Ven and Delbecq (1971; 1974). The following is their list of potential process losses:

1) A "focus" effect wherein interacting groups "fall into a rut" and pursue a single train of thought for long periods (Dunnette, 1964; Torrance, 1957).

2) The "self-weighting" effect, wherein an individual will participate in the group to the extent that he feels equally competent with others (Collaros and Anderson, 1969; Kelly and Thibaut, 1954).

3) The fact that covert judgments are made but are not expressed as overt criticisms (Collaros and Anderson, 1969).

4) The inevitable presence within most organizational groups of status incongruities, wherein low-status participants may be inhibited and "go along" with opinions expressed by high-status participants, even though they feel their opinions are better (Vroom, Grant, and Cotton, 1969).

5) Group pressures for conformity and implied threat of sanctions from the more knowledgeable members (Dalkey and Hilmer, 1963; Hoffman, 1965).
6) The influence of dominant personality types upon the group (Dalkey and Hilmer, 1963).

7) The amount of time and effort spent by the group to maintain itself (Dalkey and Hilmer, 1963; Dunnette, 1964). As orientation to maintain group interaction increases, quality of solution decreases (Campbell, 1968).

8) A tendency to reach "speedy decisions" before all problem dimensions have been considered (Delbecq and Van de Ven, 1971; Maier and Hoffman, 1960).

Van de Ven and Delbecq (1971) conclude that these inhibitive factors may prevent the latent resources of group members from emerging in an interacting group.

**Consensus Groups**

A second decision-making format a group may adopt is that of a consensus group. Consensus groups allow members to have unstructured interaction, just as does the interacting group format. However, in the discussion process of the consensus group, members are generally instructed to follow specific guidelines which are designed to foster certain conflict-resolving behaviors used to achieve general agreement. The following is a list of guidelines commonly used in consensus group research (Hall and Watson, 1970; Nemiroff and King, 1975; Nemiroff, Pasmore, and Ford, 1976):

1) Avoid arguing for your own rankings. Present your position as lucidly and logically as possible, but consider seriously the reactions of the group in any subsequent presentations of the same point.

2) Avoid 'win-lose' stalemates in the discussion of rankings. Discard the notion that someone must win and someone must lose in the discussion; when impasses occur, look for the next most acceptable alternative for both parties.

3) Avoid changing your mind only in order to avoid conflict and to reach agreement and harmony. Withstand pressures to yield which have no objective or logically sound
foundation. Strive for enlightened flexibility; avoid outright capitulation.

4) Avoid conflict-reducing techniques such as the majority vote, averaging, bargaining, coin flipping, and the like. Treat differences of opinion as indicative of an incomplete sharing of relevant information on someone's part and press for additional sharing, either about task or emotional data, where it seems in order.

5) View differences of opinion as both natural and helpful rather than as a hindrance in decision making. Generally, the more ideas expressed the greater the likelihood of conflict will be; but the richer the array of resources will be as well.

6) View initial agreement as suspect. Explore the reasons underlying apparent agreements; make sure that people have arrived at similar solutions for either the same basic reasons or for complementary reasons before incorporating such solutions in the group decision.

The application of the consensus guidelines differentiates the consensus format from the unstructured format of the interacting group and thereby constitutes a facilitative intervention technique (Hall and Watson, 1970; Nemiroff and King, 1975; Nemiroff, Pasmore, and Ford, 1976).

Consensus guidelines were developed in an effort to overcome two process losses identified by Hall and Watson (1970) in an earlier study (Hall and Williams, 1970) which demonstrated the efficacy of laboratory training for improving group processes. Hall and Watson noted that two procedural factors differentiated the performance of the untrained groups from that of trained groups. The first factor, or process loss, was identified as a "strain toward convergence". Untrained groups demonstrated a rapid coalescence in resolving their task in order to reach a decision and discharge their assigned responsibility. Furthermore, the closer the group came to reaching their
decision, the more the impact of the strain toward convergence became evident. The convergence strain predominated to the point that the importance of the decision task and the members' emotional reactions became secondary to the endeavor for closure. Trained groups, on the other hand, avoided premature convergence and even promoted individual expression of opinions and ideas in the early stages of the task.

The second factor, directly related to the convergence strain phenomenon, concerned the resolution of conflict. Untrained groups' opinion differences served to frustrate the groups' implicit goal of quick adjournment. Consequently, untrained groups employed quick decision-making techniques, such as majority rule, to quickly resolve an issue so that the group might continue. As the group approached convergence, they became progressively less tolerant of opinion differences. Conversely, trained groups encouraged conflict, which they perceived as an indication of incomplete sharing of information among members. Differences of opinion were seen as a natural outcome of a group situation and therefore produced little frustration among members.

Hall and Watson (1970) introduced the consensus guidelines in an attempt to break the convergence strain phenomenon and to legitimatize certain adaptive group behaviors. The guidelines were designed to promote opinion sharing by directing the group toward a consensual resolution of conflict. Hall and Watson conducted their study to test the assumption that a group's performance is a function of the member's opinion of their potential as a group and their shared perceptions of what constitutes appropriate member behavior. The
results of the study indicated that the groups receiving the consensus guidelines outperformed the uninstructed groups on group effectiveness are reflected by several measures of decision quality. Interestingly, the two groups did not differ in the amount of time required to reach their final decision. The performance differences were attributed to the utilization of the consensual decision guidelines by the instructed group. It was inferred that the uninstructed groups performed less effectively because, in the absence of the consensus guidelines, they resorted to more traditional methods of decision making such as majority rule.

Nemiroff and King (1975) extended Hall and William's (1970) and Hall and Watson's (1970) work with consensus guidelines by combining self-reports with observer reports to verify the decision-making processes used by groups in an evaluative task, the NASA Lost on the Moon exercise (Hall and Watson, 1970). Nemiroff and King (1975) employed a slightly modified version of the consensus guidelines used by Hall and Watson (1970) in which group members were asked to follow in resolving conflict. Observers recorded the frequency of use of conflict-reducing techniques such as majority vote, averaging of rankings, and trading. The length of time to complete the task, within an imposed 40 minute limit, was also recorded. After finishing the task, group members completed a questionnaire assessing their reactions to their group's performance in terms of satisfaction with the group's decisions, satisfaction with their own performance, and perceived group effectiveness. The results of the study indicated that the instructed groups produced a significantly better quality of decision than was
produced by the uninstructed groups when adjusted for pre-discussion resources. Nemiroff and King suggested that the consensual technique employed by the instructed groups promoted a fuller sharing of ideas among participants while uninstructed groups resorted to the decision styles of majority vote, averaging, and trading.

Nemiroff and King (1975) found that the instructed groups used almost 50 percent more time in reaching their decisions on the experimental task than did the uninstructed groups. This finding is in conflict with earlier studies (Hall and Williams, 1970; Hall and Watson, 1970) which reported that instructed (trained) groups required an equal amount of time to complete the task as did the uninstructed groups.

Nemiroff and King (1975) found no differences between instructed and uninstructed subject's reactions to questions concerning their satisfaction with group decisions, satisfaction with self-performance, and perceived group effectiveness. Thus, Nemiroff and King noted that although consensual decision techniques permit increased member involvement in the decision process, they do not necessarily increase acceptance of the group's final decision, nor do they necessarily foster favorable attitudes toward working in groups.

However, the consensus method promotes certain behaviors that reduce the potential for process loss. The consensus guidelines reduce the likelihood of social pressure and individual dominance by encouraging open expression of disagreement. Moreover, they increase the likelihood that conflict is regarded as a natural occurrence in an open discussion; thus differences of opinion are viewed as helpful and members are not preoccupied with the secondary goal of promoting their
Nominal Group Technique

The nominal group technique is a structured method of group decision making. Group members silently and independently generate possible solutions to the decision-making task. Following this silent period, members take turns in a round-robin fashion explaining their ideas which are recorded for the group. This is followed by an interaction period where members may seek clarification and elaboration of particular ideas that they may not fully understand. In the final stage, members secretly vote on the ideas presented; the votes are then pooled yielding a ranked order of solutions.

It is important to differentiate between the term "nominal group" and the "nominal group technique" in reference to decision-making studies. The term nominal group has been used to refer to groups of individuals who have been brought together to collectively form a group. No verbal interaction is permitted and typically the effect of the presence of other people on productivity is studied (Vroom, Grant, and Cotton, 1969). The concept of the nominal group technique was developed by Andre' L. Delbecq and Andrew Van de Ven (Van de Ven, 1974; Van de Ven and Delbecq, 1974). The method of decision making was derived from social-psychological studies of decision conferences and policy board and program planning committees in community agencies requiring the participation of low income people.

Delbecq and Van de Ven report having much success with the implementation of this intervention technique in health agencies, social service, education, industry, and in public administration
agencies (Delbecq and Van de Ven, 1970; 1971; Delbecq, Van de Ven, and Gustafson, 1975; Delbecq, Van de Ven, and Wallace, 1972; Van de Ven, 1974; Ven de Ven and Delbecq, 1971; 1972(a); 1972(b); 1974). The technique has received further acceptance as a facilitative intervention (Ford and Nemiroff, 1975) useful in determining training needs (Green, 1974), improving communication problems (Green and Pietri, 1974; Huseman, 1972; Huseman, Lahiff, and Well, 1974; Knippen and Van Voorhis, 1974; Vroman and Green, 1974) and in organizational development strategies (Mosley and Green, 1974).

Delbecq and Van de Ven (1974), Delbecq, Van de Ven, and Gustafson (1975), and Van de Ven (1974), attribute the effectiveness of the technique to the imposed structured process, which is based on past research. The imposed structure of the nominal group technique acts to increase the potential productivity of a decision-making group. Van de Ven and Delbecq believe the following research to substantiate their claims about the nominal group technique. They feel that nominal technique groups:

1) Stimulate creative tension by means of the presence of others, the silence, and the evidence of activity. This tension is important for the individual commitment to the search process. Thus, the social facilitation of the group setting is retained and amplified (Dalton, 1970).

2) Avoid evaluation or elaborating comments while problem dimensions are being generated (Maier and Hoffman, 1960).

3) Provide each individual time and opportunity to engage in reflection (search) and force participants to record their thoughts (Dunnette, 1964; Horowitz and Newman, 1964; Maier and Solem, 1952).

4) Avoid the dominance of group output by strong personality types (Maier and Maier, 1957).

5) Prevent premature closure to the alternative search process.
and decision making (Bennett, 1955; Maier and Hoffman, 1960).

6) Allow all participants to share in the opportunity for influencing the direction of group-decision outcome (Goldman, Bolen, and Martin, 1961; Pelz, 1956).

7) Encourage the generation of minority opinions and ideas, which consequently are more likely to be voiced (Maier and Solem, 1952).

8) Tolerate conflicting, incompatible ideas since all ideas are revealed in writing (Deutsch, 1949; Guetzkow and Gyr, 1954).

9) Alleviate "hidden agendas" or covert political group dynamics which are difficult to develop when writing (Fouriezos, Hutt, and Guetzkow, 1950).

10) Induce a sense of responsibility in the members to achieve group success (Benne and Sheats, 1948).

11) Impose a burden upon all participants to work and produce their share in the necessary task (Bales, 1953; Deutsch, 1949).

12) By means of written expression, induce a greater feeling of commitment and a greater sense of permanence than does spoken expression (Bouchard, 1969; Horowitz and Newman, 1964).

13) Separate ideation (problem-identification) from evaluation (solution-getting) which is superior to group processes which combine them (Brilhart and Jochem, 1964; Maier, 1958; Maier and Hoffman, 1960; Maier and Maier, 1957).

14) Increase the quality of performance by employing processes which (a) retard speedy decisions, and (b) cause the group to perceive the task with an attitude of "problem-mindedness" as opposed to "solution-mindedness" (Maier, 1958; Maier and Solem, 1952).

15) Make use of structured group processes which facilitate problem solving by (a) specifying role requirements (Taylor, Berry, and Block, 1958) and (b) structuring communication networks (Leavitt, 1951).

16) Incorporate the round-robin process in the group process which facilitates self-disclosure of ideas, even by less secure members who may hesitate to bring some problem dimensions before the group in the conventional interacting situation (Culbert, 1968).
Van de Ven and Delbecq (1971, p. 210) have repeatedly applied their technique on problems requiring idea generation and have specified that:

When the task requirement of a group is fact-finding or information generation, use of nominal processes are suggested by the research. When the problem requires information synthesis, evaluation, or group consensus, interacting group processes are prescribed (Delbecq and Van de Ven, 1971; Dunnette, 1964; Maier and Hoffman, 1960).

The above statement may explain why a technique that has generated many reports of "applied" success and research studies using generative tasks (Carr, Green, and Hughes, 1977; Chung and Ferris, 1971; Geren, 1978; Green, 1975; Stumpf, Freeman, and Zand, 1979; Van de Ven, 1974) has produced a paucity of research using evaluative tasks.

In one of the very few studies employing an evaluative task, the Lost at Sea exercise (Nemiroff and Pasmore, 1975), with the nominal group technique, Nemiroff, Pasmore, and Ford (1976) compared performance and attitude measures and the time required to complete the task in decision-making groups using either the nominal group technique (Van de Ven and Delbecq, 1974), the consensus approach (Hall and Watson, 1970; Nemiroff and King, 1975), or the interacting group format. On three measures of performance, consensus group decisions were significantly better than the decisions of the interacting groups; there were no differences between the decisions reached by the nominal and the interacting groups. The nominal technique groups were outperformed by the consensus groups on only one performance measure, quality.

Group member's satisfaction with their group's decisions and
with their own performance, and general attitudes toward the experiment were assessed by a 14-item post-experimental questionnaire. The findings revealed a consistent pattern for items assessing the perceived quality of a group's decision and self-satisfaction with participation and performance. Members of consensus groups believed their decisions to be better and were more satisfied with their decision than were interacting group members. There were no differences found between nominal and interacting groups, and nominal and consensus groups on any of the 14 items. Nominal groups completed the task in significantly less time (19.39 minutes) than did either consensus (28.22 minutes) or interacting groups (27.50 minutes). There were no time differences found between consensus and interacting groups, a finding which was contrary to Nemiroff and King (1975) but consistent with Hall and Williams (1970) and Hall and Watson (1970).

In summary, the groups using the consensus format were more effective than the groups using the interacting format and, in one case, than those using the nominal group technique on performance and attitude measures. Nemiroff et al. (1976) suggested using the nominal group technique in situations where time is a critical factor and the desired quality of the group decision is high but not the utmost.

A recent study by Herbert and Yost (1979) compared the effectiveness of interacting groups and groups using the nominal group technique in solving the NASA Lost on the Moon exercise (Hall and Watson, 1970). Herbert and Yost (1979) modified the nominal group technique by eliminating the second silent voting phase and replaced it with group discussion voting. This modification in the process of the
nominal group technique has been described by Holloman and Hendrick (1971) as a "judgment-discussion-judgment" approach rather than the nominal group technique. The results on three performance measures revealed that the decision of the modified nominal group technique groups were better than those of the interacting groups. This finding was contradictory to that of Nemiroff, Pasmore, and Ford (1976). Herbert and Yost explained that this difference may be due to their modification in the nominal group technique to include a consensus seeking phase in the final voting stage.

Neither Nemiroff, Pasmore, and Ford (1976) nor Herbert and Yost (1979) offered insight as to what process losses might be operating in groups using the nominal group technique. However, Van de Ven (1974), Van de Ven and Delbecq (1974), and Delbecq, Van De Ven, and Gustafson (1975) observed several deficiencies in the technique. During the discussion phase the possibility exists that the interactions of the group members may promote frustration and result in a fractionated group.

A second process loss may result from the dissatisfaction of group members with the highly structured process of the nominal group technique. The implementation of the process requires advanced planning to prepare materials and the structured format allows for only one presentation of a topic during the meeting. The imposed structure requires conforming behavior from all participants, a condition which may be uncomfortable to some group members.

The nominal group technique helps to eliminate several process losses. The technique calls for a round-robin presentation of
individual decisions which provides equal opportunity for all members to express ideas and encourages minority opinions. Furthermore, the final group decision is the product of pooled individual votes which are cast in secret. Thus, the effects of social pressure and individual dominance are less likely to influence the nominal technique group's productivity.

**Delphi Technique**

The final decision-making technique to be reviewed is the Delphi technique. The Delphi concept was originated in the early 1950's in the Air Force sponsored defense research, "Project Delphi", conducted by the RAND Corporation (Dalkey and Helmer, 1963). The research focused on the use of expert opinion and had the objective to "... obtain the most reliable consensus of opinion from a group of experts ... by a series of intensive questionnaires interspersed with controlled opinion feedback" (p. 458).

Participants in Delphi groups never assemble nor do they know the identity of the other members. After receiving the decision-making task, members are free to develop solutions at their own leisure. Upon completion of the task they return their input to a central monitoring committee which then pools the members' responses and comments. The pooled information is returned to the group members who may then compare their responses to those of the other participants and, if they wish, may change their opinions or add further comments. This information is again returned to the monitoring committee for collation of the responses. This reiterative process may continue until there is a convergence of opinion or until a point of diminishing returns is
reached.

Delphi studies have been conducted in a variety of settings. Originally the Delphi technique was used in long-range forecasting particularly in highly technological organizations. However, Delphi studies have also been conducted to evaluate the quality of life (Dalkey, Rourke, Lewis, and Synder, 1972), to evaluate possible budget allocations, to identify possible advantages and disadvantages of potential policy options, to plan curriculum development, and in health care planning (Linstone and Turoff, 1975).

Although cases employing the Delphi technique number in the thousands, one of the technique’s developers, Olaf Helmer (1975), noted that the Delphi method still lacks a sound theoretical base. Helmer suggested that this deficiency is a result of a lack of scientific study examining the process of the technique, probably stemming from the fact that by definition the Delphi technique is concerned with the use of experts and that experts in any field rarely are available as laboratory subjects.

Widespread use of the Delphi technique has led to many variations in format and implementation among practitioners. Disagreement still exists among practitioners on several points (Turoff, 1970):

1) Should the identity of the respondent group be anonymous among its members, to the monitoring team, and to the recipients of the Delphi findings?

2) Should open-ended or closed-ended questions be used to obtain information from the respondent group?

3) How many iterations of questionnaires and feedback reports are needed?

4) What should be included as feedback and what should be eliminated?
5) How much time is the respondent group allowed?

6) Do emotional arguments convey content that should be retained in the exercise?

Turoff (1970) states that there are no hard and fast rules to guide the design of a Delphi group. He further states that subjective judgments must be made by the monitoring committee regarding the quantity of information retained in the feedback reports. This judgment should be guided by the needs of the recipients of the final Delphi product.

The aforementioned uncertainties associated with the design and implementation of the Delphi process have produced some criticisms of the technique. Sackman (1975), the most vocal of the critics, claims that most Delphi studies are unscientific and that a psychometrically sound questionnaire would produce more effective results than would a Delphi study. Reaction to Sackman's critique has been strong: according to Goldschmidt (1975) many of Sackman's claims are out of context or unfounded. Even though there have been some poorly developed applications of the technique, many of Sackman's conclusions about past Delphi research are inappropriate. For example, Sackman evaluated the fitness of the Delphi technique by comparing it with the "Standards for Educational and Psychological Tests" published by the American Psychological Association specifically to apply to standardized tests; Delphi proponents point out that the Delphi technique was not conceived as a psychological or educational test nor has it been used for those purposes (Coates, 1975; Goldschmidt, 1975; Jillson, 1975; Scheele, 1975).

Dalkey, one of the earlier researchers working on Project
Delphi at the RAND Corporation, is one of few who has compared the effectiveness of the Delphi technique with other decision-making formats (Dalkey, Rourke, Lewis, and Synder, 1972). Dalkey (1968; 1969) conducted two studies that compared the effectiveness of groups using face-to-face discussion (interacting groups) with groups using four rounds of anonymous questionnaire feedback (Delphi groups). Participants solved almanac type questions (e.g. How many telephones were there in the United States in 1954?) and were given feedback in the form of medians and quartiles for responses from the previous rounds. The decisions of the Delphi groups were found to be more accurate than the decisions of the interacting groups. Although there were no statistically significant differences between the two decision-making formats, Dalkey (1972) stated that "When this experiment is considered along with several others showing the same kind of outcome, the results appear more significant" (p. 24).

Campbell (1966) also compared four-round Delphi groups with face-to-face groups (leaderless interacting groups). Campbell concurred with Dalkey, finding Delphi groups to be more effective on economic forecasting problems than were face-to-face groups.

Gustafson, Shulka, Delbecq, and Walster (1973) were the first researchers to compare the effectiveness of the Delphi technique with the nominal group technique; interacting groups and individuals were also included in their study. A fuller appreciation of the results of this study might be gained if the similarities and the contrasts of the group processes in the Delphi technique and in the nominal group technique are noted (Table 1). Both interventions follow a sequence of
Table 1

Group Processes in the Delphi Technique and the Nominal Group Technique (NGT)

<table>
<thead>
<tr>
<th>Group Process</th>
<th>Delphi</th>
<th>NGT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants required to write down their solutions.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Information about other members' solutions are presented in writing.</td>
<td>Yes (monitoring committee)</td>
<td>Yes (on NGT board)</td>
</tr>
<tr>
<td>Clarification of Questions</td>
<td>Yes (through written feedback)</td>
<td>Yes (orally in round-robin)</td>
</tr>
<tr>
<td>Voting procedure: secretly, then arrive at a final ranking through a pooled vote</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Identity of respondents is anonymous.</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Members meet face to face</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Presence of dynamics of social interaction</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Modes of communication:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>written</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>visual</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>oral</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
structured group processes which tend to minimize some of the process losses associated with interacting groups (Delbecq, Van de Ven, and Gustafson, 1975; Van de Ven, 1974; Van de Ven and Delbecq, 1971).

Although there are a number of similarities between the Delphi technique and the nominal group technique, Gustafson et al. (1973) found major differences between groups using the two formats on problems requiring subjective likelihood estimates (e.g. The observed height of a person is 68 inches. Is the person more likely to be a male or female? How much more likely?). Results indicated that groups using the nominal group technique were superior to the other three decision-making formats; interacting groups were second best, followed by individual estimates, and the two-round Delphi technique, respectively. The written feedback process employed by groups using the Delphi technique appeared to lead to a reduction of quality in the groups' performance and thus acted as a process loss (Gustafson et al., 1973). Gustafson et al. speculated that the feedback without clarification may have led to distortion of the feedback information.

An implication of the Gustafson et al. (1973) study is that discussion and/or the social factors present in groups using the nominal group technique may serve to increase a group's potential productivity. A corollary to this may be that the lack of discussion and/or the lack of social factors may operate as a process loss in groups using the Delphi technique. Contrary to this viewpoint, both Dalkey and Helmer (1963) and Turoff (1970) stress that the absence of a group setting facilitates decision making in the Delphi technique as the respondents are anonymous and the fear of potential repercussions
and embarassment are removed.

However, any conclusions based upon the findings of the Gustafson et al. (1973) study may be premature. Van de Ven and Delbecq (1974) proposed that the poor performance of the Delphi process may be explained by "invalid experimental manipulations and testing" by Gustafson et al. In an attempt to defray the costs of the extensive interrogation and questionnaire feedback required by the Delphi technique, a variant of the Delphi process called estimate-feedback-estimate was concocted. This process required the participants to exchange answers through written communication in the presence of the other group members. Van de Ven and Delbecq (1974) noted that working in the presence of others permitted social facilitation. The "unnaturalness" of communicating to other group members through written messages while in their presence may have induced negative social facilitation.

Miner (1979) extended the work done by Gustafson et al. (1973) to include not only groups using the Delphi technique and the nominal group technique but also groups using the approach of "Problem Centered Leadership" (PCL). The PCL approach to decision making calls for a special type of interacting group centered around the effective use of a discussion leader trained in the principles of leadership developed by Maier (1952; 1963). The task that Miner's groups were asked to perform was a role-playing exercise entitled "Change of Work Procedures" (Maier, 1952). The Delphi groups were continued until a consensus was reached or for a maximum of seven rounds.

The result indicated that there were no differences between
the three decision-making formats on measures of quality or acceptance. Acceptance was evaluated by a single question asking the participants to respond on a ten-point Likert-scale as to how they felt about the decision reached by the group. An analysis of the effectiveness measure, determined by multiplying the quality scores by the acceptance scores, revealed that groups using the PCL approach had scores superior to groups using the other two decision-making formats. There were no differences between groups using the Delphi technique and the nominal group technique on measures of effectiveness.

Miner (1979) suggested that groups using the Delphi technique or the nominal group technique incur a process loss due to their structured approach which centers on the quality dimension of problem solving and consequently neglects the acceptance dimension. This conclusion may be questionable based on the fact that the acceptance scores of the three decision-making formats were nearly equal. It was the impact of the quality score on the effectiveness measure of the PCL approach that differentiated it from the other two approaches.

Miner's (1979) findings lend themselves to criticism on several other points. The choice of a role-playing exercise as the task of the Delphi and the nominal technique groups may in itself bias the findings of the study due to the inherent requirements of the task. It should also be noted that the groups using the PCL approach did not receive all the materials concerning the task that were given to the Delphi and the nominal technique groups, which may have limited discussion concerning the omitted materials in the PCL groups. The strongest criticism leveled against this study concerns the
implementation of the Delphi technique. Miner's use of the Delphi process smacks of the same invalid experimental manipulations observed in Gustafson et al. (1973). Group members using the Delphi process were "... assigned to a predetermined seating arrangement so they could not ascertain their group composition." Manipulation such as this violates many of the basic principles of the Delphi technique, e.g., members do not meet face to face, and certainly opens the group to being susceptible to the negative social facilitation described by Van de Ven and Delbecq (1974).

The Delphi technique was compared with the social judgment analysis method of decision making in a study by Rohrbaugh (1979). The social judgment analysis method of decision making entails having group members solve a problem in an interacting group format, however, the focus of attention is centered on the cognitive feedback influencing members' decisions rather than on decision outcome. Cognitive feedback is comprised of the personal preferences of individual members and the importance assigned each preference by that member.

No differences were found between the two decision-making formats on quality measures. However, the social judgment analysis method was significantly better at reducing disagreement than was the Delphi technique. Rohrbaugh (1979) explained this finding by noting that participants using the social judgment analysis developed "cognitive maps" of the logic used by other group members in reaching a decision, which helped to pinpoint areas of disagreement. The author noted that groups using the Delphi process may have been subject to
process losses because of their lack of discussion and understanding of other members' logic in reaching decisions.

**The Present Research**

**Purpose**

Taken together Steiner's (1972) concepts of productivity and group process form a very pragmatic model for the researcher interested in studying decision-making groups. The major purpose of the present research was to determine which decision-making format, interacting, consensus, nominal group technique, or the Delphi technique, was most effective on evaluative problem-solving tasks, or in terms of Steiner's model, to determine which decision-making format maximized actual productivity by minimizing process loss. By holding the resource variables constant, one may measure the differential effects of each decision-making format on actual productivity and the process losses associated with each format. Higher productivity measures identify the more effective formats; the less effective formats result in lower productivity measures and a greater process loss.

The present study attempted to contribute to the needed effort to study systematically decision-making formats which has been noted by several of the leading proponents in the field of group problem solving. Van de Ven (1974, p. 103) stated:

An important area for future applied research is to experimentally compare the relative merits of alternative process for decision making on the evaluative phase of problem solving.

Linstone and Turoff (1975) expressed hope that "... experimental
psychologists and others in related fields will take a more active interest in exploring the Delphi technique" (p. 11).

**Characteristics**

Measures of decision quality and acceptance were evaluated in this study as previous theoretical work by Hoffman (1979), Maier (1963), and Vroom and Yetton (1973), has repeatedly stressed the importance of these two dimensions in achieving an effective solution. This study employed a ranking task, the NASA Lost on the Moon exercise (Hall and Watson, 1970), which is frequently used in evaluative decision-making research (Hall and Watson, 1970; Herbert and Yost, 1979; Nemiroff and King, 1975).

The review of the literature revealed that many idiosyncratic modifications have been made on all of the decision-making formats. A reference to previous studies using the processes included in each decision-making technique might demonstrate the consistency of the formats that were used in this study with those of other studies.

Interacting groups have consistently maintained an identical format in the vast majority of the literature. The interacting group used in the present study did not depart from this well established format of unstructured interaction in a leaderless group.

The consensual approach followed the guidelines used by Hall and Watson (1970), and Nemiroff, Pasmore, and Ford (1976), with one additional guideline which is based on the conclusions reached by Lane, Mathews, Chaney, Erffmeyer, Reber, and Teddlie (1980). The nominal group technique method was similar to that utilized by Nemiroff, Pasmore, and Ford (1976).
Because of the time and expense involved in compiling questionnaires in the Delphi technique, it has frequently been modified for the convenience of the researcher (Gustafson et al., 1973; Miner, 1979). Unfortunately, other reports of the Delphi method lack a clear description of the implementation of the technique (Rohrbaugh, 1979).

Due to the lack of consistency in the above studies, the Delphi technique employed in this study was modeled after the Delphi conducted by Van de Ven (1974) in a thorough investigation of the technique on a generative problem. All participants remained anonymous to other group members. Every comment made by a participant, including emotional comments, was included in the feedback reports. The number of questionnaire rounds used in Delphi research has ranged from two (Gustafson et al., 1973; Van de Ven, 1974) to seven (Miner, 1979); similarly, recommendations for the number of rounds that should be used has ranged from two or three (Turoff, 1970) to three to five (Delbecq, Van de Ven, and Gustafson, 1975). Following the recommendations of Delbecq et al. (1975), the present study used five rounds of questionnaires and an additional round for comments on the study.

Hypotheses

Based on Steiner's (1972) model of group process and productivity and previous research related to the dimensions of quality and acceptance the following hypotheses were generated:

**Hypothesis 1**: There will be variation in solution quality as a function of decision-making format.

More specifically, based on previous research it was hypothesized that:
Hypothesis 1A: Groups using the consensus method will produce higher quality decisions than those of interacting groups (Hall and Watson, 1970; Nemiroff and King, 1975; Nemiroff, Pasmore, and Ford, 1976).

Hypothesis 1B: Groups using the nominal group technique will produce higher quality decisions than those of interacting groups (Gustafson et al., 1973; Herbert and Yost, 1979).

Hypothesis 1C: Groups using the Delphi technique will produce higher quality decisions than those of interacting groups (Campbell, 1966; Dalkey, 1968; 1969).

Groups that allow for structured interaction and discussion among members to clarify ideas as part of the group process should reduce process loss (Gustafson et al., 1973; Rohrbaugh, 1979), thus, based on these findings, it was hypothesized that:

Hypothesis 1D: Groups using the nominal group technique will produce higher quality decisions than those of the Delphi groups.

Based on Steiner's theory and on research that has identified sources of process loss, groups following a structured format should also minimize process loss (Leavitt, 1951; Maier, 1958; Maier and Maier, 1957; Maier and Solem, 1952; Taylor, Berry, and Block, 1958); however, due to the existing contradiction between data (Nemiroff, Pasmore, and Ford, 1976) and theory, no specific hypotheses were made concerning the outcome of comparisons between the following:

1) Consensus groups as compared with nominal technique groups.
2) Consensus groups as compared with Delphi groups.
Hypothesis 2: Decision-making formats that maximize members' perceived influence and perceived satisfaction will lead to solutions that promote higher measures of acceptance than will those formats that foster less perceived satisfaction and influence by members (Hoffman, Burke, and Maier, 1965; Hoffman and Maier, 1959). Based on previous research, it was hypothesized that:

Hypothesis 2A: Groups using the consensus method will reach decisions that will demonstrate higher measures of acceptance than will interacting groups (Nemiroff, Pasmore, and Ford, 1976).

Groups that benefit from social facilitation should minimize process loss and thereby demonstrate higher measures of acceptance (Van de Ven, 1974), thus, following from previous research it was hypothesized that:

Hypothesis 2B: Groups using the consensus method will reach decisions that will demonstrate higher measures of acceptance than will Delphi groups.

Hypothesis 2C: Groups using the nominal group technique will reach decisions that will demonstrate higher measures of acceptance than will Delphi groups.

As no consistent pattern of results has emerged from the literature, no hypotheses in terms of acceptance measures were made concerning the following comparisons:

1) Consensus groups as compared with nominal technique groups.
2) Interacting groups as compared with nominal technique groups.
3) Interacting groups as compared with Delphi groups.
METHOD

Subjects: The subjects were 144 male students enrolled in undergraduate psychology classes at Louisiana State University. All students were volunteers and were given extra credit for their participation in this study.

Design. This research utilized four treatments (group decision-making formats) in a completely randomized design. The types of group decision-making formats were (1) interacting, (2) consensus, (3) nominal technique, and (4) Delphi.

Instruments.

Problem-Solving Exercise. The problem-solving task used in this research was the NASA Lost on the Moon exercise (Hall and Watson, 1970), which is included as Appendix A. The task requires the students to imagine themselves as members of an ill-fated space crew which has crash landed on the moon, 200 miles away from the designated rendezvous point with the mother ship. The crew's survival depends upon reaching the mother ship. All but 15 items aboard the ship have been damaged or destroyed during the landing. The items must be ranked in terms of their importance for the survival of the crew.

The correct or "best" ranking of the items has been developed by experts at the National Aeronautics and Space Administration's Crew Equipment Research Department of the Manned Spacecraft Center at Houston, Texas. This problem allows for a quality and an acceptance
measure to be determined as explained in the dependent variable section. Appendix B contains the correct NASA answers and the rationales for the order of their ranking of the items.

**Questionnaire.** A post-experimental questionnaire is included as Appendix C. Questionnaire items 1-15 are self-report measures of satisfaction adapted from Hoffman (1979). Van de Ven's (1974) measure of perceived satisfaction is included as items A, B, C, D, and F. The remainder of the items was included in the questionnaire for exploratory purposes only and were not analyzed in this dissertation. Items 4 and 12 were omitted from the questionnaire when it was administered to the Delphi groups as their reference to group meetings made them inapplicable. Items B, E, F, G, L, and M were worded so that references to "your group" were replaced by "the Delphi method". Two items, T and U, were added to the Delphi questionnaire in an attempt to ascertain if there were any violations of the Delphi assumptions by the Delphi participants.

**Apparatus.** The apparatus for the nominal group technique decision format consisted of a 32" X 40" matting board on which the 15 NASA items were listed in random order. Five hooks were positioned to the right of each item so that numbers indicating the four individual and the group rank for each item could be displayed on the board. The individual rankings were represented by black numerals in the first four columns and the group rankings were represented by red numerals in the fifth column.

The apparatus for the Delphi decision format consisted of
thirty-six 9 1/2" X 12 1/2" string and button envelopes, each of which contained the directions and worksheets found in Appendices D, E, F, G, H, and I. A number identifying a participant's materials was written on the outside of each envelope.

**Procedure.** The procedure for three of the formats, interacting, consensus, and the nominal group technique, are similar and are described together first, then the procedure for the Delphi technique will be presented.

*Interacting, Consensus, Nominal Group Technique*

Students volunteered for this research by placing their name on a centrally located sign-up sheet. At that time students also picked up "reminder slips" (Appendix J) which explained the importance of each individual's presence and the effect his absence might have on others who volunteered. The slip also contained the date, time, and location where the students should report for the research. Prior to the arrival of the students, the male experimenters were randomly assigned to one of the three decision-making formats. Two four-person groups were conducted simultaneously by the two experimenters. Upon the arrival of four or eight male subjects, one of the experimenters initiated the experiment by stating the following:

"We would like to thank you for your participation in our research. Mr. ________ and I are members of a research team which has been conducting research on groups for over a year and a half and has made some important discoveries. Before we begin we would like to assure you that everyone present will receive two hours of extra credit."
However, before we start, we need to ask you a few important questions. We need to see how many of you are familiar with the exercise we are using today. It is called the NASA Lost on the Moon problem and involves the crew of a spaceship which has crashed on the moon. The crew is trying to reach a rendezvous point where it will meet with a mother ship. The crew's job in this problem is to rank 15 items in terms of their importance in allowing the crew to reach the rendezvous point. Is anyone familiar with the problem?

Students familiar with the problem were taken from the experimental room and told that any previous exposure to the problem may influence their group's score. If less than eight subjects arrived for the experiment, enough subjects to conduct one group were randomly chosen, and any subjects beyond the four were dismissed. These subjects were informed why there were not participating, and were given extra credit. The remaining students were told why the others were not participating. The experimenter then asked which students were friends. The students were then randomly divided into two groups of four, with any friends placed in different groups. Each group was randomly assigned an experimenter and an experimental room. The students were seated in chairs positioned along the walls of the room. The experimenter said:

"As we mentioned earlier, we have been conducting some important research on small groups for over a year and a half. Our findings from this research have helped make the Psychology Department at LSU one of the leading contributors in the area of problem solving. Your participation in this research is very important to us, (and the
reputation we are making for LSU), so please follow the instructions we will give you and feel free to ask any questions that you may have.

We are interested in the way small groups of people solve problems. We would like you to work on a problem, first by yourself and later as a group. Let us start first by reading the problem. I will read it out loud and you should follow along as I read it."

The experimenter handed each person a copy of the Lost on the Moon exercise and worksheet (Appendix A). The experimenter instructed the students to fill in the information blanks at the top of the worksheet and then read the problem aloud to the students. The procedure varied for each decision-making format at this point. The instructions for each format are described separately below.

Interacting Format

The experimenter continued by reading the following instructions:

"We would like you to rank the 15 items by yourself in terms of their importance to your survival. It should take you 10 to 15 minutes to rank the items. You may begin now but before you do, please reread the problem to yourself."

After the students had completed the worksheet they were instructed to move from their individual desks to one of the four chairs located around a circular table positioned in the center of the room. The experimenter then said:

"Now we would like you to solve the same problem again but this time as a group. Your group is using the interacting method in reaching your decision. Interacting groups are being used more and
more frequently in business meetings today. Please record your group's rankings on the group worksheet I am distributing. (The experimenter distributed a copy of the group worksheet to each individual, Appendix A.) You may begin now."

When the students indicated that they had completed their group ranking they were asked to return to their individual desks. The experimenter distributed another copy of the individual worksheet (Appendix A) and a questionnaire (Appendix C). The following instructions were then read:

"I would now like you, individually, to rank the items, one last time. You may refer to your initial set of rankings or your group's ranking, although it is not necessary to duplicate them. This worksheet should represent your final, individual ranking of the items. The yellow sheets of paper which were distributed are a questionnaire about this study. After you have completed this copy of the worksheet, please complete the questionnaire.

Finally, I ask you not to discuss this study with any other students, as they may also wish to participate. Please be aware that you may only participate in this research one time. I thank you for taking time to be involved with the LSU small group problem-solving research."

Upon the completion of the final rankings and questionnaires, all worksheets were collected and the students were given their research credit slips and dismissed.

**Consensus Format**

The consensus definition and guidelines used in this study were
first developed by Hall and Watson (1970), and later used by Nemiroff and King (1975), and Nemiroff, Pasmore, and King (1976). The seventh guideline is taken from work done by Lane, Mathews, Chaney, Erffmeyer, Reber, and Teddlie (1980).

The experimenter continued by reading the following instructions:

"We would like you to rank the 15 items by yourself in terms of their importance to your survival. It should take you 10 to 15 minutes to rank the items. You may begin now but before you do, please reread the problem to yourself."

After the students had completed the worksheet they were instructed to move from their individual desks to one of the four chairs located around a circular table positioned in the center of the room. The experimenter then said:

"This is an exercise in group decision making. Now we would like you to solve the same problem again, but this time as a group. The following list of instructions is designed to help your group work effectively by using the method of group consensus in reaching your decision. Group consensus is being used more and more frequently in business meetings today. (The experimenter distributed the consensus guidelines (Appendix K) and read them out loud.) Please try to adhere to the guidelines listed on the sheet. Follow along with me as I read them aloud.

'Your group is to employ the method of group consensus in reaching its decision. This means that the ranking for each of the 15 survival items must be agreed upon by each group member before it
becomes a part of the group decision. Consensus is difficult to reach. Therefore, not every ranking will meet with everyone's complete approval. Unanimity, that is a unanimous decision, is not a goal (although it may be achieved unintentionally), and it is not necessary that every person be as satisfied as if he had complete control over what the group decides. What should be stressed is the individual's ability to accept a given ranking on the basis of logic—whatever his level of satisfaction—and his willingness to entertain such a judgment as feasible. When the point is reached at which all group members feel this way you may assume that you have reached a consensus as it is defined here and the judgment may be entered as a group decision. This means, in effect, that a single person can block the group if he thinks it necessary; at the same time, it is assumed that this option will be employed in the best sense of fair play. The guidelines to use in achieving consensus follow on the next page.

1. Avoid arguing for your own rankings. Present your position as clearly and logically as possible, but consider seriously the reactions of the group in any subsequent presentations of the same point.

2. Avoid 'win-lose' stalemates in the discussion of rankings. Discard the notion that someone must win and someone must lose in the discussion; when impasses occur, look for the next most acceptable alternative for both parties.

3. Avoid changing your mind only in order to avoid conflict and to reach agreement and harmony. Withstand pressures to yield which have no objective or logically sound foundation. Strive for enlightened flexibility; avoid outright giving up.

4. Avoid conflict-reducing techniques such as the majority vote, averaging, bargaining, coin flipping, and the like. Treat differences of opinion as indicative of an incomplete sharing of relevant information on someone's part and press for additional sharing, either about task or emotional data, where it seems in order.
5. View differences of opinion as both natural and helpful rather than as a hindrance in decision making. Generally, the more ideas expressed the greater the likelihood of conflict will be; but the richer the array of resources will be as well.

6. View initial agreement as suspect. Explore the reasons underlying apparent agreement; make sure that people have arrived at similar solutions for either the same basic reasons or for complementary reasons before incorporating such solutions in the group decision.

7. Work to produce the solution that is most acceptable to every member of your group.

Are there any questions about these guidelines?

When you have completed your group's rankings write them on the group worksheet I am handing out. (The experimenter distributed a copy of the group answersheet (Appendix A) to each member.) Please complete the information at the top of this worksheet. Before beginning your group discussion take 10 minutes to reread and study the consensus guidelines so you may become more familiar with them. I will let you known when 10 minutes are up."

After 10 minutes the experimenter continued.

"Keep your guidelines handy so that you may refer to them if you wish. You may begin the group discussion now."

When the students indicated that they had completed their group ranking the were asked to return to their individual desks. The experimenter distributed another copy of the individual worksheet (Appendix A), and a questionnaire (Appendix C). The following instructions were then read:

"I would like you, individually, to rank the items, one last time. You may refer to your initial set of rankings or your group's ranking, although it is not necessary to duplicate them. This work-
sheet should represent your final, individual ranking of the items. The yellow sheets of paper which were distributed are a questionnaire about this study. After you have completed this copy of the worksheet please complete the questionnaire.

Finally, I ask you not to discuss this study with any other students, as they may also wish to participate. Please be aware that you may only participate in this research one time. I thank you for taking the time to be involved with the LSU small group problem-solving research."

Upon the completion of the final rankings and questionnaires, all worksheets were collected and the students were given their research credit slips and dismissed.

Nominal Group Technique

The experimenter continued by reading the following instructions:

"We would like you to rank the 15 items by yourself in terms of their importance to your survival. In the space next to each item write down your thoughts or reasons why you ranked each item as you did. For example, imagine that I am working on a problem in which people are lost at sea and one of the items is a comb. I might think that it was important because it could be used as a saw to cut food or wood. So, I would rank the item and next to the rank write "could be used as a saw to cut food or wood". I now want you to take 10 to 15 minutes to rank the items and write down your rationale for each ranking. Before you do that, please reread the problem to yourself."
After the students had completed the worksheet they were instructed to move from their individual desks to one of the four chairs located around a circular table positioned in the center of the room. The experimenter then said:

"Now we would like you to solve the same problem again, but this time as a group. The following list of instructions is designed to help your group work effectively by using what is known as the 'Nominal Technique' method of decision making. This method is being used more and more frequently in business meetings today. (The experimenter distributed the nominal technique guidelines (Appendix L) and read them out loud.) Please try to adhere to the guidelines listed on the sheet. Follow along with me as I read them aloud.

1. During the last few minutes each of you ranked the 15 items and wrote down your reasons for each ranking on your worksheet. Now I would like you to present your rankings and reasons using the board I am hanging up. (The experimenter will hang the nominal group technique board on the wall so all members of the group can see it.) Each of you will tell the rest of the group what rank you assigned to an item and then the reason why you ranked it as you did. Please refer to your worksheet and give only the ranks and reasons that you listed on your worksheet. (Do not change your ranks or reasons because of someone else's comments or rationales.) We will proceed around the table and will let each member of the group comment on an item before moving on to the next item. As the presentations are made, please do not discuss your decision (rankings) with other group members. As you tell me the rank you gave an item I will place that number next to the item on the
board. For instance, if you ranked "Box of matches" as number "7", I
would place a "7" next to "Box of matches" on the board. (The
experimenter will demonstrate how he will be using the nominal group
technique board.) Again, while a group member is discussing his
ranking there should be no talking by other members. In other words,
only one person is to be talking at a time and only while he is giving
his presentation. Also, while giving your presentation, do not discuss
the rationales of the other members who have presented before you.
Every member will present his rankings for a particular item before
we move to the next item on the list.

2. After all four members have had an opportunity to present
their rankings for all of the 15 items, there will be a period of open
group discussion. All members will be able to discuss their rationales
and ask questions of others about their decisions in an open forum
format. After the discussion session, you will individually fill out
another copy of the worksheet on which you will rerank the 15 items.
At this time you should take into account any new information you
consider to be important that you may have gained from listening to the
other group members. You will not be required to write an explanation
of your rankings on this copy. Do not talk while you fill out Copy 2.

3. When Copy 2 is completed I (the experimenter) will collect
the answersheets and use your individual rankings to determine a
ranking for the group. Your individual ranking of the items on this
copy will be averaged to determine a group ranking of the items. The
group's ranking for each item will be designated in the last column on
the board with a red number."
The students were asked to reread the instructions before beginning the task and to complete the information blanks at the top of Copy 2. The students proceeded according to the above directions. After the group ranking was determined and displayed for all group members to observe the experimenter distributed a third copy of the problem (Appendix A) and a questionnaire (Appendix C). The students were asked to return to their individual desks. The following instructions were then read:

"I would now like you, individually, to rank the items, one last time. You may refer to your initial set of rankings or your group's ranking (as shown in red on the board) although it is not necessary to duplicate them. This worksheet should represent your final, individual ranking of the items. The yellow sheets of paper which were distributed are a questionnaire about this study. After you have completed this copy of the worksheet please complete the questionnaire.

Finally, I ask you not to discuss this study with any other students, as they may also wish to participate. Please be aware that you may only participate in this research one time. I thank you for taking the time to be involved with the LSU small group problem-solving research."

Upon the completion of the final rankings and questionnaires, all worksheets were collected and the students were given their research credit slips and dismissed.

**Delphi Technique**

**Recruitment of Subjects.** Students in a large Introductory
Psychology class were informed by their instructor of the opportunity to participate in this research project. The students were told that a doctoral candidate was conducting research on decision making and needed 36 volunteers to participate in a study. The course instructor informed the students that the study would involve a substantial amount of time outside of the classroom. It was explained that the task would require students to take a problem home, complete it, and then return it the next class meeting. During the following class meeting the students would again pick up the problem with some additional comments for them to take home, reevaluate, and return the following class. This process would continue for a total of 12 consecutive class periods. Extra credit would be awarded for participation in the study. Of the 86 male students that expressed interest in volunteering for the research project, 36 were randomly selected to participate.

Explanation of the Study. Students whose names were drawn to participate in the study were instructed to meet at the front of the classroom. The principle investigator reiterated what the course instructor had already mentioned. He began:

"My name is Bob Erffmeyer and I am a graduate student working on my Ph.D. I need your help in this study, if you are interested in participating. Before deciding whether or not you are interested in spending many hours of your time, and many hours of my time, please listen to a description of the study and what is required of you if you desire to participate.

I am interested in the way people solve problems. In
particular, I am interested in how people in organizations who are great distances apart from one another conduct meetings. For example, you may have heard of companies using telephone conference calls, where everyone has a common line and can share in a discussion with participants who are in other cities. Another example, although less well known, of a meeting that would allow people in separate places to communicate without having a meeting is called the \textit{Delphi technique}. That is what this study is about.

Participants in a Delphi meeting never meet face to face. They are free to work on the problem at their own convenience and in private. After reading about the problem, participants write down their comments and possible solutions. Each participant then returns his materials to the coordinator of the meeting. (I will be the coordinator.) The coordinator then summarizes the responses and returns them to the participants so they may read everyone's comments. Based on this new information given by the other group members, respondents can reevaluate or change their current position and add comments expressing agreement, disagreement, or clarification concerning the items.

This chain of events (a) giving your comments, (b) reading a summarized report of all participants' suggestions and opinions, (c) then again giving your comments, may occur several times. In our study this will happen five times. Another feature of this type of meeting is that each of the participants and their suggestions remain anonymous to everyone in the group except the coordinator. The reason for remaining anonymous is particularly important, so that group
members will not be overly influenced by domineering personalities or social pressures of other members.

The type of problem you will be working on will be ranking items in terms of importance and giving a short (one sentence) explanation why you ranked each item as you did. This should take a half an hour to complete; you will do this five times for a total of 2 1/2-3 hours work. If you participate, you will be randomly assigned to a group with three other people. You will not know who the other group members are, nor will you ever meet them - this is an important feature of a Delphi group.

In this study it is important that you do not discuss the problem you are working on with anyone. I am interested in how your group works. If you discuss this with a friend or roommate you will invalidate this study as they may be familiar with the problem or may tell you some information that you did not get from your group members.

It is important that you do not try to look up the answer or find information about it. This too would invalidate your group as I am interested in only how you work together.

Finally, if you decide to participate in this study, it is important that you pick up and return your response envelope on time, that is, attend every class during the next four weeks.

Extra Credit. Eighteen extra-credit points (credit for nine hours of volunteer participation) will be given only if all four members of your group follow the instructions and return material on time. If you fail to complete your response sheet, turn it in late, or forget about it, you and the three other members of your group will
only receive the extra-credit points that you have earned up to that time. You will not receive any additional points and may not be able to continue in the experiment. Therefore, if you do not complete your assignment, you will be wasting your time, three other people's time, and my time. If someone in your group is ill, he may phone me or my assistants and we will try to arrange to pick up his material that day so that your group can continue to participate. If we cannot reach the missing person and the material is not returned on time, your group members will receive one point for each day your group participated. I would like everyone to participate on all 12 days and receive all 18 extra-credit points. (The students were not told the following but, in reality, if someone had become ill and the group had dropped out of the study, everyone in it would have received all 18 points.)

If you think this experiment will require too much of your time, or that you may not be able to follow the instructions about not discussing this with other people, or that you may not attend all of the next 12 class sessions, please let me know now since your behavior can result in three other people not getting the full amount of extra-credit. Shorter experiments (that last 1-1 1/2 hours) are available for you to participate in and receive extra credit.

Please stay only if you are interested and can fulfill all the requirements of this experiment. Everyone else may leave.

**Screening for previous exposure to the problem.** The exercise we will be using in this study is called the NASA Lost on the Moon exercise. Briefly, it is about a space crew that is lost on the moon
and has to rank 15 items in terms of importance to their survival. If you have already done this problem, would you please stand up?"

Students who stood up were told the following:

"If you are familiar with the problem you will not be able to participate in this study. Anyone who has already done the exercise may be familiar with the correct answers and cannot be included." Students who were familiar with the problem were thanked for their interest and dismissed.

**Distribution of materials (Round 1).** String and button envelopes with identifying numbers were distributed to the 36 participants. Students were told that the number on the outside of their envelope would identify their material throughout the study. This number appeared on all papers given to the participants.

The materials used in Round 1 may be found in Appendix D. The investigator explained each of the forms contained in the participants' envelopes. Two copies of the "Application Blank: were given to the students; the students were requested to sign both copies, to return one to the experimenter and to keep the other for themselves. Also included in the first round materials were two pages of directions which reiterated the procedure explained by the investigator dealing with the operations of a typical Delphi group and elaborating on the mechanics of how their Delphi group would operate. In addition the students were given a calendar outlining the dates the envelopes containing the exercise should be picked-up and returned. The last form in the packet was a copy of the NASA problem and worksheet.

The 36 males were divided into nine four-person groups so that
no two people sitting together during the explanation of the Delphi procedure were in the same group.

Students who initially failed to return their packets were contacted by phone and reminded to return their material. All 36 participants completed the study and returned the materials for all five rounds and the questionnaire round.

Round 2. Before picking up the materials for Round 2 the students were given a brief (5 minute) explanation of the forms in their envelope (Appendix E). The cover sheet reminded the participants when the material should be returned, restated the problem, and explained the new worksheet. An identical four-page worksheet was used for the remaining three rounds with the exception of the reminder space on the bottom of the fourth page which differed for each round. The last page reminder is included in Appendices F, G, and H, respectively for rounds three, four, and five.

Round 3. Materials distributed for Round 3 are included in Appendix F. Introduced this round was a summary sheet, which summarized the individual participant's rankings and his group's past rankings of the 15 items for each previous round. The summary sheets were returned by the participants after each round and updated with the latest individual and group rankings, then returned to the participants the following round. Also included in this round's packet was a "Notice" sheet (printed on green paper) which explained to the participants the benefits of giving a complete one sentence explanation of their rationales for their rankings. The cover sheet in the envelope for Round 3 explained all new material contained in the
envelopes.

**Round 4 and Round 5.** Materials distributed for Round 4 are contained in Appendix G, and those for Round 5 are in Appendix H.

**Final Round (Questionnaire Round).** The cover sheet for the Final Round explained how to complete the five page questionnaire (printed on yellow paper) which was distributed along with the worksheets. The method of recording each student's extra credit was also presented on the cover sheet. These materials are contained in Appendix I.

**Dependent Variables.** The dependent variables in this study were quality and acceptance.

**Quality.** The Lane, Mathews, and Buco (1981) system of scoring the NASA Lost on the Moon ranking task for quality requires that both the individual and group responses be compared against the correct NASA solution (Hall and Watson, 1970). The quality measure for the first and second individual ranking were obtained in the following manner:

1) For every group of individuals, based on each individual's initial ranking of the 15 items, an average rank for each item was calculated.

2) The 15 items were reranked from 1 to 15 by assigning the rank 1 to the item with the lowest average rank, the rank 2 to the item with the next lowest rank, etc.

3) The correct NASA rank for each item was subtracted from the rank of that item obtained in the reranking procedure in Step 2. This resulted in 15 deviation scores for each
group of individuals.

4) The absolute value of the 15 deviation scores were summed to yield a **pooled individual quality score**, which is inversely related to the quality of the decision.

The quality measure for the group ranking was obtained in the following manner:

1) For every group, the correct NASA ranking for each of the 15 items was subtracted from that group's ranking of the items to obtain 15 deviations.

2) The sum of the absolute values of these deviations was calculated. This number represented the **group quality score** on the problem.

This system of scoring was applied in the interacting, consensus, and nominal group technique conditions resulting in three quality scores for each group:

a. a pooled individual quality score based on the initial set of individual rankings.

b. a group quality score.

c. a pooled individual quality score based on the second set of individual rankings.

In the Delphi condition the scoring system was also applied, resulting in three quality scores for each Delphi group:

a. a pooled individual quality score based on the initial set of individual rankings.

b. a group quality score. (Because the Delphi participants never met as a group to rank the items, this score was calculated by the monitoring committee using the same four steps described above to obtain the pooled individual quality score.)
c. a pooled individual quality score based on the final set of individual rankings.

Acceptance. Two types of acceptance measures, a behavioral measure and a self-report measure, were employed in this study. The behavioral measure of acceptance that was used in this research was developed for the studies conducted by Lane et al. (1980) and Mathews et al. (1980). Prior to these studies, acceptance was typically assessed by self-report measures of satisfaction with the solution, with the opportunity to influence the group solution, and/or with the individual member's influence over the group solution (Hoffman, 1979; Hoffman, Burke, and Maier, 1965). In both the Lane et al. (1980) and the Mathews et al. (1980) studies acceptance was assessed by determining the average degree of correlation between the group's ranking of the 15 items and each individual's final ranking. Thus, an individual's acceptance of the group's ranking is reflected by the degree of agreement between the group's ranking and his final individual ranking.

The self-report measures of acceptance that were used in this study were drawn from two sources, Hoffman (1979) and Van de Ven (1974). The first self-report measure consists of fifteen 6-point Likert-type questions measuring satisfaction which were adapted from Hoffman (1979). These fifteen questions are listed in Appendix C as items 1-15.

The second self-report measure of acceptance was adapted from Van de Ven's (1974) measure of perceived satisfaction. This measure is comprised of five questionnaire items reflecting satisfaction with the group process and outcome. These items appear in Appendix C as items A, B, C, D, and F. The responses to these five items were made on a
five-point Likert-scale. The responses of individual members within each group to each of the five items were averaged to determine the group response (Van de Ven, 1974; Van de Ven and Delbecq, 1974). By averaging the five-item scores of each group, an overall measure of group satisfaction was developed for each of the four decision-making formats.

**Data Analysis.** Separate analyses were performed on the quality measure and on both of the acceptance measures. A 4 (decision formats: interacting, consensus, nominal group technique, and Delphi technique) X 3 (time: first pooled individual ranking, group ranking, second pooled individual ranking) repeated-measures analysis of variance with decision format and the repeated measure of time as the main factors was performed on the quality measure. A series of non-orthogonal contrasts were used to test Hypotheses 1A-1D.

The behavioral measure of acceptance was analyzed using a 4 (decision formats: interacting, consensus, nominal group technique, and Delphi technique) X 2 (acceptance measures: the mean of the correlations of the first individual scores with the group score and the mean of the correlations of the second individual scores with the group score) repeated-measures analysis of variance with decision format and the repeated measure of time as the main factors. A series of non-orthogonal contrasts were used to test Hypotheses 2A-2C. The 15 self-report measures of acceptance drawn from Hoffman (1979), and the self-report measure of acceptance drawn from Van de Ven (1974) were independently analyzed using a one-way analysis of variance with decision format as the factor of interest. Significant results for the
self-report measures were explored using Duncan's multiple-range test.
RESULTS

Quality. The quality measures were collected and calculated according to previously described procedures. Means for the quality measures classified by condition are presented in Table 2. A 4 (decision formats: interacting, consensus, nominal group technique, and Delphi technique) X 3 (time: first pooled individual ranking, group ranking, second pooled individual ranking) repeated-measures analysis of variance with decision formats and the repeated measure of time as the main factors was conducted. It is summarized in Table 3. Table 3 indicates that the main effect for time was significant ($p < .0001$). It also indicates that both the main effect for decision-making formats and the time X decision-making format interaction were not significant (both $p's < .25$). A Duncan's multiple-range test was used to explore the significant main effect for time. The test revealed that the scores for Time 1 were of a significantly ($p < .05$) lower level of quality than were the scores for both Time 2 and Time 3. There was no significant difference between the quality scores for Time 2 and Time 3.

Hypothesis 1 stated that there will be variation in solution quality as a function of decision-making format. A priori contrasts were conducted to test Hypotheses 1A-1D. The contrasts revealed that, as Hypothesis 1C predicted, groups using the Delphi technique produced significantly ($p < .05$) higher quality decisions than those of interacting groups. Although the contrast did not reach significance
TABLE 2
Mean Quality Measures By Decision-Making Format

<table>
<thead>
<tr>
<th>Time</th>
<th>Condition</th>
<th>INT</th>
<th>CON</th>
<th>NGT</th>
<th>DELPHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual (1)</td>
<td></td>
<td>36.88</td>
<td>38.22</td>
<td>38.44</td>
<td>34.66</td>
</tr>
<tr>
<td>Group (2)</td>
<td></td>
<td>29.55</td>
<td>26.44</td>
<td>30.22</td>
<td>22.44</td>
</tr>
<tr>
<td>Individual (3)</td>
<td></td>
<td>28.88</td>
<td>26.22</td>
<td>32.44</td>
<td>22.22</td>
</tr>
</tbody>
</table>
### TABLE 3

Summary of Analysis of Variance for Quality Measures

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>3</td>
<td>255.36</td>
<td>1.58</td>
<td>.2130</td>
</tr>
<tr>
<td>Error A (Groupno(Cond))</td>
<td>32</td>
<td>161.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>2</td>
<td>1141.44</td>
<td>61.22**</td>
<td>.0001</td>
</tr>
<tr>
<td>Condition X Time</td>
<td>6</td>
<td>26.43</td>
<td>1.42</td>
<td>.2216</td>
</tr>
<tr>
<td>Error B (Residual)</td>
<td>64</td>
<td>18.64</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*aOne-tailed probability value.*
for Hypothesis 1A (p < .06), the differences were in the predicted direction, i.e., groups using the consensus method produced higher quality decisions than did the interacting groups. Furthermore, the contrasts did not support Hypotheses 1B (p > .30) and 1D (p < .10); there were no differences between the decision quality of the groups using the nominal group technique and that of either groups using the interacting method (Hypothesis 1B) or groups using the Delphi method (Hypothesis 1D).

Acceptance

Behavioral Measures of Acceptance. The behavioral acceptance measures were collected according to the previously described procedure. The behavioral measures of acceptance employed were the mean of the correlations of the first individual scores with the group score and the mean of the correlations of the second individual scores with the group score. Table 4 contains the means for the behavioral measures of acceptance classified by decision-making format.

A 4 (decision formats: interacting, consensus, nominal group technique, and Delphi technique) X 2 (acceptance measures: the mean of the correlations of the first individual scores with the group score and the mean of the correlations of the second individual scores with the group score) repeated-measures analysis of variance with decision formats and the repeated measure of time as the main factors was conducted. It is summarized in Table 5. The analysis revealed a significant difference in acceptance among the decision-making formats (p < .02) as well as a significant main effect for time (p < .0001). However, the time X decision-making format interaction failed to reach
TABLE 4
Mean Behavioral Acceptance Measures By Decision-Making Format

<table>
<thead>
<tr>
<th>Time</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INT</td>
</tr>
<tr>
<td>Mean Correlation of First Individual Scores with the Group Score</td>
<td>0.75</td>
</tr>
<tr>
<td>Mean Correlation of Second Individual Scores with the Group Score</td>
<td>0.95</td>
</tr>
</tbody>
</table>
### TABLE 5

Summary of Analysis of Variance for Behavioral Measures of Acceptance

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>3</td>
<td>.0195</td>
<td>4.31*</td>
<td>.0116</td>
</tr>
<tr>
<td>Error A (Groupno (Cond))</td>
<td>32</td>
<td>.0045</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>1</td>
<td>1.0537</td>
<td>235.17**</td>
<td>.0001</td>
</tr>
<tr>
<td>Condition X Time</td>
<td>3</td>
<td>.0103</td>
<td>2.29</td>
<td>.0961</td>
</tr>
<tr>
<td>Error B (Residual)</td>
<td>32</td>
<td>.0048</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*One-tailed probability value.*
significance \((p < .10)\). Inspection of the relevant means in Table 4 shows more acceptance between the mean correlation of the second individual scores with the group score than between the mean correlation of the first individual scores with the group score. A Duncan's multiple-range test was conducted on the data to investigate the significant decision-making format effect. The test revealed that there was a significantly \((p < .05)\) lower level of acceptance for the nominal group technique method than for the other three decision-making formats. There were no significant differences between the behavioral measures of acceptance among the interacting, consensus and Delphi decision-making formats.

Hypothesis 2 stated that decision-making formats that maximize members' perceived influence and perceived satisfaction will lead to solutions that promote higher measures of acceptance than will those that foster less perceived satisfaction and influence by members. A priori contrasts were conducted to test Hypotheses 2A-2C. Hypothesis 2A predicted that consensus groups would reach decisions that would demonstrate higher measures of acceptance than would interacting groups. Hypothesis 2C predicted that nominal technique groups would reach decisions that would demonstrate higher measures of acceptance than would Delphi groups. The contrasts indicated significant differences between the acceptance measures of the groups using the consensus method and those of the interacting groups \((p < .05)\) and between the acceptance measures of the groups using the nominal group technique and those of the Delphi groups \((p < .02)\). Therefore both Hypotheses 2A and 2C were supported. A contrast failed to support
Hypothesis 2B although, as predicted, groups using the consensus method reached decisions with somewhat higher levels of acceptance than those of the Delphi method group (p < .07).

Self-Report Measures of Acceptance. The fifteen self-report measures of acceptance from Hoffman (1979) and the measure of perceived satisfaction from Van de Ven (1974) were independently analyzed using a one-way analysis of variance with decision format as the factor of interest. A Duncan's multiple-range test was conducted for each measure to test for homogeneity among the means of the decision formats. A summary of the results of these analyses is presented in Table 6.
<table>
<thead>
<tr>
<th>Question</th>
<th>Predicted</th>
<th>C &gt; I</th>
<th>C &gt; D</th>
<th>N &gt; D</th>
<th>No Prd</th>
<th>No Prd</th>
<th>No Prd</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am satisfied with the amount of influence of or say I had over my group's decision. (0.01**)</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(I &gt; D)</td>
</tr>
<tr>
<td>I am satisfied with the solution reached by my group. (0.01**)</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(I &gt; D)</td>
</tr>
<tr>
<td>The people in my group freely expressed their feelings or emotions. (0.80)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(C &gt; N)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Everybody participated in the discussion in my group. (0.59)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>My group definitely achieved a high quality solution. (0.08)</td>
<td>*</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My group's final solution was definitely acceptable to everyone in the group. (0.01**)</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td>(C &gt; N)</td>
<td></td>
<td>(I &gt; D)</td>
</tr>
<tr>
<td>My group did not seem to have leadership. (0.64)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Predicted</td>
<td>C &gt; I</td>
<td>C &gt; D</td>
<td>N &gt; D</td>
<td>No Prd</td>
<td>No Prd</td>
<td>No Prd</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
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<td>--------</td>
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<td>--------</td>
</tr>
<tr>
<td>8. The group's decision reflected my own opinion. (.06)</td>
<td>Duncan's</td>
<td>C vs I</td>
<td>C vs D</td>
<td>N vs D</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Disagreement among group members was openly expressed. (.18)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Everyone agreed with the final group solution. (.01**)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. My opinion about some or all of the items is reflected in my group's</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>decision. (.03*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. A few people dominated the discussion in my group. (.75)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I would be willing to work with these same people on other types of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>problems. (.04*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I liked the method our group used to solve the problem. (.01**)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Duncan's C vs I, C vs D, N vs D, C vs N, I vs N, I vs D comparisons.
TABLE 6 (continued)

<table>
<thead>
<tr>
<th>Question</th>
<th>Predicted</th>
<th>Duncan's</th>
<th>C &gt; I</th>
<th>C &gt; D</th>
<th>N &gt; D</th>
<th>No Prd</th>
<th>No Prd</th>
<th>No Prd</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. My group closely followed the procedure outlined in the instructions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.06)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Van de Ven's Perceived</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction Measure (.01**)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Number of Measures</td>
<td>1</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The probability of a significant effect in the analysis of variance follows each measure of acceptance in the table; an asterisk (*) indicates a significant effect. An asterisk in the body of the table indicates a significant effect for the Duncan's multiple-range test (p<.05).
DISCUSSION

Using Steiner's conceptual framework, four decision-making formats were compared on two dimensions of an effective decision, quality and acceptance (Maier, 1963). The results of the present research provided modest support for the first hypothesis, which stated that variation in solution quality would be a function of decision-making format. The analyses of the data supported one of the four quality sub-hypotheses and the results were in the predicted direction for one other. Stronger support was obtained for the second hypothesis, which stated that the decision-making formats that maximize members' perceived influence and perceived satisfaction would lead to solutions that promote higher acceptance than would those formats that foster less perceived satisfaction and influence by members. Two of the three acceptance sub-hypotheses were supported by the behavioral measures of acceptance. Furthermore, the third sub-hypothesis was supported by the two self-report measures of acceptance.

The discussion of the results of this study will be organized by decision-making format. The unstructured, interacting format, was used as a control and will not be discussed separately but will serve as a basis for comparison in the discussion of each of the other techniques.

Consensus Groups

The findings from this study revealed that for quality there were no differences between the consensus format and any of the other decision-making formats. However, the data did approach significance
in the hypothesized direction when the consensus method was compared to the interacting format. Hall and Watson (1970), Nemiroff and King (1975), and Nemiroff, Pasmore, and Ford (1976), have demonstrated that consensus groups produce significantly higher quality decisions than do interacting groups.

Interestingly, the mean quality scores for the interacting and consensus groups from the Nemiroff and King (1975) study are almost identical to the mean quality scores for the interacting and consensus groups in the present study, as is indicated in Table 7. Yet, the differences in quality for consensus and interacting groups in the Nemiroff and King study were highly significant ($p < .01$) while the differences in quality for consensus and interacting groups in the present study failed to reach significance ($p < .06$). The obvious reason for this discrepancy lies in the difference in the initial individual scores for the two studies.

An explanation for these results lies in the scoring algorithm used to obtain the initial scores. It has been demonstrated that the traditional scoring method used by Hall and Watson (1970), Nemiroff and King (1975), and Nemiroff, Pasmore, and Ford (1976), consistently underestimates the initial ability of a decision-making group (Lane, Mathews, and Buco, 1981; Slevin, 1978), while the scoring algorithm used in the present study provides an unbiased estimate of initial ability (Lane, Mathews, and Buco, 1981). Thus, if the consensus method were equally effective in improving quality in all four studies, the three earlier studies might demonstrate a significant improvement in quality because their underestimate of the initial ability would
Table 7

Mean Individual and Group Quality Scores on the NASA Task from Studies which have Compared Consensus and Interacting Groups

<table>
<thead>
<tr>
<th>Study</th>
<th>Format</th>
<th>Present Research</th>
<th>Nemiroff &amp; King</th>
<th>Nemiroff, Pasmore, &amp; Ford</th>
<th>Hall &amp; Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Individual</td>
<td>INT</td>
<td>36.88</td>
<td>39.09</td>
<td>-</td>
<td>47.52</td>
</tr>
<tr>
<td></td>
<td>CON</td>
<td>38.22</td>
<td>41.79</td>
<td>-</td>
<td>45.07</td>
</tr>
<tr>
<td>Group</td>
<td>INT</td>
<td>29.55</td>
<td>29.77</td>
<td>-</td>
<td>34.19</td>
</tr>
<tr>
<td></td>
<td>CON</td>
<td>26.44</td>
<td>26.50</td>
<td>-</td>
<td>25.94</td>
</tr>
</tbody>
</table>

The Lost at Sea task (Nemiroff and Pasmore, 1975) was used in the Nemiroff, Pasmore, and Ford (1976) study, therefore the means are not comparable.
result in an artificially inflated improvement score. However, the present study might fail to show such an effect even though the actual amount of improvement in quality was equal to that in the earlier studies.

An implication from the findings of the quality measure is that additional training in the consensus guidelines may be desirable for the groups employing the technique to improve their effectiveness. Hall and Williams (1970), Maier (1950; 1963) and Maier and Hoffman (1960; 1965) have all suggested this possibility. Training in the consensus guidelines would provide an opportunity for the development of discussion skills as well as assuring that the desired group behaviors would become normative. The subjects in the present study had only a ten-minute period in which to master the guidelines.

In the present study, acceptance was evaluated with a behavioral measure and two self-report measures. Only two previous studies, Nemiroff and King (1975) and Nemiroff, Pasmore, and Ford (1976), have investigated the acceptance dimension of decision making with consensus groups. Both of these studies used only self-report measures of acceptance.

The results obtained using the behavioral measures of acceptance in the present study concurred with Nemiroff, Pasmore, and Ford (1976) by revealing that the consensus format promoted more acceptance than did the interacting format. However, this finding is in conflict with the earlier report by Nemiroff and King (1975) who found no difference between the two formats.

There is no apparent explanation for the lack of concordance
between the results of the present study and those of Nemiroff and King (1975). Moreover, Nemiroff, Pasmore, and Ford (1976) offered no explanation for the discrepancy between the findings of their study and those of the earlier Nemiroff and King (1975) study.

Although there were no differences between the behavioral measures of acceptance of the consensus groups and those of Delphi groups, the findings were in the predicted direction; consensus groups demonstrated more acceptance than did Delphi groups. Moreover, considerable support for this hypothesis was found in the analysis of the self-report measures of acceptance. Consensus groups fostered more perceived satisfaction than did Delphi groups; significant differences were found in the responses given to nine questions ascertaining perceived influence on the group process and satisfaction with the group decision.

Although no predictions were made comparing the consensus method and the nominal group technique format, self-report measures revealed differences between the two. Groups using the consensus format developed more perceived satisfaction and responded more favorably to five of the questionnaire items than did the groups using the nominal group technique format.

In summary, it is concluded that the consensus guidelines do promote adaptive behaviors that reduce the potential for process loss associated with social pressure and opinion differences. Consensus group members support the group decision and gain satisfaction both from their participation in the process and from their final product.
Nominal Group Technique

Groups using the nominal group technique comprised the second type of decision-making format. The analysis of the data revealed no significant differences between the nominal group technique format and the other three decision-making formats on the quality measure. This finding may come as no surprise to the originators of the technique (Van de Ven and Delbecq, 1971, p. 210) who expressed the following:

When the task requirement of a group is fact-finding or information generation, use of nominal processes are suggested by the research. When the problem requires information synthesis, evaluation, or group consensus, interacting group processes are prescribed (Delbecq and Van de Ven, 1971; Dunnette, 1964; Maier and Hoffman, 1960).

It may be that the structuring of process in tasks of an evaluative nature may inhibit discussion and thereby serve as a process loss.

More specifically, the analysis of quality measures revealed no differences between the nominal technique groups and the interacting groups. This is contrary to the results obtained in earlier research conducted by Gustafson et al. (1973) and Herbert and Yost (1979) in which nominal technique groups produced higher quality decisions than did interacting groups. An explanation for this discrepancy is that Herbert and Yost's (1979) version of the nominal group technique process was a variant described as "judgment-discussion-judgment" (Holloman and Hendrick, 1971) which included a consensus-seeking phase in the final voting stage, rather than the secret balloting advocated by Van de Ven and Delbecq (Van de Ven, 1974; Van de Ven and Delbecq, 1974).

Although not supporting any hypothesis made in this study, the
quality measures do lend support to the findings of Nemiroff, Pasmore, and Ford (1976). They found no differences on a quality measure between groups using the nominal group technique and those using an interacting format.

Based on the research of Gustafson et al. (1973) and Rohrbaugh (1979), it was predicted that nominal technique groups would outperform Delphi groups on the quality measure. Re-examination of the basis for this prediction discloses several weaknesses in the logic underlying the prediction. The finding of Gustafson et al. (1973) that nominal technique groups outperformed Delphi groups on a quality measure, may be discounted on the basis of their violations of the principles underlying the implementation of the Delphi procedure (Van de Ven and Delbecq, 1974). This may have been sufficient enough to warrant considering their version of the technique something other than a Delphi.

Rohrbaugh (1979) expressed the belief that groups that allowed for structured interaction and discussion among members would reduce process loss. This prediction was offered on the basis of a comparison of groups using the Delphi method and the subjective judgment analysis method and did not include a comparison of groups using the nominal group technique. Had this been examined, he may not have posited such a statement.

Although there were no differences in the quality measures associated with the nominal group technique format, the analysis of the behavioral measure of acceptance revealed that, as predicted, groups using the nominal group technique reached decisions that demonstrated
higher levels of acceptance than did groups using the Delphi method. In addition, groups using the nominal group technique responded more favorably than did Delphi groups on five questionnaire items, revealing a difference between the satisfaction and influence perceived by nominal technique groups and Delphi groups.

The results of this section may accent the need for continued research on decision-making formats which are free from the effects of idiosyncratic modifications in the technique. Predictions based on studies with modifications in the technique were not supported. The results of the present study support the one uncriticized study dealing with evaluative tasks and the nominal group technique format (Nemiroff, Pasmore, and Ford, 1976). In their research, there were no quality differences between the nominal group technique format and the interacting format.

The process losses noted by Van de Ven and Delbecq (1974) (i.e., the conforming behavior required by a structured intervention such as the nominal group technique and the frustration experienced in the interaction period of the nominal group technique) may in fact be hindering the effectiveness of the nominal technique groups. Even though the round-robin procedure may insure participation by all members, it may also serve to reveal members who have little knowledge about the task. This in turn, may lead to reduced participation by those members or discrediting of the less competent members' contributions by others.

It may be that the nominal group technique is more appropriate in brainstorming situations or, as Delbecq, Van de Ven and Gustafson
(1975) have suggested, in situations in which it is important to insure participation by group members who might otherwise withhold their input.

**Delphi Technique**

A priori Post-ANOVA tests on the Delphi technique revealed, as predicted, that groups using this technique reached higher quality decisions than did groups using an interacting format. This finding concurs with those of Dalkey (1968; 1969) and Campbell (1963) who also found the Delphi technique to result in higher quality decisions than did the interacting method. The present findings are in disagreement with the conclusion of Gustafson et al. (1973) who found the interacting groups to be superior to the Delphi groups on quality measures of decision making. This discrepancy lends support to the criticisms by Van de Ven and Delbecq (1974) that Gustafson et al. (1973) violated many principles central to the Delphi technique.

The Delphi technique is the only technique investigated that resulted in a differentially higher quality decision; it is ironic that it is also the technique that fostered the least amount of acceptance. The analysis of behavioral acceptance measures revealed that groups using the nominal group technique demonstrated more acceptance of their solutions than did groups using the Delphi technique. Furthermore, the analysis of the self-report acceptance measures revealed that both the consensus and the interacting formats fostered more acceptance than did the Delphi format.

Three of the more notable Delphi proponents, Dalkey and Helmer (1963) and Turoff (1970) have noted that the absence of a group setting facilitates decision making in the Delphi technique since the
respondents are anonymous and the fear of potential repercussions and embarrassment are removed. The findings of this study offer moderate support for this statement, although it appears that the reduction of social interaction which results in a gain in the quality dimension of an effective decision results in a loss in the acceptance dimension. Hackman and Oldham (1980) reinforce this point by stating the "... devices [such as the Delphi method] minimize process losses by minimizing process itself" (p. 204).

However, it should be noted that the Delphi technique was designed and most often used to obtain an expert opinion from a group of specialists who would not necessarily be involved in the implementation of their decision. Therefore, acceptance by the decision-making group is not necessarily one of the objectives of the Delphi technique.

Conclusions

The findings of the present research have implications for the selection of a decision-making format to be used in group problem-solving situations. These implications are:

1. In situations that require solutions with a high quality component, only a secondary emphasis on acceptance, and in which time is not a prime concern, the Delphi technique would be the most appropriate decision-making format.

2. In situations that require solutions with a high degree of acceptance and only a secondary emphasis on quality, the consensus method would be the most appropriate decision-making format.

3. Although none of the formats in the present study
differentially fostered both high amounts of quality and acceptance, it is suggested that in situations requiring solutions with both high quality and high acceptance components, the consensus method would be the most appropriate decision-making format. This suggestion is based on implications from Maier (1963) and from the results of Lane et al. (1980), who demonstrated that decision-making groups that focus their attention on obtaining a solution with a high acceptance component simultaneously improve the quality of their decision. The consensus format fostered the largest amount of acceptance of the decision-making groups in the present study. The consensus format may create a more favorable climate for offering and discussing ideas, thereby creating the potential for solutions with a high degree of quality.

Maier and Hoffman (1964) have noted that problems differ in the degree to which quality and acceptance are essential in making decisions effective. They point out that this indicates the need for an appraisal of these separate factors before deciding on a decision-making approach for obtaining a solution. Evidence is available that demonstrates that managers in decision-making positions are able to distinguish the varying amounts of quality, acceptance, and the combination of the two required in different problem-solving situations (Maier and Hoffman, 1964; Newstrom, 1972). Thus, the value of a particular decision-making format for a given situation is determined not only by the problem at hand, but also by the amount of quality and acceptance required by the situation.

Although precautions were taken to insure the generalizability of these findings to organizational settings, certain limitations
should be addressed. Admittedly, there are obvious differences between this research and actual work in organizations. For example, the groups involved in this research were ad hoc, student groups, fully aware that their participation with other group members would be limited to one and half hours. In addition, Delphi participants were aware that their anonymity would be kept after the end of their four weeks of participation in the Delphi group. Moreover, the generalizability of the particular evaluative task used in this research may be at issue.

An area of concern is indicated by some lack of concordance between the behavioral measure of acceptance and the self-report measures of acceptance. There is not an entirely consistent pattern to the acceptance measures; across various comparisons, occasionally a particular decision-making format may show more behavioral acceptance but less self-reported acceptance than the other format in question, and show just the opposite pattern when compared to a third format. However, this was not a frequent occurrence.

The behavioral measure of acceptance, which was the mean correlation between the group score and the second individual scores, revealed a high amount of agreement between the group score and the second individual score. This may be an artifact of the manner in which the second individual decisions were made. Immediately following the group decision, the remaining materials were distributed to the subjects who were told to determine their second individual decision, complete the questionnaire and that this would conclude their participation in the research, so they would then be free to leave.
Future research might allow for a period of several days to pass between the group decision and the second individual decision, rather than the brief five-minute period in the present study. Such an extended period of reflection might result in a more accurate representation of what might occur in an organizational setting, as well as serve to diminish the "dash-for-the-door" effect noted in present research with undergraduate participants.

In sum, this study constitutes the first simultaneous investigation of the four decision-making formats: the interacting method, the consensus method, the nominal group technique, and the Delphi technique, on the dimensions of quality and acceptance. Behavioral measures of acceptance previously had not been examined in any of the four decision-making formats. No modifications were made in the intervention techniques in order to preserve their integrity. The findings of this study add support to the claims that the results of research using modified intervention techniques may be suspect. Implications for future research using quality and acceptance measures were discussed. It was concluded that the results of this study may be of assistance to the practitioner interested in selecting the appropriate decision-making format for evaluative problem-solving situations.
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APPENDICES
Appendix A

NASA Individual and Group Worksheet
Instructions: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lit surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During re-entry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip.

Below are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance in allowing your crew to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important.

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Box of matches</td>
</tr>
<tr>
<td></td>
<td>Food concentrate</td>
</tr>
<tr>
<td></td>
<td>50 feet of nylon rope</td>
</tr>
<tr>
<td></td>
<td>Parachute silk</td>
</tr>
<tr>
<td></td>
<td>Portable heating unit</td>
</tr>
<tr>
<td></td>
<td>Two .45 calibre pistols</td>
</tr>
<tr>
<td></td>
<td>One case dehydrated Pet milk</td>
</tr>
<tr>
<td></td>
<td>Two 100-lb. tanks of oxygen</td>
</tr>
<tr>
<td></td>
<td>Stellar map (of the moon's constellation)</td>
</tr>
<tr>
<td></td>
<td>Life raft</td>
</tr>
<tr>
<td></td>
<td>Magnetic compass</td>
</tr>
<tr>
<td></td>
<td>5 gallons of water</td>
</tr>
<tr>
<td></td>
<td>Signal flares</td>
</tr>
<tr>
<td></td>
<td>First aid kit containing injection needles</td>
</tr>
<tr>
<td></td>
<td>Solar-powered Fm receiver-transmitter</td>
</tr>
</tbody>
</table>
Appendix B

Correct NASA Rankings and Rationales
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Box of matches</td>
<td>Useless since there is no oxygen on the moon to sustain a flame.</td>
</tr>
<tr>
<td></td>
<td>Food concentrate</td>
<td>Efficient means of supplying energy requirements.</td>
</tr>
<tr>
<td>6</td>
<td>50 feet of nylon rope</td>
<td>Useful in scaling cliffs, tying injured together, etc.</td>
</tr>
<tr>
<td>8</td>
<td>Parachute silk</td>
<td>Protection from sun's rays.</td>
</tr>
<tr>
<td>12</td>
<td>Portable heating unit</td>
<td>Only useful if on the dark side of the moon.</td>
</tr>
<tr>
<td>11</td>
<td>Two .45 calibre pistols</td>
<td>Possible source of self-propulsion.</td>
</tr>
<tr>
<td>12</td>
<td>One case dehydrated Pet milk</td>
<td>Duplicates food concentrate in bulkier form.</td>
</tr>
<tr>
<td>1</td>
<td>Two 100-lb. tanks of oxygen</td>
<td>Most pressing survival need.</td>
</tr>
<tr>
<td>3</td>
<td>Stellar map (of the moon's constellation)</td>
<td>Most important means of determining position and directions.</td>
</tr>
<tr>
<td>9</td>
<td>Life raft</td>
<td>CO₂ bottle in military raft may be used for propulsion.</td>
</tr>
<tr>
<td>14</td>
<td>Magnetic compass</td>
<td>Virtually useless since magnetic field on the moon is not polarized.</td>
</tr>
<tr>
<td>2</td>
<td>5 gallons of water</td>
<td>Absolute necessity to sustain life.</td>
</tr>
<tr>
<td>10</td>
<td>Signal flares</td>
<td>Possible distress signal once close enough to mother ship to be seen.</td>
</tr>
<tr>
<td>7</td>
<td>First aid kit containing injection needles</td>
<td>Needles for vitamins, medicines, etc., will fit special aperture in NASA space suits.</td>
</tr>
<tr>
<td>5</td>
<td>Solar-powered FM receiver-transmitter</td>
<td>For communication with mother ship; but FM require line-of-sight transmission and short ranges.</td>
</tr>
</tbody>
</table>
Appendix C

Post-Experimental Questionnaire

Interacting, Consensus, and Nominal Technique Groups
QUESTIONNAIRE

Instructions: This questionnaire consists of a series of statements about your experiences in your group. You will find that you agree with some and disagree with others. Please indicate your own personal reaction to each statement by responding according to the following six choices. In the parentheses ( ) to the left of each statement, write the number of the choice that best represents your degree of agreement or disagreement.

Choices: (1) Totally disagree
(2) Disagree very much
(3) Tend to disagree
(4) Tend to agree
(5) Agree very much
(6) Totally agree

1. ( ) I am satisfied with the amount of influence or say I had over my group's decision.
2. ( ) I am satisfied with the solution reached by my group.
3. ( ) The people in my group freely expressed their feeling or emotions.
4. ( ) Everybody participated in the discussion in my group.
5. ( ) My group definitely achieved a high quality solution.
6. ( ) My group's final solution was definitely acceptable to everyone in the group.
7. ( ) My group did not seem to have leadership.
8. ( ) The group's decision reflected my own opinion.
9. ( ) Disagreement among group members was openly expressed.
10. ( ) Everyone agreed with the final group solution.
11. ( ) My opinion about some or all of the items is reflected in my group's decision.
12. ( ) A few people dominated the discussion in my group.
13. ( ) I would be willing to work with these same people on other types of problems.
14. ( ) I liked the method our group used to solve the problem.
15. ( ) My group closely followed the procedure outlined in the instructions.
QUESTIONNAIRE

Instructions: Please circle the number of the statement that most accurately describes your feelings for each of the following questions.

A. To what extent did you feel free to participate and contribute your ideas?
   1. I did not feel free.
   2. I felt somewhat free.
   3. I felt moderately free.
   4. I felt mostly free.
   5. I felt completely free.

B. To what extent did you feel your time was well spent in your group?
   1. Not at all well spent.
   2. Somewhat well spent.
   3. Moderately well spent.
   4. Mostly well spent.
   5. Very well spent.

C. How satisfied were you with the quality of ideas produced by your group?
   1. Not at all satisfied.
   2. Somewhat satisfied.
   4. Mostly satisfied.
   5. Very satisfied.

D. How satisfied were you with the quantity (number) of ideas produced by your group?
   1. Not at all satisfied.
   2. Somewhat satisfied.
   4. Mostly satisfied.
   5. Very satisfied.

E. To what extent do you feel the method your group used was an effective way to evaluate ideas?
   1. Totally ineffective.
   2. Somewhat effective.
   3. Moderately effective.
   4. Mostly effective.
   5. Extremely effective.
F. To what extent do you feel the method used by your group was an effective way to generate ideas?

1. Totally ineffective.
2. Somewhat effective.
3. Moderately effective.
4. Mostly effective.
5. Extremely effective.

G. To what extent do you feel the meeting you just participated in is an effective way to deal with a problem?

1. Totally ineffective.
2. Somewhat effective.
3. Moderately effective.
4. Mostly effective.
5. Extremely effective.

H. Which statement do you think most accurately describes problem-solving situations in general?

1. Females are better than males.
2. Females and males are equal.
3. Males are better than females.

I. Which statement do you think most accurately describes the Lost on the Moon problem?

1. Males are better than females.
2. Males and females are equal.
3. Females are better than males.

J. How much confidence do you have in your final ranking?

1. None
2. A bit
3. Moderate.
4. A lot
5. Total

K. How much confidence do you have in your group's final ranking?

1. None.
2. A bit.
3. Moderate.
4. A lot.
5. Total.
Please answer these two questions.

L. In general, what did you like the most about the group you participated in?

M. In general, what did you dislike the most about the group you participated in?
Solve the following problem.

N. A person bought a horse for $60 and sold it for $70. Then he/she bought it back again for $80 and sold it for $90. How much money did he/she make in the horse business?

1. Lost $10.
2. Broke even.

O. Sex: Female Male
P. Classification in School
   Frosh. Soph. Jr. Sr. Other
Q. Age: _____ years
R. Major: ___________________
S. Are there any other comments you would like to make about your group or this experiment?
APPLICATION BLANK

Experiment ID # ____________

Name ________________________

Phone number ________________

MY SIGNATURE ON THIS SHEET, by which I volunteer to participate in the indicated experiment conducted by the indicated experimenter, signifies that I understand that all subjects in the project are volunteers, that I can withdraw at any time from the experiment, that I have been or will be informed as to the nature of the experiment, that the data I provide will be anonymous and my identity will not be revealed without my permission, and that my performance in this experiment may be used for additional approved projects, that I shall be given an opportunity to ask questions prior to the start of the experiment and after my participation is complete my questions will be answered to my satisfaction.

In agreeing to participate in this experiment I realize the importance of my contribution. I anticipate that I will complete the required work and return it on time for the next 12 class periods.

I understand that my absence may cause the other 3 members of my group to be unable to complete the experiment. If unable to attend any class with my completed materials, I will insure to help return them so as not to delay or cause my group to drop out of the project.

I also agree not to discuss this experiment with anyone else or seek out assistance from any person or material concerning the problem.

I understand that I will be told the results of this experiment upon its completion or on the last day of class. I realize that failure to comply with any of these requests may cause myself and my group not to receive full credit for participation in this experiment.

Signature ________________________
DIRECTIONS

Thank you for participating in this experiment. We are interested in the way people solve problems. In particular, we are interested in how people in organizations who are great distances apart from one another conduct meetings. For example, you may have heard of companies using telephone conference calls, where everyone has a common line and can share in a discussion with participants who are in other cities. Another example, although less well known, of a meeting that would allow people in separate places to communicate is called the Delphi technique.

Participants in a Delphi meeting never meet face to face. They are free to work on the problem at their own convenience and in private. After reading about the problem participants write down their comments and possible solutions. Each participant then returns his materials to the coordinator of the meeting. Bob Erfmeyer will be the coordinator of the Delphi groups. The coordinator then summarizes the responses and returns them to the participants so they may read everyone’s comments. Based on this new information given by the other group members, respondents can reevaluate or change their current position and add comments expressing agreement, disagreement, or clarification concerning the items.

This chain of events (a) giving your comments, (b) reading a summarized report of all participants’ suggestions and opinions, (c) then again giving your comments, may occur several times. In our experiment this will happen five times. Another feature of this type of meeting is that each of the participants and their suggestions remain anonymous to everyone in the group except the
Directions (Continued)

coordinator. The reason for anonymity of group members is so that members will not be overly influenced by domineering personalities or social pressures of other members.

Your identification number in this experiment is ____, this number should be on all materials you receive and should be on all materials you return.

To summarize you instructions:

1) Read the problem.

2) Rank the 15 items and in one sentence comment on the importance or lack of importance of each item.

3) Place the completed answersheet (keep everything else) in the envelope it came in and return it to the next class period on Friday, October 24.

4) If you cannot bring the material in for the class, or forget it, please bring them to Room 318, Peabody Hall, before 11 A.M. the day they are due.

Please remember:

1) If you have any questions call Bob at 766-3979, or 769-4448.

2) Please do not discuss this problem with anyone.

3) Bring the completed answersheet to the next class.

Thank you,

Bob Erffmeyer
### Delphi Pick-Up & Return Dates

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
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<td></td>
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<td></td>
<td><strong>PICK-UP</strong></td>
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<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>31</td>
<td>Nov. 1</td>
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<tr>
<td></td>
<td><strong>PICK-UP</strong></td>
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<td><strong>RETURN</strong></td>
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<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>RETURN</strong></td>
<td></td>
<td><strong>PICK-UP</strong></td>
<td><strong>RETURN</strong></td>
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<td>10</td>
<td>11</td>
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<td>15</td>
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<td></td>
<td><strong>PICK-UP</strong></td>
<td></td>
<td><strong>RETURN</strong></td>
<td><strong>PICK-UP</strong></td>
<td><strong>QUESTIONNAIRE</strong></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td><strong>RETURN</strong></td>
<td><strong>QUESTIONNAIRE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The calendar above outlines your Delphi group's schedule. It shows when you should pick up your materials and when you should return them. Always pick up and return materials at the front of the room after class.

**Please Remember:**

1. If you have any questions call Bob at 766-3979 or 769-4445.
2. Do **NOT** discuss this problem with anyone.
3. If you cannot bring the materials or forget to bring them to class, please bring them to Room 318 Peabody Hall before 11:00 the day they are due.
4. All 4 group members must return their materials before any receive credit.
5. Pick up a new answersheet and problem on the days indicated on the calendar.
6. Bring the completed answersheet in your response envelope and return them to class.
Instructions: You are a member of a space crew originally scheduled to rendezvous with another ship on the lighted surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During re-entry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip.

Below are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance in allowing your crew to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important. In the space to the right of each item write a brief (about one sentence) explanation of why you ranked that item in the order you did.

1. Box of matches
2. Food concentrate
3. 50 feet of nylon rope
4. Parachute silk
5. Portable heating unit
6. Two .45 calibre pistols
7. One case dehydrated Pet milk
8. Two 100-lb. tanks of oxygen
9. Stellar map (of the moon's constellation)
10. Life raft
11. Magnetic compass
12. 5 gallons of water
13. Signal flares
14. First aid kit containing injection needles
15. Solar-powered Fm receiver-transmitter
To restate your problem: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During re-entry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip.

On the following pages are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance in allowing your crew to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important.

What follows is a summary of how the four members of this Delphi group ranked the items and their explanations for doing so. Please review the 15 items. If you wish to add comments expressing agreement, disagreement, or clarification concerning the items please do so in the space provided. Finally, please rank order the items as you perceive their importance at this time and state your reason for your ranking.
<table>
<thead>
<tr>
<th>Item</th>
<th>Group’s Rank (Round ___)</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box of Matches</td>
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<td></td>
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<td>Average Rank: ______</td>
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<td>- Your Rank This Round</td>
<td>Reason:</td>
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<tr>
<td>Food Concentrate</td>
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<tr>
<td>Average Rank: ______</td>
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<td>- Your Rank This Round</td>
<td>Reason:</td>
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<tr>
<td>50 feet of nylon rope</td>
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<td>Average Rank: ______</td>
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<td>- Your Rank This Round</td>
<td>Reason:</td>
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<tr>
<td>Parachute Silk</td>
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<td>Average Rank: ______</td>
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<td>- Your Rank This Round</td>
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<tr>
<td>Item</td>
<td>Group's Rank (Round__)</td>
<td>Reason</td>
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<td>------------------------------------------------</td>
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<tr>
<td>Portable Heating Unit</td>
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<td>Average Rank:</td>
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<tr>
<td>Item</td>
<td>Group's Rank (Round__)</td>
<td>Reason</td>
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<tr>
<td>Two .45 Calibre Pistols</td>
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<td>Average Rank:</td>
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<tr>
<td>Item</td>
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<td>Reason</td>
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<tr>
<td>One Case Dehydrated Pet Milk</td>
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<td>Item</td>
<td>Group's Rank (Round__)</td>
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<td>Two 100-lb. Tanks of Oxygen</td>
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<td>Stellar Map (of the moon's constellation)</td>
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<tr>
<td>Life Raft</td>
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<tr>
<td>Magnetic Compass</td>
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<tr>
<td>5 Gallons of Water</td>
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<tr>
<td>Item</td>
<td>Group's Rank (Round __)</td>
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<tr>
<td><strong>Item</strong></td>
<td><strong>Group's Rank</strong></td>
<td><strong>Reason</strong></td>
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<tr>
<td>Solar-powered PM Receiver-transmitter</td>
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<tr>
<td>Item</td>
<td>Group's Rank (Round 2)</td>
<td>Reason</td>
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<tr>
<td>Signal Flares</td>
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<td>First Aid Kit Containing Injection Needles</td>
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<td>- Your Rank This Round</td>
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<td>Solar-powered FM Receiver-transmitter</td>
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<td>Average Rank:</td>
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<tr>
<td>- Your Rank This Round</td>
<td></td>
<td>Reason</td>
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</tbody>
</table>

When you have finished put all your answersheets in your envelope and return it on Wednesday. Bring it to the front of the classroom after class. Then, on Friday don't forget to pick up your new envelope.

If you have any questions call dob at 764-3979, or 769-4448.
Appendix F
Delphi Materials
Round 3
Once again we would like you to:

1) Carefully re-read the problem.

2) Read the explanations given by your group members for ranking the items in the order they did.

3) Reevaluate your position and write a brief explanation of why you ranked the items as you did.

4) Also included in this packet is a new sheet that summarizes both your rankings and your group's rankings for the previous rounds. You may use it to see how you and your group's rankings have changed.

   Please return it each time with your answersheets.

5) Place the completed answersheets and the new summary sheet in your envelope and return it after the next class, Monday.

6) If you have any questions please call Bob at 766-3979, or 769-4448.

To review: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During re-entry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip.

On the next 4 pages are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance in allowing your crew to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important.

In the space to the right of each item write a brief (about one sentence) explanation of why you ranked that item in the order you did.
### SUMMARY OF ITEM RANKINGS

This is a summary sheet that shows your rankings and your group's ranking of the 15 items. You may use it for review if you wish. Please do not write on this sheet (do not fill in rankings). Return this sheet with your answersheet each round.

**Your Rankings**

<table>
<thead>
<tr>
<th>Item</th>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
<th>Round 4</th>
<th>Round 5</th>
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<tbody>
<tr>
<td>Box of matches</td>
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<tr>
<td>Food concentrate</td>
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<td>50 ft. nylon rope</td>
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<td>Parachute silk</td>
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<tr>
<td>Heating unit</td>
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<tr>
<td>Two .45 pistols</td>
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<tr>
<td>One case Pet milk</td>
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<tr>
<td>2 oxygen tanks</td>
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<td>Stellar map</td>
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<td>Life raft</td>
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<td>Magnetic compass</td>
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<td>5 gallons water</td>
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<td>Signal flares</td>
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<td>First aid kit</td>
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<td>FM receiver-trans.</td>
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**Group's Rankings**

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<th>Item</th>
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<td>Box of matches</td>
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<td>Food concentrate</td>
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NOTICE

When you finish ranking the items this round you will be past the half way point of this study. This note is to serve as a reminder that in order for the other 3 members in your group to benefit from your ideas you should state more clearly your reason for ranking the items as you did. It would be better if you could give your reasons as completely as possible. Reasons such as: same, no need, not necessary, not applicable, essential, for survival, etc. are not as useful as providing a more complete explanation.

1) For example: if you rank fishing line & hook 8 - necessary for survival

this does not tell your group members why it is necessary.

2) It is important that you do not put "same" down for a reason, try to clearly state your reason.

3) If on any items you feel your ranking is more correct than other group members' you might try to persuade them by giving additional reasons for your ranking.

4) Reasons left blank are not acceptable.
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<tr>
<th>Item</th>
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<th>Item</th>
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<th>Item</th>
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Remember:
- return your 4 answersheets and
- the summary sheet
to class on Monday. On Wednesday pick up your new envelope. If you have any questions call Bob at 766-3979 or 799-4448.
The directions for this round are as follows:

1) Review the problem.

2) Study the reason given by your 3 other group members for their rankings.

3) Reevaluate your position and write a brief explanation of why you ranked the items in the order you did. If on any items you feel your ranking is more correct than other group members' you might try to persuade them by giving additional reasons for your ranking.

4) When you have completed the answersheets place them and your summary sheet in your envelope and return it after the next class, Friday.

5) If you have any questions please call Bob at 766-3979 or 769-4448.

To review: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During re-entry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip.

On the next 4 pages are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance in allowing your crew to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important.

In the space to the right of each item write a brief (about one sentence) explanation of why you ranked that item in the order you did.
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<tr>
<th>Item</th>
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<td>Signal Flares</td>
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<tr>
<th>Item</th>
<th>Group's Rank (Round 4)</th>
<th>Reason</th>
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<tbody>
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<td>First Aid Kit</td>
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<td>Containing Injection Needles</td>
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<th>Item</th>
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<th>Reason</th>
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<tbody>
<tr>
<td>Solar-powered FM Receiver-transmitter</td>
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<td>- Your Rank This Round</td>
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<td>Reason:</td>
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</table>

**A REMINDER**

- Return your 4 answersheets and
- the summary sheet
to class on Friday. Then, on Monday pick up your new envelope.
If you have any questions call Bob at 766-3979 or 769-4448.
Appendix H

Delphi Materials

Round 5
ATTENTION CREW MEMBER. READ THIS!

1) Round 5 (this round) is the last opportunity you will have to influence your crew's (other crew members') final rankings. As in the previous rounds, you may change your ranking or clarify your position (keep present ranking) to show agreement, or disagreement with the responses.

2) Reevaluate your position and write a brief explanation of why you ranked the items in the order you did. If on any items you feel your ranking is more correct than other group members' you might try to persuade them by giving additional reasons for your ranking.

3) When you have completed the answersheets place them and your summary sheet in your envelope and return it after the next class, Wednesday.

4) The remaining schedule is as follows:
   Wed. Nov. 12 - Return Round 5
   Fri. Nov. 14 - Pick up Questionnaire
   Mon. Nov. 17 - Return Questionnaire

   All 4 members must complete and return the questionnaire to obtain maximum credit.

5) If you have any questions please call Bob at 766-3979, or 769-4448.

To review: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During re-entry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip.

On the next 4 pages are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance in allowing your crew to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important.

In the space to the right of each item write a brief (about one sentence) explanation of why you ranked that item in the order you did.
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<tr>
<th>Item</th>
<th>Group's Rank (Round 5)</th>
<th>Reason</th>
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<td>Signal Flares</td>
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- When you finish -

Return the 4 answersheets and summary sheet in your envelope on Wednesday. On Friday pick up your packet which will contain a questionnaire. If you have any questions call Bob at 766-3979, or 769-4448.
Appendix I

Delphi Materials

Final Round (Questionnaire Round)
DIRECTIONS FINAL ROUND

Return to class on Monday, November 17, 1980

Your packet contains 2 different sheets:

1) the summary and answersheets (white)
2) a questionnaire (yellow)

Both need to be filled out and returned.

1) Answersheets (white)
   Your group's final rankings are shown on your summary sheet
   and on your answersheet (as the average rank). We would
   like you to rank the items one last time, by yourself.
   Please take a few minutes to fill out your final opinion
   on the ranking of these items. It is not necessary to
   follow your last set of rankings or your group's rankings.

2) Questionnaire (yellow)
   Answer the questions according to the directions given
   in the questionnaire section.

Note:
- Your extra credit points will automatically be recorded
  when your group completes and returns the problem and
  questionnaire. You will not have to turn in a "pink slip"
  to receive your extra credit. On next Monday, Nov. 24,
  a list will be posted so you may verify how many points
  you received if you wish.
- If you have any questions please call Bob at 766-3979, or
  769-4448.

To review: You are a member of a space crew originally scheduled to
rendezvous with a mother ship on the lighted surface of the moon. Due to
mechanical difficulties, however, your ship was forced to land at a spot
some 200 miles from the rendezvous point. During re-entry and landing,
much of the equipment aboard was damaged and, since survival depends on
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On the next 4 pages are listed the 15 items left intact and undamaged after
landing. Your task is to rank order them in terms of their importance in
allowing your crew to reach the rendezvous point. Place the number 1 by the
most important item, the number 2 by the second most important, and so on
through number 15, the least important.

In the space to the right of each item write a brief (about one sentence)
explanation of why you ranked that item in the order you did.
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A Final Reminder

After you have finished ranking the items and giving a reason for the rankings go on to the questionnaire section (yellow pages). Return both the questionnaire and the 4 answersheets on **Monday, November 17, 1980.** If you have any questions about this or the questionnaire call Bob at 766-3979, or 769-4448.
QUESTIONNAIRE

Instructions: This questionnaire consists of a series of statements about your experiences in your Delphi group. You will find that you agree with some and disagree with others. Please indicate your own personal reaction to each statement by responding according to the following six choices. In the parentheses ( ) to the left of each statement, write the number of the choice that best represents your degree of agreement or disagreement.

Choices: (1) Totally disagree
(2) Disagree very much
(3) Tend to disagree
(4) Tend to agree
(5) Agree very much
(6) Totally agree

( ) I am satisfied with the amount of influence or say I had over my group's decision.

( ) I am satisfied with the solution reached by my group.

( ) The people in my group freely expressed their feelings or emotions.

( ) My group definitely achieved a high quality solution.

( ) My group's final solution was definitely acceptable to everyone in the group.

( ) My group did not seem to have leadership.

( ) The group's decision reflected my own opinion.

( ) Disagreement among group members was openly expressed.

( ) Everyone agreed with the final group solution.

( ) My opinion about some or all of the items is reflected in my group's decision.

( ) I would be willing to work with these same people on other types of problems.

( ) I liked the method our group used to solve the problem.

( ) My group closely followed the procedure outlined in the instructions.
QUESTIONNAIRE

Instructions: Please circle the number of the statement that most accurately describes your feelings for each of the following questions.

A. To what extent did you feel free to participate and contribute your ideas?
   1. I did not feel free.
   2. I felt somewhat free.
   3. I felt moderately free.
   4. I felt mostly free.
   5. I felt completely free.

B. To what extent did you feel your time was well spent in your Delphi group?
   1. Not at all well spent.
   2. Somewhat well spent.
   3. Moderately well spent.
   4. Mostly well spent.
   5. Very well spent.

C. How satisfied were you with the quality of ideas produced by your group?
   1. Not at all satisfied.
   2. Somewhat satisfied.
   4. Mostly satisfied.
   5. Very satisfied.

D. How satisfied were you with the quantity (number) of ideas produced by your group?
   1. Not at all satisfied.
   2. Somewhat satisfied.
   4. Mostly satisfied.
   5. Very satisfied.

E. To what extent do you feel the Delphi method was an effective way to evaluate ideas?
   1. Totally ineffective.
   2. Somewhat effective.
   3. Moderately effective.
   4. Mostly effective.
   5. Extremely effective.
F. To what extent do you feel the Delphi method was an effective way to generate ideas?

1. Totally ineffective.
2. Somewhat effective.
3. Moderately effective.
4. Mostly effective.
5. Extremely effective.

G. To what extent do you feel the series of "Delphi meetings" you just participated in is an effective way to deal with a problem?

1. Totally ineffective.
2. Somewhat effective.
3. Moderately effective.
4. Mostly effective.
5. Extremely effective.

H. Which statement do you think most accurately describes problem-solving situations in general?

1. Females are better than males.
2. Females and males are equal.
3. Males are better than females.

I. Which statement do you think most accurately describes the Lost on the Moon problem?

1. Males are better than females.
2. Males and females are equal.
3. Females are better than males.

J. How much confidence do you have in your final ranking?

1. None.
2. A bit.
3. Moderate.
4. A lot.
5. Total.

K. How much confidence do you have in your group's final ranking?

1. None.
2. A bit.
3. Moderate.
4. A lot.
5. Total.
Please answer these two questions.

L. In general, what did you *like the most* about the Delphi group you participated in?

M. In general, what did you *dislike the most* about the Delphi group you participated in?
Solve the following problem.

N. A person bought a horse for $60 and sold it for $70. Then he/she bought it back again for $80 and sold it for $90. How much money did he/she make in the horse business?

1. Lost $10.
2. Broke even.

O. Sex: Female Male

P. Classification in School:
   Frosh. Soph. Jr. Sr. Other

Q. Age: ______ years

R. Major: __________________________

S. On the average, how much time did you spend each time you solved the problem? ________________

T. We would like your honest opinion of how difficult it was not to discuss this problem with anyone else? (You will get your full 18 extra credit points no matter how you answer this question, please be honest.)

1. I did not discuss the problem with anyone.
2. I discussed the problem with only my closest friend.
3. I slipped and discussed the problem with several people.

If you answered 1 or 2, how much help did you get and do you think it influenced your responses?

______________________________

U. Are there any other comments you would like to make about Delphi groups or this experiment?
Appendix J

Reminder Slip
- REMINDER SLIP -

You have signed up to earn extra credit by participating in research.

Date: ________________ Time: ________________ Place: Auditorium 103

The success of this session depends upon your attendance. Since a complete group is necessary for this research, without your presence the other volunteers for this session may not be able to participate in the research.

Please try to keep your appointment.

Dr. I.M. Lane
Coordinator Research Committee
Appendix K

Consensus Group Guidelines
GUIDELINES FOR A CONSENSUS GROUP

Your group is to employ the method of group consensus in reaching its decision. This means that the ranking for each of the 15 survival items must be agreed upon by each group member before it becomes a part of the group decision. Consensus is difficult to reach. Therefore, not every ranking will meet with everyone’s complete approval. Unanimity, that is a unanimous decision, is not a goal (although it may be achieved unintentionally), and it is not necessary that every person be as satisfied as if he had complete control over what the group decides. What should be stressed is the individual’s ability to accept a given ranking on the basis of logic – whatever his level of satisfaction – and his willingness to entertain such a judgment as feasible. When the point is reached at which all group members feel this way you may assume that you have reached a consensus as it is defined here and the judgment may be entered as a group decision. This means, in effect, that a single person can block the group if he thinks it necessary; at the same time, it is assumed that this option will be employed in the best sense of fair play. The guidelines to use in achieving consensus follow on the next page.
1. Avoid arguing for your own rankings. Present your position as clearly and logically as possible, but consider seriously the reactions of the group in any subsequent presentations of the same point.

2. Avoid 'win-lose' stalemates in the discussion of rankings. Discard the notion that someone must win and someone must lose in the discussion; when impasses occur, look for the next most acceptable alternative for both parties.

3. Avoid changing your mind only in order to avoid conflict and to reach agreement and harmony. Withstand pressures to yield which have no objective or logically sound foundation. Strive for enlightened flexibility; avoid outright giving up.

4. Avoid conflict-reducing techniques such as the majority vote, averaging, bargaining, coin flipping, and the like. Treat differences of opinion as indicative of an incomplete sharing of relevant information on someone's part and press for additional sharing, either about task or emotional data, where it seems in order.

5. View differences of opinion as both natural and helpful rather than as a hindrance in decision making. Generally, the more ideas expressed the greater the likelihood of conflict will be; but the richer the array of resources will be as well.

6. View initial agreement as suspect. Explore the reasons underlying apparent agreements; make sure that people have arrived at similar solutions for either the same basic reasons or for complementary reasons before incorporating such solutions in the group decision.

7. Work to produce the solution that is most acceptable to every member of your group.
Appendix L

Nominal Technique Group Guidelines
NOMINAL TECHNIQUE GUIDELINES

1. During the last few minutes each of you ranked the 15 items and wrote down your reasons for each ranking on your worksheet. Now I would like you to present your rankings and reasons using the board I am hanging up. Each of you will tell the rest of the group what rank you assigned to an item and then the reason why you ranked it as you did. Please refer to your worksheet and give only the ranks and reasons that you listed on your worksheet. (Do not change your ranks or reasons because of someone else’s comments or rationales.) We will proceed around the table and will let each member of the group comment on an item before moving on to the next item. As the presentations are made, please do not discuss your decisions (rankings) with other group members.

As you tell me the rank you gave an item I will place that number next to the item on the board. For instance, if you ranked "Box of matches" as number "7", I would place a "7" next to "Box of matches" on the board. Again, while a group member is discussing his ranking there should be no talking by other members. In other words, only one person is to be talking at a time and only while he is giving his presentation. Also, while giving your presentation, do not discuss the rationales of the other members who have presented before you. Every member will present his ranking for a particular item before we move to the next item on the list.
2. After all four members have had an opportunity to present their rankings for all of the 15 items, there will be a period of open group discussion. All members will be able to discuss their rationales and ask questions of others about their decisions in an open forum format. After the discussion session, you will individually fill out another copy of the worksheet on which you will rerank the 15 items. At this time you should take into account any new information you consider to be important that you may have gained from listening to the other group members. You will not be required to write an explanation of your rankings on this copy. Do not talk while you fill out Copy 2.

3. When Copy 2 is completed I (the experimenter) will collect the answersheets and use your individual rankings to determine a ranking for the group. Your individual ranking of the items on this copy will be averaged to determine a group ranking of the items. The group's ranking for each item will be designated in the last column on the board with a red number.
VITA

Robert Charles Erffmeyer was born in Galesburg, Illinois on May 15, 1954. He graduated from Galesburg Senior High School in 1972. In the fall of 1972 he attended Purdue University in West Lafayette, Indiana, studying pre-veterinary medicine. He returned to Galesburg in January, 1973, and enrolled in Knox College for a liberal arts education with a psychology major. In June, 1976, he received his Bachelor of Arts degree, cum laude. In August, 1976, he enrolled in the Graduate School of Louisiana State University, majoring in Industrial-Organizational Psychology, with a minor in Management. He received his Master of Arts degree in May, 1979. On June 14, 1981, he will marry Elizabeth Lynn Shoefelt, who shares his interest in Industrial-Organizational Psychology and is working toward her doctoral degree in this area. He is a candidate for the Doctor of Philosophy degree at the spring commencement, May, 1981.
Candidate: Robert Charles Erffmeyer

Major Field: Psychology

Title of Thesis: Decision-Making Formats: A Comparison on an Evaluative Task of Interacting Groups, Consensus Groups, the Nominal Group Technique, and the Delphi Technique

Approved:

[Signature]
Major Professor and Chairman

[Signature]
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signature]

[Signature]

[Signature]

Date of Examination:

May 4, 1981