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The impact of social cuing on idea generation

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The University of Arizona, 1987
THE IMPACT OF SOCIAL CUING ON IDEA GENERATION

by

Patricia Clendenning Nelson

A Thesis Submitted to the Faculty of the
DEPARTMENT OF MANAGEMENT AND POLICY
In Partial Fulfillment of the Requirements
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In the Graduate College
THE UNIVERSITY OF ARIZONA

1987
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ABSTRACT

Research on the performance of brainstorming groups has consistently found that nominal groups generate more ideas than real groups. The factors distinguishing individual and interactive brainstorming are social inhibition, efficiency and social cuing. To test the impact of social cuing on idea generation, differences in efficiency and social inhibition must be eliminated. This research used a network of microcomputers and electronic brainstorming models to analyze the affect cuing has on idea generation. The key findings of this research are: (1) social cuing does not effect the quantity of ideas generated during brainstorming; and (2) the use of electronic models can eliminate differences in social inhibition and efficiency between individual and interactive idea generation. There was no statistical difference in the quantity of ideas generated by the nominal and real groups. There was no difference in subject level of satisfaction with one process over another.
CHAPTER 1
INTRODUCTION

Groups are superior to individuals for decision analysis. Groups are usually better at generating options and probing their relative advantages and disadvantages; therefore groups have a better chance of structuring an unstructured situation. However, to be effective a group will require a great deal of communication among participants. (Turoff and Hiltz, 1982)

The group is an important element in organizational decision-making. As indicated in the above quote, there are advantages that occur when individuals interact in a decision-making situation. One advantage of using groups to make decisions is that they can use the diverse skills and experience of their members to produce a greater number of approaches to the problem. However, group decision-making activities can also be flawed. The need for communication among the members can impact the effectiveness of the group. Research on the alternatives generation phase of group decision-making indicates that the ideational output in a group setting is affected by the need to communicate. Bringing together a group to generate a wider range of alternatives may inhibit the performance of group members. Tools have been developed to improve the process of group decision-making. This
research is concerned with one aspect of decision-making, idea generation, and a tool developed to improve idea generation, brainstorming.

Alexander F. Osborn introduced the term "brainstorming" in *Applied Imagination: Principles and Procedures of Creative Thinking* in 1953. Brainstorming is a technique for facilitating creative idea generation in groups by reducing the inhibitory effects of group interaction. In Osborn's concept, the sole consideration is the generation of ideas, not their evaluation. The objective is to elicit as many ideas as possible from a group. No criticism is allowed as this inhibits creative thinking and participant willingness to verbalize ideas. By not allowing for criticism and evaluation during the brainstorming sessions, participant inhibition decreases and group ideation increases. Osborn saw group brainstorming as more productive than individual idea generation: "...the average person can think up to about twice as many ideas when working in a group than when working alone." (Osborn 1953, pp. 228-229).

Two factors receive primary credit for increasing group productivity in brainstorming. The first is the absence of criticism. No evaluation of ideas is allowed until the brainstorming session is over. Osborn stated: "The average group can produce nearly ten times as many
ideas, in the same length of time, when ideation is unhampered as when judgement is allowed concurrently to interfere." (Osborn 1953, pp. 232-233). The second is the power of association. An idea put forth by one participant stirs that person's imagination as well as the associative powers of others. Hitchhiking, or presenting an idea linked to a previous idea, is a priority. Throughout this research, this power of association is referred to as "social cuing".

Brainstorming is still a widely used technique. Geschka (1978) reported the results of a survey conducted from 1971 to 1973. Of the 126 respondents from industrial companies, 80 percent answered they had a good or comprehensive knowledge of the brainstorming method. Twenty-three respondents answered that they applied the method often.
1.1 Group Versus Individual Idea Generation

Two types of groups are referenced throughout this research and previous brainstorming studies: real and nominal. Real groups, or interacting groups, consist of individuals that brainstorm or generate alternatives on a problem together. Nominal groups, or individual groups, consist of individuals who brainstorm alone but whose output is evaluated as if the members have worked together. Thus, the difference between the two is that in real groups the members interact. The output of a nominal group provides a measure to compare the performance of an interacting group with the results that would have been obtained had the individuals worked alone. This allows researchers to measure the effect group interaction has on ideation.

Considerable research has been done on individual versus group idea generation since Osborn's publication. Contrary to Osborn's expectations research has consistently found that nominal groups outperform interacting groups (Taylor, Berry and Block 1958, Dunnette, Campbell and Jaastad 1963, Campbell 1968, Bouchard 1969, Vroom, Grant and Cotton 1969, Bouchard and Bare 1970, Dillon, Graham and Aidells 1972, Lewis, Sadosky and Connolly, 1975). Although these studies indicate that group brainstorming
may not be effective for group idea generation, the method is still widely used in industry and academia (Jablin and Sussman 1978). The variable generally measured when nominal and real groups are compared is the number of unique ideas generated by the group on a specific question or issue (Taylor, Berry and Block 1958, Dunnette, Campbell and Jaastad 1963). An idea is considered unique if it is appropriate to the task and it is the first occurrence of the idea. An idea put forth by two group members is only counted once.

Various explanations have been provided to explain why a number of individuals working alone can outperform an interacting group. The factors differentiating real and nominal groups can be placed into three categories: social inhibition, social cuing, and efficiency.

The negative impacts of social inhibition on interactive brainstorming include fear of criticism from other group members (Taylor et al. 1958), communication apprehension (Jablin and Sussman 1978), and status and competency differences (Jablin and Sussman 1978). The negative impacts on efficiency include production blocking and mismanagement of time (Lamm and Trommsdorff 1973). The impacts of social cuing seem most equivocal. On one hand, cognitive inertia often results during brainstorming. Agreement is psychologically more comfortable than
disagreement and therefore, discussion is limited to those categories socially validated. This promotes single track thought and limits the performance of groups (Lamm and Trommsdorff 1973). On the other hand, creative thinking may be enhanced by incidental or environmental cues. Research has shown that a dyad has a higher function of creativity than individuals working alone (Torrance 1971). The impact of social cuing itself has not been tested due to the difficulty in neutralizing the other effects—social inhibition and efficiency.

Given that the goal of brainstorming is to produce a quantity of ideas, existing research suggests that the benefits of this procedure do not outweigh the inhibiting or negative effects. However, if the negative impacts of efficiency and social inhibition could be eliminated, it is possible the benefit due to social cuing could allow interacting groups to outperform nominal groups. This research uses computer support to minimize the impacts of efficiency and social inhibition, and to test the effect of cuing on idea generation.
1.2 Computer Support for Unstructured Processes

Automated support for decision making processes has been a focus of research efforts since the 1970's (Gerrity 1971). This support has primarily focused on improving the efficiency of decision making through increased access to information and the use of quantitative models to analyze information. Many computer models are available to help process and structure this quantitative data. A new direction in decision support is the development of computer-based systems for use by groups of people jointly responsible for decision-making (DeSanctis and Gallupe 1985). This includes models to provide support to enhance creativity and judgement. These models are designed to assist with unstructured, strategic decisions within the organization (Applegate 1986).

The University of Arizona has constructed the Department of Management Information System's Planning and Decision Laboratory to provide a research facility for the study of planning and decision processes. Two tools, utilizing networked microcomputers allow for anonymous idea generation either interactively or individually. This creates an environment where most of the identified factors affecting group versus individual productivity in idea generation can be eliminated. The computer-based
interactive brainstorming model facilitates group members interaction while reducing inhibitory influences to enhance the participation of group members. Individual and group idea generation are subject to the same social inhibitory and efficiency effects. The difference that remains between the two methods is social cuing.
1.3 Research Questions

Group decision-making is extensive in organizations yet it can produce less than perfect results. The generation of alternatives (idea generation) is one aspect of decision-making where research has shown individuals are more effective than groups. Computer-based systems have the potential to overcome some of the inefficiencies of group decision-making. This research uses computer-based brainstorming tools to eliminate some of the factors affecting the ideational output of groups. This allows for testing the first research question - how does social cuing affect the quantity of ideas produced during idea generation.

This analysis is important for several reasons. First, it provides the opportunity to isolate the effect of social cuing on idea generation. Idea generation is an important process to study because the need to generate and analyze ideas is essential to decision-making. Studies on the benefits of group versus individual idea generation generally have used a methodology similar to Osborn's structured brainstorming. Consistently, these studies find that individuals outperform groups (Taylor et.al. 1958, Dunnette et.al. 1963). The explanations of cause have been diverse, though most focus on the impact of social
inhibitions and efficiency. Technology is now available that may tap the beneficial aspects of group ideation while neutralizing the negative. This research will analyze whether exposure to the ideas of other group members hampers or facilitates the generation of ideas. Second, it provides the opportunity to analyze the impact of computer technology on the idea generation process. Considerable effort is being expended to develop models that facilitate unstructured, strategic processes. This research will provide insight on how these models may be used in one phase of the decision process. This research thus involves, in a broader sense, a look at how information technologies can be employed to enhance the creative activity of groups of decision makers. As such it has implications for the use of creativity enhancing, automated tools for decision support.

A second factor of interest in this study is participant satisfaction with both the process and the outcome of the brainstorming sessions. The benefit of using one process over another is not solely determined by the quantity of ideas generated. One method may provide more user satisfaction and thus achieve higher value from that perspective. Additionally, the use of an unfamiliar tool for communication (the computer) may cause dissatisfaction. The second research question in this
thesis is to assess how important the interactive component of idea generation is in promoting participant satisfaction with the process and the outcome.
CHAPTER 2
REVIEW OF THE LITERATURE

The review of literature pertinent to this research is divided into four sections:

1. Idea generation;
2. Group process;
3. Computer mediated communication; and
4. Satisfaction.

2.1 Idea Generation

Extensive interest in brainstorming began with the publication of Applied Imagination: Principles and Procedures of Creative Thinking by Alexander F. Osborn in 1953. He proposed that our judicial mind which analyzes, compares and chooses affects our creative mind which visualizes, foresees and generates ideas. The two minds can operate in opposition. The judicial mind can inhibit or destroy the productivity of the creative mind. The brainstorming technique developed by Osborn solves this by dividing the creative process into two phases, idea generation and idea evaluation. During idea generation, judgement is suspended and analysis of ideas is prohibited. During the idea evaluation phase, the judicial mind can evaluate the products of the idea generation phase.
There are four principles that guide the use of this methodology: (1) criticism of ideas is ruled out; (2) group members are encouraged to contribute all ideas no matter how far fetched; (3) quantity of ideas is the objective of the session; and (4) combination and improvement (or hitch hiking) are encouraged. Underlying arguments for the benefits of group brainstorming is the assumption that the psychological safety of evaluation free group discussion will result in increased ideation. Osborn proposed group ideation as superior to individual due to the synergistic effect of people working interactively. Osborn ascribed this benefit to the power of association. An idea stirs the presenter's imagination as well as the associative powers of others. The cuing provided by interaction was seen as a key factor in increased group performance. Various versions of Osborn's brainstorming technique remain in wide use today.

Many studies have been conducted since that time to look at the benefits of group ideation. Some of the early studies indicating the value of interactive brainstorming compared the output of an interacting group with one individual (Taylor and Faust 1952, Osborn 1957). A major contribution of Taylor (1954) was to compare the output of an interacting group with the merged output of a like number of individuals working alone. This was termed a
"nominal group" signifying a group in name only. Thus it was possible to compare the output of the same number of people working interactively and individually. Taylor, Berry and Block (1958) compared real and nominal groups on three dependent measures: the average number of ideas produced, the average number of unique ideas, and ratings of feasibility, effectiveness, generality, probability and significance of ideas. They found the performance of real groups inferior to nominal groups for both quality and quantity measures. They postulated this was due to a felt possibility of criticism from other group members and the tendency of groups to fall into a rut, or single train of thought. Dunnette, Campbell and Jastaad (1963) replicated the Taylor et al. study, modified to have subjects participate in both individual and group sessions. They also found that nominal groups outperformed the real groups and that this was most pronounced when individual brainstorming was preceded by group discussion. This study concurred with Taylor et al., in attributing to groups the tendency to get into a rut and for individuals to feel inhibited by the presence of other group members.

Other studies started to consider what could be causing individuals to outperform groups. Campbell (1968) using an industrial sample and a real, complex problem, compared the solution quality of real versus nominal groups
under three conditions: individual solutions, individual solutions after hearing group discussion without criticism, and group solution after discussion. The quality of the group solution was inferior to the nominal group and to the average individual scorer. Bouchard (1969) looked at whether feedback affected the performance of brainstorming groups. After two experiments, he concluded that individual brainstorming under feedback and non feedback conditions is far superior to either group brainstorming or critical problem-solving. Bouchard and Hare (1970) looked at whether group size has any impact on the comparison of real and nominal groups. No major increases in performance resulted in the real groups as size was increased from five to nine. The nominal groups remained more effective than the real groups. The crucial problem identified was the lack of effective management of time in the groups. Bouchard (1972) looked at the effect of requiring all subjects to participate for some fixed portion of the time available to the group to address the problem of mismanagement of time. Although nominal groups outperformed real, the finding was not significant. Bouchard concluded that using a sequential procedure for participation, real groups could perform as well or better than a comparable nominal group. In a review of empirical research on group versus individual brainstorming
performance, Lamm and Trommsdorff (1973) identified some consequences of group participation that hindered interactive brainstorming groups. One factor was production blocking, the implicit rule that only one member speak at a time. In a four man interacting group, each individual only had available one-fourth of the time available to individuals working alone. Dillon, Graham, and Aidells (1972) looked at the effect of training and practice on individual and group performance. Group practice followed by individual brainstorming produced the largest number of ideas. The general superiority of individuals over groups appeared even more pronounced when the motivation was high and the problem was real. Bouchard, Barsaloux, and Drauden (1974) looked at the effect of various factors on brainstorming outcomes. The significant findings of this research was that there is no size effect for real groups and that nominal groups outperformed real groups. Forced participation in this instance did not increase the performance of the real groups, negating Bouchard's 1972 hypothesis. Vroom, Grant and Cotton (1969) found that nominal groups produced about twice as many ideas as real groups. They attributed the differences to the inhibitory effects of the presence of the other group members and to the fact interaction tends to result in members developing a common set in their approach to a problem. Jablin and
Sussman (1976) looked at the impact of communication apprehension on brainstorming performance. They found that subjects low in communication apprehension produced more ideas than those high in communication apprehension. They conclude that the requirement for oral communication inhibits performance. Differences in communications skills may result in perceptions of status differences which may foster inhibition. Jablin, Seibold, and Sorenson (1977) analyzed the effect of personal inhibition on brainstorming performance. The study used subjects high and low in communication apprehension. They found that subjects low in communication apprehension did produce more ideas than subjects with high communication apprehension, and that no significant difference existed in their productivity in nominal groups. They conclude that whether one will brainstorm better alone or in a group depends on one's predisposition toward interacting in groups. Subjects high in communication apprehension performed best when working alone. Street (1974) analyzed whether social facilitation causes the decreased effectiveness of groups. According to social facilitation theory, the presence of others leads to heightened arousal or drive. This increases the likelihood of giving well learned versus creative responses to stimuli. For decreased performance (i.e. lessened creativity) to result, Street found that the groups had to
be interacting, not just located in the same room. He concluded that differences in group and individual performance do not result from physiological arousal but rather from group norms of noninvolvement. Comadena (1984) found that the factors inhibiting performance in brainstorming groups are the nature of the task itself, the cognitive ability of the group member, social skills and the environment. He concludes task attraction and communication apprehension are the most important factors in brainstorming performance. Table 2.1 presents a summary of group effects suggested in past research as inhibitors of group brainstorming performance. An excellent review of empirical research on brainstorming is presented in Jablin and Seibold (1978).
# TABLE 2.1
FACTORS SUGGESTED AS INHIBITING PERFORMANCE OF INTERACTING BRAINSTORMING GROUPS

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<tr>
<td>Fear of criticism (disapproval) from other group members</td>
<td>Taylor et.al., 1958</td>
</tr>
<tr>
<td></td>
<td>Dunnette, et.al., 1963</td>
</tr>
<tr>
<td></td>
<td>Vroom et.al., 1969</td>
</tr>
<tr>
<td>Tendency to adopt a single train of thought</td>
<td>Taylor et.al., 1958</td>
</tr>
<tr>
<td></td>
<td>Dunnette, et.al., 1963</td>
</tr>
<tr>
<td></td>
<td>Vroom et.al., 1969</td>
</tr>
<tr>
<td>Use of time limited by other group members</td>
<td>Lamm and Trommsdorff, 1973</td>
</tr>
<tr>
<td>Anxiety about verbal communication</td>
<td>Jablin and Sussman, 1978</td>
</tr>
<tr>
<td></td>
<td>Jablin et.al., 1977</td>
</tr>
<tr>
<td></td>
<td>Comadena, 1984</td>
</tr>
<tr>
<td>Perceived status differences</td>
<td>Jablin and Sussman, 1978</td>
</tr>
<tr>
<td></td>
<td>Collaros and Anderson, 1969</td>
</tr>
<tr>
<td>Group norms of non-involvement</td>
<td>Street, 1974</td>
</tr>
</tbody>
</table>

Other idea generation techniques including interacting and nominal brainwriting were developed to improve the efficiency of idea generation. The Nominal Group Technique or NGT (Delbecq and Van de Ven 1971, and Delbecq, Van de Ven and Gustafsen 1975) was developed to
help overcome the social inhibitions caused by group dynamics. This method also separates idea generation and idea evaluation. In idea generation, individuals generate written lists of ideas alone. After ten minutes of individual brainstorming, the participants share their ideas in a round-robin fashion. The second phase involves structured group discussion of each idea and prioritization of ideas through group voting and negotiation. Geschka (1980) and VanGundy (1981) discuss the Interactive Brainwriting Technique developed at the Battelle Institute in Frankfurt, Germany. This technique was originally developed to promote anonymity and promote the efficiency of group brainstorming. In this technique, group members write an idea on a blank sheet of paper which they then return to the center of the table and draw another sheet of paper. Participants are encouraged to read the ideas of others, but not to evaluate the ideas. They are encouraged to create new ideas based on what they have seen and to combine ideas. This phase of ideas generation is followed by group discussion, voting and consensus negotiation. The advantage of this technique is it is more efficient as participation is continuous, and no group member can dominate the discussion. Social inhibition factors are neutralized to some extent as comments are written. However, anonymity cannot be assured as handwriting may be
recognized. The three other alternatives to brainstorming presented below were described by VanGundy (1984).

1. Discussion 66: groups have six members including a leader. A single problem is assigned to the group and a solution must be reached in six minutes. The group then gets another problem to solve. This procedure is seen as less inhibiting due to the small group size.

2. Gordon Technique: only the group leader knows at first what the actual problem is to be solved. The group is first introduced to a general problem area abstract in scope. After group members generate ideas on this general problem, a less abstract problem is presented. Key bits of problem information are introduced gradually. The process continues until the real problem is actually introduced. Not focusing on the precise problem initially avoids premature decisions.

3. Delphi Technique: a number of experts in a given field or area are given a questionnaire to complete. Results are collated and distributed back to the participants with the contributions remaining anonymous. The process is continued to reach consensus.
2.2 Factors Inhibiting Group Process

Studies analyzing group interaction, provide insight on why fewer ideas have been produced in interacting as opposed to nominal groups. A number of studies look at the barriers that affect the free expression of ideas in groups. Hoffman (1965) outlines many of these studies and their findings. In his review of past studies, Hoffman identifies the major barriers to effective problem-solving as those conditions which prevent the free expressions of ideas in a group. These barriers include the personal characteristics, perceived ability and prior experience of group members. The personal characteristics of group members is a factor: people without confidence are more likely to conform to group norms. Perceived ability is a factor: people conform to the opinions of people they like and judge these people more proficient. Prior experience is a factor: individuals tend to rely on the group to solve a problem when the group has been successful in the past. Size affects participation in groups. As groups grow, the distribution of participation becomes more skewed with one or more people doing most of the talking. Potential dissenters become reluctant to voice their opinion because they may be thought deviant from the group. Power structure creates barriers: the
presence of authority relations in a group seems to change the nature of the discussion. There is greater concentration on the ideas of the high status person. These and other barriers negatively impact creative aspects of group problem solving.

Other authors have also identified aspects of group process that impact the output of groups. Huber (1982) outlines the process losses that occur in group communication. Some of his key findings are:
1. domination by a few members suppresses the contributions of others and therefore restricts the availability of information;
2. low status members defer their opinions;
3. there are strong group pressures for conformity; and
4. mis-communications occur as information is shared.

Maier (1967) identified both advantages and disadvantages to group problem-solving. The benefits include:
1. greater total knowledge and information available;
2. there are a greater number of approaches to the problem;
3. there is better comprehension of the decision; and
4. participation in problem-solving increases acceptance. This point of Maier's is discussed in more detail in section 2.4.

The liabilities of group activities include:
1. social pressure on group member - there is a desire to be a good group member and accepted, and
2. individual domination: dominant individual emerges and has more than his share of influence on the outcome.

Haier concludes: "If liabilities inherent in groups are avoided, assets capitalized upon, and conditions that can serve either favorable or unfavorable outcomes are effectively used, it follows that groups have a potential which in many instances can exceed that of a superior individual functioning alone, even with respect to creativity."

The group process issues identified above support the factors summarized in Table 2.1, suggested as inhibitors of ideational proficiency in interacting groups. Factors that block the free expression of ideas in groups include the presence of an authority figure, domination by a few group members, perceived and actual status differences, and pressures for conformity. The review by Hoffman (1965) cites research studies on each of these factors.
2.3 Computer-Mediated Communication

Studies on computer mediated communication and teleconferencing provide insight into the influence of computer technology on group decision-making. Literature on the effects of computer-mediated communication on the organization indicate the use of technology will change group processes. Strickland et al. (1976) found that in computer-mediated discussions no clear leader emerges, and role differentiation is less pronounced and more unstable. The group structure and hierarchy that generally emerge in face-to-face communication are not so clear in mediated-communication. Turoff and Hiltz (1982) found that groups communicating face-to-face were more likely to generate a dominant member or leader than groups communicating via computers. Some of their key finds were that:

1. face-to-face groups generated two to three times as many communications units as the computer groups but they both reached the same quality of decision.
2. There was more opinion giving in computerized conferences. This was however, negatively associated with the ability to reach consensus.

Krueger (1976) found that participation in group communication was most equal when teletypewriters were used. Face-to-face communication resulted in the least
equal participation. Siegel et al. (1986) had three person groups wrestle with a problem in three different communication modes: face-to-face; interactively at a computer terminal not knowing which group member they were communicating with; and a second time at the terminals, knowing the identity of the other communicators. The authors found that although the participants were just as focused on task, it took longer to forge consensus on the terminal. Participants using the computer were more likely to hold divergent points of view and stick to them. There was more resistance to social pressure. These computer-mediated discussions were less inhibited than the face-to-face discussions. Groups communicating via computer had more equal participation among the group members than did the face-to-face groups. The authors concluded that communication by computer encourages self-expression which makes agreement harder to achieve. Kiesler (1986) discusses the impact new technology has on the way social and work activities are organized. Computers limit the information communicators get about the social context of their messages. People focus their attention on the message rather than on each other. The decoupling of the message from its source causes communication to become unregulated. People feel less empathy, less guilt, less concerned with how they compare with others and are less
influenced by group norms. People become less concerned with status and making a good impression. They become more extreme, impulsive and self-centered. Communication is less inhibited. Johansen, Valle, and Spangler (1979) found that in computer-mediated communication the communication channels are limited. The removal of factors such as body language and voice intonation leads to more focused communication. Differences in background, organizational commitment and goals and objectives become less perceptible. An additional finding is that people who are socially uncomfortable and easily dominated can play a more dynamic role in computer conferencing. Hiltz and Turoff (1978) made a similar finding. They identified computer conferencing as less intimate and exposing than face-to-face conferences. The ability to be anonymous facilitates impersonal conversation. As the communicators are alone, they are free to express disagreements or put forth unpopular ideas. The content of ideas can be focused on without distorting the reception of information. A summary of the effects of computer-mediated versus face-to-face communication are included in Table 2.2.
### TABLE 2.2
SUMMARY OF RESEARCH ON THE EFFECTS OF COMPUTER-MEDIATED COMMUNICATION

<table>
<thead>
<tr>
<th>COMPUTER-MEDIATION EFFECT</th>
<th>STUDIES</th>
</tr>
</thead>
</table>
| Role differentiation and group structure are less clear and more unstable | Strickland et al., 1976  
Turoff and Hiltz, 1982  
Kiesler, 1986  
Johanssen, et al., 1979 |
| Decreased inhibition - more opinion giving | Turoff and Hiltz, 1982  
Siegel et al., 1986  
Hiltz and Turoff, 1978 |
| Increased time to reach consensus | Turoff and Hiltz, 1982  
Siegel, et al., 1986 |
| Equalization of participation | Krueger, 1976  
Siegel, et al., 1986 |
| More resistance to social pressure | Siegel, et al., 1986  
Kiesler, 1986 |
| More focused communication | Kiesler, 1986  
Johanssen et al., 1979  
Hiltz and Turoff, 1982 |

Williams (1977) has published an excellent review of experiments comparing face-to-face and mediated communication. These early studies provide support for the findings presented in Table 2.2.
2.4 Satisfaction

Another area of interest is literature on the issue of how participant satisfaction with the decision making process and the outcome of the process affects the success of that group. Maier (1952) distinguishes between two dimensions to the solution of a problem: quality and acceptance. Maier (1963, p. 253) goes on to define quality as "the objective features of a decision" while acceptance is "the degree to which the group that must execute the decision accepts it". Member ratings of satisfaction with the solutions were highly correlated with the subject's own ratings of satisfaction with their influence over the decision. Acceptance seems to be related to the freedom of the decision process rather than the objective quality of the decision itself. "A group member will feel satisfied to the extent that he feels he has influenced the group decision appropriately." (Hoffman, 1968, p. 121).

This involvement in idea generation and information gathering, the first phase of the problem-solving cycle, could affect participant satisfaction with the outcome of the process. A group more satisfied with the process and outcome of a decision-making session may have greater confidence in the decision. Maier (1967) found that participation in problem-solving increases acceptance.
This is important in that some problem solutions depend upon the support of others for implementation. He states: "Insofar as group problem-solving permits participation and influence, it follows that more individuals accept solutions when a group solves a problem than when one person solves it" (Maier 1967, p. 240). The use of an interactive group decision support system for idea generation should facilitate participation by all group members in the decision-making process. When groups solve problems, more people accept and feel responsible for making the solution work. DeStephen (1983) found that a group is more successful if the members like the solution to a problem or support the findings. The findings of his study confirmed that increased feedback leads to increased decision satisfaction.
2.5 Summary

Past research comparing the quantity of ideas generated by real and nominal groups has consistently shown that the subjects working alone outperform interacting groups. Research on interactive versus individual idea generation and group process have identified a number of factors that can inhibit group brainstorming. The factors differentiating interactive and individual brainstorming are combined into three categories, social inhibition, efficiency, and social cuing, for further discussion in this paper.

Social inhibition includes the fear of disapproval or criticism of an idea, anxiety about verbal communication, perceived status differences, the presence of authority figures, and group norms of noninvolvement. These tend to hinder individuals from freely expressing ideas in groups. Efficiency refers to differences in efficiency between the two processes. This includes the fact that in verbally interacting groups, only one person can productively speak at a time. This could block the production of new ideas and slow the process of sharing ideas in interacting groups. Individuals working alone can work continuously and simultaneously. This category also includes efficiency differences in the communication modes.
used. Some studies have compared oral group performance with written individual performance (Bouchard, 1969, Siegel et al., 1986). One communication mode may be more efficient than another. The effect of social cuing in idea generation is most equivocal. Exposure to the ideas of the other participants is expected to stir the associative powers of the presenter and the other group members (Osborn, 1953). However, previous research has also identified a tendency for group members to adopt a single line of thought (Taylor et al., 1958; Dunnette, et al., 1963; Vroom et al., 1969). The isolated effect of cuing has not been measured due to the difficulty in mediating the effect of social inhibition and efficiency differences.

Research on computer-mediated communication indicates that the use of this technology will change the group processes that exist in face-to-face communication. Research has found changes in inhibition, participation patterns, group structure and resistance to social pressure. It is proposed that using individual and interactive automated brainstorming models on a computer network, the inhibition of the idea generation process attributable to social influences will be reduced. Anonymity is maintained as computer-mediated communication allows group members to express their feelings without fear of disapproval from group members or authority figures.
Group members who suffer from communication anxiety are not required to verbally express their ideas in front of a group. Using the automated brainstorming models can equalize the efficiency of the two processes. All users can simultaneously input ideas. No group member can dominate the process. All subjects communicate in a typewritten mode making the output comparable. This research is conducted with the assumption that brainstorming on a computer network will eliminate the social inhibition and efficiency differences between the interactive and individual brainstorming. This allows the impact of social cuing on ideation to be tested.

Use of an interactive electronic brainstorming model may lead to greater participant satisfaction with the process used and the outcome of the idea generation process. The anonymous interchange of comments lessens status differences and encourages equal participation. Participants may thus feel their input receives a greater degree of consideration. This may lead to greater acceptance of the decision or plan that results from the process.
CHAPTER 3

FRAMEWORK FOR THE RESEARCH

This research represents a small part of an on-going program of research currently underway at the University of Arizona. The research utilized a decision support system implemented in the Department of Management Information Systems' (MIS) Planning and Decision Laboratory. The system implemented in the MIS Planning and Decision Support Laboratory is part of the Plexsys Research Project; a project concerned with the design of an integrated workbench of automated tools to support organization and information systems planning, information system requirements analysis, logical and physical information system design, and information system implementation, evaluation and maintenance throughout the system development lifecycle. A complete description of the design, implementation and evaluation of the system designed to support complex, unstructured decision processes is contained in Applegate (1986).
3.1 Setting

The MIS Planning and Decision Laboratory has been constructed to provide a research facility for the study of planning and decision processes. Executives use the facility for organizational planning and to solve complex, unstructured decision problems. A diagram of the laboratory is presented in Figure 3.1.

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FIGURE 3.1
MIS PLANNING AND DECISION LABORATORY
A large U-shaped table is equipped with networked microcomputers recessed into the table to facilitate the interaction among participants. A large screen projection system is also on the network which permits the display of work done at individual workstations or of aggregated information from the total group. Break-out rooms are equipped with microcomputers networked to the microcomputers at the main conference table. The output from small group sessions can also be displayed on the large screen projector and can then be updated and integrated with the planning results.

Participants using the MIS Laboratory can interact with a variety of automated and manual planning and problem-solving models that provide support throughout the planning and decision process. Three general classes of planning and problem-solving models are implemented in the system: (1) idea generation models, (2) organizational planning models, and (3) data analysis and decision models.
3.2 Experiment Models

This experiment used two of the three models that are currently implemented in the idea generation and analysis class of models. These are two automated idea generation models, Electronic Brainstorming Individual (EBS I) and Electronic Brainstorming Group (EBS G). The general nature of these models allows them to be used throughout the planning process to generate ideas in a wide variety of areas including critical planning issues, strengths and weaknesses of the organization, and strategic options.

The EBS I and EBS G models both utilize the same user interface and keystrokes to minimize the learning required to operate the models. Only one screen is used in each tool. The screen is designed to simulate a tablet on which users can jot down ideas in response to a question. The methodologies for the use of the models are presented below:

1. ELECTRONIC BRAINSTormING INDIVIDUAL: Each group member sits in front of a microcomputer that has the EBS I screen on the video display. The specific question or topic for the idea generation session is displayed at the top of the screen. Each member is instructed to key in as many ideas as possible on the topic or question within a given time period. Group members are asked to focus on generating as many ideas as possible and to avoid trying to critique their comments. Participants are informed all comments will be shared with the group after the session but that the source of specific comments will remain anonymous. At the end of the session, the individual files are consolidated into a single file which is printed for analysis by the group.
2. ELECTRONIC BRAINSTORMING GROUP: Each group member sits in front of a microcomputer that has the EBS G screen on the video display. The specific question or topic for the idea generation session is displayed at the top of the screen. A comment window appears on the screen and participants are instructed to type in an idea that relates to the question at the top of the screen. Only five lines are provided for a single comment to stimulate the sharing of ideas and promote the synergistic effect of group members' comments. When group members are through entering an idea, they send their comment to a central server where it is exchanged for a file containing ideas from other group members. Group members are asked to focus on generating as many ideas as possible and to avoid trying to critique their comments. Participants are also informed that all comments will be shared with the group but that the source will remain anonymous. As the session continues, the page that once contained only the question, becomes filled with ideas from the other members of the group. Users can scroll through the ideas so the comments of other group members can be read during the entry of their next idea. At the end of the session each file is shipped to the server and consolidated into a single file. This is printed out for analysis by the group.

The methodology for idea generation using the EBS I model resembles the Nominal Group Technique methodology proposed by Delbecq and Van de Ven (1971). This electronic version has the additional benefit of providing automatic recording of the ideas of each participant in the computer. This eliminates the need for verbal round robin sharing of ideas. Each participant can be given a copy of the session output. This preserves the anonymity of the process. The methodology for the EBS G most closely resembles the Brainwriting Pool Technique. It has been designed to neutralize the group effects that inhibit the free flowing nature of the idea generation process without loss of the
synergistic effects of exposure to the ideas of others. The ability to have parallel idea generation by using the computer network, improves the efficiency of the process similar to the Brainwriting Pool Technique. Additionally, the ideas are automatically recorded in the computer.

The primary difference between the two models as implemented in the MIS Planning Laboratory concerns the interactive sharing of ideas. Using EBS C, ideas are shared between participants during the idea generation process. The question addressed by this research, is whether this facilitates or hinders the process of generating ideas.
3.3 Pilot Study

On July 18, 1986, a pilot study was conducted at the MIS Planning and Decision Laboratory to prepare for the conduct of the actual experiment. The two following sections address the methodology of the pilot test and the results. The outcome of the pilot test resulted in significant changes to the experiment format.

3.3.1 Pilot Test Methodology

The pilot test used students from MIS 111, an introductory computer literacy course. It was designed to test the methodology proposed for the experiment. The hypotheses addressed in the pilot test and the experiment are:

**Hypothesis 1:** There is no difference due to social cuing in the quantity of ideas produced during individual and interactive idea generation.

**Hypothesis 2:** There is no difference in participant satisfaction with the process and outcome of ideation using the interactive or individual idea generation model.

In hypothesis 1, the dependent variable "quantity of ideas generated", refers to the number of different task-appropriate ideas produced. Whether one idea differed from another was evaluated by two raters working independently.
In hypothesis 2, the dependent variable "participant satisfaction" refers to a rating developed from subject responses on a series of questionnaires.

Three questionnaires were used during the pilot test. A pre-session questionnaire was used to gather demographics and computer literacy statistics from the subjects. A second questionnaire was used after the subjects had used the first of the two brainstorming models. It measured subject satisfaction with the process and outcome of the first tool used. The third questionnaire was used after the second brainstorming model. It was designed to measure comparative satisfaction with the two models and allowed for comments on the technology.

The class was divided into four groups of seven subjects each. Using a randomized block design, each group participated using the individual and interactive brainstorming models. The objective was to achieve maximum differentiation of the treatment variable and to control for other systematic variance within the subjects and the experiment. Method of idea generation (individual versus group), and order of presentation were the blocking variables. Two questions, that were previously tested as comparable (Dunnette, et al., 1963) were posed to each subject. Analysis was then conducted by analysis of variance (ANOVA). For the first hypothesis, the dependent
variable was the number of unique ideas produced. Unique ideas were determined by two independent raters by analyzing the output of the groups. For the second hypothesis, the dependent variable was subject level of satisfaction with the process and outcome of the session. Participants rated satisfaction with the first model on the second questionnaire. The third questionnaire gathered data on subject satisfaction with the models after both had been used. The schedule for presentation of the problems is presented in Figure 3.2.

<table>
<thead>
<tr>
<th>FIRST</th>
<th>SECOND</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP 1 INDIVIDUAL/QUESTION1</td>
<td>INTERACTIVE/QUESTION2</td>
</tr>
<tr>
<td>GROUP 2 INTERACTIVE/QUESTION1</td>
<td>INDIVIDUAL/QUESTION2</td>
</tr>
<tr>
<td>GROUP 3 INDIVIDUAL/QUESTION2</td>
<td>INTERACTIVE/QUESTION1</td>
</tr>
<tr>
<td>GROUP 4 INTERACTIVE/QUESTION2</td>
<td>INDIVIDUAL/QUESTION1</td>
</tr>
</tbody>
</table>

FIGURE 3.2
PRESENTATION OF PILOT TEST QUESTIONS
3.3.2 Results of the Pilot Test

Reported Satisfaction of Subjects Using Automated Technology for Idea Generation. Three questions on the post session questionnaire were designed to measure satisfaction. On a one-to-ten scale, subjects were asked to compare which tool contributed to a more satisfactory process, a more satisfactory outcome, and which tool they preferred using. A score of one indicated the individual process is much better, a score of ten indicated the interactive process is much better. For each group of seven subjects a mean satisfaction score was determined for each of the three questions. Reliability between the questions was calculated by a Pearson Product-Moment Correlation. Reliability between the questions was consistently above the .62 level. The correlations were sufficiently close to consolidate the ratings into one score. The consolidated scores for the four groups is presented in Table 3.1.
TABLE 3.1  
PILOT TEST PARTICIPANTS MEASURED LEVEL OF SATISFACTION

<table>
<thead>
<tr>
<th>GROUP</th>
<th>MEAN</th>
<th>STANDARD DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP 1:</td>
<td>7.452</td>
<td>3.215</td>
</tr>
<tr>
<td>GROUP 2:</td>
<td>8.000</td>
<td>2.690</td>
</tr>
<tr>
<td>GROUP 3:</td>
<td>8.667</td>
<td>1.944</td>
</tr>
<tr>
<td>GROUP 4:</td>
<td>8.071</td>
<td>2.439</td>
</tr>
</tbody>
</table>

where:  
GROUP 1 = INDIV/Q1 INTER/Q2  INT = Individual Model  
GROUP 2 = INTER/Q1 INDIV/Q2  INDIV = Individual Model  
GROUP 3 = INDIV/Q2 INTER/Q1  Q1 = Question 1  
GROUP 4 = INTER/Q2 INDIV/Q1  Q2 = Question 2

The data does not approximate a normal distribution. The distribution is skewed to the higher numbers indicating a preference for the interactive process.

The post-session questionnaire was useful for providing input on how subjects rated use of the models after they had worked with both. However, the ratings of satisfaction were not usable for the ANOVA. The ANOVA was intended to analyze the satisfaction ratings given by the participants for each process. Ratings of the two processes would be compared to see if there was a difference in indicated satisfaction between the two processes. This required calculating a mean satisfaction score for each process for each group. This data was collected on the
second and third questionnaires. The questionnaires, however, were not set up properly to collect this data. The second questionnaire asked subjects to rate on a 1 to 10 scale their perception of the process and outcome of the session. This was after only one model had been used. The third questionnaire allowed subjects to compare the two models after both had been used. There were questions on process, outcome and which method subjects would like to use in a real decision-making situation. These questions also provided a 1 to 10 scale, with a low score indicating the individual model was preferred and a high score indicating the interactive model was preferred. Analyzing satisfaction using the ANOVA and the two satisfaction scores would be misleading due to the meaning of the different scales. The data were still valuable in indicating a preference for the interactive model after both had been used.

Quantity of Ideas Generated. The quantity of ideas generated was evaluated by two independent raters. The evaluators reconciled all differences in quantity of ideas found. Table 3.2 summarizes the results.
### TABLE 3.2

PILOT TEST

<table>
<thead>
<tr>
<th>QUANTITY OF UNIQUE IDEAS GENERATED</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIVIDUAL</strong></td>
<td><strong>INTERACTIVE</strong></td>
</tr>
<tr>
<td>GROUP 1</td>
<td>23</td>
</tr>
<tr>
<td>GROUP 2</td>
<td>29</td>
</tr>
<tr>
<td>GROUP 3</td>
<td>32</td>
</tr>
<tr>
<td>GROUP 4</td>
<td>38</td>
</tr>
</tbody>
</table>

Data were analyzed using a two factor analysis of variance. The results of the analysis are presented in Table 3.3. These results should not be considered conclusive due to the small sample size.

### TABLE 3.3

PILOT TEST ANALYSIS OF VARIANCE

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>MEAN-SQUARE</th>
<th>F-RATIO</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORDER</td>
<td>1</td>
<td>0.125</td>
<td>.006</td>
<td>.943</td>
</tr>
<tr>
<td>METHOD</td>
<td>1</td>
<td>28.125</td>
<td>1.316</td>
<td>.315</td>
</tr>
<tr>
<td>ORDER *</td>
<td>1</td>
<td>21.125</td>
<td>.988</td>
<td>.376</td>
</tr>
<tr>
<td>METHOD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERROR</td>
<td>4</td>
<td>21.375</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DF = Degrees of Freedom
Although the results are not conclusive, the pilot test provided valuable insight. The size of the mean square for the order by method interaction was sufficiently large to produce concerns about order effects. Based on the findings of the pilot test, the methodology of the experiment was changed.
3.4 Research Methodology

This experiment was set up to test two hypotheses. These are:

**Hypothesis 1:** There is no difference due to social cuing in the quantity of ideas produced during individual and interactive idea generation.

**Hypothesis 2:** There is no difference in participant satisfaction with the process and outcome of ideation using the interactive or individual idea generation model.

In hypothesis 1, the dependent variable "quantity of ideas generated", refers to the number of different task-appropriate ideas produced. In hypothesis 2, the dependent variable "participant satisfaction" refers to a rating developed from subject responses to a questionnaire.

3.4.1 Data Collection

Data were collected from ten groups of four subjects each, using EBS G. Data collected from forty four individuals using EBS I were collated into 11 groups for analysis. Where possible, the four subjects used to compose a group, did actually brainstorm in the room at the same time. However, during some experiment sessions there were more or less than the number of participants needed to form groupings of four. In these cases, the data were collected and the subjects randomly assigned to statistical groups.
To test the first hypothesis, the number of unique ideas generated per group was collected. Twenty minutes was allowed for brainstorming. To familiarize the participants with the technology and the model, a five minute warm up session was held before the actual question was given. Data were analyzed for total quantity of unique ideas generated.

**Conduct of Sessions.** Each session was led by the researcher, assisted by another graduate student. To avoid facilitator induced differences, the introduction and instructions given to the participants were videotaped. Each subject received a folder containing the two questions and the pre and post session questionnaires. Subjects were not allowed to converse during the session.

**Control.** Before each session, the subjects were randomized. Each subject was given a number corresponding to the interactive or individual brainstorming tool and was randomly assigned to one of the two processes. One question was used for all subjects.

**Time of Sessions.** A twenty minute period was allowed for each group to brainstorm on the experiment question. A five minute period was allowed for each group to brainstorm on a practice question before the experiment to familiarize subjects with the models. For the interactive groups, the twenty minute session did not
actually result in twenty minutes of time to input comments into the terminal. The interactive nature of the EBS G model causes some input time to be unavailable. After a comment has been entered, the user sends his comment back through the network, where it is exchanged for a different file. At the time of the experiment there was, approximately, a 17 second delay between the time a file was sent and a new file received. An adjustment could have been made to compensate for this delay. However, it was decided not to make this adjustment because time spent waiting could be used productively even though ideas could not be entered into the network.

3.4.2 Subjects

The subjects of the experiment were male and female students from an introductory computer literacy course, MIS 111. The students were requested to participate in the experiment on a voluntary basis; instructors offered extra credit for participation. To encourage active participation during the session, the MIS Department made $75.00 available for awards. Awards were offered to the groups and individuals producing the most unique ideas. Prizes were awarded to the interactive groups that came up with the most unique ideas during the session and the individuals that produced the most unique ideas. First place winners received $10.00; second place winners received $5.00. A
pre-session questionnaire was used to collect data on the computer literacy and the demographics of the subjects. A post-session questionnaire was used to assess participant satisfaction with the process used to generate ideas, the outcome of the session, and perception of the impact of the computer technology on the process. The questionnaires are included in Appendix A. The results of these questionnaires are discussed in later sections.

It was planned to use subjects from one section of MIS 111. Students were requested to sign up for one of ten scheduled sessions. The sessions were scheduled to fall outside the times the participants would normally attend class; Tuesday and Thursday from 2:00 to 3:15. The sessions were held Monday, September 29, 9:00 a.m. to 4:00 p.m. and Tuesday, September 30, 9:00 a.m. to 2:00 p.m. Two groups of four subjects each were to participate in a given session. Ten subjects were registered for each session in case some subjects did not show up. "Extra" subjects were to be assigned to the individual tool and combined as nominal groups for data analysis. Although students volunteered for the experiments, the number that attended was insufficient; only 34 of the 80 registered students attended. As a result, it was necessary to set up additional experiment sessions. To insure a higher turnout, subjects were also sought from a different section of MIS 111. Fifty-six
subjects showed up for the second series of experiments, conducted on Friday, October 1, 1986, 9:00 a.m. to 4:00 pm.

3.4.3 Problem Selection

This experiment paralleled previous experiments comparing the effectiveness of nominal and interacting brainstorming groups in the production of ideas. The problem selected for use in this experiment has been used previously in research of idea generation (Dunnette et.al., 1963). The problem used was:

We don't think this is very likely to happen, but imagine for a moment what would happen if everyone born after 1986 had an extra thumb on each hand. The extra thumb will be built just like the present one is, but located on the other side of the hand. It faces inward, so that it can press against the fingers, just as the regular thumb does now. The question is: What practical benefits or difficulties will arise when people start having this extra thumb?

The problem used in the five minute warmup session has also been used in the past (Dunnette, et.al., 1963).

Suppose that discoveries in physiology and nutrition have so affected the diet of American children over a period of 20 years that the average height of Americans at age 20 has increased to 60 inches and the average weight has almost doubled. Comparative studies of the growth of children during the past five years indicate that the phenomenal change in stature has stabilized so that further increase is not expected. What would be the consequences? What adjustments would this situation require?
3.4.4 Data Analysis

For the first hypothesis, the dependent variable was the total number of unique ideas produced in a group. For EBS G, a group was defined as the four subjects that had interactively worked together. For EBS I, a group was defined as the output of four subjects. Where possible, the four subjects included in the group had brainstormed in the room at the same time. This was accomplished in 7 of the 11 nominal groups (63.6%). Many of the experiment sessions had too many or too few subjects to do this type of grouping. In these cases, subject files were randomly assigned to statistical or nominal groups for analysis.

After completion of the experiments, the responses of the subjects were analyzed to determine the number of unique ideas or solutions generated per group. The raw output from the brainstorming sessions was given to two raters for analysis. The raters were the experimenter and the assistant acknowledged earlier. The raters independently analyzed the output from each group to determine the number of unique ideas generated by each group. For the subjects using EBS I, a total number of unique, or non-repetitive, ideas for each individual in the group was first determined. The lists of the four individuals were then again analyzed to eliminate any repetitive ideas among them, forming a composite list of unique ideas for the group. The group
total was used for further data analysis. For the subjects using EBS G, the output from the group as a whole was analyzed to develop a master list of unique ideas. This list was used for further analysis. The resulting lists of the two raters were analyzed to identify where differences existed. All differences were reconciled to the satisfaction of the two raters.

The mean number of ideas or solutions produced by the interacting groups was compared with that produced under the individual brainstorming condition. Only individual or unique ideas were counted. An idea produced by two or more members of the same group, was counted only once.

For the second hypothesis, the dependent variable was subjects' level of satisfaction with the process and the outcome, including the quality of ideas produced. Each subject received a questionnaire to assess satisfaction with their participation after completing the brainstorming session. Satisfaction scores of participants using the interactive and individual methods were compared along a number of dimensions. The results are discussed in the next chapter.
CHAPTER 4
RESULTS AND ANALYSIS

The experiment sessions were conducted on September 29 - 30, and October 3, 1986 at the MIS Planning and Decision Laboratory. Analysis of the results is presented in 4 sections:
1. Demographics of subjects;
2. Quantity of ideas generated;
3. Reported satisfaction of subjects using the automated technology for idea generation; and
4. Participant perception of how the use of computer technology hindered or facilitated the idea generation process.

4.1 Demographics of Subjects

Students from an introductory computer course were used as subjects. These subjects were chosen because it was assumed that their computer familiarity would bear the closest resemblance to that of the typical executive. Additionally, it was predicted that these subjects would be quite homogeneous, as the typical student in the subject pool is a full-time student in their first or second year of a four-year program. Characteristics of these subjects are presented in Tables 4.1, 4.2, 4.3, 4.4 and 4.5.
**TABLE 4.1**  
AGE  

<table>
<thead>
<tr>
<th></th>
<th>INDIVIDUAL</th>
<th>INTERACTIVE</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
<td>18</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>MAXIMUM</td>
<td>42</td>
<td>29</td>
<td>42</td>
</tr>
<tr>
<td>MEAN</td>
<td>20.93</td>
<td>20.21</td>
<td>20.59</td>
</tr>
<tr>
<td>STD DEVIATION</td>
<td>5.06</td>
<td>2.82</td>
<td>4.14</td>
</tr>
</tbody>
</table>

**TABLE 4.2**  
DISTRIBUTION OF SEX  

<table>
<thead>
<tr>
<th></th>
<th>INTERACTIVE</th>
<th>INDIVIDUAL</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALE</td>
<td>27</td>
<td>31</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>67.5</td>
<td>73.8</td>
<td>70.7</td>
</tr>
<tr>
<td>FEMALE</td>
<td>13</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>32.5</td>
<td>26.2</td>
<td>29.3</td>
</tr>
</tbody>
</table>

**TABLE 4.3**  
SELF-REPORTED TYPING SKILLS  

<table>
<thead>
<tr>
<th></th>
<th>INDIVIDUAL</th>
<th>INTERACTIVE</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>MAXIMUM</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>MEAN</td>
<td>4.24</td>
<td>5.06</td>
<td>4.63</td>
</tr>
<tr>
<td>STD DEVIATION</td>
<td>2.33</td>
<td>2.00</td>
<td>2.21</td>
</tr>
</tbody>
</table>

Key: 1 = poor  
10 = excellent
### TABLE 4.4
**FREQUENCY OF COMPUTER USAGE AT HOME**

<table>
<thead>
<tr>
<th></th>
<th>INDIVIDUAL</th>
<th>INTERACTIVE</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MINIMUM</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>MAXIMUM</strong></td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>0.75</td>
<td>0.7</td>
<td>0.73</td>
</tr>
<tr>
<td><strong>STANDARD</strong></td>
<td>1.18</td>
<td>1.34</td>
<td>1.26</td>
</tr>
</tbody>
</table>

**KEY:**
0 = never  
1 = occasionally  
2 = monthly  
3 = weekly  

### TABLE 4.5
**FREQUENCY OF COMPUTER USAGE AT WORK OR SCHOOL**

<table>
<thead>
<tr>
<th></th>
<th>INDIVIDUAL</th>
<th>INTERACTIVE</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MINIMUM</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>MAXIMUM</strong></td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>2.62</td>
<td>2.35</td>
<td>2.49</td>
</tr>
<tr>
<td><strong>STANDARD</strong></td>
<td>0.88</td>
<td>1.12</td>
<td>1.01</td>
</tr>
</tbody>
</table>

**KEY:**
0 = never  
1 = occasionally  
2 = monthly  
3 = weekly  
4 = daily
The distribution of age, presented in Table 4.1, approximates a normal distribution. The stem and leaf plot is included in Figure 4.1. The age of seven of the participants does fall outside of the normal distribution. This is due to the tight distribution in age. The majority of the participants (80%) were 18 - 21 years of age.

Table 4.2 presents the distribution of sex among the subjects. The percentage of a given sex in each group was comparable.

Self-rated typing skills of the subjects is presented in Table 4.3. Subjects rate their typing skills at about average (4.6 on a scale of 1 - 10 with 1 representing poor and 10 representing excellent). The distribution of typing skills also approximates a normal distribution. The stem and leaf plot is included in Figure 4.2. The subjects using the interactive model did have a slightly higher average typing ability (mean of 5.06 versus 4.24). This difference is not significant at the .05 confidence level.

The initial questionnaire collected information on the frequency of computer usage at home and work or school. This data is presented in Tables 4.4 and 4.5.
Minimum 17  
Maximum 42

2 Cases Subjects Declined to State Age - Missing Values are Excluded From the Plot.

FIGURE 4.1  
STEM AND LEAF PLOT OF THE SUBJECTS' AGE

Minimum 0  
Maximum 10

84 Cases Included in the Plot

FIGURE 4.2  
STEM AND LEAF PLOT OF THE SUBJECTS' SELF-REPORTED TYPING SKILLS
The totals reported for the individual and interactive groups represents the average value reported by subjects using that model. Using a t-test, it was determined that a significant difference did not exist between the mean reported values of computer usage of subjects using the two models. The subjects using the two models had comparable experience with the computer. Therefore, the responses of all participants were combined for further analysis. As illustrated, some regular use of the computer at work, home or school is reported. The more frequent use of the computer at school was expected, as the subjects were enrolled in a basic computer literacy class.

A premise made in choosing students as subjects was that their computer literacy would closely resemble that of a typical executive. This is important for generalizing some of the research findings to the business environment, where these computer software programs are designed for use. Previous studies in the MIS facility had observed high level managers from various organizations using these automated tools for actual organization planning sessions. Data on the frequency of computer usage collected from these managers were analyzed to determine if their frequency of use was similar to that of the subjects. Twenty-two pre-session questionnaires had previously been collected from two planning groups (Applegate 1986). A summary of the data
collected from these questionnaires is presented in Table 4.6.

**TABLE 4.6**
**SUMMARY OF FINDINGS FROM OTHER STUDIES**

<table>
<thead>
<tr>
<th></th>
<th>TYPING</th>
<th>HOME COMP. USE</th>
<th>WORK COMP. USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
<td>1.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MAXIMUM</td>
<td>10.0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>MEAN</td>
<td>5.2</td>
<td>1.05</td>
<td>1.73</td>
</tr>
<tr>
<td>STANDARD DEVIATION</td>
<td>2.7</td>
<td>1.47</td>
<td>1.87</td>
</tr>
</tbody>
</table>

The data presented in Table 4.6, collected from previous planning sessions, and the data presented in Tables 4.3, 4.4, and 4.5, collected from the subjects, were analyzed to determine if the subjects did possess comparable computer skills to executives that have used the facility. Using a t-distribution, as shown in Table 4.7, no significant difference in the means for typing skills and frequency of home computer use were found. The difference in frequency of computer use at work or school was found to be significant at the .1 level. However, the researcher feels the difference is really overstated by these figures. The more frequent computer use at schools is a recent phenomena as subjects were four weeks into a basic computer literacy class. At this point in the learning cycle,
although they had some recent exposure to the technology, it was at a fundamental level. Therefore, the researcher concludes that the typing skills and computer familiarity of the subjects was reasonably the same as executives who have used the MIS facility in the past.

### TABLE 4.7
COMPARISON OF COMPUTER FAMILIARITY OF SUBJECTS WITH EXECUTIVES THAT HAVE USED MIS FACILITY IN THE PAST

<table>
<thead>
<tr>
<th></th>
<th>Home Use</th>
<th>Work Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subj Other</td>
<td>1:1.03</td>
<td>0:0:1.04</td>
</tr>
<tr>
<td>Max</td>
<td>10:4</td>
<td>4:4:4</td>
</tr>
<tr>
<td>Mean</td>
<td>4.63:5.2</td>
<td>.73:1.05</td>
</tr>
<tr>
<td>S.Dev.</td>
<td>2.21:2.7</td>
<td>1.26:1.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.49:1.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.01:1.87</td>
</tr>
</tbody>
</table>

SUBJ = Combined value of all subjects that participated in this brainstorming experiment.

OTHER = Combined value from twenty-two executives that previously used the EBS models.

T = T score with 104 degrees of freedom.

This analysis identifies a similarity between the computer familiarity of the subjects and executives that previously used the brainstorming models. The results obtained from this research could be indicative of results that would be during an actual executive brainstorming session.
4.2 Quantity of Ideas Generated

Results from the output of the experiment sessions were analyzed to determine the number of unique ideas generated by each group. Table 4.8 summarizes the results of the brainstorming session for the eleven groups using EBS I and the 10 groups using EBS G.

<table>
<thead>
<tr>
<th>IDEA SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIVIDUAL (EBS I)</strong></td>
</tr>
<tr>
<td>46</td>
</tr>
<tr>
<td>41</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>44</td>
</tr>
<tr>
<td>59</td>
</tr>
<tr>
<td>39</td>
</tr>
<tr>
<td>33</td>
</tr>
<tr>
<td>73</td>
</tr>
<tr>
<td>71</td>
</tr>
<tr>
<td>46</td>
</tr>
</tbody>
</table>

**TOTAL**

<table>
<thead>
<tr>
<th>MEAN</th>
<th>STANDARD DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>48.36</td>
<td>14.073</td>
</tr>
<tr>
<td>40.6</td>
<td>11.078</td>
</tr>
</tbody>
</table>

The distribution of quantity of ideas generated per group for both the individual and the interactive groups approximates a normal distribution. Figure 4.3 presents the
stem and leaf plot of the quantity of ideas generated by the groups using the interactive brainstorming model. Figure 4.4 presents the stem and leaf plot of the quantity of ideas generated by the groups using the individual brainstorming model. The results of groups using the same brainstorming model were consolidated for further analysis.

A t-test comparison of means was used to evaluate whether the number of unique ideas generated using the interactive model was significantly different than the number generated using the individual model. The difference between the two means was tested for significance at the .1 significance level. The alternative hypotheses are:

H0: U1-U2 = 0 There is no significant difference between the mean number of unique ideas generated using the interactive brainstorming model and the individual brainstorming model.

H1: U1-U2 ≠ 0 There is a significant difference between the mean number of unique ideas generated using the interactive brainstorming model and the individual brainstorming model.

The decision criteria for deciding which hypothesis to accept is:

Accept H0 if the t-statistic calculated from the data is less than or equal to the t-criterion value obtained from the tables.

Accept H1 if the t-statistic calculated from the data is greater than the t-criterion value obtained from the tables.
FIGURE 4.3
STEM AND LEAF PLOT
QUANTITY OF UNIQUE IDEAS GENERATED BY GROUPS USING THE
INTERACTIVE BRAINSTORMING MODEL

1 6
2
3 H 34
3 9
4 M 1
4 H 557
5 1
5 5

Minimum 16
Maximum 55
10 Values Reported

FIGURE 4.4
STEM AND LEAF PLOT
QUANTITY OF UNIQUE IDEAS GENERATED BY GROUPS USING THE
INDIVIDUAL BRAINSTORMING MODEL

3 03
3 9
4 H 14
4 M 66
5 H 0
5 9
6
6
7 13

Minimum 30
Maximum 73
11 Values Included in the Plot
The estimated standard error is 5.568, and the t value is 1.39. There are 19 degrees of freedom (11 + 10 - 2) and the criterion value of t at the .1 significance level for 19 degrees of freedom is 1.729. Since the observed t-value, 1.39, is less than this critical t-value, H0 is accepted. On the basis of the sample data, it can be concluded the population means are the same and the difference in the average number of ideas generated by participants using the interactive and individual models can be attributed to chance errors of sampling. This leads to the conclusion that there is no impact on idea generation due to social cuing.
4.3 Reported Satisfaction of Subjects Using Automated Brainstorming Models for Idea Generation

One of the factors this experiment was designed to measure is level of participant satisfaction with the interactive versus the individual method of generating ideas. Three questions on the post-session questionnaire were designed to measure satisfaction. On a one-to-ten scale, subjects were asked to rate their satisfaction with their ability to generate a lot of ideas during the session, their satisfaction with the quality of ideas they were able to generate and their satisfaction with the software program used to facilitate idea generation. A score of 1 indicated dissatisfaction with the process, a score of ten indicated high satisfaction with the process. The responses of all subjects using the interactive model and all subjects using the individual model were consolidated to provide a mean value for each question for each model. The results from the questionnaires are presented in Table 4.9.
TABLE 4.9
SATISFACTION

<table>
<thead>
<tr>
<th>MINIMUM</th>
<th>MAXIMUM</th>
<th>MEAN</th>
<th>STAND.DEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&quot;</td>
<td>Q1 : 2.0</td>
<td>10.0</td>
<td>6.775</td>
</tr>
<tr>
<td>N&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&quot;</td>
<td>Q2 : 3.0</td>
<td>10.0</td>
<td>6.550</td>
</tr>
<tr>
<td>E&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&quot;</td>
<td>Q3 : 1.0</td>
<td>10.0</td>
<td>7.825</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&quot;</td>
<td>Q1 : 1.0</td>
<td>10.0</td>
<td>6.068</td>
</tr>
<tr>
<td>N&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D&quot;</td>
<td>Q2 : 2.0</td>
<td>10.0</td>
<td>5.909</td>
</tr>
<tr>
<td>I&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&quot;</td>
<td>Q3 : 3.0</td>
<td>10.0</td>
<td>7.409</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&quot;</td>
<td>Q1 : 1.0</td>
<td>10.0</td>
<td>6.404</td>
</tr>
<tr>
<td>O&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&quot;</td>
<td>Q2 : 1.0</td>
<td>10.0</td>
<td>6.214</td>
</tr>
<tr>
<td>A&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L&quot;</td>
<td>Q3 : 1.0</td>
<td>10.0</td>
<td>7.607</td>
</tr>
</tbody>
</table>

Q1 - How satisfied were you with your ability to generate a lot of ideas during this session?
Q2 - How satisfied were you with the quality of ideas you were able to generate during this session?
Q3 - How satisfied were you with the software program you used to generate ideas.

The mean values for each question, obtained from subjects using the interactive and individual models, were compared using a t-test. The framework for the analysis and the results of the t-test are presented in Tables 4.10a, 4.10b, and 4.10c.
TABLE 4.10A
SATISFACTION WITH QUANTITY OF IDEAS GENERATED

<table>
<thead>
<tr>
<th></th>
<th>INDIVIDUAL</th>
<th>INTERACTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
<td>6.086</td>
<td>6.775</td>
</tr>
<tr>
<td>STANDARD</td>
<td>2.297</td>
<td>1.790</td>
</tr>
<tr>
<td>OBSERVATIONS</td>
<td>44</td>
<td>40</td>
</tr>
</tbody>
</table>

The results of the t-test showed that the difference in these values is not significant (t = -1.5624) at the .1 confidence level.

TABLE 4.10B
SATISFACTION WITH QUALITY OF IDEAS GENERATED

<table>
<thead>
<tr>
<th></th>
<th>INDIVIDUAL</th>
<th>INTERACTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
<td>5.909</td>
<td>6.550</td>
</tr>
<tr>
<td>STANDARD</td>
<td>1.696</td>
<td>1.584</td>
</tr>
<tr>
<td>OBSERVATIONS</td>
<td>44</td>
<td>40</td>
</tr>
</tbody>
</table>

The results of the t-test showed that the difference in these values is not significant at the .05 confidence level (t = -1.7845). It is significant at the .1 level.
The t-test showed that the difference in these values is not significant at the .1 level ($t = -.9517$).

These findings lead the researcher to conclude that there was very little difference in satisfaction between the participants using the models. Based on the literature referenced in Chapter 2, previous research at the MIS Laboratory and the pilot test, it was predicted that subjects would be more satisfied with the model that allowed the subjects to interact during idea generation.

My expectation is that these ratings significantly underestimate user preference for the interactive model. This preference is more apparent in the open-ended question on the post-session questionnaire that allowed subjects to discuss how the technology facilitated or hindered the idea generation process. Many of the participants using the individual model saw the primary value of the tool to be one
of efficiency, i.e., the automatic recording of the ideas. Subjects identified a number of other benefits with the interactive model. Subject comments are discussed in more detail in the next section.

One reason these results could understate the actual preference is that the subjects did not have experience with both tools and a basis for comparison did not exist.

Satisfaction with the perceived quality of the session output is the only measure where subjects indicated higher satisfaction with one process over another. This difference, however, was significant at the .05 level, not the .1 level generally used in this paper. Given the measured difference in satisfaction values for two of the measures were not significant, and that the quality measure was not significant at the .1 level, the experimenter concludes these values do not indicate a higher satisfaction with the use of one model over another.
4.4 Subject Perception of how the use of Computer Technology Hindered or Facilitated Idea Generation

The post-session survey contained open ended questions that allowed the subjects to list factors that hindered or facilitated the process of generating ideas. These factors are discussed in the following two sections.

4.4.1 Factors That Facilitated the Idea Generation Process

To assess subjects' perception of the role of computer technology, the post session questionnaire stated "Please list specific ways that the computer technology helped you to generate ideas." Table 4.11 presents a sample of the factors that were frequently mentioned by subjects using the interactive tool.

| TABLE 4.11 |
| FACTORS FACILITATING IDEA GENERATION |
| INTERACTIVE MODEL |

"" "Being able to look at what ideas other people had, " brought about more ideas I had." "
"" "No one knew who sent the idea and could elaborate " on it with an unbiased opinion." "
"" "I feel it helps because I was not embarrassed to " state my ideas since no one would know they were " mine. ...I didn't have to wait for someone else " to finish speaking." "
"" "The time to generate ideas was used more " efficiently." "

72
Table 4.12 presents a sample of the factors relating to technology that were frequently mentioned by subjects using the individual model.

**TABLE 4.12**

**FACTORS FACILITATING IDEA GENERATION**

**INDIVIDUAL MODEL**

<table>
<thead>
<tr>
<th>Factor Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;I saw my own ideas which led to the creation of new ones.&quot;</td>
</tr>
<tr>
<td>&quot;It helped in organizing ideas by allowing me to add and modify the ideas that came to mind.&quot;</td>
</tr>
<tr>
<td>&quot;The storage of previous ideas allowed me to concentrate on new ones.&quot;</td>
</tr>
<tr>
<td>&quot;The computer technology helped because I could see what I had brainstormed. It helped to be able to correct mistakes quickly.&quot;</td>
</tr>
</tbody>
</table>

There were some factors identified as facilitating idea generation for both models. The primary factor mentioned frequently in both is the issue of efficiency. Early use of these brainstorming models led to predictions they would tend to increase the efficiency of the process. Three of the key services performed by the models are the automatic recording of the ideas, the ability to edit, and the opportunity for parallel idea generation or multiple users. These efficiencies were noted by subjects using both
models. These benefits in themselves indicate the usefulness of automated idea generation.

A second factor identified by subjects using both models is the benefit of exposure to other ideas. Subjects noted that exposure to the ideas of other members stimulated new ideas of their own. This is pronounced in the interactive mode, although subjects using the individual tool also noted this benefit.

The benefit of exposure was not mentioned frequently by subjects using the individual model. More seemed to feel that the computer technology was neutral. One subject noted: "I really don't think the computer technology actually help(ed) me generate ideas. The computer to me is just a screen and the experiment could have been done just as easy on paper." Thus, using a computer for this process is more efficient, though it may not increase ideational proficiency.

Early use of the automated brainstorming models predicted these tools would tend to decrease the inhibition of the idea generation process related to social influence. The literature cited in Chapter 2 identified a number of group social influences that contributed to the decreased effectiveness of group brainstorming as opposed to individual brainstorming, when using manual techniques. These factors include:
1. fear of social disapproval from group members;
2. the presence of authority figures;
3. a tendency to copy the responses of a dominant member; and
4. anxiety about verbal communication.

The use of computer-mediated communication in general and the interactive brainstorming model specifically, allows each group member to enter ideas into the computer anonymously. Complete anonymity can be maintained allowing subjects to express their ideas without fear of disapproval from the group members or authority figures. Subjects that suffer from communication anxiety can still express their ideas to the group. The status or role of each individual is not associated with the comment, so it can be evaluated on its own merit, not on the source. The factors subjects list as facilitating the idea generation process support these suppositions. The technology does appear to neutralize the group effects that have been suggested as inhibitors of idea generation during group brainstorming. Thus participants were more willing to state their opinions. This benefit is most marked when comparing interactive brainstorming face-to-face with use of an automated tool. The interactive brainstorming model is also an enjoyable tool with which to work. As one participant noted: "The
interactive method was almost too fun to consider an experiment."

4.4.2 Factors That Hindered the Idea Generation Process

The post-session survey also contained an open-ended question that allowed the subjects to list factors associated with the technology that inhibited the idea generation process. Electronic Brainstorming does appear to neutralize many of the group effects associated with inhibited interactive brainstorming. However, specific aspects of the technology that hindered the process were also identified. Table 4.13 lists a variety of factors frequently mentioned by the subjects that hindered the idea generation process using the interactive model.

| TABLE 4.13 |
| FACTORS INHIBITING IDEA GENERATION |
| INTERACTIVE MODEL |

- "...when you do read other people's ideas it can throw you off the track."
- "The long wait after inputing an idea."
- "Since the computer is new to me, I was intimidated by it at first which made me slower."
- "The only thing that hindered me was the typing."
- "...upon seeing other ideas, I felt some of mine weren't good enough."

- "...when you do read other people's ideas it can throw you off the track."
- "The long wait after inputing an idea."
- "Since the computer is new to me, I was intimidated by it at first which made me slower."
- "The only thing that hindered me was the typing."
- "...upon seeing other ideas, I felt some of mine weren't good enough."
Table 4.14 lists factors frequently mentioned by the subjects that hindered the idea generation process using the individual model.

**TABLE 4.14**

**FACTORS INHIBITING IDEA GENERATION**

**INDIVIDUAL MODEL**

<table>
<thead>
<tr>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;I type slower than I write.&quot;</td>
</tr>
<tr>
<td>&quot;It slowed my thinking when I had to stop to correct typing errors.&quot;</td>
</tr>
<tr>
<td>&quot;Lack of familiarity with the equipment kept me from knowing if I was utilizing it to...full benefit.&quot;</td>
</tr>
<tr>
<td>&quot;...a bit intimidating.&quot;</td>
</tr>
</tbody>
</table>

Two primary problems were noted with use of both models: subjects unfamiliarity or discomfort with the computer and the need to type input. To overcome some of the unfamiliarity the subjects were given a five minute warmup session. This was followed by an opportunity to ask any questions about the operation of the system. However, the unfamiliarity with the computer as a communications medium persisted. This difficulty will only be overcome with experience. Typing ability was the second primary problem. Subjects rated their typing ability as just below average (see Table 4.3). A number expressed frustration at the slowness in entering their ideas. Some inefficiency
does results from the increased difficulty in typing and reading as a communication mode as opposed to writing, speaking, or listening.

A third inefficiency is related only to the interactive model. At the time of the experiment, there was an average delay of 17 seconds between the time a subject sent a comment off to be exchanged for another comment file and the time the new file was received. It is possible that the participants used this time productively by framing their next comment or it could be that they were idle. This key area of inefficiency has since been reduced to less than 5 seconds with programming enhancements.

Two other comment areas from subjects using the interactive model deserve special mention. The first is the negative impact of exposure to the ideas of other participants. Based on the review of the literature discussed in Chapter 2, it was expected that this exposure could lead to a tendency to follow a train of thought, or fall into a rut. Subjects did note that they lost track of their own ideas when they reviewed those of group members. However, they did not note that it stifled their own creativity or willingness to enter comments. The subjects did not perceive that they fell into a single train of thought. The second is a unique comment that conflicts with an assumption made in this research. This subject
commented: "...upon seeing other ideas, I felt some of mine weren't good enough." A strongly held premise in working with this technology is that perceived status differences or concerns about the "quality" of ideas are eliminated by the anonymous nature of the process. Fear of social disapproval or ridicule is a powerful inhibitor. This comment indicates that some self-censoring of comments could occur even though the source of the comments is not identifiable.

Another question on the post-session questionnaire assessed participant perception of how important the computer technology is for idea generation in the individual and interactive modes. Importance was rated on a scale of 1 to 10, with 1 indicating not important and 10 indicating very important. Table 4.15 presents a summary of the results from the experiment sessions.
The difference in mean values for the two methods is not significant at the .1 level (t = -.0948). For both methods of idea generation subjects rated the technology as important for the generation of ideas.

A final question was posed to subjects using the interactive model. The question asked was "How did exposure to the ideas of other participants affect your ability to generate ideas?" The objective of this question was to substantiate or backup the results of the analysis of the number of unique ideas produced. The rating was on a scale of 1 - 10 with 1 indicated exposure hindered the process and a 10 indicating exposure helped. The consolidated ratings are provided in Table 4.16.
TABLE 4.16
AFFECT OF EXPOSURE TO OTHER IDEAS

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>10</td>
<td>7.95</td>
<td>1.663</td>
</tr>
</tbody>
</table>

The 40 subjects that used the interactive tool identified exposure to the ideas of other participants as an important influence on their ability to generate ideas.
4.5 Summary

The results of the experiment indicate that social cuing has no impact on the quantity of ideas generated in brainstorming. Using automated brainstorming models to eliminate the differences between interactive and individual brainstorming allowed the impact of cuing to be isolated and measured. The use of a post session questionnaire allowed participants to identify factors that facilitated or hindered the process of generating ideas using electronic models. Key factors that appear to facilitate the process are:

1. Anonymity
2. Multiple simultaneous users
3. Automatic recording of output
4. Neutralizes effects of authority, power and status
5. Exposure to the ideas of other participants and/or ability to reference your own ideas.

Key factors that appear to inhibit the idea generation process include:

1. The computer is an unfamiliar tool for many participants
2. The need to type input
3. Reading takes more time than listening
4. There was a delay in the return of a screen of comments
in the interactive mode. This could lead to inefficient use of time and/or cause ideas to be lost.

The post session survey indicated there was a high level of satisfaction with the use of the Electronic Brainstorming models and the use of computer technology for the process. While some factors in the technology inhibit idea generation, the benefits seem to outweigh the disadvantages. Chapter 5 discusses the limitations and implications of the results of this experiment.
CHAPTER 5
IMPLICATIONS AND LIMITATIONS

The need to work in groups has become more necessary as organizational problems increase in complexity, and the location of expertise and knowledge becomes more diffused. How groups can operate most efficiently is of considerable practical importance with an important issue being idea generation and information gathering as the first step in the problem solving or decision making process. The popularity and success of the brainstorming process, as a frequently used tool for idea generation, has been attributed to the separation of idea generation and evaluation, and the associative benefit of exposure to the ideas of other participants.

Research has consistently found that nominal groups can produce more unique ideas than interacting groups. The factors identified as differentiating the output of interactive and individual brainstorming groups have been placed into three categories. These are social inhibition, efficiency and social cuing. Interactive brainstorming groups are subject to inefficient time usage and the impact of social inhibition has on the participants. The impact of exposure to the ideas of other participants has on the outcome of a brainstorming session is most equivocal. This
exposure could lead to increased ideation due to association, it could lead to group members adopting a single line of thought, or it could have no affect at all on the outcome. The impact of cuing itself on ideation has not been previously isolated due to difficulties in eliminating differences in efficiency between interacting and nominal groups and the need for face-to-face communication in interacting groups.

Advances in microcomputer and local-area network technology have made it feasible and affordable to develop automated brainstorming models. Currently implemented in the University of Arizona MIS Planning and Decision Laboratory are automated interactive and individual brainstorming models. The interactive model provides the benefits of exposure to the ideas of other participants while ensuring anonymity in the process. This research sought to measure the impact social cuing has on the quantity of unique ideas produced during brainstorming. To accomplish this, interaction was accomplished via microcomputers on a local area network to equalize, to the extent possible, the efficiency of individual and interactive idea generation and neutralize the factors leading to social inhibition during interaction. This made the two methods more comparable. A secondary topic was to analyze how the interactive component of brainstorming
affected participant satisfaction with the process and outcome of the brainstorming session.

Automated support for unstructured strategic decisions is a new focus for research efforts. The University of Arizona MIS Planning and Decision Laboratory is used to study the influence of technology on planning and decision processes. This research provides insight on how technology can be used to support qualitative processes such as idea generation.

The implications and limitations of this research are discussed in three sections:
1. Social cuing;
2. Computer support for unstructured processes; and
3. Satisfaction.
5.1 Social Cuing

The results obtained in this research indicate social cuing does not impact the quantity of ideas generated during a brainstorming session. The primary difference between the two models utilized in this research, is that the interactive model anonymously provides the subjects access to each others ideas. Comparing the mean number of ideas produced by 11 groups using the individual model and 10 groups using the interactive model, it was statistically determined that there is no difference in the quantity of ideas generated by groups brainstorming individually or interactively. This result contradicts theory on the beneficial effects of association. In this instance, nominal groups and interacting groups generated the same quantity of unique ideas. It appears that if there is a benefit due to exposure to the ideas of other participants, it is canceled by the negative impact of cognitive inertia or that this exposure is actually distracting. This result also contradicts the results obtained in previous research comparing the output of individual and interacting brainstorming groups (Taylor et.al 1958, Dunnette et.al. 1963, Campbell 1968, Bouchard and Hare 1970, Bouchard et.al. 1974). In this research, the nominal groups did not outperform the interacting groups. The quantity of ideas
generated using the two models was the same. The computer-mediated communication reduced or eliminated the factors blocking the ideational proficiency of interacting groups. Social cuing did not cause the interacting groups to outperform the nominal groups.

**Implications.** One implication of this finding is that social cuing in interactive idea generation does not lead to more ideas being produced than if the participants brainstorm individually. This finding contradicts Osborn's brainstorming theory (1953). The cuing provided by interaction in group brainstorming does not lead to increased group performance. When the objective is to produce a maximum quantity of ideas, the same result may be obtained by the participants working individually with the results combined. The interactive model yields results comparable to the individual model when the negative effects that interaction has on efficiency and inhibition are eliminated. This was obtained in this research by having subjects interact via a computer network.

A second implication is that if interaction is necessary during a brainstorming session, improved results in terms of quantity of ideas produced, will result if automated support (such as EBS C) is utilized. It was possible to obtain the same quantity of ideas interactively as individually when computer technology was utilized. This
is a different result than that obtained when manual brainstorming models are used.

This research contributes to existing literature some insight on why nominal groups have consistently outperformed interacting groups using manual brainstorming models. Eliminating, to the extent possible, the negative effects of social inhibition and differences in efficiency made the methods comparable in output. A different result was obtained when computer-mediated interaction occurred than in previous research where interaction occurred face-to-face.

Limitations. A significant limitation of this research is that it was not possible to actually eliminate all of the social inhibition and efficiency differences between the two methods. The social inhibitions appear neutralized to a great extent. However, one subject using the interactive model did indicate he censored his output after he compared it with other participants. It was expected that the anonymous nature of the process would eliminate this type of censoring. As this self-censoring could occur with both models, the impact on both processes should be the same.

Accounting for all differences in efficiency was more difficult than eliminating the social inhibition effects. Several differences between the two models were
not completely eliminated in this study. These are the
time subjects using the interactive model used, waiting for
a comment file to come back after a comment was sent and the
time spent reading the comments of the other participants.
Other research conducted in the MIS Laboratory, reported in
Applegate (1986), identified how time was used in
brainstorming sessions that were a part of actual
organization planning sessions. Applegate found that during
an average brainstorming session, 57% of the time was spent
entering comments into the terminal, 12.6% was spent
waiting for the next screen, 27% was spent reading the
comments on the screen, and 3.4% was spent in verbal
interaction. The time spent waiting for a screen that is
referenced in this study was reduced before the research
reported in this paper was conducted. However, it does
provide an indication that potentially there is more
unproductive time associated with the interactive model. It
will take a user longer to read through a file containing
comments from other participants than to reference their own
comments. The time spent waiting for a screen may also be
less productive than always having a file available in which
to input a comment as the individual model provides. The
impact, if any, on the results of this study should be that
the output of the interactive group is understated. The
output from the interactive model could increase if more
time was allowed. Perhaps an area for future analysis would allow participants to continue entering ideas for as long as they would like.

It is postulated that the relative inefficiency of the interactive model caused the output of the interactive groups to be understated. Subjects who used the interactive tool rated exposure to the ideas of other subjects as an important influence. However, this exposure did not result in a higher quantity of ideas being produced using the interactive model. This could be due to the wait for the screen and the need to read and process the comments of the other participants. This took up a significant portion of the time available for ideation.

A factor which limits the applicability of this research is that it used students and a "what if" question. The students did, however, have computer and typing skills comparable to executives that have used the facility in the past for actual planning sessions. The results do not represent idea generation when specific pieces of knowledge may rest with different individuals. This question required creative, not practical solutions. The results may be different when the problem is real and expertise from various participants is necessary to solve the problem.

A final limitation is that this experiment used students who do not know each other instead of an intact
work group. The inhibitory social effects are likely to be more pronounced in a work group where roles and status differences have developed. Future research might compare the output of an established work group brainstorming under two conditions - interactively face-to-face and interactively over microcomputers. The quantity of ideas produced should increase when the computer-mediated communication replaces face-to-face.
5.2 Computer Support for Unstructured Processes

Using the computer network and the automated brainstorming model produced results different from research conducted in the past comparing interactive and nominal brainstorming groups. Previous research has consistently found that nominal (non-interacting) groups outperform interacting groups. Table 2.1, in Chapter 2, summarizes the factors previous research has identified as contributing to this result. A review of research on the impact of computer-mediated communication, indicated that the use of this technology can change group processes. Table 2.2, in Chapter 2, summarizes findings made in previous research about the changes that will occur. Notable among them is that social inhibitions will be reduced through the anonymity provided by this mode of communication. From the literature review it appeared that the support provided by computer-mediated communication could override the inhibitory aspects of group interaction affecting brainstorming groups. The use of automated models could also equalize the efficiency of the two processes. Using a local area network, participants could participate simultaneously using the same communication mode (typing). This research found that the use of software tools developed to support the unstructured nature of idea generation,
eliminated many of the factors that previously hindered the interactive process.

**Implications.** The use of computers for brainstorming can negate the impacts of social inhibition. Applegate (1986) demonstrated that the development of a system that allows for interactive yet anonymous brainstorming is technically possible. This research indicates that not only is this type of decision support possible, but that it can be effective in promoting the generation of ideas in interacting groups. This finding is consistent with previous research on computer mediated communication (Turoff and Hiltz 1982, Kiesler 1986, Siegel et al. 1986). This finding has implications for the future use of technology for interactive discussion. The results of the post-session questionnaire indicate that the subjects like the anonymous nature of the computer-mediated communication. This anonymity decreased the incentive to censor comments due to concern about how they may be received. The computer technology forces a focus on the content of ideas, away from the source of ideas. This eliminates social inhibitions such as a fear of disapproval and status differences. The other studies referenced above, have found similar decreases in inhibition during computer communication. Given the computer helps to neutralize these effects, it becomes apparent that the output of interacting
brainstorming groups should improve in relation to the output of non-interacting brainstorming groups. A practical implication is that if the need to brainstorm interactively exists, use of the automated tools can negate some of the negative group effects. The quantity of ideas generated will be the same as if the participants had brainstormed alone.

A second implication for the future use of technology in this context is the benefit due to efficiency. The automatic recording of ideas, the ability to reference your own or other participants ideas and the ability to edit comments provided by both models seems to increase efficiency. Some inefficiency is associated with typing and reading as opposed to listening and speaking. However, it appears that the positive aspects of efficiency outweigh the negative. The improvement over the manual models was noted by participants using both models. This was true even though these subjects rated their typing ability below average and computer familiarity as moderate. These factors do not appear to outweigh the benefits.

The final implication is the positive feedback this research provides for the future use of creativity enhancing, automated tools for decision support. Subject unfamiliarity with computer use and moderate typing skills did not dampen subject enthusiasm for the process.
Computer-mediated communication was able to eliminate barriers to the free expression of ideas in an interacting group.

The improved performance of interactive brainstorming groups vis a vis nominal groups using the computer-mediated communication instead of face-to-face is a significant finding.
5.3 Satisfaction

A questionnaire was used to gather input on subject satisfaction with the process and outcome of the session as well as factors that helped or hindered the brainstorming process. Subjects using both models indicated satisfaction with the process they used to generate ideas. They also rated the technology as important to the process. Overall, no significant difference was found in subject perception of satisfaction between the interactive and the individual processes. Of the three measures used to gather this data only one, the perception of the quality of the output, was close to significant. However, this was significant at the .05 level, not the .1 significance level used throughout this research. This experiment did not seek to measure the difference in the quality of the output produced by the two processes. This data does exists for analysis by another researcher.

Satisfaction was analyzed for several reasons. First, the decision to choose one method or another may not be determined solely by which method will generate a higher quantity of ideas. Greater satisfaction with one method may provide justification for greater use. Second, use of these tools requires the use of a computer and typing for communication. This unfamiliar communication method could
have been dissatisfying for the participants. This could negatively impact the use of technology in this context.

**Implications.** One implication is that the interactive component of brainstorming may not lead to higher satisfaction with the process. Thus, greater support for and acceptance of the output should not be expected when the interactive process is used.

Another implication is that subjects were satisfied with the automated processes even though they only had moderate typing skills and computer familiarity. The familiarity of the subjects used was the same as that of executives that have used the research facility previously. Therefore, this unfamiliarity with the computer process should not affect the results obtained when business people are used instead of students. Lack of experience with this communication medium should not be a hindrance to effective use.

**Limitations.** A problem with the application of the satisfaction scores is that a different result may have been obtained if the participants had used both models. During the pilot test, subjects used both the interactive and the individual models. After the session, a preference for the interactive method was indicated. No basis for comparison existed during the actual experiment. The different results obtained during the pilot test indicate a tendency to prefer
the interactive mode after both models have been used. The high satisfaction scores obtained from all the subjects that participated in the experiment could be partially attributed to the subjects' enjoyment with participating in this research.
5.4 Conclusion

The primary finding of this research is that social cuing does not increase the quantity of ideas produced during creative idea generation. However, the use of computer-mediated communication for interactive brainstorming did improve the output of interacting groups vis-a-vis nominal groups.

Previous research in brainstorming has found that nominal groups consistently outperform interacting brainstorming groups even though the interactive model provides exposure to the ideas of other participants. The expected benefit due to the associative power of interaction was not seen. Instead, factors associated with interaction, such as social inhibitions and the inefficiency of the process, lead to nominal groups generating a higher quantity of unique ideas than interacting groups. The actual role that exposure to the ideas of other participants had on the total quantity of unique ideas could not be determined.

This research sought to use computer-mediated communication to negate all of the factors differentiating the interactive and individual brainstorming processes, except for social cuing, to isolate the effect social cuing has on idea generation. Use of the computer models allowed social inhibition and efficiency differences to be eliminated to a
great degree. The primary difference that remained between the two models was the exposure to the ideas of the other participants that the interactive model allowed. The use of the computer models for brainstorming did produce different results than those achieved in the past using manual models. The interactive and the nominal groups produced the same quantity of ideas during a brainstorming session.

No statistical difference was found between the mean number of unique ideas produced by subjects brainstorming in nominal groups and subjects brainstorming in interacting groups. This indicates that the use of computer-mediated communication eliminated the status and efficiency differences between the two processes. In the interacting groups, no additional benefit due to cuing was noted. However, the subjects did indicate that the exposure to the ideas of others participants was valuable. The impact of social cuing may be understated by this research because the efficiency of the two processes was not completely equal. The need to briefly wait for a new file of comments to be received after a comment has been sent over the network and the need to read and process the comments of the other participants could have caused the interactive model to be less efficient than the individual model. This indicates the output of the interactive groups could be expected to rise if this efficiency difference was completely
eliminated. An impact on outcome due to social cuing may be measurable, if the subjects are allowed an unlimited amount of time in which to brainstorm.

Subjects using both tools were satisfied with the process used to generate ideas and rated technology as important to the process. Their unfamiliarity with the computer technology and their average typing ability did not affect satisfaction with the session.
APPENDIX A
PRE-SESSION AND POST-SESSION QUESTIONNAIRES
MIS PLANNING AND DECISION LABORATORY
PRE-SESSION SURVEY

== CASE NAME: IDEA GENERATION EXPERIMENT ==
" " SESSION #: " "
DATE : SEPTEMBER , 1986 ==

PERSONAL DATA:
SEX: M F AGE:

MAJOR:

1. HOW WOULD YOU RATE YOUR TYPING SKILLS?
   1 2 3 4 5 6 7 8 9 10
   _____-_____--_____--_____--_____--_____--_____--_____--_____--_____--
   POOR FAIR EXCELLENT

2. DO YOU USE A COMPUTER AT HOME? _____YES _____NO
   IF YES, HOW OFTEN?
   _____DAILY _____WEEKLY _____MONTHLY _____OCCASIONALLY

3. DO YOU USE A COMPUTER AT WORK OR SCHOOL?
   _____YES _____NO
   IF YES, HOW OFTEN?
   _____DAILY _____WEEKLY _____MONTHLY _____OCCASIONALLY

4. IF YOU USE A COMPUTER AT HOME, SCHOOL OR AT WORK, WHAT ARE THE APPLICATIONS THAT YOU COMMONLY USE? (CHECK ALL THAT APPLY)
   _____WORDPROCESSING LIST PACKAGE(S):
   _____SPREADSHEETS LIST PACKAGE(S):
   _____DATABASE LIST PACKAGE(S):
   _____PROGRAMMING LIST LANGUAGE(S):
   _____OTHER
   LIST ALL THAT APPLY:
MIS PLANNING AND DECISION LABORATORY
POST PLANNING SESSION SURVEY
INTERACTIVE MODEL

CASE NAME: IDEA GENERATION EXPERIMENT
SESSION #:
DATE: SEPTEMBER, 1986

1. How satisfied were you with your ability to generate a lot of ideas during this session?

1 2 3 4 5 6 7 8 9 10

VERY DISSATISFIED NEUTRAL VERY SATISFIED

2. How satisfied were you with the quality of ideas you were able to generate during this session?

1 2 3 4 5 6 7 8 9 10

VERY DISSATISFIED NEUTRAL VERY SATISFIED

3. How satisfied were you with the software program you used to generate ideas?

1 2 3 4 5 6 7 8 9 10

VERY DISSATISFIED NEUTRAL VERY SATISFIED

4. How did exposure to the ideas of other participants affect your ability to generate ideas?

1 2 3 4 5 6 7 8 9 10

HINDERED NO EFFECT HELPED

5. How important do you feel the computer technology is for helping you to generate ideas as a group?

1 2 3 4 5 6 7 8 9 10

NOT IMPORTANT NEUTRAL VERY IMPORTANT
6. Please list specific ways that the computer technology helped you generate ideas.

7. Please list specific ways that the computer technology hindered you in generating ideas.
MIS PLANNING AND DECISION LABORATORY
POST PLANNING SESSION SURVEY
INDIVIDUAL MODEL

CASE NAME: IDEA GENERATION EXPERIMENT
SESSION #:
DATE : SEPTEMBER , 1986

1. How satisfied were you with your ability to generate a lot of ideas during this session?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</tr>
</tbody>
</table>

VERY DISSATISFIED
NEUTRAL
VERY SATISFIED

2. How satisfied were you with the quality of ideas you were able to generate during this session?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
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</table>

VERY DISSATISFIED
NEUTRAL
VERY SATISFIED

3. How satisfied were you with the software program you used to generate ideas?

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VERY DISSATISFIED
NEUTRAL
VERY SATISFIED

4. How important do you feel the computer technology is for helping you to generate and record ideas?

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NOT IMPORTANT
NEUTRAL
VERY IMPORTANT
5. Please list specific ways that the computer technology helped you generate ideas.

6. Please list specific ways that the computer technology hindered you in generating ideas.
LIST OF REFERENCES

Applegate, Lynda McDonald (1986). "Idea Management in Organizational Planning." Department of Business Administration, University of Arizona.


