Improving Idea Generation During Decision Making in Small Group Computer Conferences

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Abstract: Decision making in small group computer conferences tends to suffer from some of the sarne problems as face-to-face interactive groups. For example, there may be unequal participation, some group members may tend to contribute few ideas, and the group may focus too quickly on new ideas. This paper describes a technique for computer conferencing which should help to alleviate these problems. It is an adaptation and combination of the nominal group and rational decision making techniques, and provides a structure for the decision making process while at the same time it tends to improve group creativity by encouraging individual contribution. The technique has been used for simulated business decision making in student groups with sizes varying from 4 to 13 members.

INTRODUCTION

Computer conferencing and its close relative electronic mail have received considerable recognition as problem-solving and learning tools in educational institutions (Hiltz, 1986; Hiltz & Turoff, 1978; Kaye, 1987; Mason, 1987; McCreary & Van Duren, 1987; Rice & Case, 1983; Ujimoto & James, 1987; Welsch, 1982). An important aspect of using a computer mediated medium such as this is its impact on group behavior, and this has been investigated by, among others, Beckwith (1987), Kerr and Hiltz (1982), Kiesler, Siegel and McGuire (1984), McGuire, Kiesler and Siegel (1987), Stefik, Foster, Bobrow, Kahn, Lanningand Suchman (1987), Siegel, Dubrosvsky, Kiesler and McGuire (1986), and Nunamaker, Applegate and Konsynski (1988).

The differences between group behavior within a computer conference as compared to face-to-face meetings have also required the development and adaptation of appropriate management techniques. In particular, the role of a human moderator in organizing, leading, and controlling computer conferences has been emphasized by a number of researchers (Hiltz & Turoff, 1978; Ujimoto & James, 1987; Stix, 1987). Stodolsky (1988) suggested a form of computer moderation for synchronous computer-mediated meetings, where time sequencing of participant contributions is a known problem (Hesse, Werner & Altman, 1988), but users tend to dislike such control mechanisms (Dubrovsky, Kiesler & Siegel, 1983).

CJEC, VOL. 18, NO. 2, PAGES 111 - 123, ISSN 0710 4340

Feenberg (1986) notes the major functions which characterize the computer conference moderating role as: setting context, norms, and agenda, recognition, prompting, weaving (summarizing and promoting unity), and meta-commenting. Kerr (1984) discusses the structured tasks and the roles of the computer conferencing moderator. Most are agreed that the moderator plays a key role in promoting a successful outcome of a decision-making conference, although a great deal of skill is required if the views of the group and not necessarily the moderator are to prevail in the final decision. One critical aspect is group motivation, but in the educational context as compared to the business or scientific environment and particularly for decision making, this is less of a concern to the moderator because individual contributions can be monitored, and individual achievement records provide the necessary motivation (Mason 1987).

Traditionally, the role of the moderator has been cast in the position of managing within the context of the computer conference equivalent of the interactive group meeting. Several meeting support methods have also been adapted to computer conferencing. The Delphi technique has been adapted by implementing a computer voting procedure (Turoff, 1972; Waggoner, 1987), and a modified Delphi technique has been used (Kerr & Hiltz, 1982) to collect date from expert panels. Nunamaker, Applegate and Konsynski (1988) have developed an electronic brainstorming tool for synchronous computer-mediated meetings.

A fairly recent development has seen experimentation with group decision support systems (GDSS) in business settings (Cook, Ellis, Graf, Rein & Smith, 1987; DeSanctis & Gallupe, 1985; Stefik, Foster, Bobrow, Kahn, Lanning & Suchman, 1987; Nunamaker, Applegate & Konsynski, l988). Gallupe (1988) also reported on the application of a GDSS for teaching business cases. AGDSS consists of a set of software, hardware, and language components and procedures that support a group of people engaged in a decision-related meeting. While this is a fairly broad definition, GDSS implementation has usually been in a synchronous meeting environment with all the group members meeting in a well-equipped "decision room." A related system is the PCS system (Shaw, 1988) which could be used in a remote mode. PCS enables a number of individuals to interact through networked personal computers to develop mutual understanding of a problem domain through the use of repertory grid techniques. A survey by Gray (1986) indicates that GDSS may have a bright future, but technology requirements (for example further development in the use of artificial intelligence techniques), and the high cost of many of these systems are current inhibiting factors.

In this paper, we are concerned primarily with asynchronous decision-making by small groups, which includes the group product and community decision making classifications from the range of functions which McCreary and Van Duren (1987) have defined for computer conferencing in education. This involves group problem solving in such areas as the preparation of case reports, discussion papers, proposals, etc. A technique will be described which improves group creativity through the adaptation of the nominal group technique (Van de Ven & Delbecq, 1974) to computer conferencing, within a particular decision making structure. This can be organized and managed in a straightforward manner by the conference moderator.

PROBLEM SOLVING TECHNIQUES

Terry and Franklin (1982) describe five major approaches to problem solving: a) Routine; b) Scientific; c) Decisional; d) Creative; and e) Quantitative. The Routine approach is used when there is a known standard method to solve the problem. The Scientific approach (or Scientific Method) is well-known in academic research, and involves stating a proposition, investigating that proposition thoroughly using existing knowledge or by performing experiments, stating a tentative solution to the proposition, and cycling back to restate the proposition if necessary, The Decisional approach (often called Rational Decision-Making) appears in a variety of forms (Simon, 1960; Feldman & Arnold, 1983), and also is an iterative process. Activities which occur during the three phases of the Decisional (Rational Decision Making) approach appear in Table 1. Decision making may cycle several times through one or more of these phases before a final decision is reached.

Table 1
The Rational Decision Making Process

1) *Intelligence*

- a) Assemble the known facts, and any facts which can be inferred from the problem context
- b) Identify the problem(s) to be addressed

2) Design

- c) List possible alternative solutions to the problem(s), along with their attributes

3) Choice

- d) Select an appropriate decision based on the alternatives considered above
- e) Set out an implementation procedure

The Creative problem solving approach is not necessarily a highly organized or structured approach to decision making. Its object, once the problem has been stated, is to encourage creativity and idea fluency, to verify and evaluate the proposed solution, and then to propose its application. The Quantitative approach is to formulate the problem, build a mathematical model to represent the system under study, and then to derive an answer from the model.

For the purpose of this discussion, let us consider a type of problem which occurs abundantly in the instructional environment, in the general class of non-recurrent and qualitative complex decision making, such as report preparation or case study assignments which are often done by small groups. Here, a quantitative measure of complexity which can be used is the number of potential alternative solutions (Payne, 1976). Problem solving in this instance cannot be handled by the Routine approach, since there are no standard procedures for such problems. Mathematical models typically cannot be used for complex qualitative problems, thus ruling out the Quantitative approach and leaving b), c), and d) as the most likely choices. Although there are similarities among these procedures, the Scientific approach lends itself well to the generation of new knowledge through experimentation, and the incorporation of that knowledge into the solution.

The Decisional or Creative approaches are more suitable for the group solution of complex problems to be considered here. The Decisional approach aids the group by imposing a structure on the problem-solving process, whereas the Creative approach mainly concentrates on improving the creativity of solutions proposed by group members. Group problem solving tools which fit into the class of Creative decision making include Brainstorming (Osborn, 1957), and the Nominal Group and Delphi techniques (Delbecq, Van de Ven, & Gustafson, 1975).

Several of these techniques have been adapted for use in asynchronous computer conferencing (CCA). The most widely used method for CCA is an adaptation of the common face-to-face Interactive Group (IG) method, where participants read messages that others have added, and then respond with their own messages. This is the most efficient and natural technique for simple information interchange, but it is not necessarily the most creative. Also, if decisions are to be made and reports are to be developed by deadline time, the process must also be managed properly through a moderator who is responsible for setting up a plan, organizing a procedure, and controlling the implementation of the process through to the final decision-making and report-generating stages.

The Nominal Group (NG) technique was originally developed as a face-to-face method for improving group creativity, by emphasizing individual contribution and avoiding unequal participation or group dominance by individuals. Delbecq, Van de Ven, and Gustafson (1975) describe the procedures for the standard NG technique, which is a structured group meeting in which the participants sit around a table. They initially do not speak to one another, but write ideas on paper relating to the topic at hand. Then each individual, in round-robin fashion, presents one idea from his or her private list. A recorder writes the idea on a flip chart in full view of the group. When all ideas have been listed, discussion follows, to clarify ideas or to express support or non-support. Group decisions are by majority vote.

The main advantage claimed for the NG over the IG approach is the larger number of alternatives generated, enhancing the likelihood of a better decision. Burton (1987) notes that interacting groups are better at synthesizing and evaluating information, and achieving group consensus. Nominal groups are better at fact finding, idea generation, establishing objectives and priorities, and reduction of errors and estimation variability. He also suggests that a contingency approach might be appropriate, where the technique selected depends upon the nature of the problem, the group and the participants. We would expect some of these advantages and disadvantages to carry over to the computer conferencing forms of both these techniques, but this may be tempered by the fact that the literature on computer conferencing consistently indicates, for example, that there is more equal participation with computer-mediated conferencing than with face-to-face communication (Siegel, Dubrovsky, Kiesler & McGuire, 1988).

THE NOMINAL GROUP ADAPTATION FOR COMPUTER CONFERENCING

There are many ways to structure a conference discussion, but if decisions are to be made, a good way to structure the agenda is through the Decisional approach. It is also possible to superimpose on the Decisional approach an adapted form of the nominal group technique, with the resulting structure being called the Computer Conferencing Nominal Asynchronous (CCNA) approach. This combines the creative advantages of the nominal group technique with the logical management structure of the rational decision making approach.

Using the CCNA structure, group members send their initial comments to the moderator by private electronic mail. The moderator summarizes the comments when all group members have contributed, and puts the summary into electronic conference form, to which group members can comment and add. When each phase (Intelligence, Design or Choice) of the conference is complete, the cycle of private mail and then conference discussion is repeated, until a consensus has been reached in the final decision and implementation phase. In this way, CCNA differs from the standard NG technique because, after the initial presentation of a summary ofindividual member opinions, the group works towards a consensus rather than using a majority vote. Consensus decision making is appropriate with the CCNA technique because interactive group problems such as unequal participation, which the nominal group approach is designed to overcome, tend to be less dominant in the computer conference (Siegel, Dubrovsky, Kiesler & McGuire, 1986; Kerr & Hiltz, 1982). At the same time, CCNA exhibits an advantage over the CCA methodology, as does NG over IG (Burton, 1987), since it aids in the generation of ideas by encouraging more individual contributions.

CCNA also tends to inhibit motivation loss, coordination loss, and diffusion of responsibility which are adverse effects caused by large interactive groups (Feldman & Arnold, 1983). Coordination loss is lessened because students can interact at their own convenience while meeting deadlines imposed by the moderator. Overall responsibility is assigned to the moderator and, if the moderator is skilful, the group will be able to meet its deadlines. Group members are motivated because they are aware that their individual contributions are recorded, and those members who let the group down may be penalized.

The definite generation of more alternatives for the purpose of decision making does not necessarily result in better decisions. In fact, since we are limited in our cognitive ability to process information, only a limited number of alternatives can be assembled at one time, and as a result we tend to satisfice (Simon, 1960), or select the best of the alternatives which can be considered rationally, rather than to optimize over all possible (or known) alternatives. In a complex situation, there may be hundreds or thousands of alternatives, and it is virtually impossible for an individual or group to search the problem space completely. However, the collective action of a group will normally allow the logical examination of more alternatives than a single individual, tending to lead to a better decision.

In the experiment reported here, measurements were performed on the impact of group size on the number of alternatives generated and the quality of the final decision, when using the CCNA method. At the same time, the general feasibility of the approach was examined. The educational objectives of the exercise included:

1) to expose participants to current computer-supported conferencing technology;
2) to enable participants to become familiar with the advantages and disadvantages of computer-supported decision-making; and
3) to develop an understanding among the participants of how to improve idea generation in a small group.

METHOD

The study was carried out with four groups of MBA students taking information systems courses. Each group analyzed a business mini-case entitled "Quality Assurance Analyst Certification" (Senn, 1987). The groups, designated A, B, C and D, had 4, 4, 7 and 13 members, respectively, The conferencing system used was CoSy(R) (Van Duren, 1986) running on a VAX 11/

780. Students could access the system at their convenience using terminals or microcomputers running terminal emulation software. All of the students had some computer-related experience. Prior to the start of the experiment, the students were trained by working through an example computer conferencing case. The same conference moderator was responsible for all four conferences, and was experienced in the case material but did not participate in the discussions. The moderator's duties were to impose deadlines and to generate summaries at the end of each of the three phases of the decision-making process. To ensure that no moderator bias or distortion entered into the discussion, participants were required to enter their comments in point form (usually one line or less), and the moderator "summarized" (or rather, sorted) by grouping together related comments by the group members into a set of structured facts, alternatives or decisions (depending upon the decision-making phase underway) as the conference proceeded.

The groups were given two weeks to analyze the case, preparing their results with the help of the CCNA methodology. Each phase of each conference was recorded and then examined upon completion of the conference.

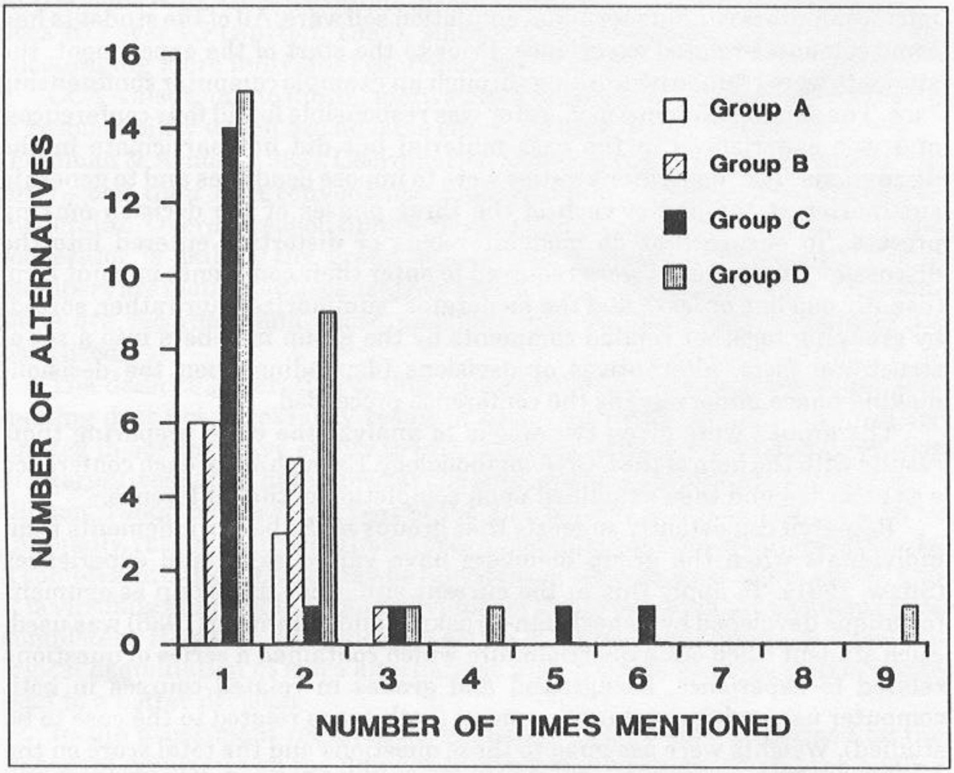
Research consistently suggests that groups make better judgments than individuals when the group members have varied skills and experiences (Shaw, 1981). To apply this in the current situation, the group assignment technique developed by Beheshtian-Ardekani and Mahmood (1986) was used. Each student filled out a questionnaire which contained a series of questions related to experience, background and grades in related courses in both computer use and general management (both areas related to the case to be studied). Weights were assigned to these questions and the total score on the questionnaires used as a ranking to assign students by cycling through the groups while working down the ranking. Because this project involved groups of unequal size, the objective was to set up groups with the same average weighted questionnaire scores. This assignment technique achieves the objective of high intra-group heterogeneity with minimum inter-group differences in average skill levels, and should be used whenever feasible in making group assignments.

RESULTS

The number of alternatives (unique within a group) generated during Phase II of the Decisional process was significant ($p = .03$, R^2 (adj.) = .90) when regressed against group size. Thus the number of alternatives generated using this method is largely explained by group size, as one might expect since group members work alone in generating initial alternatives and do not see each other's alternatives until the summary has been prepared by the moderator. This encourages individual contributions to a broader set of alternatives.

In a complex problem such as the case studied here, there will be many possible alternatives. It is therefore expected that the duplication of alterna-

Figure 1. *Alternatives Defined by Each Group*



tives selected by group members should not be high. This was borne out by the results shown in Figure 1, where the number of alternatives is plotted for each of the four groups against the number of times an alternative is mentioned. The number of distinct alternatives mentioned by each group was 9, 12, 18 and 25 for groups A, B, C and D, respectively. Of these, fully 64% were mentioned only once in any particular group (duplications between groups not excluded in the totals). The one alternative which usually showed the largest number of duplications in any group was "do nothing", which is always an alternative. Of further interest from the within-group alternatives generated is the fact that, except for the "do nothing" alternative, the proposed alternatives are typically not mutually exclusive in that there could be some overlap and complementarity, and the final group decision usually included a combination of alternatives rather than any single one. For groups A, B, C, and D, 3, 3, 3 and 4 alternatives respectively were used in the final proposed decisions and implementations.

The quality of the group decisions was also evaluated by three experienced judges, who rated the case reports on five quality-related questions (Archer, 1988) on an 11-point Likert-type scale. The average rating of these five questions was then used as a comprehensive decision quality measure. The reliability of the judge data was .60. Aregression of the comprehensive quality measure against group size was not significant (p = .06, R^2 (adj.) = .23).

DISCUSSION

In a controlled educational environment such as that offered by computer conferencing, it is important to encourage students both to be creative and to learn from their colleagues as well as from other sources. The CCNA technique appears to enhance the creative process, while the associated structures described for this experiment provide an organized and controllable environment which can be managed by a skilled moderator. The most difficult and time-consuming aspect of managing such a conference is the summarizing required, but this is true of any decision-making conference and will be a continuing problem until natural language understanding (NLU) software with the necessary capability is available to aid in this task. The time required for summarizing can and should be alleviated by requiring participants to enter their comments in abbreviated point form. Archer (1988) compared four types of meeting techniques (including CCNA) with equal group sizes. In that comparison, it was found that the amount of time spent by conference moderators was not significantly different among the four techniques, so there is no time penalty to the moderator who uses CCNA.

For larger groups, there is a litany of potential problems (Feldman & Arnold, 1983) which can militate against a quality solution in the normal face-to-face or asynchronous computer conferencinggroup meetingformats. This is normally true for group sizes larger than five, although Nunamaker,Applegate and Konsynski (1988) reported that participant satisfaction actually increased with group size in their GDSS experiments (this may be due to the fact that their participants met as groups, with computer-aided support). The CCNA approach also tends to alleviate this problem and as a result the potentially high collective creativity of the larger group can be used to advantage in preparing solutions which reflect the views of a larger number of participants.

Among the negative aspects of computer conferencing is that, on average, people prefer face-to-face meeting techniques rather than computer conferencing. This is not alleviated by the CCNA technique; in fact the original nominal group technique, although it has proven to be better in a number of ways for creative problem solving than interactive group techniques, has not achieved widespread use in the world of business (claims of its proponents aside). This is due to the same reason that computer conferencinghas not been widely accepted in business (even though it has been well-received in academia). That is, people still prefer to interact directly if at all possible. The enhanced educational benefits of improved techniques may not be met with initial enthusiasm by students but, as indicated by Mason (1987), the two major elements to the effective use oflearninggroups are: active participation by students in the discussion, and faculty expertise and guidance provided through structured tasks. These two elements are prominent features of the approach described in this paper, and it should also be noted that the CCNA technique greatly reduces the temporal problems of participants, comment sequencing which are usually attributed to asynchronous computer conferencing (Hesse, Werner, & Altman, 1988). This is because participants are required to focus on only one topic at any given time, so there is little likelihood that other sequences of interactions unrelated to that topic will occur. While the instructor did not intervene in the discussions described for this experiment in order to avoid biasing the results, it would enhance student learning if the instructor did take part in the discussions at the end of each of the three decision-making phases, in order to promote discussion in areas not already explored by the participants.

Those computer conferencing techniques which can be shown to improve the ability of participants to work together in business and academic environments will ultimately become more widely accepted if easy-to-use user interfaces can be developed for computer-mediated conferencing, and this is a thrust of current Group Decision Support System research (Nunamaker, Applegate, & Konsynski, 1988). In fact, CCNA could also be adapted to synchronous mode (CCNS) as an adjunct to GDSS, thus providing a technique for improvinggroup creativity in synchronouscomputer-mediated environments.

The participants agreed that the educational objectives of the computer conferencing exercise (including, of course, learning the case material!) were met by the CCNA technique. These objectives are independent of spatial separation of group members, indicating obvious potential for the use of CCNA in distance education, although this was not explored in this study. Distance education is receiving more attention in North America, albeit perhaps not with the concentrated effort seen in the U.K. (Mason, 1988). The CCNA approach could aid in supporting computer-mediated distance learning through, for example, the process of assigning discussion group membership, the structured nature of the group decision-making process, and the defined manner in which group members contribute to the discussion independently of others. Each of these attributes of CCNA should encourage individuals to learn on their own, from other group members, and from the instructor, independent of spatial separation, and with temporal constraints which are not nearly as severe as in synchronous conferencing.

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