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A COMPARISON OF COMPUTER CONFERENCES

WITH FACE – TO – FACE MEETING FOR

SMALL GROUP BUSINESS DECISION

BY

Norm P. Archer

Faculty of Business

McMaster University

Hamilton, Ontario

Canada L8S 4M4

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McMASTER UNIVERSITY

1280 Main Street West
Hamilton, Ontario, Canada L8S 4M4
Telephone (416) 525-9140

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By
Norm. P. Archer
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A comparison of computer conferences with face-to-face meetings for small group business decisions

NORMAN P. ARCHER

Faculty of Business, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4M4, Canada

Abstract. This study reports on the evaluation of four meeting techniques for decision-making by small groups. Two face-to-face and two computer conferencing techniques were evaluated by small groups solving business cases. Particular groups varied widely in their satisfaction with different meeting techniques, but there was no significant difference in the quality of the group decisions.

1. Introduction

Computer-mediated conferencing is becoming an accepted technique in supporting group interactions during decision-making. Much of the early work with computer conferencing in problem solving by geographically dispersed groups is discussed by Hiltz and Turoff (1978) and Rice (1980). Group problem solving through business and scientific applications of computer conferencing, and its close relative electronic mail, have been studied in some detail (Caswell 1988, Chess and Cowlishaw 1987, Grayson 1983, Hiltz and Turoff 1981, 1985, Kerr and Hiltz 1982, Kiesler 1986, Livingston 1984, Philips 1982, Rice 1987). Specific educational applications have also been investigated (Bissell *et al.* 1987, Hiltz 1986, Kaye 1987, Mason 1987, McCreary and Van Duren 1987, Rice and Case 1983, Ujimoto and James 1987, Welsch 1982). There are a wide variety of systems available to support these applications (Chess and Cowlishaw 1987, Flavin 1985, Livingston 1984, Meeks 1985) but the success of computer-mediated communications for widely dispersed group members is obviously dependent upon the availability of data communication networks (Quarterman and Hoskins 1986). The successful development of group decisions by such means is also highly dependent upon the organization and control of the conference by a moderator (Caswell 1988, Feenberg 1986, Turoff and Hiltz 1982).

Hiltz and Turoff (1978) suggested the adaptation of the Nominal Group and Delphi techniques to computer conferencing, and voting capabilities can be built into computer conferencing systems (Hiltz and Turoff 1981, 1985) to support the Delphi approach. The Nominal Group technique has been tested in a computer conferencing mode (Archer 1989), and a modified Delphi technique has been used (Kerr and Hiltz 1982) to collect data from a number of expert panels.

The computer conferencing applications mentioned above have generally been used in the asynchronous mode. That is, conference group members read messages from other members and submit their own comments independently of whether other members are currently using the system. Such conferences may last for weeks before arriving at a conclusion (if in fact one is forthcoming), depending largely upon the ability of the moderator to organize the conference and maintain the interest of group members. Recently, a good deal of research has also been done in the area of synchronous computer-mediated conferencing, in the form of Group Decision Support Systems (DeSanctis and Gallupe 1985). Such research has emphasized the provision of

synchronous on-line technical support during meetings, but asynchronous computer-mediated conferencing is normally used only as a group communications vehicle.

2. Small group decision making

The study reported in this paper describes the results of small group decision making with realistically complex business mini-cases. Two forms of asynchronous computer conferencing were used: Computer Conferencing Asynchronous (CCA) and Computer Conferencing Nominal Asynchronous (CCNA), compared with two well-known face-to-face meeting techniques: the normal Interactive Group (IG) technique, and the Nominal Group (NG) technique (Delbecq *et al.* 1975).

In the IG technique, a moderator chairs the meeting according to a prepared agenda and takes responsibility for preparing the final report. The moderator solicits the opinions of group members and the group interacts freely until a final decision is made, which in most cases is a consensus. On the other hand, the NG technique uses 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. The group decision is made by majority vote.

The CCA approach is the most widely used computer conferencing technique, and can be compared with the IG approach except that communications are asynchronous and mediated by computer. Group members may view the comments of others and add their own at any time during the conference, which may last several days or weeks. The CCNA approach (Archer 1989) is a computer conferencing adaptation of the Nominal Group technique, in that 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 of the conference is complete, the cycle of private mail and conference discussion is repeated, until a consensus has been reached on the final decision and implementation approach. In this way, CCNA differs from the standard NG approach because, after the initial presentation of a summary of individual member opinions, the group works towards a consensus rather than using a majority vote. Consensus decision making is more feasible with the CCNA technique because interactive group problems, which the nominal group approach is designed to overcome, tend to be less dominant in the computer conference (Kerr and Hiltz 1982). At the same time, CCNA should exhibit an advantage over the CCA methodology, as does NG over IG (Burton 1987), since it should aid in the generation of ideas by encouraging more individual contributions.

Some of these techniques have previously been compared. The IG and NG techniques have been compared for their effectiveness in face-to-face (FTF) group decision processes (Burton 1987, Jewell and Reitz 1981, Van de Ven and Delbecq 1974). 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. Experiments have also been carried out (Hiltz *et al.* 1980) in a time-constrained environment to compare synchronous computer conferencing (CCS) with IG meetings, with the conclusion that there was no difference in the quality of solutions reached by either method. It was also found that IG conferences reached a consensus much more frequently than the CCS

computer conferencing groups, and that FTF communication was rated by the participants to be significantly more satisfactory.

Turoff and Hiltz (1982) concluded that there was no difference in the quality of decisions made by small FTF groups as compared to computer conferencing decisions. Kerr and Hiltz (1982) received a mixed response from a panel of experts questioned on a variety of experiences on the quality of decisions resulting from computer conferencing compared to FTF conferences. Factors which affect decision making in computer-mediated conferences have also been examined (Kiesler *et al.* 1984, McGuire *et al.* 1987, Siegel *et al.* 1986). Burton (1987) suggests that the wide diversity of findings concerning user satisfaction with group performance in decision making is a function of situational factors such as the nature of the task, the group, or the individuals.

There are some very fundamental differences among the four group decision-making techniques discussed in this paper, and these might be expected to have an impact on the quality of decisions made. For example, it is well-known that group decisions can be strongly influenced by one strong individual in the IG environment. This type of influence is not expected to be as great in any of the other environments. Group decision-making in the IG and NG environment can also take place over a relatively short period of time, often at one meeting of the group. However, asynchronous computer-mediated conferences may continue for a number of days, giving participants more of an opportunity to think about their responses to the comments of their colleagues, and perhaps to make higher quality contributions to the discussion. Counterbalancing this is the fact that spontaneity from personal interaction is missing from the computer-mediated conferences, and the synergistic effects of group interactions tend to be quite different.

3. Group membership assignment

In this study, to reduce bias in the measurements, a great deal of care was taken in assigning group membership. The four group conferencing methodologies were tested on four mini-cases assigned to four groups of MBA students taking an advanced information systems course in information resource management. Students were motivated to do well because the case studies were an integral part of their course of studies. Of the 18 students, four were assigned to two groups, and five to each of the remaining two groups. Each group was assigned a different methodology in turn (but in a different order for each group) to solve each of the four mini-cases, so that each group was exposed once to the use of each methodology, and the four different methodologies were used for each mini-case. The conferencing system used was the CoSy(R) conferencing system (Meeks 1986) running on a VAX 11/780. The system could be accessed by students at their convenience, from terminals or from 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 groups were also trained in the use of the nominal group technique, and were supplied with a flip chart when using this technique. Each group was given two weeks to complete each case study, so the total length of the experiment was eight weeks.

In assigning members to groups, it was important to minimize potential performance differences among groups but at the same time to maximize the potential performance of each group. Research consistently suggests that groups make better judgments than individuals when the group members have varied skills and

experiences (Shaw 1981). A group assignment technique was needed which improved the likelihood that inter-group effects, when they existed, were not due to differences among the average skill levels of the groups.

Therefore, the technique developed by Beheshtian-Ardekani and Mahmood (1986) and modified by Muller (1989) was used. Each student filled out a questionnaire based on the published and validated instrument (Beheshtian-Ardekani and Mahmood 1986) which contains a series of questions related to experience, background and grades in related courses in both computer use and general management. Weights were assigned to these questions and the total score on the questionnaires was used as a ranking to assign students permanently to groups. This assignment technique achieves the objective of high intra-group heterogeneity with minimum inter-group differences in average skill, education, and experience levels, when adjustments are made to accommodate the reservations noted by Muller (1989). That is, the people-sequential method was used instead of the optimal assignment method to avoid the optimization algorithm's propensity to create highly polarized (bimodal) group assignments.

In the application of business games to education, it has been noted (Norris and Niebuhr 1980) that, in selecting members for teams, it is not important to the final result whether the team was assembled voluntarily or involuntarily. In the present experiment, the involuntary assignment of members to groups would therefore not be expected to affect the results.

4. Decision quality

Decision quality can be equated with decision effectiveness. A number of measures of effectiveness have been proposed for group decisions. Van De Ven and Delbecq (1974) used as their criteria the quantity of ideas and perceived group satisfaction. Note, however, that it has been observed (Hoffman *et al.* 1965) that group satisfaction is not related to the quality of the decision. Burton (1987) used quality measures with criteria such as practicality of implementation, pervasiveness or the capacity to integrate a number of issues or subproblems, and impact on the total long-range effect of implementation. Hoffman and Maier (1967) define quality as the adequacy of the solution in terms of the objective facts of the problem.

For the purposes of this study, effectiveness was measured in two ways: perceived group satisfaction as described by the participants themselves, and quality of work as expressed by the opinions of experienced referees. Perceived satisfaction was measured using a validated questionnaire from the work of Van de Ven and Delbecq (1974) which was filled out individually by group members at the conclusion of each assignment. Quality of work was measured using a questionnaire based on validated definitions of quality (Burton 1987, Hoffman and Maier 1967) other than participant satisfaction, and filled out by three qualified referees who examined the group case reports. All the questionnaires were pre-tested. The referees were advanced PhD students in information systems, each with a minimum of three years of business experience in addition to academic training. The group identity and the methodology used for each case study result were concealed from the referees.

5. The experiment

The four mini-cases used in the experiment were qualitative studies related to information systems management. Three mini-cases which involved unstructured decision-making were selected from the text by Senn (1987), and one mini-case

involving semi-structured decision-making was selected from Davis and Olson (1985); the latter mini-case could be solved by a contingency approach provided by the authors. The mini-cases were:

(*a*) 'Will The Real Information System Please Stand Up?' (Senn, pp. 57–58.)
(*b*) 'The Very New Company'. (Davis and Olson, p. 497.)
(*c*) 'Using Computers To Assist In Promotion Decisions'. (Senn, pp. 529–530.)
(*d*) 'Quality Assurance Analyst Certification'. (Senn pp. 277–278.)

Other published studies on decision making, because of their focus on some particular attribute of the decision process, have often used standardized problems which lent themselves to the generation of a final decision relating to only one of the alternatives. Either the alternatives specified were mutually exclusive (Payne 1976), or there was an explicit and quantitative single result required (Hiltz *et al.* 1980, McGuire *et al.* 1987, Turoff and Hiltz 1982). The current study focused instead on the overall effectiveness of decision making with realistic qualitative business problems. There could be many interdependent attributes related to such decisions, and each attribute could have a number of different levels. Thus, if each distinct combination of attribute levels is counted as a separate alternative, the number of potential alternatives is often combinatorially very large. Because of this, satisficing (Simon 1960) behaviour was expected because of task complexity and solution multiplicity. It would be virtually impossible (except for Case *b*), to identify and list all possible alternatives, let alone to consider them all in a rational manner.

A group member was selected as moderator by the members of each group, for each case. This duty rotated among group members, and the moderator participated in the decision-making process as well as being responsible for recording for both the group members and the referees, in summary form, the outcome of each phase of the problem solution. Summarization after each phase tends to improve the content of the knowledge brought forward to the next phase, whether or not the meeting is computer-mediated. To provide a built-in decision structure, all the groups were required to use a three-phased approach based on rational decision-making (Simon 1960, Feldman and Arnold 1983), to organize the group work. The activities involved in the three phases of decision making were:

1. *Intelligence*
(*a*) List the facts given in the case statement, and any facts which can be inferred from the context.
(*b*) Identify the problem(s) to be addressed.

2. *Design*
(*c*) List possible alternative solutions to the problem(s), along with their pros and cons.

3. *Choice*
(*d*) Select an appropriate decision.
(*e*) Set out an implementation procedure.

For each group using a computer conferencing technique for a particular case, the three decision phases were set up in advance as separate topics on the conferencing system. All groups, whether computer conferencing or face-to-face techniques were used, were required to prepare a final report which summarized the results from each of the three phases. This report was used by the judges to evaluate decision quality.

Groups were supplied with detailed instructions on how to follow the decision-making approach, but were free to cycle back to a previous phase at any time if they wished to do so. However, once work in a particular phase was complete there was usually no explicit cycling back.

Individual participant satisfaction data were collected by questionnaire. After each case had been completed, participants completed the questionnaire (Van de Ven and Delbecq 1974) shown in table 1, using a five point Likert-type scale to measure response.

5.1. *Data analysis*

Exploratory data analysis through an unbalanced repeated measures latin square design was used to analyse the responses from each question for the four treatments (Methods), with blocking for Case and Group. The data were effect-coded, and analysed using regression (Pedhazur 1982), according to the recommended procedure (Appelbaum and Cramer 1974) for non-orthogonal analysis of variance. Two-way interaction effects were observed between Method and Group, and verified by a lack-of-fit analysis. Unfortunately, a four by four latin square can be analysed with a maximum of 15 independent variables after allowing for the constant term. Nine of these are used up by the blocking and treatment effects, leaving only six for the interaction effects. Since nine variables were required if the Method × Group interaction effects were to be fully included, the data analysis was incomplete. However, a limited analysis could be made of the data, based on estimates of the results with the two-way interactions partially included. Depending upon the degree of non-orthogonality in the unbalanced design, this approach may cause minor errors in the variable estimates. In addition, there is some confounding to be expected between Case and Group × Methodology interactions in the latin square design (Myers 1979), so caution must be used in interpreting the significance tests of these effects.

Table 2 shows the results from the analysis of the perceived participant satisfaction data.

The R^2 (adj) values for Questions 1, 5 and 6 were low, and these questions were therefore not considered in the analysis. Questions 2, 3, and 7 had significant interaction effects, while question 4 had significant main effects for Group. Question 2 related to satisfaction with the study method, questions 3 and 4 related to satisfaction with the outcome of the case study, and question 7 related to both the study method and the case.

The Case main effect in table 2 was significant for six of the satisfaction questions. Unfortunately, due to the logistics of the experiment, it was necessary for all the groups to do the cases in the same order. Hence, learning effects were confounded with case effects and no conclusions can be derived from this result.

Table 1. Perceived satisfaction questions.

(1)	To what extent did you feel free to participate and contribute ideas?
(2)	To what extent did your feel your time was well spent with this study method?
(3)	How satisfied were you with the number of facts generated and the problem(s) identified by your group?
(4)	How satisfied were you with the number of alternative decisions generated by your group?
(5)	How satisfied were you with the overall quality of ideas generated by your group?
(6)	How satisfied were you with the quality of the final decision chosen by your group?
(7)	To what extent do you feel this is an effective way to deal with this type of problem?

Table 2. Analysis of perceived participant satisfaction.

Question	R^2 (adj)	Significance Overall F	Method	Group	Case	Group × Method
1	0·18	*	*	*	ns	ns
2	0·45	**			**	*
3	0·26	**			**	*
4	0·27	**	ns	**	**	ns
5	0·16	*	ns	ns	**	ns
6	0·20	*			**	**
7	0·44	**			**	*

Note: ** and * denote significance at 0·01 and 0·05 levels, respectively; ns = not significant.

5.1.1. *The number of alternative solutions*

Participants were observed to adopt a coping mechanism for dealing with the combinatorially large number of alternatives to complex problems. This seemed to be accomplished in Phase 2 of each case study by proposing simple alternatives which might by themselves serve as solutions. Most of these alternatives were not mutually exclusive except, of course, 'do nothing' which was often included as a stated alternative. By combining various of these simple alternatives in the final choice phase, synergistic solutions could often be developed which were better than any of the originally proposed simple alternatives. In this way, the number of potential alternatives actually stated by participants could be drastically reduced while maintaining a reasonably wide variety of choice in constructing the final decision. This appears to be a consequence of the rational decision-making approach, where iterations occur among the steps in the decision process (Simon 1960). Table 3 shows the average number of alternatives generated per group using each methodology, and the average number of these 'simple' alternatives actually used in the development of the final decision. Since Case B was highly structured with a limited set of alternatives, it was not included in this analysis.

Perceived satisfaction with the number of alternatives generated (question 4 in table 2) was not significant on Methodology. Also, although the number of alternatives is higher for the nominal techniques NG and CCNA in table 3, it is not significantly (0·05) higher. Van de Ven and Delbecq (1974) found that the number of alternatives generated by the NG method was significantly larger than with the IG method, and one suspects that more training and supervision in the current experiment might have generated a significant difference here as well. On the other hand, the experiment was an attempt to move the measurements of these techniques closer to the real world, where experienced supervision and extensive training are not always the norm.

5.1.2. *Group preferences*

Question 2 (time well-spent with this method) and question 7 (satisfaction with technique effectiveness for this type of problem) on the perceived satisfaction questionnaire were both significant on Methodology × Group interactions (table 2). The simple main effects were examined by the Tukey–Kramer pair-wise comparison procedure (Neter *et al.* 1985), and this analysis showed that groups tended to have more extreme and diverse opinions concerning the CCNA and IG methods than with the

Table 3. Alternatives generated; and used in final decision.

Methodology	Average number generated per case	Average number used in final decision
Int. Group	5·30	3·50
Nom. Group	7·25	2·75
C.C. Asynch.	6·75	3·50
C.C. Nom. Asynch.	7·75	2·50
Overall averages	6·90	3·00

Note: Case *b* not included.

Table 4. Decision quality questions.

(1) How closely does the solution correspond to the problem as originally defined by the group?
(2) How well have all the facts developed by the group been addressed by the solution and implementation?
(3) How well have the appropriate alternative solutions been integrated into the final decision and implementation?
(4) How practical and feasible is the proposed solution and implementation?
(5) How well do you feel that the real problem(s) has (have) been solved?

CCA and NG methods. Thus, instead of general agreement, groups had quite different perspectives on the effectiveness of different conferencing techniques on the decision process.

5.1.3. *Decision quality*

Questions based on decision quality measures are shown in table 4. Data were gathered from the referees, who examined the reports prepared by each of the groups, and ranked each case through the decision quality questions on a three point scale: 1 (poor), 2 (fair) and 3 (good).

In addition to the quality measures scored by the referees, the average of these five ratings was also calculated as a composite quality measure. Excluding Case *b* because of its special structured nature, the Cronbach alpha reliability of the composite measure was 0·74. Since a contingency technique was available for developing a decision for Case *b*, the solution for this case was developed accordingly and the group results for Case *b* judged against this solution. Table 5 shows the statistical analysis of the referee data for the five basic questions and for the composite quality measure. Of the results in table 5, questions 3, 5, and the composite measure had significant interaction effects, and questions 2 and 3 had significant group and case main effects, respectively. Questions 3 and 5 refer to the quality of the solution, as does the composite measure.

The simple main effects of the composite result were analysed by the Tukey–Kramer procedure, but only one group's decision quality was significantly better in comparing one method with any other. These results are therefore not definitive in favour of any one methodology. The conclusion is that decision quality did not depend upon the meeting methodology used.

Table 5. Results from analysis of decision quality.

Question	R^2 (adj)	Significance Overall F	Method	Group	Case	Group × Method
1	0·38	*	ns	ns	ns	ns
2	0·40	*	ns	*	ns	ns
3	0·30	*			*	*
4	0·22	ns	ns	ns	ns	ns
5	0·28	ns			ns	*
Comp.	0·37	*			ns	*

Note: * denotes significance at 0·05 level; ns = not significant.

6. Discussion

This study has been an attempt to move the analysis of the effects of decision-making by computer conferencing into a realistic but measurable simulation of a business environment. The results tended to show that, if the phases of the decision process were organized and managed in a rational manner, the quality of decision-making for complex business problems did not depend upon whether or not group interactions were computer-mediated, in agreement with previously reported measurements. The practical implication is that business decision quality will not degrade if it is necessary to use computer-mediated conferences to overcome problems such as geographical separation, inability to schedule meetings, etc.

An additional finding from the experiment was that the actual amount of working time spent by group members in arriving at a decision was not significantly dependent upon the methodology used. However, the elapsed time spent in arriving at a decision was generally much longer for computer-mediated meetings than for face-to-face meetings, since the computer-mediated meetings were asynchronous. This would tend to militate against the use of asynchronous computer-mediated meetings for small groups in urgent situations.

A very interesting aspect of this study was the finding that groups vary quite widely in their satisfaction with different meeting techniques. This variation occurred even when care had been taken to maximize inter-group homogeneity in terms of average individual education, skill, and experience, indicating that other individual characteristics (e.g., introversion/extroversion, learning strategy, cognitive style, attitude, expectation, etc.) or group characteristics (e.g., cohesiveness, leadership, etc.) must influence reactions to different group meeting methodologies. Why and how this group phenomenon occurs should be a very interesting research topic since it may hold the key to the more widespread acceptance of computer conferencing as a regular business tool.

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