Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 2003 Proceedings

Americas Conference on Information Systems (AMCIS)

December 2003

Delphi Structure and Group Size in Asynchronous Computer-Mediated Communications

Hee-Kyung Cho
New Jersey Institute of Technology

Murray Turoff
New Jersey Institute of Technology

DELPHI STRUCTURE AND GROUP SIZE IN ASYNCHRONOUS COMPUTER-MEDIATED COMMUNICATIONS

Hee-Kyung Cho
New Jersey Institute of Technology
hkc7959@njit.edu

Murray Turoff
New Jersey Institute of Technology
turoff@adm.njit.edu

Abstract

Communication structure is a way of improving the effectiveness of group communications by imposing rules or procedures of communications. Delphi is a communication structure which has been widely used to collect ideas and opinions from temporarily and geographically dispersed experts. A new approach in Delphi implementation using asynchronous Computer-Mediated Communication (CMC) is developed. A 2X2 controlled experiment investigates the effectiveness of Delphi structure on small-sized (5-6 members) and medium-sized (10-12 members) asynchronous CMC groups. The group task is to generate the ideas of potential applications of pervasive devices that can track the location of people and objects. The results indicate that the Delphi structure does result in more unique ideas per person than the unstructured condition and small-sized groups do generate more unique ideas per person than medium-sized groups.

Introduction

Asynchronous Computer-Mediated Communication (CMC) is a system in which temporarily and geographically dispersed groups collaborate by making contributions at any time and place. Previous research showed that asynchronous CMC has advantages in generating more creative ideas [11], in inferring ideas from stated facts [17], and in making more effective decisions in new product development [16], compared to face-to-face communications. However, previous research on asynchronous CMC communications reported many problems such as long time lags between question and reply, "dropout" or "latency" problems, and the "multi-headed animal syndrome." These problems might be due to lack of sharing of the time and place in asynchronous environments [6]. Imposing a communication structure (often accompanied with human facilitation) could alleviate these problems in asynchronous CMC but there were not many studies proving the effectiveness of communication structuring in asynchronous CMC environment.

"Structuring" restricts or channels communications with specific procedures. Among the many communication structuring methods designed to enhance group productivity are brainstorming [12], Nominal Group Technique (NGT) [23] and the Delphi Method [9]. To investigate the effect of the use of communication structure in asynchronous groups, Delphi structure, a widely used structuring method to facilitate geographically and temporally dispersed discussion groups, was chosen.

In this study, a computer-based Delphi structure was implemented through asynchronous CMC. This study investigated the separate and joint effects of group size and Delphi structure on the effectiveness of task-oriented asynchronous CMC groups, by comparing the number of unique ideas.

Literature Review

Group Size

Most investigations of the effect of different group sizes in CMC involved computer brainstorming using idea generation tasks. Most of the research used group size and technology (electronic brainstorming vs. verbal brainstorming) as independent variables and effectiveness (i.e., the number of unique ideas, the quality of ideas) and perceived effectiveness (satisfaction, perceived

process gains and process losses) as main dependent variables [1, 3, 4, 2, 5, 20, 21]. In terms of the number of ideas groups generated, the findings suggest that (1) large groups benefit more from computer technology than small groups, (2) diversity of knowledge of group members—rather than the group size itself—increases group performance. However, there are not many studies investigating the effect of group size in terms of per person performance—which would be a more accurate group performance measure reflecting the synergy effect. Furthermore, there was no empirical study on the effect of group size in asynchronous CMC.

Group Communication Structure (Delphi Structures)

Delphi [9] is a communication structure for asynchronous dispersed groups, usually large (15 to 300 individuals), through written modes. Delphi typically deals with ill-defined or complex tasks involving many different task types from McGrath's task circumplex, rather than involving a specific subtask [9]. In traditional paper-and-pencil based Delphi, a human facilitator organizes opinions or judgments contributed from geographically and temporally dispersed experts through multiple rounds of carefully designed questionnaires, and feeds back a summary of the views for each round. The initial phase of Delphi processes is for exploring a specific problem domain and it usually involves extensive literature reviews or surveys. After the participants are well-informed on the problem domain, they are asked to generate a list of similar items as useful inputs to solve the given problem. Through a series of voting iterations, they evaluate the list of items generated and explore reasons for disagreements. The final goal of this process is to seek either consensus or explanation of disagreements. Delphi structure is widely used in various applications such as public policy, forecasting, education, and software development but there is no comparative controlled experiment in the asynchronous environment which tested the effectiveness of this method in idea generation and evaluation.

As a communication structure, Delphi has two characteristics [18]: (1) feedback of summarized views of other members is presented to the group members, who are then given a chance to change their earlier opinions or judgments; and (2) anonymity is often used to avoid social pressures. The feedback-revision process is the heart of Delphi processes.

In computer-based versions of Delphi [18], asynchronous CMC is used as a delivery medium instead of mailed questionnaires. As a result, the round structure of paper-and-pencil based Delphi is changed into continuous asynchronous contributions and the resulting materials, organized with a minimum level of human intervention [18]. The required structures such as nominal contribution and controlled feedback are enforced by human facilitation in paper-and-pencil based Delphi, while special software features for automated facilitation, such as moderated conferences, can be used in a computer-based Delphi.

Research Framework

The main objective of communication structuring is to make larger groups to communicate better without potential process losses and CMC uses computer technology to structure communications. However most of the previous studies in CMC investigated the effect of computer technology on different group sizes, not the effect of communication structures. Moreover the effect of different group sizes has not been studied in asynchronous CMC. Even though some empirical studies attempted to test the effectiveness of the Delphi method, most of those studies compared paper-and-pencil based Delphi groups with face-to-face groups. In this study, the same communication medium (asynchronous CMC) was given to both conditions to test the effect of Delphi structure with controlling the medium effects. Also the effectiveness of Delphi structure was compared in groups in different sizes. Figure 1 represents the conceptual framework of this study.

Hypotheses

Van de Ven and Delbeq (1974) found that Delphi groups generated more unique ideas than non-structured interacting groups. Even in Electronic Brainstorming Systems (EBS) research, individuals working alone have been found as productive (i.e. in terms of number of unique ideas) as EBS groups wherein group members interact each other [8, 14]. Nominal contributions without evaluation in the early phase of idea generation and controlled feedback in Delphi groups should produce more unique ideas than the free-formed contributions in unstructured asynchronous groups because group members are more likely to commit to the search process due to the silent generation of ideas—the evidence of search activity [22]. This silent idea generation phase would allow group members to reflect fully on the problem without interference. This process allows individuals to generate more ideas by exercising their creativity fully. Previous research [13, 15] on free-riding, social loafing and social matching showed that constant feedback could harm the effectiveness of the group by setting a lower norm of performance in the early stage of group process.

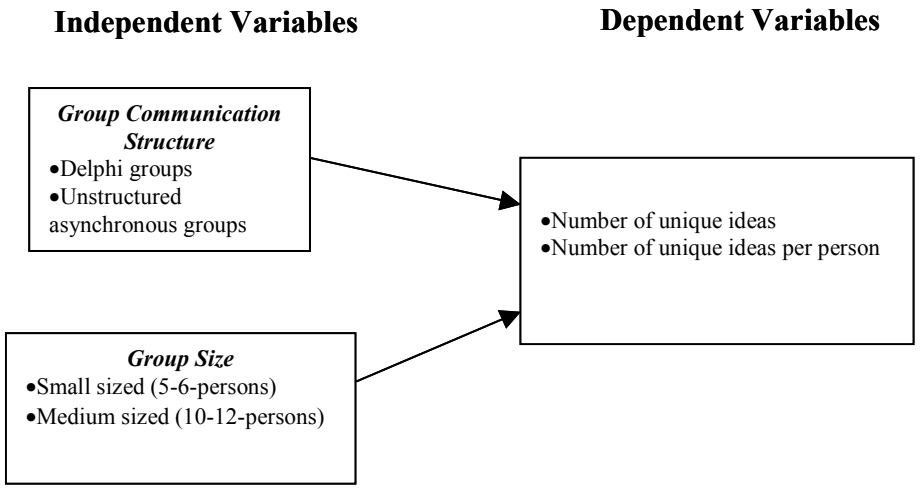

Figure 1. Conceptual Framework of This Study

It is therefore more effective to provide group feedback after each individual fully considers and searches his/her own alternatives. Therefore, it is expected that Delphi groups are likely to generate more unique ideas than unstructured asynchronous groups. This leads to:

H1a. Delphi groups will produce more unique ideas than unstructured asynchronous groups.
H1b. Delphi groups will produce more unique ideas per person than unstructured asynchronous groups.

Previous GSS studies showed the relative superiority of large groups in terms of the number of unique ideas produced compared to small groups [1, 3, 4, 2, 5, 20, 21]. However, most previous GSS research on group size did not investigate the effects of group size in terms of number of ideas per person. Dennis and Valacich's experiment (1993) is the only one which reported this effect but they also did not find main effects of group size on per person performance. Even though previous research did not find clear main effects of group size on per person performance, it is speculated that small groups will produce more unique ideas per person than large groups, based on the assumption that a large group would have a higher level of process losses such as free-riding / social loafing. This leads to:

H2a. Medium-sized groups will produce more unique ideas than small-sized groups.
H2b. Small-sized groups will produce more unique ideas per person than medium-sized groups.

Dennis and Valacich's experiment (1993) found an interaction effect between group size and technology: Medium-sized (12 members) groups had more benefits of computer support than small (6 members) groups, in terms of per person ideas. From this finding, we may expect an interaction effect between imposing a structure[1] and group size for per person performance. Van de Ven and Delbecq (1971) also stated that as group size increases, the superiority of structured groups such as Delphi or NGT groups over unstructured groups increases in terms of total number of unique ideas and the quality of ideas produced, because structured group processes can accommodate large numbers of participants. Group size is expected to interact with Delphi structure because without any structure, it is likely that medium-sized asynchronous groups (which need more coordination efforts) will suffer disproportionately from coordination problems and process losses than small-sized counterparts. This leads to:

H3a. Communication structure interacts with group size in a synergetic manner so that medium-sized Delphi groups produce disproportionately more unique ideas than small-sized Delphi groups.
H3b. Communication structure interacts with group size in a synergetic manner so that medium-sized Delphi groups produce disproportionately more unique ideas per person than small-sized Delphi groups.

[1]In Dennis and Valacich (1993)'s study, a technology structure (not a communication structure) was used. However, we can assume that technology will impose a kind of structure to group communication.

Research Methodology

Task

The Special Technology Inc. task was specifically designed for this study. A hypothetical case of a computer chip manufacturing company which has just developed a pill-sized object-tracking device is given to all groups. Groups are required to generate as many ideas of possible applications of such a device as possible, develop positive and negative consequences for each application generated and evaluate each application idea in terms of the level (3 point-scale) of potential impacts the consequences of the application may have in U.S. society. This task corresponds to the combination of a creativity task (Type 2 in McGrath's Task circumplex) and a decision-making task (Type 4) [10]. More importantly, it is an example of a complex social policy issue for which more public involvement could be obtained with appropriate structures for large groups of people to participate in what might be termed a "social decision support system" [19]. The task was tested and revised based on the subjects' responses to the task questionnaire distributed in the pilot studies.

Experiment Design

In order to test the hypotheses, a controlled experiment with a 2 (group size) X 2 (communication structure) factorial design was conducted. In the dimension of group size, Small-sized groups (5-6 members per group) were compared to medium-sized groups (10-12 members). In the dimension of communication structure, Delphi groups were compared to unstructured asynchronous groups. Because of the long time period (two-and-half weeks of experiment) and limited number of potential subjects who could be used in one semester, the cutoff points for group size (6 vs. 12 members) were chosen in order both to be compatible with Electronic Brainstorming studies investigating the effect of group size [5, 2] and to be practical in terms of obtaining sufficient subjects. Any small-sized group in which more than one member and any medium-sized group in which more than two members dropped out from the experiment was discarded from data analysis. It is not avoidable to have a buffer of group size considering high drop out rates in asynchronous CMC experiments [7].

The other independent variable of this study is communication structure. Delphi groups were compared with unstructured asynchronous groups and both groups used asynchronous CMC as their communication medium.

Subjects

396 subjects (11 groups per condition) were recruited from undergraduate (junior and senior) level courses in the Computer Science and Information Science departments at New Jersey Institute of Technology. Students were given an option of participating in this experiment for an assignment for their courses or doing an alternative assignment. Students who decided to participate were instructed to read the on-line tutorial on Webboard system use and finished four training exercises. Through this training, students in all groups were exposed to the concept of posting ideas or comments, replying to other persons and posting in a moderated conference. After finishing the training exercises, students were assigned to a group. Each student was given a unique pen-name (login name) and password for accessing the experiment discussion board assigned to the group. This pen-name consists of two parts—group ID and the serial number in the group.

Technology Used

Webboard, a Web-based asynchronous group communication system, was used in this study. In this system, a discussion board was given to a group and each board could have different conferences. Before the task was posted in the conference, group members were instructed to log into the discussion board and select a group coordinator. The group coordinator was responsible for distributing the workload of writing a group report to every member and ensuring that the group report was submitted on Webboard by the end of the experiment period. The experiment took two and a half weeks. Group members were instructed to finish the task and post their group report by the last day of the experiment.

Delphi Groups

Different Delphi implementations (such as ranking type voting and Likert scale type voting) were pilot tested through two sets of pilot studies. Structure and procedures were modified accordingly and the finalized version involves the idea generation phase, the evaluation phase and two iterations of voting. In the idea generation phase (three days), groups were asked to generate as

many ideas of their own as possible in a moderated conference which did not allow members to see the postings of other members. Then the facilitator (the first author of this paper) revealed the list of ideas posted in that conference and members had opportunities to develop the consequences or to comment on each other's ideas and/or add more ideas to the list (evaluation phase—two days). By aggregating this list of ideas, the facilitator made a web-based questionnaire using Survey Tracker and posted the URL of that questionnaire in the group Webboard. In this questionnaire, groups were asked to rate each idea in terms of five Likert scales of relative importance (the first voting—two days) and to comment on each idea. Survey Tracker produced a brief report on the result of the first voting and the facilitator posted the URL of this report and the URL of the second voting questionnaire in the group Webboard. In the second voting (two days), groups were asked to read the voting report and rate each idea in terms of three levels of relative importance (Very important, Important, Not important) and also to comment on each idea.

Table 1 explains the implementation of Delphi structure which was used in this study, compared with traditional paper-and-pencil Delphi.

Unstructured Asynchronous Groups

Members in unstructured asynchronous groups complete the task without the Delphi structure described in the previous section. However, since the anonymity effect has been shown significant in previous CMC studies, this effect was controlled in our study by providing pen-names to members in both the Delphi and the unstructured conditions. Subjects generated, discussed and evaluated ideas in one conference and that conference was not moderated—that is, they were able to see ideas and comments posted by other members any time.

Table 1. Paper-and-Pencil Delphi vs. Computerized Delphi Implemented in This Study

	Paper-and-Pencil Delphi	Delphi structure in this study
Anonymity	Anonymous contributions	Pen-name is used in this study
Facilitator	*Human Facilitator* designs the procedure and questionnaire/organizes the list of items/summarizes responses and feeds those responses back to the participants.	*Human Facilitator* designs the procedure and instructions/ aggregates responses *Automated Facilitation*: such as moderation functions which support Nominal Idea Generation/Group Feedback/ Controlled Discussion In this study a combination of human and automated facilitation is used.
Delivery (Asynchronous Communication Medium)	Facilitator designs and mails *questionnaires* to participants	A combination of an asynchronous CMC (Webboard) and survey software (SurveyTracker) is used. Facilitator posts a sequence of instructions in the conference in Webboard and also provides the URL of on-line surveys for voting.
Nominal Idea Generation	Participants fill out the questionnaire and mail it back to the facilitator.	Participants post ideas in a moderated asynchronous conference where members cannot see others' postings.
Group Feedback	Facilitator summarizes and mails participants' responses with the subsequent questionnaire	Facilitator approves and reveals the list of items generated by group members. Facilitator generates a report of voting results using Survey Tracker and posts the URL of the report in the Webboard.
Controlled Discussion	Participants fill out and mail the questionnaire (comments on each item and/or voting)	Participants comment on others' ideas in a Webboard conference and also provide the reasons / comments on voting in on-line voting surveys.
Iteration	The subsequent questionnaire is distributed to participants together with a summarized report of the previous round. Participants are given opportunities to change their judgments, based on the group view.	A sequence of instructions is posted in a conference. Two rounds of voting are used.

Measures of Dependent Variables (Number of Unique Ideas)

In order to discover unique ideas, the first author of this paper categorized the total list of ideas aggregated from all groups (including duplications removed from the list by the facilitator in Delphi groups) in terms of eight functions of the devices (Tracking/Monitoring, Logging, Locating, Controlling, Sensing, Recording attendance or inventory, Identifying, and Studying) and subjects to be tracked (such as criminals, animals, etc.) Then, this categorization was also reviewed by the two dissertation advisors of the first author. Each category in this categorization represented a unique idea. Only the most specific concept was counted as one idea in case general and specific concepts appeared in one group: for example, only "Tracking suspect's alibi" was counted when it appeared together with the ideas of "Tracking and monitoring people" and "Tracking suspects" in one group. This categorization is reasonable since the task asked to generate as many ideas of specific uses of tracking devices for specific subjects, as possible. Table 2 shows some examples of this categorization.

Table 2. Example of Idea Categorization

Function of Device	Subjects	Description	Number of Occurrences
Tracking/Monitoring	People	Tracking/Monitoring people	8
	Suspects	Tracking/Monitoring suspects	35
	Suspect's alibi	Tracking suspect's alibi	1
Locating	Organ donors	Locating registered organ donors	1
	Luggage for airlines	Locating luggage for airlines	9
Sensing	Hikers	Sensing status of hikers	4
	Unborn babies	Sensing status of unborn babies	3

After sorting out the list of ideas in terms of this categorization, the number of unique ideas appeared in the group discussion (the Webboard discussion conference) were counted for each group. We believe this method did provide solid criteria to count the ideas conceptually unique within the group. Table 3 compares the total number of ideas with the number of unique ideas in each condition. To calculate the number of unique ideas per person, the number of unique ideas was divided by the group size.

Table 3. Number of Ideas in the Four Conditions

(total number of ideas, number of unique ideas)

Condition	Small	Medium
Delphi	(160, 150)	(274, 241)
Unstructured	(102, 97)	(182, 166)

Results

The data from 44 groups (11 per condition) were collected and analyzed. Analysis of variance (ANOVA) was used to test the hypotheses. Table 4, 5 and 6 show the results. In analyzing the number of unique ideas, it was found that Delphi groups generated significantly more unique ideas than unstructured asynchronous groups ($p=0.0002$) and medium-sized groups generated significantly more unique ideas than small-sized groups ($p<0.0001$). In analyzing the number of ideas per person, main effects on both dimensions were also found; Delphi groups generated significantly more unique ideas per person than unstructured asynchronous groups ($p<0.0001$) and small-sized groups generated more unique ideas per person than medium-sized groups ($p=0.0429$). However, no significant interaction between group size and structure was found in terms of either the number of unique ideas ($p=0.8439$) or the number of unique ideas per person ($p=0.1649$).

Table 4. Number of Unique Ideas Mean

(standard deviation)

	Small	Medium	
Delphi	13.64 (2.66)	21.91 (5.77)	17.77 (6.09)
Unstructed	8.82 (2.04)	16.60 (4.67)	12.52 (5.27)
	11.23 (3.38)	19.38 (5.82)	15.21 (6.23)

Table 5. Number of Unique Ideas per Person

mean (standard deviation)

	Small	Medium	
Delphi	2.27 (0.44)	1.83 (0.48)	2.05 (0.51)
Unstructed	1.47 (0.34)	1.38 (0.39)	1.43 (0.36)
	1.87 (0.56)	1.62 (0.48)	1.75 (0.54)

Table 6. Results of ANOVA

Dependent Variables	Hypotheses	Mean Square Error	(F, df)	Significance Level	Conclusion
Number of unique ideas	H1a*** (structure)	275.17	(16.73, 1)	0.0002	Supported
	H2a*** (group size)	691.52	(42.04, 1)	<.0001	Supported
	H3a (interaction)	0.65	(0.04, 1)	0.8439	Not supported
Number of unique ideas per person	H1b*** (structure)	4.16	(23.90, 1)	<.0001	Supported
	H2b* (group size)	0.76	(4.38, 1)	0.0429	Supported
	H3b (interaction)	0.35	(2.00, 1)	0.1649	Not supported

*** p=.001, ** p=.01, * p=.05

The result shows that Delphi structure is effective for asynchronous CMC groups in generating more unique ideas. It is argued that the silent idea generation phase of the Delphi structure might have made group members to commit more to searching alternatives. In general, this result is consistent with the findings of Van de Ven and Delbeq (1971, 1974) and the previous EBS studies, which showed the superiority of a structured approach in idea generation tasks, but could have different interpretations. Since the same amount of discussion time and the same communication medium (asynchronous CMC) were given to both the Delphi and the unstructured groups in our study, it is inferred that the significant difference in the number of unique ideas have only come from the difference in the communication structuring approaches. This effect of the structured approach in idea generation tasks is not conclusive in the study of Van de Ven and Delbeq (1971, 1974) or the previous EBS studies because of the uncontrolled factors of the communication medium (in case of both the EBS studies and Van de Ven and Delbecq's study) or the discussion time (in case of Van de Ven and Delbecq's study).

The result also shows medium-sized groups generate more unique ideas in total than small-sized groups and this is consistent with the general findings of EBS studies. However this superiority of larger groups does not seem to relate to the synergy effects of having more people in a group because a person in a medium-sized group generates significantly fewer unique ideas than a person in a small-sized group. From this finding, we could infer that a person is more likely to suffer from process losses when he/she works in a medium-sized group than in a small-sized group.

In terms of the interaction effect between group size and structure, the resulting direction (p=0.1649) of the average number of unique ideas per person is opposite to the authors' prediction: in average, medium-sized Delphi groups did produce relatively less unique ideas per person than small-sized Delphi groups. This finding contrasts to the results of the EBS studies which showed that medium-sized groups benefited more from technology-supported structure (EBS) than small-sized groups.

Conclusions and Limitations

This study investigates the effectiveness of Delphi structure on asynchronous CMC groups. This study also advances from the previous CMC studies on group size by investigating this effect in asynchronous environments. A computer-based implementation of Delphi structure was developed and used in this study. The finding suggests that Delphi structure helps asynchronous CMC groups to generate more unique ideas per person. The finding on the dimension of group size suggests that having more people in an asynchronous CMC group does not always help individuals to generate more unique ideas, even though the total quantity of ideas increases. No interaction effect was found between group size and structure.
However, there are some limitations on this study. A specific categorization method (categorization throughout the whole groups in terms of functions of tracking devices and subjects to be tracked) was used for the identification of unique ideas. The unique

number of ideas could be different if other methods are used. Alternative methods of identification should be developed and compared with the result of the current method to test the validity of the current method in future research. The result of this study was based on the number of unique ideas which appeared in group discussion boards. However, observations revealed the cases where ideas in discussion failed to appear in the group reports. In future research, the same analysis has to be done using number of unique ideas in the group reports. As with all controlled experiments using students, the generalizability of results to "real" groups doing "real" tasks is somewhat in question. However, the policy analysis task for the groups in the study was "real" in the sense that it closely related to the course topics they were studying. The student subjects received a substantial part of their course grade, based on the quality and regularity of their participation. Thus, they were motivated to put their best efforts, even though it was a laboratory task. Moreover, analysis of the background questionnaires showed that 70% of the student subjects have been employed full-time in industry. Thus, they do have some "real world" experience.

This study investigated only at the "quantity" of ideas. Since the objectives of idea generation task is to generate as many "quality" ideas as possible, it is also necessary to examine the quality and creativity of these ideas and also the subjective satisfaction of the participants. In addition, it is necessary to examine what process gains helped members in Delphi groups and what process losses discouraged medium-sized groups while they performed the task.

Acknowledgements

This research was partially supported by the New Jersey Center for Pervasive Information Technology.

References

[1] Aiken, M., Krosp, J., Shirani, A. and Martin, J. "Electronic Brainstorming in Small and Large Groups," *Information and Management* (27), 1994, pp. 141-149

[2] Dennis, A. R. and Valacich, J. S. "Computer Brainstorms: More Heads are Better than One," *Journal of Applied Psychology* (78:4), 1993, pp. 531-537.

[3] Dennis, A. R., Valacich, J. S. and Nunamaker, J. F. "An Experimental Investigation of the Effects of Group Size in an Electronic Meeting Environment," *IEEE Transactions on Systems, Man, and Cybernetics* (25:5), 1990, pp. 1049-1057.

[4] Dennis, A. R., Valacich, J. S. and Nunamaker, Jr., J. F. "Group, Sub-group and Nominal Group Idea Generation in an Electronic Meeting Environment,", HICSS, 1991, pp.573-579.

[5] Gallpue, R. B., Dennis, A. R., Cooper, W. H., Valacich, J. S., Bastianutti, L. M. and Nunamaker Jr., J. F. "Electronic Brainstorming and Group Size," *Academy of Management Journal* (35), 1992, pp. 350-369.

[6] Hiltz, S. R., Dufner, D., Holmes, M. and Poole, M. S., "Distributed Group Support Systems: Social Dynamics and Design Dilemmas", *Journal of Organizational Computing* (1:2), 1991, pp. 135-160.

[7] Hiltz, S. R., Turoff, M., and Johnson, K., "Group Decision Support: The Effect of Designated Leader and Statistical Feedback in Computerized Conferences", *Journal of Management Information Systems* (8:2), 1991, pp. 81-108.

[8] Hymes, C., and Olson, G., "Unblocking Brainstorming Through the Use of a Simple Group Editor," *Proceedings of the Conference on Computer Supported Cooperative Work*, 1992, pp. 99-106.

[9] Linstone, H.A. and Turoff, M., *The Delphi Method: Techniques and Applications*, Addison-Wesley, 1975. Retrieved March 17, 2003, from New Jersey Institute of Technology, Information Systems Department Web site: **http://www.is.njit.edu/pubs/delphibook/index.html**.

[10] McGrath, J., *Groups: Interaction and Performance,* Englewood Cliffs, NJ: Prentice-Hall, 1984.

[11] Ocker, R., Hiltz, S. R., Turoff, M. and Fjermestad, J. "The Effects of Distributed Group Support and Process Structuring on Software Requirements Development Teams: Results on Creativity and Quality," *Journal of Management Information Systems* (12:3), 1995/1996, pp. 127-.

[12] Osborn, A. F. *Applied Imagination*, 1953, Scribner's, New York.

[13] Paulus, P. B. and Dzindolet, M. T., "Social Influence Processes in Group Brainstorming," *Journal of Personality and Social Psychology* (64), pp. 575-586.

[14] Pinsonneault, A., Barki, H., Gallupe, R. B. and Hoppen, N. "Electronic Brainstorming: The Illusion of Productivity," *Information Systems Research* (10:2), 1999, pp. 110-133.

[15] Roy, M. C. and Gauvin, S. "Electronic Group Brainstorming: The Role of Feedback on Productivity," *Small Group Research* (27:2), 1996, pp. 215-247 .

[16] Schmidt, R., Lyytinen, K., Keil, M., Cule, P. "Identifying Software Project Risks: An International Delphi Study," *Journal of Management Information Systems* (17:4), 2001, pp. 5-36.

[17] Shirani, A., Tafti, M., and Affisco, J., "Task Technology Fit: a Comparison of Two Technologies for Synchronous and Asynchronous Group Communication", *Information and Management* (36:3), 1999, pp. 139-150.
[18] Turoff, M. and Hiltz, S. R., "Computer Based Delphi Processes", in *Gazing Into the Oracle: The Delphi Method and Its Application to Social Policy and Public Health*, Adler, M. and Ziglio, E. (editors), London, Kingsley Publishers, 1995, pp. 55-88.
[19] Turoff, M., Hiltz, S.R., Cho, H.K., Li, Z. and Wang, Y. "Social Decision Support Systems (SDSS)", *Proceedings of the Thirty-Fifth Hawaii International Conference on System Sciences, 2002,* Washington DC: IEEE Computer Society (CD Rom).
[20] Valacich, J. S., Dennis, A. R. and Nunamaker Jr., J. F. "Group Size and Anonymity Effects on Computer-Mediated Idea Generation," *Small Group Research* (23:1), 1992, pp. 49-73.
[21] Valacich, J. S., Wheeler, B. C., Mennecke, B. E., and Wachter, R. "The Effects of Numerical and Logical Group Size on Computer-Mediated Idea Generation," *Organizational Behavior and Human Decision Processes* (62:3), 1995, pp. 318-329.
[22] Van de Ven, A. H. and Delbecq, A. L. "Nominal Versus Interacting Group Processes for Committee Decision-Making Effectiveness," *Academy of Management Journal* (14), 1971, pp. 203-212.
[23] Van de Ven, A. H. and Delbecq, A. L. "The Effectiveness of Nominal, Delphi, and Interacting Group Decision Making Process," *Academy of Management Journal* (17:4), 1974, pp. 605-621.