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Hsu-Hsiu Cheng

Jyun-Cheng Wang

Chui-Chen Chiu

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Hsu-Hsiu Cheng
Department of Information Management
National Chung Cheng University
Chia-yi, Taiwan
ludvik@mis.ccu.edu.tw

Jyun-Cheng Wang
Department of Information Management
National Chung Cheng University
Chia-yi, Taiwan
jcwang@mis.ccu.edu.tw

Chui-Chen Chiu
Department of Information Management
National Chung Cheng University
Chia-yi, Taiwan
chiuc@mis.ccu.edu.tw

## Abstract

E-mail is an indispensable communication tool in the modern enterprise organizes. E-mail is also so prominent for these teams that they communicate via e-mail daily, and is the main media for asynchronous meetings. This study explores the suitability of using e-mail to support group decision making. In order to reduce the communication obstacle which the group may encounter while using the asynchronous communication of E-mail, this study proposes two group techniques suitable for E-mail–Nominal Group Technique (NGT) and Round-Robin NGT. This study also explores the effectiveness of E-mail-mediated group supported by the structured group techniques and which type of task suitable for E-mail-mediated group. An experiment involving a total of 150 undergraduates was conducted. Results show that group techniques used in this study appears to be useful for facilitating E-mail-mediated group. But task type had no significant influence on E-mail-mediated group.

**Keywords**：E-mail, Nominal Group Technique, Task Type, Group Decision Making

## 1. Introduction

Electronic mail (E-mail) is undoubtedly the most successful application in the cyberspace. Even someone said that the e-mail has been the most successful communication technology since the invention of the TV.

E-mail also plays an important role in organization communication. Two major organizational shifts are the movement toward teams and the movement toward nonstandard work schedules. This has simultaneously increased the need for meetings and decreased the ability to meet [1]. In order to meet the new environment, one of the trends is virtual teams - groups of people who work together although they are often dispersed across space, time, and/or organizational boundaries.

After studied 12 virtual teams, Lurey and Raisinghani [2] found that e-mail was so prominent for these teams that 80% of the team members communicated via e-mail daily. Other team-based communication technologies like group telephone conferences, groupware applications, and video conferences were not often used. E-mail is the main tool to support asynchronous meeting and an important media to support future organization (virtual organization)[3].

On the other hand, most of computer-mediated communication research focused on Group Support Systems (GSS) research. Results of these studies show that using GSS brings considerable productivity promotion and reduces costs for organizations [4]. But the efforts of GSS research had limited effect on business world, GSS is diffusing slowly [5] [6]. Besides, Most of GSS research limited to “decision room” support system for synchronous communication. Mandviwalla and Gray [5] suggested that GSS research should expand to include commercial systems and to asynchronous and distributed work.

This study explores the suitability of using e-mail to support asynchronous group decision making.

## 2. Literature Review

### 2.1. Electronic mail

Massachusetts Institute of Technology designed E-mail in 1965 for experiment purpose. In 1969, US military developed ARPANET to link up computers as a network; E-mail was the most popular and frequently used application [7]. E-mail began to be used commercially in 1977.

The range of early E-mail definition is very extensive, from telex to computer conferencing system. Almost all the electronic ways to convey message can be called E-mail.

This study follows the definitions of Sproull and Kiesler [7]. An Electronic Mail System (EMS) uses computer text-processing and communication tools to provide a high speed information exchange service anyone with a computer account can create and send information to anyone who has a mailbox on that computer or on any other computer to which it is connected through a computer network.

### 2.2. E-mail-mediated Meeting

Sproull and Kiesler [8] organized a series of email meeting reports, they found that computer-mediated meeting was equal than face-to-face meeting, namely the conferee had equal time to provide opinions. E-mail also drew the status disparities of conferee. In the face-to-face meeting, the high social status conferee’s opinion had obvious influence to final conclusion; the same situation is not relatively obvious in E-mail-mediated meeting.

On the other hand, conferee in face-to-face meeting

which speak in turn tended to follow and agree with previous speaker. This kind of trend was not so obvious in E-mail-mediated meeting. The result of study showed that E-mail lacked the social context to incline to be unanimous and convergent. When needing a common consensus to make decision, E-mail-mediated meeting required more time and efforts.

Shirani et al, [9] thought that E-mail was asynchronous in both time and place, which allows, and perhaps encourages, greater use of human information processing resulting in deeper analysis which is crucial in the late stages of a group decision.

### 2.3. Nominal Group Technique

Nominal Group Technique (NGT) was developed by Andre L. Delbecq and Andrew H. Van de Ven in 1968. It was derived from social-psychological studies of decision conferences, management-science studies of aggregating group judgments, and social-work studies of problems surrounding citizen participation in problem planning. The NGT overcomes a number of critical problems typical interacting groups, such as, individual inhibitions and premature evaluation in interacting groups result in a decrease in quality of group ideas in terms of creativity, originality, and practicality. And the interacting group tends to pursue a single train of thought for long periods.

Perry [10] found from interview that E-mail is great for discussing and exchanging information, but it is hard to reach a decision about something that is complex and multifaceted.

Same results also found in other literature [8, 11, 12], usually members of distributed or asynchronous group are difficult to keep consciousnesses of being in a group [6, 12]. E-mail lacks for relevant social clues to understand others' real purposes of their expression [8, 9], and when or where to stop discussing [8, 10].

E-mail is used in asynchronous situation mainly, and a kind of comparatively poor social clues communication tool [13]. For preventing the problem mentioned above, it needs special structural group technique to support [3, 14], like Nominal Group Technique (NGT) or Delphi Techniques [15].

The structural group techniques were designed to coordinate communication and solve obstacles and settle difficulties that may be encountered in face-to-face communication. And relevant researches did prove that NGT was able to reach the anticipated goal. Moreover, asynchronous communication is much more often to encounter communication obstacles. Dowling and Louis [1] found that asynchronous group can benefit from NGT than synchronous groups.

The purposes of this study are to explore the effectiveness of NGT supported E-mail-mediated group. But because the original design of NGT is in a meeting room, mediated by paper and pen, and face-to-face. The implementation of NGT with e-mail in this study would slightly change. This study took the original spirit of NGT, and referred to relevant researches [1, 15, 16], and proposed two group techniques suitable for E-mail. The one close to the original design is named "Nominal Group Technique (NGT)". The second modification is called "Round-Robin NGT". This study also added E-mail-mediated meetings without group technique support called "Interacting Groups".

### 2.4. Task Type

McGrath [17] has combined the main ideas of a number of scientists into a conceptually related set of distinctions about tasks. McGrath proposes that there are four general processes. They indicate what the group is to do: to Generate (alternatives), to Choose (alternatives), to Negotiate, and to Execute.

Choose type tasks can be subdivided into Intellective type and Decision-Making type (Preference type). There is a logically correct answer in Intellective task, the goal of the task is to find out this correct answer; No obvious correct answer in Preference task, the goal of the task is to seek the common consensus while everyone having a different preference.

In the theory of information richness, Daft and Lengel [18] argued that there is an optimal fit between situational equivocality and media. And the main notion of task-media fitness theory [17] is that optimal richness requirement of tasks varies from type to type and the performance of a group depends on the extent to which the task fits the communication environment [19]. That is to say that complicated tasks relying on members' interaction to coordinate conflict and convey social clues. Complicated tasks relatively need media that can convey rich information.

## 3. Research Hypotheses

The purposes of this study are to compare E-mail-mediated meetings supported with or without group technique (Interacting group, NGT and Round-Robin NGT) and to explore which type of task suitable for E-mail-mediated group. This study focuses on group decision outcome and team relationship development. According to these goals, we developed the following hypotheses.

The purposes of NGT are to offer conferee time to deliberate, chance to participate, and a situation to concentrate on topic. NGT is superior to Interacting group no matter at productivity or satisfaction [20]. The disparity on satisfaction is especially obvious. The meetings of E-mail usually to go on by asynchronous way and members are relatively difficult to keep consciousnesses of being in a group, and to understand others' real purposes of their expression for e-mail lacking relevant social clues. Moreover, Dowling and Louis [1] found that groups using asynchronous NGT produce better decision results within shorter time than using face-to-face NGT.

NGT offer members fair chances to participate in discusses [20]. When members can participate in the meeting, and make some contribution to last decision, they will probably be satisfied with the decision, too [21]. So we proposed H1a, H1b, H2a and H2b as follow

H1a: Under conditions of Preference task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision than those not supported by group technique (Interacting group)

H1b: Under conditions of Preference task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision scheme than those not supported by group technique (Interacting group)

H2a: Under conditions of Intellective task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision than those not supported by group technique (Interacting group)

H2b: Under conditions of Intellective task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision scheme than those not supported by group technique (Interacting group)

Group members' more effective information exchange may cause them to understand their task s better and generate more creative solutions, thereby leading to better decisions [22]. The main purpose of group techniques is to dispel the communication obstacles. Besides, in Round-Robin NGT the conferee can see others' suggestion at the same time while expressing an opinion; it is to increase conferee to keep senses of participation and cohesion [23]. Members of cohesive teams tend to engage in more social interactions and view mutual opinions positively [21]. So we proposed H3a and H3b as follow.

H3a: Under conditions of Preference task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will make better decision than those not supported by group technique (Interacting group)

H3b: Under conditions of Intellective task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will make better decision than those not supported by group technique (Interacting group)

Preference task has no correct answer; it can only rely on group members to discuss, coordinate conflict, and reached a common view. Intellective task has an only one correct answer, members only need to participate in meeting and exchange information with each other. Do not need to coordinate the cognitive conflict of each other very much among members.

For Preference task, E-mail might be unable to offer enough social clues and decline members' satisfaction and perceived decision quality. Intelligence type task will not face this kind of situation. So we proposed the following hypotheses.

H1c: In E-mail-mediated meeting without supported by group technique

(Interacting group), groups facing Intellective task will be more satisfied with decision than those facing Preference task

H1d: In E-mail-mediated meeting supported by NGT, groups facing Intellective task will be more satisfied with decision than those facing Preference task

H1e: In E-mail-mediated meeting supported by Round-Robin NGT, groups facing Intellective task will be more satisfied with decision than those facing Preference task

H2c: In E-mail-mediated meeting without supported by group technique

(Interacting group), groups facing Intellective task will be more satisfied with decision scheme than those facing Preference task

H2d: In E-mail-mediated meeting supported by NGT, groups facing Intellective task will be more satisfied with decision scheme than those facing Preference task

H2e: In E-mail-mediated meeting supported by Round-Robin NGT, groups facing Intellective task will be more satisfied with decision scheme than those facing Preference task

H3c: In E-mail-mediated meeting without supported by group technique

(Interacting group), groups facing Intellective task will make better decision than those facing Preference task

H3d: In E-mail-mediated meeting supported by NGT, groups facing Intellective task will make better decision than those facing Preference task

H3e: In E-mail-mediated meeting supported by Round-Robin NGT, groups facing Intellective task will make better decision than those facing Preference task

As to asynchronous group, relationship development is much harder than face-to-face group. But for the group supported by group technique, the technique will facilitate communication [20]. Team members should also be more willing and able to communicate freely and help each other [24]. Besides, in Round-Robin NGT the conferee can see others' suggestion at the same time while expressing an opinion; it is to increase conferee to keep senses of participation and cohesion [23]. So we proposed H4a, H4b, H5a and H5b.

H4a: Under conditions of Preference task, E-mail-mediated groups supported by Round-Robin NGT will have higher team cohesiveness than those not supported by Round-Robin NGT

H4b: Under conditions of Intellective task, E-mail-mediated groups supported by Round-Robin NGT will have higher team cohesiveness than those not supported by Round-Robin NGT

H5a: Under conditions of Preference task, E-mail-mediated groups supported by Round-Robin NGT will have higher team collaboration than those not supported by Round-Robin NGT

H5b: Under conditions of Intellective task, E-mail-mediated groups supported by Round-Robin NGT will have higher team collaboration than those not supported by Round-Robin NGT

## 4. Research Method

The research hypotheses were tested using a factorial

experiment design (2x3) with E-mail-mediated group supported by group technique and task type as independent variables. E-mail-mediated group supported by group technique with three levels: Interacting group (no group technique support), NGT support, and Round-Robin NGT support. And task type with two levels: Preference task and Intellective task.

NGT was adopted form the face-to-face design of Delbacq and Van de Ven [20] and modified to suit to e-mail environment. Round-Robin NGT was another version of modification.

Preference task was "Personal Trust Foundation" by Watson [25]. And Intellective task was "Murder One" by Pfeiffer and Jones [26]. Both tasks had been thoroughly tested by empirical studies in information systems and small group research.

Each dependent variable was measured by questionnaire. Perceived decision satisfaction and perceived decision scheme satisfaction was measured with six questions from Green and Taber [27]. Eight questions from Green and Taber [27] were used to measure perceived decision quality was measured with. Team cohesion was measured with three questions from Sashore [28]. Team collaboration was assessed with two questions form Larson and LaFasto [24]. All the original anchors and scales had been thoroughly tested by empirical studies in social psychology and information systems.

### 4.1. Subject

A total of 150 undergraduates voluntarily participated in this study. Their average age was 19.37. The subjects were randomly assigned to teams of five members each. This team size was used because many decision teams in organization have this size. Thirty teams were randomly assigned to six experiment cells (2x3). Each participant uses e-mail software built in Windows operation system to perform a six-day experiment at home or dormitory. They communicated using specially assigned electronic mail address or their own e-mail address (controlled by backup mail transmitted to facilitator) when carry out their tasks.

## 5. Data Analysis

### 5.1. Validity and Reliability

Data for dependent variables, collected after meeting were subject to validity and reliability analyses. The results of factor analyses for data collected showed that each question loaded highly on its intended dependent variable. All the dependent variables satisfied criteria for reliability at Cronbach's alpha 0.7. Thus, all the dependent variables had construct validity.

### 5.2. Hypotheses Tests

A MANOVA test involving all independent and dependent variables was carried out first. Results revealed that the interaction effect of two independent variables on all dependent was not significant. With the results, separate ANOVA tests and Tukey's LSD multiple comparisons test (if needed) could be performed for each dependent variable. All dependent variables could meet homogeneity and normality requirements of the ANOVA test. Table I shows the result of tests for all hypotheses.

Under conditions of Intellective task, E-mail-mediated group supported by group technique(no matter NGT or Robin-Robin NGT) had higher decision and decision scheme satisfaction than those not supported by group technique (H1b, H2b). Results suggest that proper group technique could reduce the influence of group think and group shifts which leads to higher perceived satisfaction. Under conditions of Preference task, only groups using Robin-Robin NGT had higher perceived satisfaction (H1a, H2a).

As to perceived decision quality, group supported by group technique (no matter NGT or Robin-Robin NGT) had higher perceived decision quality under conditions of Preference task (H3a). Result suggests that with group techniques participants have more equal chance to participate in meeting and concentrate on task topic which leads to better decision quality. Because Intellective task has an only correct answer, members only need to exchange enough information with each other to solve the task. The group technique used is this study had no significant effect on decision quality under Intellective task (H3b).

The lack of effect on team cohesion (H4a, H4b) suggested that team cohesion dependents on the accumulation of feelings and interacting experience. Group techniques in this study had no significant effect on team cohesion.

As to team collaboration, no matte under which type of task, group supported by Round-Robin NGT had better result than those not supported by Round-Robin NGT(H5a, H5b). The merit of Round-Robin NGT for conferee to see others' suggestion at the same time while expressing an opinion has a positive effect on team collaboration. However, group supported by NGT were limited to a central messages source. The team collaboration of groups supported by NGT was the same as Interacting groups. The lack of impact of Task type no on most dependent variables may be explained in two ways. First the volunteers were to learn to meet with e-mail and solve the task at the same time. Thus, the effect of task type was not so significant. Another explanation is that E-mails may be not a poor media for the volunteers in this study. According to Lee [13], the volunteers in this study were quite familiar with the computer, network and E-mail. And thus they were able to filter out necessary and rich information from the lean media – email.

**Table I：Results of Tests** (*：p<0.05　**：p<0.01)

| Dependent variables | Hypotheses | P value | Notation |
|---|---|---|---|
| decision satisfaction | H1a | 0.001** | Round-Robin NGT>Interacting |
| scheme satisfaction | H2a | 0.011* | Round-Robin NGT>Interacting |
| decision quality | H3a | 0.002** | Round-Robin NGT=NGT>Interacting |
| team cohesion | H4a | 0.261 | |
| team collaboration | H5a | 0.007** | Round-Robin> NGT NGT=Interacting |
| decision satisfaction | H1b | 0.032* | Round-Robin NGT=NGT>Interacting |
| scheme satisfaction | H2b | 0.000** | Round-Robin NGT=NGT>Interacting |
| decision quality | H3b | 0.124 | |
| team cohesion | H4b | 0.198 | |
| team collaboration | H5b | 0.016* | Round-Robin NGT> NGT=Interacting |
| decision satisfaction | H1c | 0.916 | |
| scheme satisfaction | H2c | 0.046* | |
| decision quality | H3c | 0.835 | |
| decision satisfaction | H1d | 0.462 | |
| scheme satisfaction | H2d | 0.855 | |
| decision quality | H3d | 0.201 | |
| decision satisfaction | H1e | 0.196 | |
| scheme satisfaction | H2e | 0.290 | |
| decision quality | H3e | 0.350 | |

## 6. Conclusion

The results from the experiment point to four general conclusions.

First, when under Preference task, Round-Robin NGT can provide enough ability to coordinate communication process. Results show that E-mail mediated group has better decision outcome such as decision satisfaction, decision scheme satisfaction, and decision quality and team relationship such as team collaboration.

Second, when under Preference task, though the group techniques used in this study has no significant effect on decision quality, both NGT and Round-Robin NGT can enhance decision satisfaction, decision scheme satisfaction. Moreover, Round-Robin NGT can also promote team collaboration under Intellective task.

Third, task type has no significant effect on most dependent variables. The difference of task type will not affect E-mail-mediated Groups.

Fourth, the lack of effect on team cohesion suggested that team cohesion dependents on the accumulation of feelings and interacting experience. Group techniques in this study had no significant effect on team cohesion.

Meta-analyses of prior research results suggest that when teams used electronic communication, they tend to report better perceived decision quality but poorer decision satisfaction [29]. The proposed group techniques can help asynchronous group to raise perceived decision quality and satisfaction simultaneously.

Mandviwalla and Gray [5] analyzed a large amount of GSS research, and suggested that GSS research should expand to include commercial systems, expand beyond face-to-face meetings to asynchronous and distributed work in multimedia environments, emphasize complex tasks and realistic subjects, and examine systems based on different perspectives. This study expanded traditional GSS research to asynchronous meeting and electronic mail system. This study provides a different thinking direction for relevant research.

In business environment characterized by intense competition, and globalization, asynchronous group supported by e-mail could be an effect way to solve business problems. The group technique proposed in this study can address the communication obstacle of asynchronous e-mail group. Further research must be carried out in this direction.

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