COMPUTERIZED CONFERENCING & COMMUNICATIONS CENTER

at

NEW JERSEY INSTITUTE OF TECHNOLOGY

COMMUNICATIONS AND
GROUP DECISION-MAKING

EXPERIMENTAL EVIDENCE ON THE
POTENTIAL IMPACT OF
COMPUTER CONFERENCING

RESEARCH REPORT NUMBER 2

BY

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COMMUNICATIONS AND GROUP DECISION-MAKING:

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A Selective Review of
Small Group Communications Experiments

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September, 1975

Computerized Conferencing and Communications Center

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This research was supported by NSF Grant No. DCR-01306.

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INTRODUCTION AND ACKNOWLEDGEMENTS

This paper is a selective review of small group experiments in the area of the relationship between communication (modes, structures, processes) and group decision-making or problem solving. There are literally hundreds of these experiments; the purpose of this effort has been to isolate and summarize the results of those experimental traditions which may have the most bearing upon:

a) our understanding of the probable social effects of computer conferencing as a communication mode;
b) the identification of possible experiments utilizing computer conferencing which appear to be potentially most fruitful in terms of evaluating the strengths and weaknesses of computer conferencing in facilitating or inhibiting group decision-making processes;
c) determining the potential for gaining further insight into the nature of human communications processes by employing computerized conferencing as a communications tool;
d) understanding the characteristics and capabilities of conferencing software which would be necessary in order for a non-programmer social scientist to carry out such experimentation.

For those who are not familiar with computerized conferencing as a communications medium, the paper begins with a brief overview of its nature and social characteristics. It then proceeds to review several classes of experiments on communications and group problem solving, and to deduce the implications of their findings for group decision making using communication via computerized conferencing. A section on the desirable characteristics of software and monitoring systems in order to facilitate similar controlled experiments utilizing computer

conferencing follows. Finally, the conclusions which flow from the literature review are presented in the form of a summary of potentially fruitful experiments and an inventory of hypotheses.

I am indebted to the other members of the NJIT research team for many excellent suggestions, and particularly to Murry Turoff, the Principal Investigator for the project, who made extensive, constructive criticisms of earlier drafts. Peter Anderson coauthored the chapter on software requirements. I would also like to thank Alphonse Chapanis of Johns Hopkins and Andrew Van deVen of Kent State for their cooperation. Finally, I would like to thank Daisy Lane of N.J.I.T. for a job well done in deciphering my handwriting and typing the manuscript.

COMPUTER CONFERENCING AS A COMMUNICATIONS MEDIUM: A BRIEF OVERVIEW

Just as it would be difficult to explain to someone who has never observed or participated in a face-to-face decision-making group the communications processes and social dynamics involved, so the best way to learn about computer conferencing is to take part in one. For the reader who does not know what computer conferencing is, however, a very brief description of its characteristics is presented here. More complete discussions can be found in recent publications by Murray Turoff (1975) and by Jaques Vallee, et. al., of the Institute for the Future (1974, 1975).

The combination of communications capabilities and processes which constitute "computer conferencing" make it a distinctly new communications medium. In order to participate, a person types messages or other items into a computer terminal, which is similar to an electric typewriter. The terminal is connected to an ordinary telephone. When the message and any editing are completed, it is sent over the telephone to a host computer. The computer assigns a number to the entry and stores it. The entry may be obtained on the recipient's terminal immediately or at any time in the future until it is purged from the computer's memory.

Some of the capabilities provided to the participant in this remote, written communication form are the following:

1) One can send a "public" message to everyone in the conference, or a "private" message to designated respondents. In addition, the message can be signed or anonymous.
2) Time and distance barriers are removed. Persons can send and receive communications whenever it is convenient for them and whereever they can plug in a portable terminal and connect it to a telephone.

On the other hand, geographically dispersed persons can communicate in "real time" or "synchronously" if they are all at terminals simultaneously.

3) A permanent, written copy of the communication is produced, with each participant receiving all "new" communications whenever they sign on or finish making an entry. Previous communications can be retrieved at any time by asking for a particular author, date, a key word, etc., or by asking for all entries between certain numbers or dates.

4) Editing routines make corrections and line up the entry to make it appear neat. (No secretary need be interposed in the communications process in order to produce presentable written communications.)

5) Questionnaires or "votes" may be administered through the computerized system, with the results tabulated and fed back immediately to participants as anonymous totals.

Computer conferencing as a social process differs markedly from other modes of communication, such as face-to-face meetings, telephone, or letter-writing. Among the ways in which the norms and nature of communication are altered are the following:

1) Everyone can "talk" or input whenever they wish, rather than having to "take turns" as in face-to-face verbal communications. Rather than only one person "having the floor", all participants could be typing in messages simultaneously. No one can be interrupted or "shouted down".

3) Computer conferencing is much less "intimate" and self-exposing than verbal modes. Only your words (which can be carefully considered and edited) are transmitted, not your appearance, or other personal characteristics. The possibility of sending anonymous messages "legitimately" to other members of the conferencing group increases the possibility for "impersonal", relatively emotion-free communications. Another aspect of this impersonality is that the communicator is alone, rather than in the company of others.

4) Since all communications are written, computer conferencing is less "rich" than face-to-face or telephone, in that you have no eye contact, facial expressions, gestures, verbal intonations or pauses, etc. One social implication of this is related to the folk expression that it is much easier to say something negative or critical about other people's ideas "behind their back" than "to their face." One loses some richness, but gains the escape from the uncomfortable embarrassment of having to face or listen to a potentially resentful or negative communication.

5) There is no danger of "forgetting" or "losing" communications. The complete transcript of entries is available at any time.

6) The various forms of anonymity which are available have definite implications for willingness to express deviant or unpleasant opinions, particularly to persons like one's "boss" with whom one would not usually disagree in a face-to-face situation.

THE COMMUNICATION NETWORK STUDIES

This experimental tradition began at M.I.T. with studies by Smith (unpublished) and Leavitt (1949, published 1951), first publicized and pulled into a theoretical framework in the well-known article by Bavellas (1950) titled "Communication Patterns in Task-Oriented Groups".

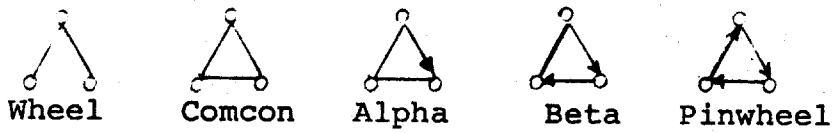
The initial experiments involved five-man groups sitting around a table divided by partitions, passing written communications to each other through slots which could be opened or closed by the experimenter to create the various communication network patterns. Leavitt used the patterns called the "circle", "chain", "Y", and "wheel", in figure one, which also shows other communication network patterns utilized in subsequent experiments in this tradition.

The initial experiments involved a simple task in which the information necessary for solution was distributed equally among the participants. Using six symbols (a circle, a triangle, an asterisk, a square, a plus sign, and a diamond), each person was given a card on which was printed five of the symbols. As Bavellas (1950, p. 728) explains the simple standard task, "although each symbol appeared on some group of four of the five cards only one symbol appeared on all five cards. The group's task was to find the common symbol in the shortest time possible."

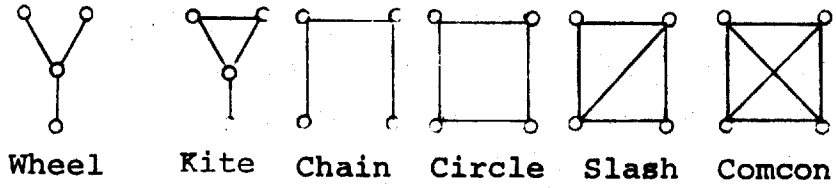
Positions in networks are located at various communication distances or number of links from each other. For instance, in the chain 0-0-0-0-0, A,B = 1 and A,E = 4. The networks were
A B C D E
conceptualized as differing in "centrality" by Bavellas and his colleagues. Relative centrality of a position is the ratio of the sum of all distances within the group to the sum of the distances from a particular position ($\Sigma d_{xy}/d_{x,y}$) (Bavellas 1950, p. 726). The various index measures of centrality that have been developed all have their limitations, but in any case, the "wheel" is the most centralized (one and only one position can

FIGURE 1

THREE-PERSON NETWORKS



FOUR-PERSON NETWORKS



FIVE-PERSON NETWORKS

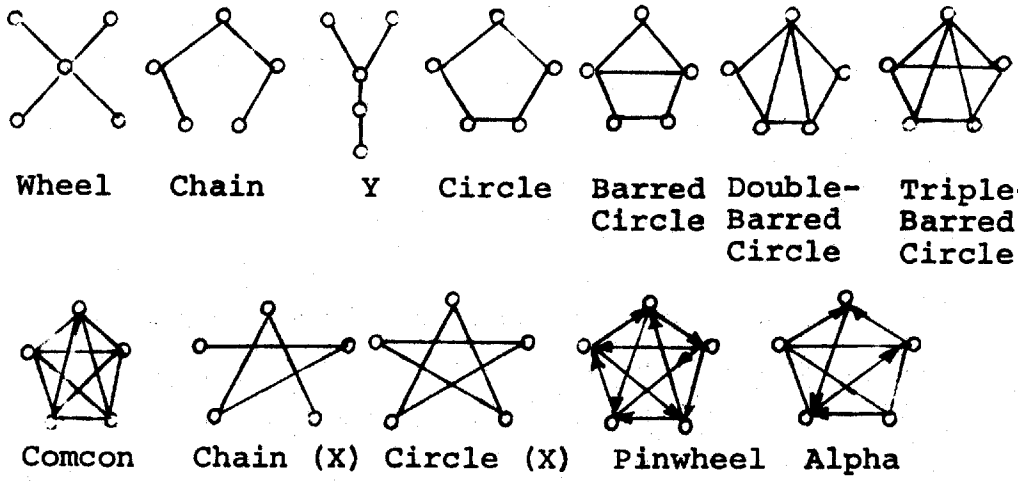


Fig. 1: Communication networks used in experimental investigations. Dots represent positions. Lines represent communication channels, and arrows indicate one-way channels.

Reproduced from Shaw, 1964.

communicate with all of the others); and the circle is the least centralized (all positions can communicate directly with two others).

The centrality of communications networks was found to be causally related to problem solving speed, accuracy and creativity, and to leadership and morale in the group. In Leavitt's experiment, (1951, p. 43) each network pattern was used for 15 trials by five groups.

The mean time in seconds for the fastest trials with a correct solution for each group differed significantly by network pattern, as did the errors made, with the more centralized networks the most efficient.

	Time (mean fastest trial)	Errors (mean total, last 8 trials)
circle	50.4	7.6
chain	53.2	2.8
y	35.4	0
wheel	32.0	0.6

It was also found that the more centralized networks sent fewer messages and were most likely to quickly develop a standard task organization for sending messages and a recognized leader (at the most central position). On the other hand, the more centralized networks were least likely to develop a "creative" solution (in Leavitt's experiments, hitting upon sending only the missing symbol, instead of the five present) and the peripheral positions gave an average of 3.2 compared with an 8.8 rating for men in the most central position (Bavellas, 1950, p. 729), and mean overall satisfaction levels were lower in centralized networks.

The original studies inspired scores of replications and variations, the most important of which involved the use of complex rather than simple problems. In one of the earliest and most important of these, Shaw (1954b) found that centrality is negatively related to problem-solving efficiency when the group is confronted with complex problems.* Using wheel and circle networks in which the subjects were required to solve complex arithmetic problems, Shaw found the circle networks solved these problems with greater speed and accuracy.

A decade later, Shaw (1964, p. 123) summarized the results of 18 different experiments which had been performed by many investigators in several nations, as shown in Table 1. (A "comparison" is a single difference in means as reported in the literature.)

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* Here is an example of a "complex" arithmetic problem.

"A small company is moving from one office building to another. It must move: (1) chairs, (2) desks, and (3) typewriters. How many trucks are needed to make the move in one trip? For a three-member group, six items of information would be needed to solve the problem and these would be usually equally divided over the group members. For example, the company owns 12 desks, 48 chairs, and 12 typewriters, and one truck-load can take 12 typewriters, or 3 desks, or 25 chairs."

TABLE 1

(Shaw, 1964)

Number of Comparisons Showing Differences Between Centralized (Wheel, Chain, Y) and Decentralized (Circle, Comcon) Networks as a Function of Task Complexity

	Simple Problems[a]	Complex Problems[b]
Time		
Centralized faster	14	0
Decentralized faster	4	18
Messages		
Centralized sent more	0	1
Decentralized sent more	18	17
Errors		
Centralized made more	0	6
Decentralized made more	9	1
No difference	1	3
Satisfaction		
Centralized higher	1	1
Decentralized higher	7	10

[a] Simple problems: symbol-, letter-, number-, and color-identification tasks.

[b] Complex problems: arithmetic, word arrangement, sentence construction, and discussion problems.

Explanations

One theoretical explanation offered for these contrasts involves processes of "saturation" and "independence." "Saturation" refers to an overload of communication input and output requirements and task demands upon a net position. "Independence" refers to the extent to which a position in a network has restrictions on its freedom of action, and is conceived of as a motivation factor.

In complex tasks, the single central position suffers from "information overload" and is "vulnerable" to "saturation" by too many requests for information, inputs of information and task requirements of the problem itself. The centralized network tends to become slow and error-prone when saturation occurs. In simple problems, the information handling is so limited and easy that no saturation at the hub is likely to occur.

On the other hand, in centralized networks only the central person is "autonomous" and controls the network. Other members lack independence of action. "Independence affects satisfaction by permitting the gratification of culturally supported needs for achievement, recognition and autonomy" (Snadowsky 1974, p. 38, summarizing the conclusions of earlier studies.) Thus, lack of independence leads peripheral members to feel dissatisfied and bored, with morale affecting their speed and accuracy, especially on simple symbol identification problems.

Another explanatory thesis involves the development of "organization" and "leadership" or "power" in networks. Since the way in which a given communication net would affect the emergence of task organization and leadership was one of the main questions posed by Leavitt and other earlier experimenters, the groups were given no information on what their overall communication structure was, no suggested task organization or time to discuss task organization, and no designated leaders. (All of these conditions, it must be noted, are contrary to the conditions generally existing in "real-world" problem-solving groups, as is the fact that only one-to-one messages can be sent, with no provisions for a one-to-all message with immediate mutually perceivable feedback). In a series of studies by Guetzkow and associates, for example, the main hypothesis is that once groups have achieved a satisfactory operational procedure or organization, there will be little or no difference among nets. The argument is: (Guetzkow and Simon, 1955, pp. 233-234) ...

> that a sharp distinction be made between: (a) the effects of communication restrictions on performance of the operating task; and (b) effects of the restrictions upon a group's ability to organize itself for such performance. That is, instead of regarding the group's problem as unitary, it appears essential to separate the operating or "substantive" task from the organization or "procedural" problem. Our hypothesis may be stated thus: Imposition of certain restrictions on the communication channels available to a group affects the efficiency of the group's performance; <u>not directly</u> by limiting the potential efficiency of task performance with optimal organization in a given net, but <u>indirectly</u> by handicapping their ability to organize themselves for efficient task performance.

In this experiment, it was found that concom or "all channel" groups and circle groups had more difficulty organizing, but once a two or three-level hierarchy was organized within them, there was no significant difference in average speed of solution among wheel, concom, and circle networks for the three fastest trials (Guetzkow and Simon, 1955, p. 248).

A series of experiments by Mulder (1960a, 1960b) presented a similar analysis. Circle groups which managed to work out a highly centralized decision-making structure or organization were actually faster than wheel networks which failed to do so. In other words, it is the decision structure which operates as an intervening variable between the communication structure and solution operations.

An important experiment by Burgess ("Communication Networks and Behavioral Consequences", 1969) confirms these explanations and also throws light on the conditions under which the potential facilitating or inhibitive role of a communications network on the problem-solving ability of a group will become operative. He used four-person groups on simple problems in centralized wheel and decentralized circle networks, and introduced the important variables of sufficient "learning time" for a group to reach a steady state in its problem-solving speed, and the use of positive reinforcement to encourage speed (reduced time in the experiment) and negative reinforcement to discourage errors (a raucous buzzer and 15 seconds of locked control board). As he pointed out, the complete absence of reinforcement as a motivating factor in previous experiments limits their generalizing ability to "real" problem solving groups, whose members generally do receive rewards for speedy and correct work.[2] Burgess found that it took, on the average, 500 trials

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[2] An interesting way to build in motivation with computer conferencing might be to start out with "bonus" pay of about $5.00 per participant, and then to charge for the use of a channel to pass a message. The group would be informed of how many messages a trial used up, and the "cost" to each member as a result.

to reach a steady state (whereas previous experimenters had not used more than 60 trials on the same group). Burgess' results indicate that it is the combined result of motivation and ease of learning the most efficient organization in various networks which explains the differences observed. Specifically, he found that (Burgess, 1969, p. 137)

> "There was an orderly progression toward smaller differences between the two networks. The difference between the nets are greatest during the acquisition state without reinforcement in effect; less so with reinforcement in effect; still less during the non-reinforced steady state period; and, finally, during the steady state periods, with reinforcement in effect, there are no differences between the networks."

It takes the circle groups longer to organize, especially if they are not highly motivated to do so. Burgess does not present any data on member satisfaction under the various network conditions, however, or on complex problems.

Leadership "style" as well as the probability of the development of a leader, appears to affect independence and satisfaction within networks. Snadowsky (1972, 1974) employed a 2 x 2 x 2 factorial design involving two kinds of communication structures (four-man comcons and four-man wheel), two types of problems (Leavitt's simple symbol identification and Shaw's complex arithmetic tasks) and two types of leadership imposed by experimental instruction (authoritarian, who was told to give orders; and democratic, who was told to encourage discussion and participation in problem solving). To simulate a stably organized work group with a formal hierarchy and task procedures, an organizational phase was separated from the operational phase.

Members of democratically led groups tended to be more satisfied than members of authoritarian groups independent of task complexity and of the type of network in which they were working (Snadowsky, 1974, 51-52). Comcons took longer than centralized wheels to get organized. During the operational phase, however, there was no difference in efficiency between the centralized and decentralized communication structures, but there were big differences between the democratic and the authoritarian leadership or power structures, with the authoritarian structures taking longer. (See Table 2)

TABLE 2

Leadership Style, Type of Network, and Solution Times
(Mean time in minutes, Snadowsky, 1972, p. 293-295)

Leadership type	Complex Problems Comcon	Complex Problems Wheel	Simple Problems Comcon	Simple Problems Wheel
Organization Period				
Democratic	13.35	12.14	11.85	11.83
Authoritarian	12.84	6.59	11.30	4.79
Operational Period				
Democratic	2.43	2.44	6.81	0.82
Authoritarian	3.20	3.13	1.11	1.21

Thus, Snadowsky's work suggests that while certain networks may be more conducive to democratic or authoritarian styles of communication, satisfaction and motivation to perform quickly and well depend partially upon this intervening variable of leadership.

As Shaw (1964, p. 112) said, "The free flow of information (factual knowledge, ideas, technical know-how, feelings) among various members of a group determines to a large extent the efficiency of the group and the satisfaction of its members." The communication networks studies have generated a great deal of information about the conditions and processes which facilitate or inhibit such a free flow.

Some Fruitful Areas for Communication Network Experimentation with Computer Conferencing

The existing network experiments have found no dependence upon group size of the operational characteristics of centralized vs. non-centralized networks. This should not be surprising since the comparisons have been made only for group sizes 3, 4, and 5.

For example, for simple common symbol problems, the Leavitt (1951), Guetzkow and Simon (1955) and Cohen, et. al. (1961) studies all used five-person groups; Shaw (1954a) used three-person networks, Lawson (1964) used four-person groups. All reported that the wheels were faster in time and made fewer errors than circles or other non-centralized networks.

Walker (1954, reported in Shaw, 1964, p. 129) directly compared three-four-and five person wheel networks with (non-centralized) comcon networks of the same size for complex (arithmetic problems) group tasks. Size per se did have an effect, with efficiency and satisfaction decreasing as group size increased from 3 to 5. However, for all sizes, efficiency and satisfaction were higher in the decentralized comcon than in the centralized wheel networks.

In "real" problem solving groups, size will often be much greater than five, and those small subgroups which do exist will tend to be embedded in much larger organizations. One can hypothesize that for groups much larger than five, (say fifteen or twenty) the comcon network would probably not be more efficient for complex problems than a more centralized structure (such as a double wheel with the two centers connected). The probable reason why these much larger networks have not been experimented with are the physical awkwardness and perhaps the impossibility of trying to build an apparatus for note-passing to accommodate fifteen people connected by a variety of easy communication (note-passing) channels of access; and the confusion and burden of trying to make an orderly collection and analysis of the process data. With computer conferencing, any number of terminal-channels may easily be accommodated, and such mechanics as keeping track of the number and length of messages sent by-whom-to-whom can be automatically stored and calculated. With terminal users in separate rooms, post-experiment questionnaires on morale or "leadership" can automatically be administered to any number of participants without danger of "contamination" by a

How tested? why is it interesting?

large number of participants crowded together in the same room talking to one another about their answers.

Likewise, the results of Burgess' (1969) experiment indicate that it would be useful to replicate early experiments like Leavitt's 1951 study with 15 trials, using some groups who are given 600 or more trials, to see if additional learning time removes the initial superiority of the wheel structure. The mass of data generated would be much more easily analyzed with the availability of automatic tabulation by the computer, rather than the tedious hand-writing of notes which Leavitt relied upon. This can facilitate much more work with learning curves and the emergence of "power" or "decision" structures within networks.

Still another direction for replication-expansion would be replication using very different socio-economic groups than the largely student population of subjects employed in most studies thus far. Business executives or government officials, for instance, could hardly be expected to travel to a college campus to sit in a laboratory, but you might get them to plug into terminals right in their offices and participate in a network experiment in exchange for an on-site seminar of some sort. It would be particularly interesting to see if Snadowsky's "democratic" leadership style is superior to "authoritarian" operation among executives or among grade-school educated working class people. Experimentation with the latter group could probably be accomplished by simply renting a storefront with several telephone connections available, plugging in the terminals, and hanging a sign in the window that $2.50 an hour or so would be paid to people to participate in an experiment. The mobility of computer conferencing means that the experimental apparatus can easily be brought to new subject populations.

PHASES AND ROLES IN GROUP PROBLEM SOLVING: BALES INTERACTION PROCESS ANALYSIS AND RELATED EXPERIMENTS

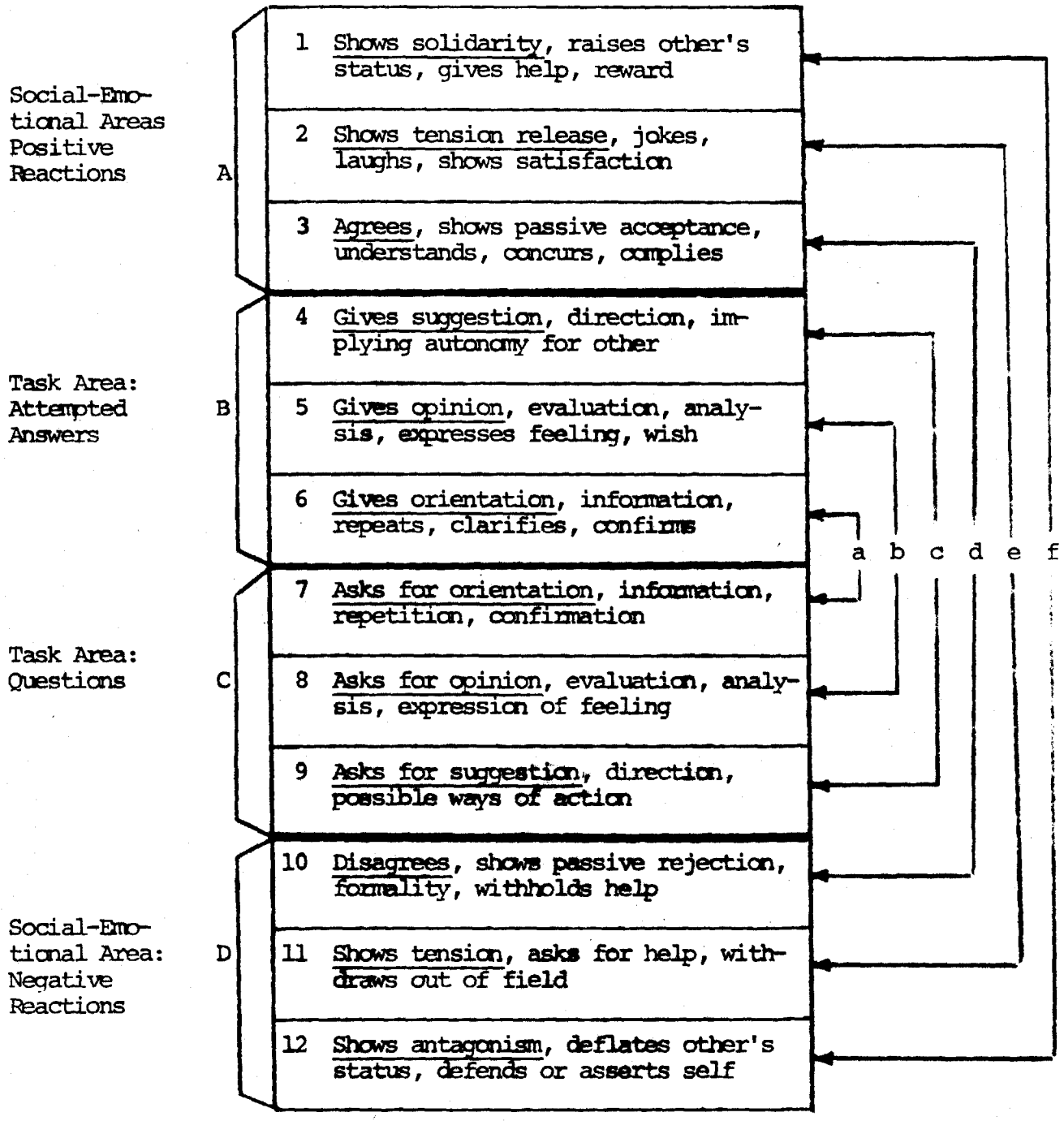
Working at the Laboratory of Social Relations at Harvard, Bales and his colleagues developed a set of categories and procedures for coding the interaction in small face-to-face decision-making groups which became very widely utilized and generated a great deal of data about the nature of communication and social processes within such groups. The twelve categories, or types of actions by an individual, are summarized in the diagram which follows, as they are related to the functional tasks of such a group (Bales 1950a, p. 258, described in great detail in 1950b).

Coding of the communications interaction by Interaction Process Analysis involves noting who makes a statement or non-verbal participation (such as nodding agreement); to whom the action was addressed; and into which of the twelve categories the action best fits. This is done on printed forms with the categories already listed, or on a moving tape. The coding process is described as follows (1950a, p. 259):

> The chairman brings the meeting up to date with a few informal remarks. He says, "At the end of our last meeting we decided that we would have to consider our budget before laying out plans in greater detail." The observer, sitting with the observation form in front of him, looks over the list of twelve categories and decides that this remark is most relevant to the problem of orientation, and specifically that it takes the form of an "attempted answer" to this problem, and so he classifies it in Category 6, "Gives orientation, information, repeats, clarifies, confirms." The observer has already decided that he will designate the chairman by the number 1, and each person around the table in turn by the numbers 2, 3, 4, and 5. The

FIGURE 2

Categories in Interaction Process Analysis
(Bales, 1950, p. 258)



INTERACTION PROCESS CATEGORIES DEFINED
AND GROUPED BY TYPES

Key: a. problems of orientation, b. problems of evaluation, c. problems of control, d. problems of decision, e. problems of tension-management, and f. problems of integration.

group as a whole will be designated by the symbol 0. This remark was made by the chairman and was apparently addressed to the group as a whole, so the observer writes down the symbols 1-0 in one of the spaces following Category 6 on the observation form.

Bales says that "in practice we find that we obtain from 10 to 20 scores per minute in keeping up with most interaction, and that this speed is not excessive for a trained observer." (1950a, p. 260) In fact, it should be noted here, there have been a great many "scoring and reliability problems in Interaction Process Analysis" (the title of an article by Waxler and Mishler, 1966). For example, Psathos (1961) found that 23% of all actions were lost when they were scored from direct observation. On the other hand, tape recordings and typescripts yield a different distribution of data, because affective gestures and intonations are lost; and in addition, it is costly and error-prone to try to make typed transcripts from recordings into the recording transcriber.

Using IPA with computer conferencing, such problems of loss or omission of data should be minimized, since all of the communication among members is stored right in the computer. Also, (as with typed transcripts made from recordings) observers can work at their own reading speed and recheck their coding. Multiple coders could easily check one another to find disagreements, or there could even be an automatic check process by the computer, similar to verifying on a keypunch, which would compare the coding of a statement with one done previously for the same statement and note any disagreement.

To return to the substance of Interaction Process Analysis, Bales and his colleagues have established that for small groups (2 to 7) asked to discuss a "real-life" type problem and reach a decision (the standard task was a complex human relations problem with no clear "solution" or "answer"), there emerges both a fairly standard distribution of types of contributions and also clear "phase" movements and regularities. For example, in Table 3 are the "interaction profile" data for 96 group sessions on the standard task (1955, p. 33). (A "series" means an uninterrupted series of statements by a single speaker.)

TABLE 3

Interaction Profile: Bales' "Standard"
Group Problem-Solving Task
(Mean Proportions of Statements by Category, Bales, 1953, p. 33)

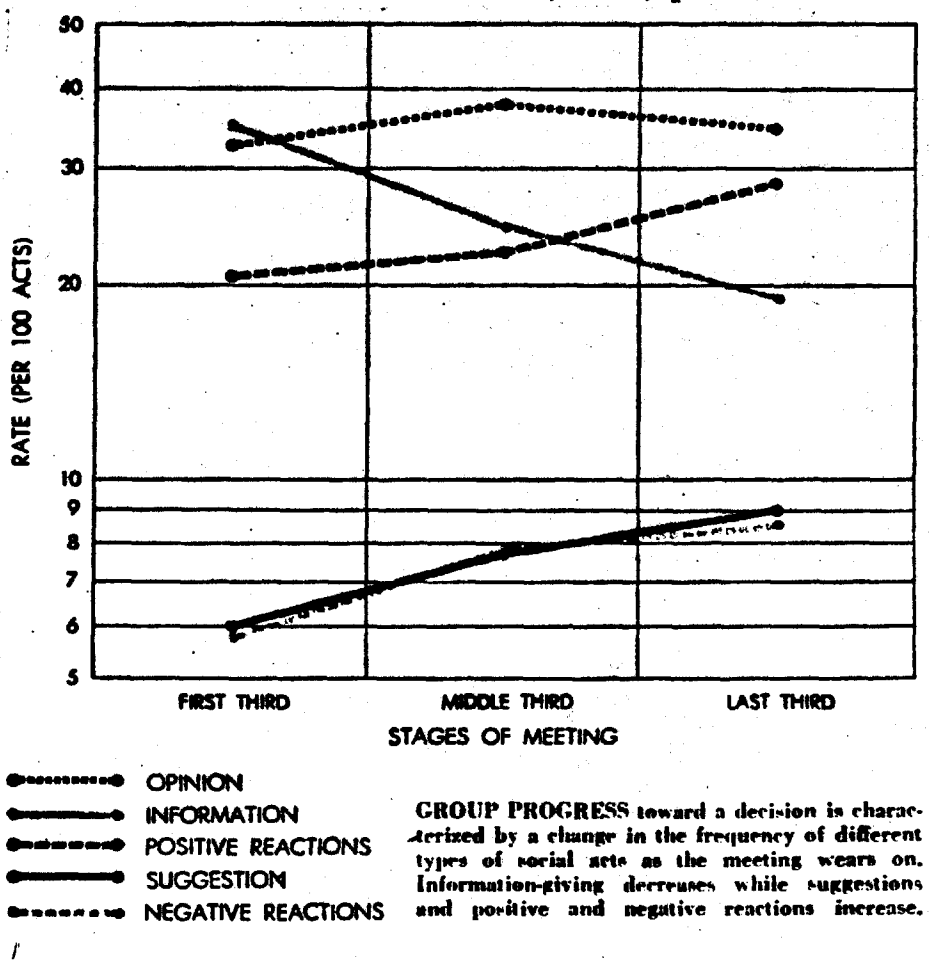
All Communication		1st Statement in Series	2nd Statement in Series
Solidarity	3.4%	4.1%	3.8%
Tension Release	6.0	8.0	1.6
Agrees	16.5	26.3	2.0
Gives Suggestion	8.0	5.9	10.0
Opinion	30.1	22.3	39.5
Information	17.9	15.4	31.4
Asks for Information	3.5	3.4	3.4
Asks Opinion	2.4	2.1	3.4
Asks Suggestion	1.1	.9	1.4
Disagrees	7.8	8.7	1.4
Tension	2.7	1.8	1.4
Antagonism	.7	1.1	.7
Total	100%	100%	100%

Bales' data indicate that a speaker's first remark is likely to be a reaction, and if he continues speaking, his second remark is likely to be a problem-solving attempt. Moreover, there are usually about twice as many positive reactions as negative reactions. Looking at the group sessions as a whole, over a third of all statements during the first third of a meeting tend to be information giving, and this declines in the next two thirds. Rates of giving opinion are usually highest in middle portion of the meeting. Other regularities discovered are that

"rates of giving suggestions are generally low in the early period and reach their high point in the last third of the meeting." (Bales, 1955, p. 33-34) These differences represent different "phases" in group problem-solving. "The process tends to move through time from a relative emphasis upon problems of orientation, to problems of evaluation, and subsequently to problems of control, and that concurrent with these transitions, the relative frequencies of both negative reactions and positive reactions tend to increase." (Bales and Strotbeck, 1951, p. 496) (By "orientation", Bales means statements in categories 6 and 7, asking for and giving information, orientation, etc. The "evaluation" phase has to do with asking for and giving opinions and analysis (categories 5 and 8). Problems of "control", according to this scheme, have to do with categories 4 and 9, asking for and giving suggestions or possible ways of acting). The phases are shown in figure 3.

FIGURE 3

Interaction Profiles:
"Phase" Movement (Bales, 1955, p. 35)



GROUP PROGRESS toward a decision is characterized by a change in the frequency of different types of social acts as the meeting wears on. Information-giving decreases while suggestions and positive and negative reactions increase.

The increases in positive and negative reactions in the last third of a problem solving conference are said to represent the need for a group to deal with the internal problems generated by the task-solving effort.

> "These increases may be connected mainly with social and emotional problems of the group process itself. The ratio of negative to positive reactions tends to be higher in response to suggestions than in response to factual statements. The decision point is a critical bottleneck in the process. Once the decision point has been passed, however, the rates of negative reaction usually fall off and the rates of positive reaction rise sharply. Joking and laughter, indicating solidarity and tension release, become more frequent. With the problems of the task and common values stabilized for the time being by the decision, the interaction process apparently turns to restabilizing the emotional states of the individuals and their social relations to one another." (Bales, 1955, p. 34.)

In other words, there is an overall phase-movement between the task-oriented problem-solving attempts oriented to the external environment, (adaptation and goal-achievement, in Parson's terms) and the social-emotional internal needs of the group and its members to resolve the tensions generated within it (Integration and Pattern-Maintenance, in Parson's Terms).

It should be noted that Bales' overall scheme of six types of "problems" faced by the group omits the kinds of phases or problems that may occur during the <u>implementation</u> of a decision. His experimental groups only had to reach a verbal decision, not carry it out.

Bales and Hare (1965) have explicitly recognized the value of the interaction profile and related analysis as a diagnostic tool. In this article, they present and summarize the interaction profiles for 21 different sets of experiments that have utilized them for many kinds of groups, tasks, and situations, including studies of the effects of LSD or alcohol on the resultant profiles. The means and standard deviations for all studies are shown in the table on the next page. The profiles for each study are also summarized in their article. As they point out,

TABLE 4

INTERACTION PROFILE FOR 21 STUDIES
USING INTERACTION PROCESS ANALYSIS:
MEANS AND STANDARD DEVIATIONS

	Category	Mean	One SD Below mean	One SD Above mean
1.	Shows solidarity	2.97	.74	5.10
2.	Shows tension release	8.17	2.40	13.90
3.	Shows agreement	10.70	5.00	16.30
4.	Gives suggestion	6.56	.77	12.40
5.	Gives opinion	22.24	13.50	30.60
6.	Gives information	28.72	17.90	39.60
7.	Asks for Information	5.88	2.90	8.70
8.	Asks for opinion	3.27	1.20	5.30
9.	Asks for suggestion	.60	.03	1.10
10.	Shows disagreement	4.73	1.80	7.50
11.	Shows tension	3.43	.78	6.00
12.	Shows antagonism	2.41	.21	4.40

Source: Bales and Hare, 1965, p. 242. Means are obtained by averaging the 21 different percentage rates.

> The population of profiles obtained by investigators who have used the method in a standard way for a given sort of group, task, or unusual condition provides a frame of reference within which any one profile gains added meaning. One may understand more about the particular situation from which his profile was obtained by discovering what other kinds of situations have given similar or different profiles. (Bales and Hare, 1965, p. 239)

It would be interesting to replicate Bales' problem-solving task groups in a computer conferencing mode to see if the same rates and phases are characteristic of computer conferencing, as compared to face-to-face conferencing. It is hypothesized that

a) disagreement (category 10) will occur more frequently in computer conferencing than in face-to-face meetings, especially if the capability for anonymous statements is present in the system;

b) the phase movement will be less clear, especially in asynchronous conferencing. There will not be as much of an end-of-the meeting emphasis on re-establishing social solidarity (categories 1 and 2). The social and functional problems caused by these differences, if they occur, should be explored.

If hypothesis a) is true, this should be an advantage of computer conferencing as a communication mode for problem solving, since it would represent less reluctance to criticize bad ideas, and should lead to more frequent high quality solutions. If hypothesis b) is true, this should be a disadvantage in terms of the subjective satisfaction of participants with the process.

It is also hypothesized that private messages will be much more heavily social-emotional than public messages and that those who receive many private messages will therefore feel more satisfied.

Inequality of Participation

One standard mode of assessment of group interaction utilized by Bales and his colleagues is the "whom-to-whom matrix", with the originators of statements designating a series of rows and the recipients, the columns.

It was found that if the

> "participants are ranked by the total number of acts they initiate, they will also tend to be ranked:
> (1) by the number of acts they receive,
> (2) by the number of acts they address to specific other individuals, and
> (3) by the number of acts they address to the group as a whole.

(Bales et. al., 1951, p. 468).

There usually emerges a "top man" who sends and receives a disproportionate number of messages, and who

> a) addresses considerably more remarks to the group as a whole than he addresses to specific individuals (whereas all men of lower rank address more of their remarks to specific individuals, especially the top person, than to the group as a whole)
> b) receives more from particular others than he gives out to them specifically (Bales et. al., 1951, p. 465).

Moreover, Borgatta and Bales (1953) found that high-status participants tend to emphasize task communications and low-status participants tend to emphasize socio-emotional communication.

In reanalyzing data from Bales and from Kadone and Lewis (1969), Reynolds (1971, p. 706) generalizes that

> "two patterns in groups from size five to ten appear to be quite stable: (1) The top initiator tends to contribute 40-50% of the acts and the remainder of the group members, no matter how many there are, divide the remaining acts among them. (2) There is a suggestion that the members divide into three "initiation classes": the top ranked persons, those group members contributing less than the top ranked person but more than 10% of the acts, and those group members each initiating less than 10% of the acts."

Commenting on the processes which produce this dominance, Bales (1955, p. 34) has written:

This tendency toward inequality of participation over the short run has cumulative side effects on the social organization of the group. The man who gets his speech in first begins to build a reputation. Success in obtaining acceptance of problem-solving attempts seems to lead the successful person to do more of the same, with the result that eventually the members come to assume a rank order by task ability. In some groups the members reach a high degree of consensus on their ranking of "who had the best ideas." (The members are interviewed by questionnaire after each meeting.) Usually the persons so ranked also did the most talking and had higher than average rates (share compared to the rest of the group) of giving suggestions and opinions.

We will examine the possible functional consequences of this emergent status hierarchy below, as well as the apparent determinant of who the leader will be when studied by Bales' procedures or a similar objective system.

Communication and the Leadership Role in Problem Solving

The amount and type of communicating which a person does in a face-to-face group discussion involving problem solving is strongly related to the probability of being perceived as a "leader." Some studies and coefficients of correlation obtained include

1) Norfleet (1949), using Bales IPA, found correlations of .94 and .95 between relative rank on amount of participation (communication) and relative rank on perceived productivity among group members.
2) French (1950) found a correlation of .96 between time spent talking and ratings of leadership.
3) Strotbeck and Hook (1961) studied 69 simulated jury deliberations and found a correlation of .69 between verbal activity (scored by Bales system) and sociometric status.

Bavelas (1965) succeeded in indicating that the communicating was the causal variable in this relationship by using reinforcement to increase the verbal participation of some low participators. The increase in their participation resulted in a corresponding increase in their sociometric rank in the next session.

Jaffee and Lucas (1969) showed that the rate of an individual's talking per se was much more closely related to his being chosen as a leader than was the correctness of the content of the remarks.

What, then, causes a person to do most of the talking? The tendency for an individual to be slow in responding or jumping into a conversation, or prone to speedy replies and interruptions, was noted by Chappel and Arensberg in 1940 and has come to be recognized as a fairly stable individual characteristic (the L.V.R., latency of verbal response, measured by response time on sentence stub completion tasks). In a task which minimized differences in competence (moral dilemmas, such as whether a man with a wife dying of cancer should steal some expensive drug which might save her), Willard and Strotbeck (1972) found that a participant's L.V.R. was the strongest predictor of participation (correlation of -.60), compared with measures of I.Q. and personality. The correlation between I.Q. and percent participation was only .12, for instance.

What is interesting here is that the evidence indicates that persons who happen to be "fast on the draw" in a face-to-face verbal situation, and who may not be particularly intelligent or correct, tend to dominate the discussion and decision-making process in small groups. Computer conferencing as a mode of communication would pretty much suppress L.V.R. as an operative variable, it is hypothesized, since all participants can be "talking" at once. Moreover, it is hypothesized, the relative verbosity of a person in written communication is much more likely to be resented than unconsciously deferred to. Thus, it is quite possible that intelligence and correctness might be much more highly correlated with the leadership and dominance processes in decision-making that developed in a computer-conferencing group. Specifically, it is hypothesized that in computer conferencing, one is more likely to get multiple leaders each specializing in and deferred to in a particular aspect of the problem

or area of expertise. Among the reasons for this, besides the fact that speedy verbalization (L.V.R.) is not operative as a factor is that there is no pressure created by a large number of participants for a single leader to emerge and keep social order by recognizing speakers, etc. The computer substitutes for this order - keeping function and removes the need for a single leader.

A second hypothesis is that in computer conferencing, there will be less tendency for a single dominant individual to emerge, and that this contrast in degree of dominance will increase the larger the size of the group. The hypothesized reasons for these anticipated contrasts is that the fact that one participant is making a statement in no way interferes with the ability of another person to be making a statement which overlaps it in time; those with slower (more "latent") verbal responses will not be "shut out" by the faster reactors in the group.

EXPERIMENTAL STUDIES OF GROUP PROBLEM-SOLVING AND RISK TAKING

Which can solve problems better, individuals or groups? The stereotyped answer, "it depends", applies here...it depends upon the nature of the task, the social and communications structures which develop, and a number of other factors.

For so-called "insight" problems for which there is a single indivisible task and a correct answer, groups seem to perform at the level of their best member...if they contain a single member who can solve the problem, then they are likely to solve it. (See for instance, Marquardt, 1955, and Faust, 1959.) However, there is often loss: Even some groups containing such individuals may not reach the correct decision, because the individual either does not bring up the correct solution, or his suggestion is argued down. On tasks involving a great deal of division of labor and coordination in a single group effort, groups (especially large ones) often cannot "get it together" and end up being unable to accomplish the task at all, or performing at the level of their least able member. For example, McCurdy and Lambert (1952) found that on "problems requiring genuine cooperation", groups were inferior to individuals, because "the less alert and less interested individuals will always interfere to some extent with the progress of the group" (p. 492).

Looking over the many kinds of group or individual problem-solving experiments that have been conducted, I would agree with Davis (1969, p. 38) that

> "The overall conclusion is that groups are usually superior to individuals in the proportion of correct solutions (quality) and number of errors, but somewhat less often are groups superior in terms of time required to reach an answer",

especially if one computes the number of person-minutes expended rather than the elapsed time from problem presentation to solution.

A basic factor at work in producing the general superiority of small groups to individuals for most kinds of problems was noted as early as 1932 by Marjorie Shaw. Whereas an individual is not likely to recognize and correct an error, group members are likely to recognize and reject errors made by others.

Davis (p. 40) sums up the various processes and advantages working in favor of the group:

1. The group potentially can increase performance through redundancy. That is to say, if the problem requires that everyone work at the same thing and if individual performance is to some degree unreliable (i.e., some probability of error exists), then multiperson work by means of duplication provides a check on the quality of the group's output.

2. If each person possesses unique but relevant information, and the task requires the several pieces of information, then the pooling of this information will allow groups potentially to solve problems that an individual cannot attack successfully.

3. If the task may be broken into subproblems, then different group members may simultaneously work at different portions of the task. This strategy accelerates work and allows early responders to check the work of the slower persons.

4. In quite a different way, questioning and debating during social interaction may stimulate new or different intra-individual thought processes that the uniform environment of the isolated individual might not provide; thus other persons have a cue value in provoking new task approaches.

5. Finally, the mere presence of others (as indicated earlier) is known to be motivating, and thus is an advantage for some tasks. Moreover, groups mediate a number of appealing by-products, ranging from status to plain fun, that have nothing to do with task performance, but which serve to keep one working.

To a large extent, the question addressed by laboratory experiments of whether the individual or the group performs "better" in problem-solving is irrelevent to decision-making and policy formulation in large-scale bureaucracies, where the shear necessity of group problem-solving is dictated by four major considerations:

a. In such functionally specialized organizations, the information needed is, in fact, spread among a large number of sources.

b. The differential impact of various "solutions" upon the functionally independent parts of the organization dictates the evaluation and weighing of them by all concerned. (The "optimal" or "best" decision by a single person or group within the organization may be a poor one in terms of its effects on others).

c. A long tradition of human-relations oriented experiments has demonstrated that the process of participation in decision-making aids the acceptance of the decision by members of the organization with a minimum of hostility and resistance (see, for instance, Coch and French, 1948).

d. The "team" effect where the group develops over time, an ability to work together in an effective manner.

The practical questions which arise from these conditions are thus, not whether problem-solving and decision-making should be done by individuals or by groups, but rather, what are the conditions which facilitate the group decision-making process in terms of best enabling the members to use all the available information and resources of its members? A brief review of some of the variables which have been found to have an impact on the quality of group solutions to problems will focus upon what appears to be a key area for experimentation with computer conferencing.

Pressures Toward Conformity

A famous experiment by Asch (1951) demonstrated that even in ad-hoc groups, there is a strong tendency for individuals to fail to express deviant opinions. About 75% of Asch's college - student subjects agreed with the other members of the group, at least some of the time, about the relative length of lines, when they could plainly see for themselves that the group was wrong. When a group has a history and a future, and a developed leadership (influence or deference) structure, the tendency to "go along" with an opinion of a plurality of the leader is that much stronger.

A study by Ziller (1955) suggests that in actual organizational hierarchies, it is helpful to build in some kind of structure to prevent the pressure of higher-ranking authorities from preventing disagreement with the opinions of management. For one set of air crews, individual judgments on a dot-estimation task were first made by the commander, then worked down to the hierarchy, prior to group discussion and group and individual decisions. For the second set of crews, the order of judgment was reversed. In the latter case, there was a greater heterogeneity of initial opinions, more equality in discussion participation rates, and more accurate group estimates than in the top-down condition. This experiment suggests that the same effects might be achieved by Delphi conferencing or computer conferencing where the possible anonymity of judgments would also protect the lower-ranking members from fear of contradicting the leader.

A second aspect of the above is the possible inhibition of the leader to bring up risky options for fear of loosing face if rejected.

Another series of experiments provides an additional line of evidence as to how high-status persons can easily combine a group to make a "wrong" decision by dominating the discussion. In 1952, Solem reported a study in which individuals and groups were asked to solve a "horse trading" problem which was adopted as the task in several subsequent studies.

A man bought a horse for $60.00 and sold it for $70.00. Then he bought it back for $80.00 and sold it for $90.00. How much money did he make in the "horse business"? (p. 28)*

In Torrance's (1954) version of the experiment with groups of three, members of B-26 crews, pilots had the highest social status, navigators medium, and gunners had the lowest status. Using three members of intact crews, Torrance found that among gunners who knew the right answer, 63% were able to convince their associates to accept this correct solution. Comparable rates were 80% for navigators and 94% for pilots. Of course, the pilots were also more successful in getting groups to accept their wrong opinions, too. As Steiner (1972, p. 25) summarizes in his review of these experiments, especially, in groups with a history and a future, the opinions and suggestions of higher status members are likely to be accepted even when they are wrong.

A related horse-trading problem experiment on 44 groups of college students (Thomas and Fink, 1961) included 18 groups in which only one of the members correctly solved the problem individually before discussion. Six of these 18 groups unanimously adopted the correct solution; in all six of these,

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*The answer is $20.00, but the majority (55%) of subjects in the Maier and Solem population thought it was either $0 or $10.00. The easiest way to demonstrate the correctness of the answer is to show the horse trader starting with $100.00 capital and then show his total at the end ($120.00).

the correct person talked more than anyone else, whereas in only one of the remaining twelve did the correct person talk the most. Looking at all groups, nine out of ten groups in which the most talkative person was correct at the beginning of discussion unanimously adopted this correct decision. Eight out of eleven groups in which there was a dominant talker with an incorrect opinion unanimously adopted this wrong decision.

In a computer conference there appears to be a mechanism at work where lengthy pieces of text are less well received than comments which are concise and to the point. A group pressure mechanism exists, in terms of the degree to which the remarks of one person are referenced by later commentary. Since mechanisms such as eye contact do not exist in this environment, textual references to others and their remarks come to the fore as "the" principal reinforcement mechanism. The distribution of such items should be greater in this type of communication process than in a verbal process.

Leadership Style

One factor that can alleviate detrimental pressures to conform to the group and avoid expressing deviant or different views is the style of leadership. For example, Lippit and White (1940)

demonstrated that an "authoritarian" leadership style fostered low frequency of suggestions, high dissatisfaction among members, and a high quantity but low quality of productivity, as compared to a "democratic" leadership style. Lyle (1961), in a replication and extension, found that "democratic" groups generated more communications among members, both task - relevant, and task - irrelevant. Maier and Maier (1957) compared a "free" discussion leadership style (in which the leader is permissive and helpful but avoids structuring the discussion) with a "developmental" style (in which the leader was not only permissive and helpful but clearly defined the problem and structured it into five sub-tasks). Subjects in the "developmental" style were about twice as likely to reach a "high-quality" decision (p. 323).

The structuring of a discussion with a "developmental" and "democratic" type of style is something which appears to come very naturally to the conveners or "chairpeople" of computer conferences, judging by the transcripts of early parts of conferences which we have seen. Repeating the Maier and Maier experiment in a computer conferencing mode might be helpful not only in testing this hypothesis, but also in developing some standard suggested "computer conferencing leadership techniques" in a short handbook form to improve the effectiveness of such groups in the future.

Heterogeneity vs. Homogeneity

A number of studies indicate that heterogeneity of members which is related to task-relevant contributions (such as different approaches to a problem or different skills) generally increases the effectiveness of a decision-making group. Thus, for instance, in solving complex human-relations problems, Hoffman and Maier (1961) and Hoffman et. al. (1962) found mixed-sex groups superior to all-male groups, and those with a "heterogeneous" mix of personalities superior to groups in which all the members had similar personalities. Ziller and Exline (1958)

and Triandes, et. al. (1962) found heterogeneous age groupings and heterogeneous religious and political attitudes to result in more effective and/or more creative solutions. (But it should be noted that the latter "groups" were only pairs). On the other hand, heterogeneity accompanied by antagonism or dislike will restrict task-relevant communications and result in inferior performance, as in the Fiedler et. al. (1961) experiment with Calvinists and Catholics in Holland (who dislike each other almost as much as the Protestants and Catholics in Northern Ireland).

Group Size

The effects of this variable interact so closely with the nature of the task and the organizational and communications structures which are provided or which emerge that it is difficult to make many meaningful generalizations.

Motivation seems to be a key process mediating the effect of group size. Shaw (1960) found that ad hoc groups of college students with two to five members were more willing to work harder on a group task than were members of groups with six to eight members. Similarly, Wicker (1969) found that members of large churches reported spending less time and energy on their organization's programs than did members of smaller churches. Shaw interpreted his results as evidence that group members who are responsible for a large share of a task will be more strongly motivated to work hard than will members of larger groups, whose work represents a smaller part of the total output. Other investigators have concluded that "members of large groups report less opportunity to contribute freely and to influence the course of events...(and) are more inclined to complain that activities are poorly organized and that their group does not function very well" (review of "Effects of Group Size and Actual Productivity", Steiner, 1972, p. 85). On the other hand, a group that is "too small" in terms of resources to perform the task is likely to get so demoralized that it gives up completely.

It seems quite possible that organization of discussion and problem-solving through computer conferencing might enable a large, diverse group to top the resources of all of the members without the loss of the ability to freely communicate and other negative effects of large size. In any case, a problem-solving experiment with small and large-sized groups would seem worth replicating. With the ability of the computer to allow structured subconferences, it may also be possible to make a large group feel it is really a collection of small working groups and retain to the small group motivation.

The Separation of the Effects of Co-Presence from those of Interaction: An Experimental Opportunity Offered by Computer Conferencing

Many experiments have demonstrated that the acquisition and use of the skills necessary to solve a problem are affected by the sheer physical presence of others, even if they are merely observers rather than co-participants in the problem-solving process. For example, Allport (1920) found that the presence of spectators increased the speed of performance on simple tasks. However, he concluded that the performance of complex intellectual tasks is commonly disrupted by the presence of others (Allport, 1924). As Kelley and Thibaut state the findings in their review (1969, pp. 2-3) "The effects are much the same whether the others provide an audience for the individual's activity or are themselves engaged in the same activity. This is a fact of considerable importance for the analysis of group problem-solving, because such activity typically brings persons together and thereby renders them susceptible to the "social-facilitation" (or social-interference) effects produced by copresence."

Zajonc (1965) has generalized that the presence of others seems to increase the individual's level of motivation, and that this "arousal" in the form of an "evaluation anxiety" favors the emission of "dominant" (well-learned) responses.

(Such responses are often incorrect in the early stages of solving a complex problem, for which new behaviors must be learned.) In addition, of course, part of the higher motivation level is directed toward non-task or social ends, including such potentially dysfunctional ends as avoiding embarrassment. In groups where more than mere co-presence is involved, processes of competition and of modelling also occur.

In their review of studies contrasting the quality of group performance and individual performance, Lorge, et. al. (1958 , p. 340) list three major kinds of "groups" that had been studied:

1. Interacting, face-to-face groups
   a. "Real" groups with a tradition of working together.
   b. Ad-hoc groups assembled for the experiment.
2. Non-interacting, face-to-face group (mere co-presence)
3. "Non-interacting non face-to-face groups" (nominal groups or aggregates - used as controls by averaging or pooling individual performances.)

What is missing from this typology is the interacting, and idea-sharing, but not face-to-face group. Experimentation with this condition is facilitated by computer conferencing, and would help considerably in separating out the effects (positive and negative) of sheer social and physical co-presence vs. discussion and sharing of ideas in problem solving.

Along these lines, it should be noted that an experiment by Dashiell in 1935, which does not appear to have been followed up by subsequent investigators, found that effects similar to but weaker than the physically "together" condition were produced by having subjects work individually on a task in different rooms but with the knowledge that they were all working on the same task at the same time.

More recently, some direct comparisons of the usual face-to-face interaction mode for group decision-making with more structured and less "intimate" modes are very important and suggestive of a promising area for research with computer conferencing. Van de Ven and Delbecq (1974, p. 606) have developed and utilized what they call the "nominal group technique" for group problem-solving, which they describe as follows:

> "The nominal group technique (hereafter NGT) is a group meeting in which a structured format is utilized for decision making among individuals seated around a table. This structured format proceeds as follows: (a) Individual members first silently and independently generate their ideas on a problem or task in writing. (b) This period of silent writing is followed by a recorded round-robin procedure in which each group member (one at a time, in turn, around the table) presents one of his ideas to the group without discussion. The ideas are summarized in a terse phrase and written on a blackboard or sheet of paper on the wall. (c) After all individuals have presented their ideas, there is a discussion of the recorded ideas for the purposes of clarification and evaluation. (d) The meeting concludes with a silent independent voting on priorities by individuals through a rank ordering or rating procedure, depending upon the group's decision rule. The "group decision" is the pooled outcome of individual votes."

Note that the kinds of operations performed by the participants could be done by computer conferencing, without the possible uneasiness which accompanies sitting around a table and looking at one another without talking.

They compared the effectiveness of this "NGT" mode of decision making with their versions of a "normal interacting" group communication process and a Delphi process, conducted as described below (pp. 605-607).

> "The format followed in interacting group meetings generally begins with the statement of a problem by the group leader. This is followed by an unstructured group discussion for generating information and pooling judgments among participants. The meeting concludes with a majority voting procedure on priorities, or a consensus decision...unlike the interacting or NGT processes where

close physical proximity of group members is required for decision making, participants in the Delphi Technique are physically dispersed and do not meet face-to-face for group decision making...While considerable variance exists in administering the Delphi process, the basic approach, and the one used in this research, is as follows: Only two iterations of questionnaires and feedback reports are used. First, a questionnaire designed to obtain information on a topic or problem is distributed by mail to a group of respondents who are anonymous to one another. The respondents independently generate their ideas in answering the questionnaire, which is then returned. The responses are then summarized into a feedback report and sent back to the respondent group along with a second questionnaire that is designed to probe more deeply into the ideas generated by respondents in the first questionnaire. On receiving the feedback report, respondents independently evaluate it and respond to the second set of questions. Typically, respondents are requested to vote independently on priority ideas included in the feedback report and to return their second responses, again by mail. Generally, a final summary and feedback report is then developed and mailed to the respondent group."

The task chosen was one which was meant to represent a subjective "real-life" human relations type problem for which there is no clearly "correct" solution and in which there is emotional involvement and different vested interests among the participants. Specifically, the problem was to define the job description of part-time student dormitory counsellors who reside in and supervise student housing.

Sixty group sessions of seven members each were conducted, with heterogeneous members representing different points of view (student residents, student housing administrators, faculty, academic administrators).

Dependent variables were the quantity of different ideas generated and satisfaction of the participants (topped by five questions covering perceived freedom to participate, time "well spent", quantity and quality of ideas, and effectiveness in dealing with the problem).

In terms of quantity of ideas, NGT groups generated 12% more than the Delphi groups (difference not statistically significant). Delphi generated 60% more than the interacting group process (significant at $p<.01$). In terms of satisfaction, the NGT groups were significantly higher than Delphi and interacting groups, whose scores were practically identical.

A content analysis of feedback generated by open-ended questions on what was liked most and least about the meeting, or Delphi generated the following summary of the qualitative differences among the three processes as conducted in this experiment (see Table 5). The author conclude (p. 620) that:

> "This research suggests that when confronted with a fact finding problem that requires the pooled judgment of a group of people, the practitioner can utilize two alternative procedures: (a) the Delbecq-Van de Ven nominal group technique for situations where people are easily brought together physically, and for problems requiring immediate data, and (b) the Dalkey delphi technique for situations where the cost and inconvenience of bringing people together face-to-face is very high, and for problems that do not require immediate solution. Both the nominal group technique and the delphi method are more effective than the conventional discussion group process."

It is important to note that either straight computer conferencing and/or Delphi conferencing need not have the disadvantages attributed to the Delphi process as conducted by Delbecq and Van de Ven, and may have all or most of the advantages attributed to their "NGT" process.

For example, there is no need for such a time lag (the conferencing may be synchronous, or in the case of Delphi conferencing, all rounds may be completed within a few weeks (see Turoff, 1971). Another major inhibitive characteristic found in this Delphi was that "there is no opportunity for social-emotional rewards in problem solving. Respondents focus all efforts on task-instrumental role activity, derive little social reinforcement from others, and express a feeling of detachment from the problem solving effort" (p. 619). This is

TABLE 5

Comparison of Qualitative Differences Between Three Decision Processes Based upon Evaluations of Leaders and Group Participants

(Van de Ven and Delbecq, 1974, p. 618)

Dimension	Interacting Groups	Delbecq-Van de Ven Nominal Groups	Dalkey Delphi Technique
Overall methodology	Unstructured face-to-face group meeting. High flexibility. High variability in behavior of groups	Structured face-to-face group meeting Low flexibility Low variability in behavior of groups	Structured series of questionnaires & feedback reports Low variability respondent behavior
Role orientation of groups	Socio-emotional Group maintenance focus	Balanced focus on social maintenance and task role	Task-instrumental focus
Relative quantity of ideas	Low; focused "rut" effect	Higher; independent writing & hitchhiking round-robin	High; isolated writing of ideas
Search behavior	Reactive search Short problem focus Task-avoidance tendency New social knowledge	Proactive search Extended problem focus High task centeredness New social & task knowledge	Proactive search Controlled problem focus High task centeredness New task knowledge
Normative behavior	Conformity pressures inherent in face-to-face discussions	Tolerance for nonconformity through independent search and choice activity	Freedom not to conform through isolated anonymity
Equality of participation	Member dominance in search, evaluation, & choice phases	Member equality in search & choice phases	Respondent equality in pooling of independent judgments
Method of problem solving	Person-centered Smoothing over & withdrawal	Problem-centered Confrontation and problem solving	Problem-centered Majority rule of pooled independent judgments

(continued)

Dimension	Interacting Groups	Delbecq-Van de Ven Nominal Groups	Dalkey Delphi Technique
Closure decision process	High lack of closure Low felt accomplishment	Lower lack of closure High felt accomplishment	Low lack of closure Medium felt accomplishment
Resources utilized	Low administrative time, and cost High participants time and cost	Medium administrative time, cost, preparation High participant time and cost	High administrative
Time to obtain group ideas	1-1/2 hours	1-1/2 hours	5 calendar months

not characteristic of the computer conferencing mode, as anyone who has examined a conference record can attest. The second major criticism found by the authors was "the absence of verbal clarification or comment on the feedback report generated by anonymous group members creates communication and interpretation difficulties among respondents" (ibid). Likewise, a computer conferencing mode can provide ample opportunity for this.

A major difficulty in replication and expansion of a comparative experiment of problem solving of the type just extensively discussed (but which would include a computer conferencing group), would be to find a comparable but suitable "problem" for the groups to be tested with. A program of comparative experimental testing of different communication modes with various types of problems and groups of varying size and characteristics would yield a great deal of knowledge which we do not now have about the characteristics of the communication and decision-making structures which can help organizations to be more effective problem solvers. A good place to begin would be a design that uses four communication-decision modes (face-to-face, "NGT", computer conferencing, delphi conferencing), two kinds of problems ("subjective" human-relations type and a more "objective" problem for which there are correct answers); and four types of groups (small and large, say 5 people and 20 people; and homogeneous vs. heterogeneous). Assuming at least five groups in each condition, however, we are talking about 160 groups, which is a fairly major undertaking.

The "Risky-Shift": Experimental Artifact?

To the extent that groups are either too conservative or too "irresponsible" and willing to "gamble", these extremes would be likely to produce poor results for group decision-making.

Beginning with Stoner (1961), a number of experiments have presented individual subjects with problems that involve a series of choices entailing various degrees of risk vs. possible payoff, of the following type: An electrical engineer has a choice between (a) remaining at his present, secure job - one with a modest salary but little hope of improvement; or (b) joining a new firm which has an uncertain future but the possibility of becoming a part-owner. (Example from Kogan and Wallach, 1964.) The subject is asked to choose what the odds for success would have to be before he would advise the fictitious engineer to attempt the risker opportunity (1 in 10, 5 in 10, 9 in 10, etc.). Then, there is a period of group discussion, and group consensus is reached on the items. Finally, there is an individual post-test. The surprising finding, almost consistently, is that the "group" decisions shift toward higher risk-taking decisions than the decisions for the combined individuals before discussion.

One hypothesized explanation is that the group causes a "diffusion" of responsibility as in the following conclusions by Kogan and Wallach (1967, p. 51)..."failure of a risky course is easier to bear when others are implicated in a decision;... consider a homogeneous group composed of test anxious individuals, that is, individuals uniformly fearful of failure...(such people) might be especially willing to diffuse responsibility in an effort to relieve the burden of possible fear of failure."

If this is truly a strong factor, then changing the decision-making mode to computer conferencing should not have much of an effect.

A second type of explanation is that the very type of individual who tends to choose the riskiest decisions is also the "take-charge", persuasive, leader type of personality, who therefore tends to dominate the group discussion and

influence the low risk takers to accept his/her position. (This explanation is advanced by Collins and Guetzkow, 1964, among others, but rejected by several subsequent experimenters such as Wallach, Kogan and Burt, as unconvincing and not supported by direct testing). To the extent that this factor is operative, then the risky-shift would be lessened by computer conferencing, because the personality attributes determining leadership and discussion - dominance in the face-to-face group are not operative (see section on the Bales studies for further discussion of this).

Another hypothesis is that something about the social nature of the group discussion process itself is involved -- perhaps the emergence of the norms of American society that people (especially men) are supposed to take risks in order to achieve success, and the consequent desire of individuals not to appear "chicken" or deviant from commonly accepted norms in publically announcing their choice. A key experiment along these lines is Wallach and Kogan (1965), who contrasted the amount of "risky-shift" in the three following situations:

a. Discussion until consensus was reached.
b. Discussion and re-voting before consensus was reached.
c. "Consensus without discussion", in which subjects communicate their risk preferences to each other by written messages without face-to-face discussion.

The "risky-shift" occurred for both face-to-face groups, but not for the written communication group.

Teger and Pruitt (1967) used a written successive ballot technique similar to a Delphi technique, and found a small "risky-shift."

To the extent that groups may have a tendency to generate riskier decisions than individuals would make on their own, the experiments suggest that computer conferencing should cut down the likelihood of imprudent or risky decisions being made, and that an experiment similar to the Wallach and Kogan one

would be interesting for exploring an aspect of the potential differences in social process between face-to-face discussion and computer-mediated discussion.

However, there is some question as to whether the so-called risky-shift is really an artifact of the experimental situation and of the hypothetical kinds of problems used in most of the studies. Note that, as in the engineer's dilemma above, there are absolutely no personal consequences for the participants for arriving at a "risky" decision. This is hardly a "real-life" kind of situation. As Burnstein (1969, p. 394) points out, in experiments in which there was some kind of real outcome involved (though usually only pennies or some other token consequence), "if unanimity is not obligatory, discussion produces little systematic change." Most tellingly, Yenon et. al (1974) did a "risky-shift" field experiment with their students in which their own course grades were involved, and compared them with a matched class which was asked to "role-play" the situation and make a "hypothetical" choice. Only 4% of participants in the "real" situation shifted to a riskier choice after discussion, compared with 31% among those making a "hypothetical" choice. As they conclude, "the risky-shift phenomenon is much dependent upon the degree to which S's perceive the situation in which they are required to make decisions as being a realistic one." (p. 138)

OTHER NEGATIVE ASPECTS OF FACE-TO-FACE DECISION MAKING GROUPS

There are a number of other "dysfunctional" processes which frequently occur in face-to-face decision-making groups and which might be greatly lessened in computer conferencing. Two will be briefly mentioned here.

1) Groups tend to get "hung up" on a topic or "in a rut", going over the same ideas rather than turning to new approaches or problems or ideas. (See, for instance, Taylor et al, 1958.)

It is hypothesized that this is because of the norm of face-to-face conversation that it is impolite to "change the subject", and that computer conferencing would be less likely to exhibit this tendency.

2) Because it is considered impolite to interrupt a speaker at a face-to-face meeting, other members are a "captive audience" to long-winded types or persons whose ideas they discount in advance. How many participants in staff meetings, etc., bring along their little toys (doodling paper, favorite key chain or small objects, to finger, etc.), or otherwise begin to exhibit signs of boredom, frustration, desire to get up and walk around, and wandering thoughts? I am aware of no empirical studies in this area (of the forms and extent of "non-participation" by group members, who stop listening and contributing and go off into their own mental worlds), but as a participant-observer in such groups, I know that this occurs and that it adversely affects group productivity.

   In computer conferencing, no participant need sit through such tedium. He/she is free to make comments and contributions at any time; skip or only briefly skim entries in which there is no interest; get up and walk around or get a cup of coffee without being deviant. It is hypothesized that this will add both to subjective satisfaction of participants and to productivity.

EXPERIMENTS DIRECTLY COMPARING THE EFFECTS OF DIFFERENT COMMUNICATION MODES

Chapanis and his associates are the most prominent experimenters in the area of directly comparing different communication modes to each other. Pairs of subjects in the Chapanis experimental series documented under "Studies in Interactive Communication" work on solving "real-life" problems for which one subject (the "seeker") typically has a task (such as putting together a household gadget), and the other subject (the "source") has some of the necessary information (such as the assembly instructions). As Chapanis (1971, p. 959-960) describes the modes utilized in the early experiments,

> "In the typewriting mode, subjects communicated through special slaved typewriters. Whatever one subject wrote on one machine appeared simultaneously on his partner's in an adjoining room. In the handwriting mode, subjects wrote messages (and passed them) back and forth to one another. In the voice mode, subjects were able to talk freely (through a cloth panel) but were not able to see each other. In the communication-rich mode, subjects sat side-by-side and were able to converse naturally using voice, gestures, and handwriting."

The typewriting mode was further subdivided into use by experienced vs. inexperienced typists.

It should be noted that the overall purpose of this series of experiments has not been aimed at assessment of computer-conferencing or any other immediately available communication technology, but rather at developing computers and computer languages that would result in human-oriented and human-acting computers like "HAL" in the film, 2001. For his experiments, Chapanis conceives of the "source" as a hypothetically ideal computer and the "seeker" as the user of that computer with the experimental communication modes modelling different possible input-output channels between a computer and a human user. (Chapanis, 1973, p. 207)

Some very important shortcomings and contrasts to computer conferencing as a mode should be noted at the outset. Only two parties were involved in these experiments, whereas in most problem-solving experiments as well as in computer conferencing, the number of participants would be four, five, or more. Secondly, only one person could be either sending or receiving a message over the single channel at the same time. The subject who did not control a voice or typewriter channel at a particular time had to just sit there and wait. By contrast, in communication-net experiments with handwritten notes, or in computer conferencing, for instance, any number of subjects may be writing or sending or receiving messages simultaneously. Therefore, the generalizability of the available experimental results of Chapanis and his associates, summarized below, is somewhat questionable.

In one set of experiments (Chapanis, 1972, 1973), forty male Baltimore high school students were used, with each pair solving only one problem using one of the five modes. (Thus, the possible effects of variations in the individual abilities of the subjects is not controlled.) In the second, thirty-two male freshmen from John Hopkins with verbal SAT scores between 600 and 700 and typing speed of at least 35 wpm were used, with each team of two solving four different problems using four different combinations of possible modes (V-V, both seeker and source using voice channel; V-T and T-V, mixed voice and typewriter; T-T, both using typewriter). Both studies found the typewriter less efficient than the voice mode. Specifically, "The average time required to reach a solution in the unmixed typewriter mode is almost exactly twice that in the unmixed voice mode (49.9 min. vs. 24.8); mixed modes (V-T or T-V) are "midway." Moreover, "About 2-1/2 times as many messages were communicated in the unmixed voice as in the unmixed typewriter mode." The mean # of words communicated was:

V-V 1165;

V-T 644;

T-V 781; and

T-T 325 (Chapanis et. al, 1974, p. 351-359)

In the first series, it should be noted, little difference was found between the two oral modes (communication rich and the voice - only), or between the three written modes (hand-writing and typewriting by experienced or unexperienced typists). (Chapanis, 1972, p. 497)

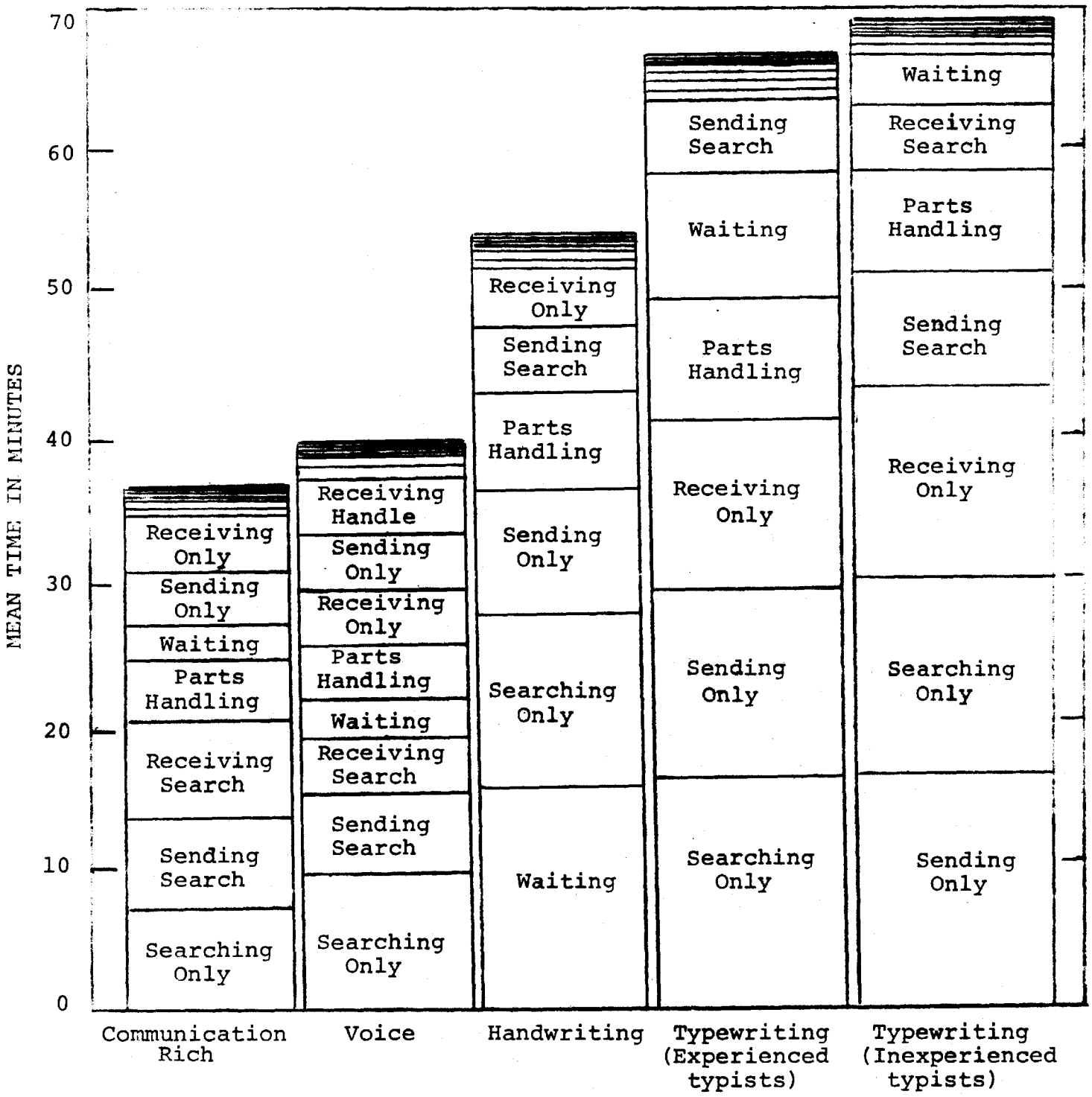
A sampling of behavior showed that both "sending" and "receiving" messages required more time in the written modes, as well as "other" activities (searching for information, etc.), because the latter could be performed simultaneously with the oral mode, but not with the written (see figure 4 below).

An additional variation included in the 1974 experiment was that half of the trials permitted subjects to interrupt each other freely at any time, and the other half could not transmit a message until the person in control of the channel voluntarily gave it up (the restricted, no interruptions condition). Overall, when subjects had the freedom to interrupt, they exchanged more messages, shorter messages, and with greater frequency per time unit. There was no overall effect on time taken to solve problems, but this is because "in the two mixed modes of communication and in the unmixed typewriter mode, problems were solved faster when S's were able to interrupt freely," (p. 355), whereas in the voice mode, it took 40% longer to solve the problems when free interruptions were allowed. These results strongly suggest that the ability to interrupt by specifying delivery of short comments to individuals in the process of doing something else, such as writing or reading other messages, should be a feature of computer conferencing.

In a subsequent series of experiments, the communications modes used were expanded to ten different channels (Ochsman and Chapanis, 1974, p. 582-583).

Figure 4

COMMUNICATION MODE BY MEAN TIME TO
PROBLEM SOLUTION, BY TYPE OF ACTIVITY
(Chapanis, 1972, p. 496)



1. Typewriting via slaved electric typewriters.
2. Handwriting via an electro-mechanical TelAutograph.
3. Voice via microphone and speaker.
4. Closed-circuit video, that is, television without voice.
5. Visual contact through a sound-insulated glass panel.

6-10, various combinations of two of the above at a time, plus a "communications-rich" mode allowing all five of the channels listed above. The experimental apparatus for these modes has also been developed to a very sophisticated level (see diagram on next page).

Whatever the channel, however, this experimental series kept the participants in two separate areas divided by the glass panel (clear or screened) and soundproofed walls. As in the earlier experiments, only pairs were used; the problems were fairly simple information-seeking and combination tasks for which there was only one correct solution; and only one person could be "sending" information at the same time. (The partner who did not "have control" of the channel(s) had a red button illuminated which locked the typewriter, speaker channel, or whatever, and could only receive messages until the channels were relinquished by the partner.)

The most basic conclusion of this experimental series was that "the single most important decision in the design of a telecommunications link should center around the inclusion of a voice channel." (p. 579) 90% of the variance in time-to-solution is accounted for by the dichotomy between those modes which had a voice channel and those which did not, with hard-copy modes taking roughly twice as long, on the average. The addition of a video channel to other channels had little or no effect on solution times. There was no difference between handwriting and typewriting. The same problems as mentioned

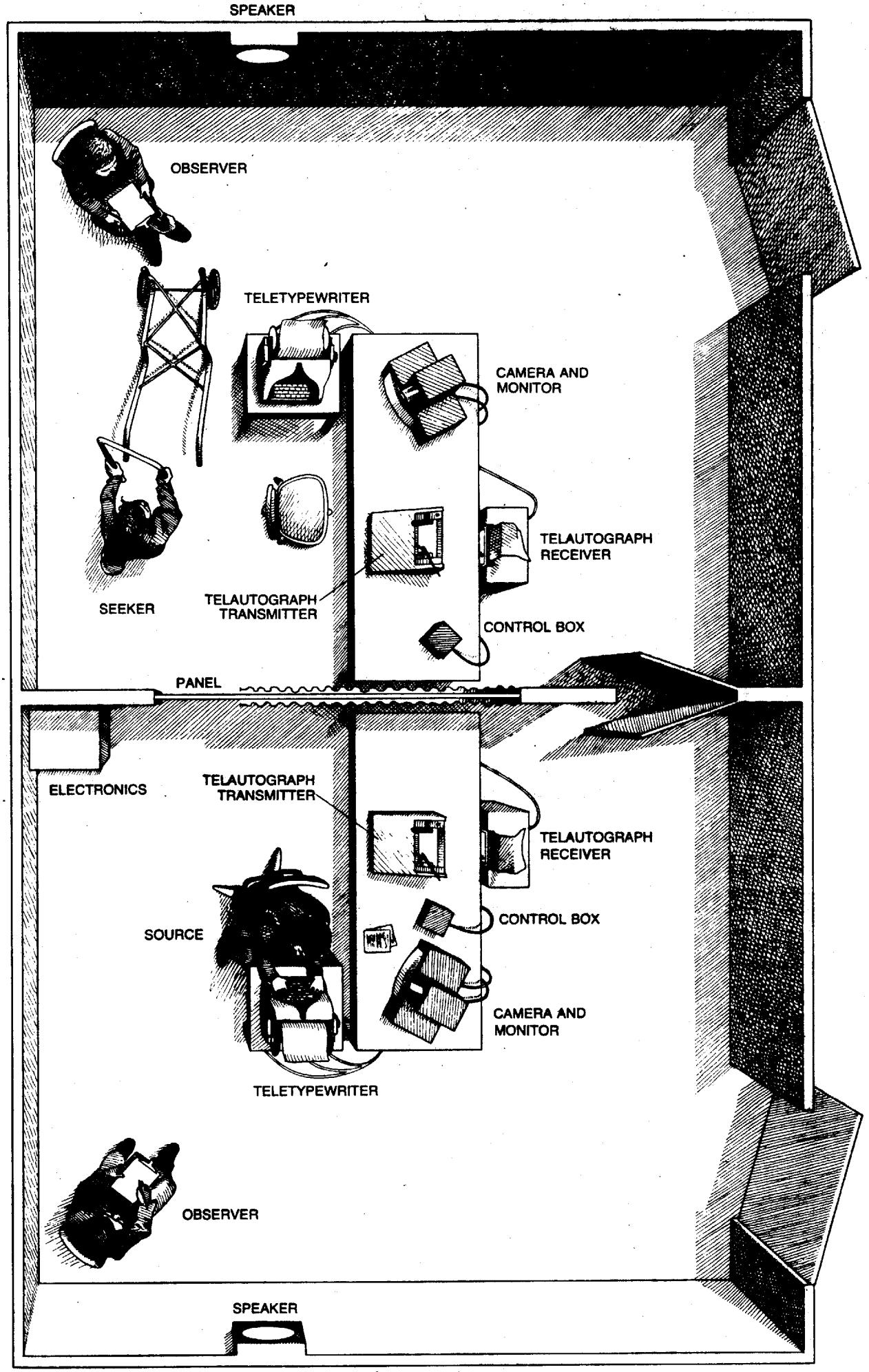


Figure 5
Laboratory Setting for the Chapanis Group's 10-Modes Experiments
(Chapanis, 1975, p. 37)

above, however, occur for generalizing these results to computer conferencing.*

Overall, Chapanis' results are certainly not very encouraging for computer conferencing, which, after all, utilizes a "typewriting mode." As has been pointed out, however, the number of participants and participation rules are so different for computer conferencing than for the "slaved typewriters" used by pairs of subjects that one cannot extend Chapanis' results to say that computer conferencing would necessarily be so much slower and less wordy than other modes in a more "real-life" type of group decision problem. His work does provide a strong model for a series of controlled experiments that does the same kind of careful, direct comparison of communication modes with one another, in terms of the amount and type of communications and the time consumed in the process.

Satisfaction of Participants

What will be the effect of communications medium upon interpersonal attraction and satisfaction of participants, and how, in turn, does this alter task effectiveness? The evidence is very skimpy here, and obviously more comparative experiments need to be done even on "older" media than computer conferencing. Chapanis and his associates have not included these as dependent variables in their experiments.

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*A personal communication from Chapanis notes that current experiments, not yet published, impose communications conditions and tasks that are much closer to computer conferencing conditions. One study uses groups of three and four persons as well as pairs. Another has subjects solve problems that have multiple possible solutions and for which argumentation, bargaining, and persuasion are important. Finally, in these recent experiments, more than one subject can "talk" or "send" at a time.

Williams (1975, p. 121), summarizing a 1971 M.A. thesis by LaPlante, says that "with positive verbal content, nonverbally rich media (face-to-face and closed circuit television) led to more favorable evaluations than nonverbally poor media (telephone and letter), while with negative verbal content, the reverse effects were observed."

Similarly, Mehrobian (1971, p. 11) has pointed out that "in terms of the immediacy that they can afford, media can be ordered from the most immediate to the least: face to face, picture phone, telephone ..." (and, below this, synchronous and ansynchronous computer conferencing and letters or telegrams). He states that the choice of media in regard to intimacy should be related to the nature of the task, with the least immediate or intimate mode preferable for unpleasant tasks.

Williams (1975) used two tasks, supposedly differing in "intimacy" for two-person conversations utilizing face-to-face, closed circuit T.V., and telephone communication modes. The conclusions were that:

> "Significant media effects on evaluation of the conversation and (less strongly) of the conversation partner have been found. Overall, these seem to take the form of the more non-verbally rich communications media leading to more favorable evaluations than the nonverbally poor media (i.e. face-to-face conversation, closed circuit television, then telephone, in that order)."

However, there were important interactions between media and type of task. Trying to explain and generalize from the differences, Williams employs Argyle and Dean's (1969) model, in which "intimacy is a function of proximity, eyecontact, smiling, topic of conversation and other factors. Immediacy has a $\cap$-shaped relation to liking, so that either too high or too low intimacy is to be avoided." He speculates that

> "for the less intimate task, the most immediate medium, face-to-face, leads to the most favorable evaluations; and the least immediate, the telephone, leads to the least favorable. For the more intimate task (of the two used), a medium of intermediate immediacy, closed circuit television, leads to more favorable evaluations; while the media of greater and lesser immediacy (face-to-face and telephone) are both on the downward sloping parts of the $\cap$-shaped curve, and lead to less

> favorable evaluations. This would suggest that with tasks of very high intimacy - perhaps very embarrassing, personal or conflictful ones - the least immediate medium, the telephone, would lead to more favorable evaluations than either of the more immediate media."

Obviously, these results are suggestive of greater participant comfort and satisfaction with a "low" immediacy or "low intimacy" mode such as computer conferencing, for <u>some</u> kinds of communication tasks. So little experimentation has been done in this area that there is a great deal of room for further research.

COMPUTER CONFERENCING LANGUAGE REQUIREMENTS*

The utility of computer conferencing as a tool for communication experiments in the social sciences depends strongly on the ease with which experimenters can tailor the structure of the conference form to their experimental design. This necessitates a specification system comparable to a computer programming language, oriented to the explicit definition of communication structures and processes. This is further reinforced by the observation that a single type of communication experiment usually leads to the development of a series of experiments, with each one a variation on the original structure. The results of one experiment suggest questions and more experiments to investigators. Therefore, it is impossible to either freeze on a design or predict evolution of a design for a particular conferencing structure or experiment. Because of this need and the expectation of unpredictable changes, any approach short of that of a language tailored to specifying communication structures would result in prohibitively costly software.

It is also quite clear that much of the experimentation to date has been limited by manual execution of the design. Therefore, language requirements are developed not only for replicating past communication experiments but also to allow extensions that are desirable or made possible in this new medium.

Such a system must optimize the ability of the social scientist to specify the communication process in his or her terms and language. This type of system capability would enable investigators to duplicate the previously discussed experiments showing the effect of computerization as well as allowing more general experiments where the computer could manage the interaction of

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*This chapter is co-authored by Peter Anderson and Roxanne Hiltz. The sample program in the appendix was written by Peter Anderson.

a group too large to be handled manually or by simple mechanical devices. In addition, completely new procedures such as dynamic communication network structures are now possible.

The full gamut of human communications can be studied effectively, with such a system, for the first time.

Before delving into detailed requirements for an experimental specification language system for social scientists, let us see how such a social science experiment would take place when managed by a computerized conferencing system. The software facilities for a communications net experiment also appear to facilitate more complex group problem-solving experiments, such as Chapanis-type experiments. Thus we will look in some detail at the kinds of programming needed to do a communications net experiment.

A single run of an experiment generally consists of (1) the administration of a set series of problems to a group of subjects, in which various subjects are given different pieces of information or instructions and the allowable communication links are specified by the experimenter, (2) a period of communication among the participants for each problem, (3) submission and checking of answers, (4) (sometimes) - administration of questionnaires to the participants. Once the problems and the various communication nets and questions are described, the various trials should be able to be administered, stored and tabulated automatically, for later retrieval by the experimenter.

For example, in the Leavitt (1951) experiment, each trial consisted of one group solving 15 problems, and there were four communication patterns.

Leavitt documents the problems very clearly. Each subject was identified as a color, though for computer conferencing, they would have to be numbers or letters or names. For trial one, subject ("white") was given a large card on which the symbols of the circle, diamond, square, plus, and asterisk were printed, and the triangle missing. The first five problems and instruc-

tions and answers is shown below (from Leavitt, 1951, p.40).

Figure 6

Instructions and Answers for Six Trials in the Leavitt Experiment with Alphabetic Equivalent For Computer Conferencing Replication

Six Symbols Used: ○ A △ B ◇ C ▭ D + E ✳ F

Trial No.	Symbol Missing From: White 1	Red 2	Brown 3	Yellow 4	Blue 5	Common Symbol
1	△ B	◇ C	✳ F	○ A	▭ D	+ E
2	◇ C	○ A	▭ D	△ B	+ E	✳ F
3	+ E	✳ F	▭ D	△ B	◇ C	○ A
4	▭ D	◇ C	△ B	✳ F	+ E	○ A
5	○ A	✳ F	+ E	△ B	▭ D	◇ C

In the Appendix to this article we show a slightly modified form of this experiment as it might be specified for a computerized conferencing system. The persons are changed from colors to one-digit numbers, and the objects from the symbols circle, triangle, etc., to letters of the alphabet.

For a social scientist to program an experiment utilizing computer conferencing, there needs to be a library of functions common to such experiments. Examples follow of such potential key words and the types of routines which they should activate.

To begin, one could define a group communication structure's members as:

MEMBERS X=(1, 2, 3, 4, 5)

so the subjects become individually known as "1", "2", "3", "4", and "5", and generically known as "X". By specifying the permissible communication channels as:

X talks to X-1, X+1,

we get the "chain structure" (see fig. a). By adding a modifier (e.g., "wrap-around") we get the "circle structure" (see fig. b).

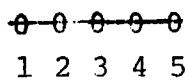

Fig a. Chain Group

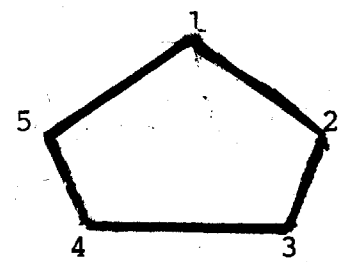

Fig. b. Circle Group

This permits the computer to police the communication for desired protocol.

The specification language must allow text manipulation for the construction of messages to participants, and the analysis of messages they send. By this means the experimenter is able to construct formats, images, and patterns for the computer to follow when instructions are delivered to a subject.

The next element that has to be specified is the answer for the problem, and what to do if the answer is incorrect.

The computer should check and evaluate the answer of each subject against pre-specified criteria. If incorrect, it should send an ERROR message, the nature of which is specified by the experimenter. For example, send the word "WRONG"; or an error handling routine that works as a negative reinforcement, such as 'No-No-No' printed out for 15 seconds on the terminal, during which time the person can do nothing to stop it.

If a participant's ANSWER is correct, this should result in the transmitting of a message like, "Thank you. Please wait for the next problem", and the shutting of all communications channels until the next trial or procedure.

Many of these features are like those used in standard computer assisted instruction (CAI) languages.

To use the example of the Leavitt-type network experiment which we have been discussing, a run would be conducted with each subject placed at an interactive terminal, such as a typewriter-like machine. The computer conferencing system will type out to each subject the information that is traditionally given orally or in writing, perhaps as follows:

IN THIS EXPERIMENT THERE ARE FIVE PEOPLE IN YOUR GROUP.
YOUR NUMBER IS #1.
EACH PERSON HAS BEEN GIVEN FIVE OF THE LETTERS A B C D E F.
THE PROBLEM YOUR GROUP MUST SOLVE IS, "WHAT LETTER DOES EVERYONE HAVE?"
TO SEND A MESSAGE, JUST TYPE THE RECIPIENT"S NUMBER FOLLOWED BY THE MESSAGE.
CHECK IT FOR TYPING ERRORS.
WHEN YOU KNOW THE ANSWER, TYPE "ANSWER=", AND YOUR ANSWER.

TRIAL 1
A C D E F
You may send to
2 and 4.

The sequence of events at subject's terminal may continue as follows:

annotations	printed on terminal
1 types	2 I HAVE ACDEF
1 receives	(FROM 2) I HAVE ADBEF
1 receives	(FROM 4) I DON"T HAVE A
1 types	2 2&3&4 HAVE B, D AND E
1 receives	(FROM 4) 5 DOESN"T HAVE D
1 types	ANSWER = E
1 receives	THANK YOU. YOU ARE CORRECT
	E IS THE COMMON LETTER
	PLEASE WAIT FOR THE NEXT PROBLEM.

As these experiments progress, the system records for later analysis each message sent, including from whom, to whom, the time of the

message, and the text of the message.

Experimentors should be able to specify appropriate halting conditions and actions, such as: when one participant or when all participants have submitted an acceptable answer (the correct one or any answer under the ANY condition), the next set of instructions for the next trial should be issued. The experimentor should also be able to specify a "questionnaire" mode of operation. One could list certain numbered questions. For example,

```
QUES. 1  =  "How much did you like your job?"
      1   2   3   4   5   6   7   8   9   10

not at                                   a great
  all                                      deal
```

This would be programmed like the ordinary experiment, by saying, for instance, "ASK QUES 1-6" at any point in the program.

Finally, the above elements of the experiment would be put into an encompassing iterative procedure, describing the repitition of the same experiment and the variations on that experiment to be given to a single set of subjects. The way this should work is that each of the decisions which has been made in the previously described steps of experimental specifications would be replaced by parameters and the conferencing system will run and rerun that set of experiments with various (pre-specified, computed, or random) settings for these parameters. This is called parametization and it yields overall system control of a series of experiments.

The experiments that have been described in the previous chapters involved communication networks that are static, that is, they do not alter their connections or method of communication between and among the nodes of the network over the course of the experiment. It is quite evident that this is a limitation in terms of desirable extensions to the design and this limitation is imposed by the available tools for such investigation. A communication network could be dynamic with its design incorporating changes that may occur when certain conditions are met. These conditions are determined by the experimental designer. A network change might, for example, reflect a forced change of the communication process by the designer based upon clock time or on some milestone in the problem-solving process. Another concept

related to this is the ability to specify an adaptive network where, for example, individual subjects or groups of subjects can choose, by their actions, intentionally or otherwise, to modify and adapt the allowed flows of communication. For example, they could purchase communication privileges.

Therefore, we propose that the language contain the facility to describe and parameterize global conditions occurring in the course of an experiment. These conditions could refer to elapsed time, a certain message being sent by a subject or a group of subjects, a certain level of voting, correct or incorrect answers to test questions, answers to surveys and straw votes, and so forth. The communication channels which are permitted between and among individual subjects could then depend upon not only the two subjects at each end of a proposed channel but also upon the conditions which are met by the other aspects of the experiment which are being recorded. For example, a communication structure might originate in terms of the complete network ("COMCON") where every member is permitted to talk to every other member, but after a specified number of messages have been sent within the network, the network structure will change to that of a centralized wheel where the individual chosen for the center or "HUB" position is that member of the group who has sent, say, the most messages (alternatively, the one who has received the most messages). Another example is that of a debate between two teams. At various intervals during the course of the experiment, the individuals may be given the opportunity to change sides or to change from neutral to pro or con or vice-versa. The members of the pro or con sides may be given the opportunity to accept or reject the new member. The possibilities are endless.

The computer conferencing system is a far better policeman than any social scientist could ever expect to be when running a communication structure experiment. If it is not specified that a particular mode of communication can take place (that is either between two individuals or a transaction of a specific type) then that communicationattempt simply will not go through, because there is no provision made for it to go through. In ordinary

communication experiments there are bound to be extraneous factors, such as facial expressions or verbal inflections which color the communication process so the experimentor cannot be completely certain just what is being measured. This allows the computer conferencing system ot be a host for a far richer assortment of communication experiments using certain very limited and precise methods of communication among the subjects.

A computer conferencing system is fully able to support such experiments. These systems are in fact capable of supporting communication structures as complex and varied as a Robert's-Rules-of-Order meeting, a debate society, or a game of bridge. Social-psychology experiments like these are only limited by the imagination of the investigators and not by the computer system tool we propose. On the other hand, social-science investigators are quite limited in using existing conferencing systems by their abilities as computer programmers. The modern attitude, "bring the computer to the person instead of the person to the computer" needs desperately to be applied in this area.

BALES INTERACTION PROCESS ANALYSIS

Given all of the capabilities and reporting described above, all that has to be added to do an IPA on computer conferencing is some sort of capability for an observer to code the "inter-action category" (or categories) in which each message belongs.

The computer is already recording who sent the message, to whom. Upon signal by the observer/recorder, the messages should be displayed one at a time, and the observer should then use a special symbol to be able to associate IPA codes with messages and message fragments for storage and future processing.

Further processing would include the generation and display of percentage distributions of types of statements, by individual and for the group as a whole for the problem; a "whom-to-whom" matrix; and either of these broken down by specific time periods within the running of the trial.

MONITORING AND REPORTING

The measurements which are to be taken to understand group communications processes as a result of the experiments performed are something which can be accomplished using the recorded information of all of the group transactions as a data base for later information processing. The specification language must allow the recording on a storage medium, such as a computer disc, the content and other relevant attributes of the messages which are sent during the course of an experiment. The language must also permit the investigator to specify other attributes of the message which should be particularly noted and recorded for later analysis. During the course of the experiment there can also be a smaller data base which is constantly being brought up to date to allow conditional direction of the experiment or its follow-up experiments with the same group of subjects. In this small data base it would record how many messages have been sent, the number of messages that have been sent and received by the individual members, the density of the various message types, etc.

On the type of communication-net experiment we have been describing, for instance, the computer would automatically record time from administration of instructions to correct completion for each participant, total messages and total words sent by each participant and to whom, the number of editing changes made, and the number of errors. These could be listed by position and also totalled for the whole trial, and printed out upon request to the experimentor, by trial. In addition, the monitor could record for each participant, by trial, time spent sending, time receiving, and total time from receipt of instructions to submission of a correct answer; these these time totals could also be automatically added up and printed out for the experimentor.

If there has been a questionnaire, the computer could print out the answers for both the individual and the group as a whole, with totals, means and standard deviations.

The experimentor should be able to get all of the above by signing on with some password and asking for "SEND RESULTS, TRIAL(S)" (1, 2, ...). The results should be able to be requested either

for a single trial or all at once. The experimentor then knows the total messages generated for each trial and for the run as a whole. A TRANSCRIPT should then be available, labelled by trial, and message number.

Finally, when the experimentor has all the desired results printed out, there should be the ability for automatic destruction or archiving of the collected data.

APPENDIX

SPECIFICATION IN A PROPOSED PROGRAMMING LANGUAGE FOR SOCIAL SCIENCE EXPERIMENTS OF A GROUP PROBLEM SOLVING EXPERIMENT

```
1.1     GROUP PROBLEM SOLVING EXPERIMENT:
1.2         ESTABLISH NETWORK 1.
1.3         GIVE SPEECH 1 TO ALL X.
1.4         DO INITIAL SHUFFLE.
1.5         START SYSTEM CLOCK.
1.6         RUN COMMON LETTER TEST 20 TIMES.
1.7         GIVE SPEECH 2 TO ALL X.
1.8         END OF G.P.S.E.

2.1     NETWORK 1 SPECIFICATION:
2.2         MEMBERS SET X = (1, 2, 3, 4, 5).
2.3         X TALKS TO X+1, X-1 (WRAP-AROUND).
2.4         MEMBER INDIVIDUAL = (ANSWER).
2.5         X TALKS TO ANSWER.
2.6         END OF NETWORK 1 SPEC.
```

3.1 SPEECH 1:

3.2 WELCOME TO THE NJIT COMPUTER COMMUNICATIONS LAB.
3.3 THANK YOU FOR HELPING OUR EXPERIMENTS ON
3.4 GROUP PROBLEM-SOLVING

3.5 YOU ARE A MEMBER OF A GROUP OF
3.6 FIVE PEOPLE. EACH KNOWN BY A NUMBER
3.7 1, 2, 3, 4, or 5. YOUR NUMBER IS ((X)).

3.8 YOU CAN SEND A MESSAGE TO
3.9 ONE OF YOUR FELLOW MEMBERS
3.10 BY TYPING THE ADDRESSEE'S DIGIT, FOLLOWED
3.11 BY THE MESSAGE, FOLLOWED BY THE
3.12 "RETURN" KEY.

3.13 YOU CAN ONLY SEND MESSAGES TO MEMBERS
3.14 ((X - > ?))

3.15 THE FIRST SERIES OF PROBLEMS YOUR GROUP WILL
3.16 TRY TO SOLVE IS THAT OF DETERMINING
3.17 WHAT "OBJECT" YOU ALL HAVE IN COMMON.
3.18 YOUR OBJECTS WILL BE LETTERS OF THE ALPHABET.

3.19 WHEN YOU THINK YOU KNOW THE COMMON LETTER,
3.20 SEND IT AS A MESSAGE TO "ANSWER".

3.21 FOR EXAMPLE, IF YOU THINK THE LETTER IS "Z", TYPE:
3.22 ANSWER Z (CARRIAGE RETURN)
3.23 END OF SPEECH 1.

```
4.1     INITIAL SHUFFLE:
4.2           ALPHA IS "ABCDEFGHIJKLMNOPQRSTUVWXYZ"
4.3           RANDOM SEED IS 2016455126.
4.4     END I.S.


5.1     COMMON LETTER TEST:
5.2           RUN SHUFFLE & DEAL
5.3           NOTE TIME.  START MONITOR.  SET DONE COUNT =0.
5.4           START COMMUNICATION FLOW.
5.5           WHEN X-> ANSWER, WITH MSG = IT THEN:
5.6                    ADD 1 TO DONE COUNT.
5.7                    GIVE CONGRATS SPEECH TO X.
5.8                    INHIBIT X FROM SENDING.
5.9           WHEN X-> ANSWER, WITH MSG NOT IT THEN:
5.10                   GIVE SORRY SPEECH TO X.
5.11          WHEN DONE COUNT = 5 THEN:
5.12                   DONE C.L.T.
5.13    END OF C.L.T.
```

```
6.1     SHUFFLE & DEAL:
6.2           SHUFFLE ALPHA.
6.3           BETA = ALPHA (1 THRU 6).
6.4           GAMMA = BETA SHUFFLED.
6.5           IT = GAMMA (6).
6.6           GIVE DEAL SPEECH TO ALL X.
6.7     END S.& D.

7.1     DEAL SPEECH:
7.2           YOUR GROUP HAS BEEN GIVEN LETTERS:
7.3                  ((BETA)).
7.4           YOUR OWN LETTERS ARE:
7.5                  ((GAMMA(X+1 THRU X+5) )).
7.6     END OF DEAL SPEECH.


8.1     SCOREBOARD MONITOR
8.2           RUN NUMBER.
8.3           TRANSACTION MATRIX COUNT.
8.4           TIME TO RUN.
8.5     END S.M.

9.1     CONGRATS SPEECH:
9.2           YES!!!  "((IT))" IS THE COMMON LETTER.
9.3           CONGRATULATIONS!  PLEASE WAIT FOR INSTRUCTIONS.
9.4     END OF C.S.

10.1    SORRY SPEECH:
10.2          NO.  THAT IS NOT THE COMMON LETTER.
10.3          PLEASE KEEP TRYING.
10.4    END OF S.S.
```

11.1 SPEECH 2:

11.2 THIS CONCLUDES THIS SERIES OF TRIALS.

11.3 THANK YOU AGAIN FOR YOUR COOPERATION, AND

11.4 HAVE A SAFE TRIP HOME. AND REMEMBER.....

11.5 COMPUTER CONFERENCING,

11.6 LIKE DIAL SOAP,

11.7 TAKES THE WORRY OUT OF

11.8 BEING CLOSE

11.9 .....BURMA SHAVE

11.10 END OF SPEECH 2.

NOTES ON THE SPECIFICATION

1.1-1.8	This is the "main program". It corresponds to a table of contents or an outline for the entire procedure. The first line, 1.1, gives the whole procedure a name, and the last line, 1.8, shows the end of its scope (cf. THE END in a novel).
1.2	NETWORK 1 is defined to the system by lines numbered 2.X. This command informs the system that this network is the particular group communications structure to be used.
1.3	SPEECH 1 -- defined on lines 3.X - is delivered to the experimental subjects known as X, as defined by the previous step.
1.4	Next, the system is directed to perform INITIAL SHUFFLE which prepares the system's internal "deck of cards" for the test. See lines 4.X.
1.5	This is a system function. The time on the system clock is recorded with each message (or other process) transacted in the experimental runs. This allows experimental statistical investigations with the fine details of time to solve problems.
1.6	This directs the system to run the experiment, 20 times, as described in lines 5.X.

2.1-2.6 Specifies the group communications structure known as NETWORK 1.

2.2 One collection of members, named "1" through "5", is generically known as X.

2.3 Each of these members can send a message to its nearest neighbor, i.e.,

member 1 can talk to members	*5	and	2
2	1		3
3	2		4
4	3		5
5	4		*1

(The *-ed items are the result of the modifier "WRAP-AROUND"),

2.4, 2.5 Another member - probably the system monitor or experimenter - goes by the name ANSWER. All the X's can send messages to it.

3.1-3.23 Define SPEECH 1, which will be given to each X.

3.7 Information between double parentheses is to be processed and replaced by some textual string by the system. So "((X))" will be replaced by the appropriate digit "1" through "5".

3.14 ((X -> ?)) will be replaced by the list of members (digits) to whom X can talk.

4.1-4.4 Defines a "deck of cards" whose individuals are the letters of the alphabet.

4.3 Some number is used to "seed" a later deck-shuffling process. Deck-shuffling is a "pseudo-random" deterministic process. When the same seed is used again, the same pseudo-random processes re-occur.

5.1-5.13	This is the heart of the experiment: the test to run 20 times.
5.2	See lines 6.X.
5.3	Three statements on one line for convenience. NOTE TIME writes the starting time on the transaction file. START MONITOR clears the previous information from the MONITOR "score-board" (see lines 8.X). DONE COUNT = 0 at the start indicates no one is done yet.
5.4	No member can communicate until enabled by such a command.
5.5-5.8	The "WHEN" instruction indicates parallel processing. The system is constantly on the look-out for the condition specified between the words WHEN and THEN; upon hitting one, the directives following are performed.

6.-6.7	Clear from its name.
6.2	The character string ("deck of cards") is re-arranged according to some shuffling algorithm. Like a simulated deck of cards, it remains shuffled.
6.3	BETA is assigned the first six items of ALPHA. If ALPHA IS "ƶYXWVUTSRQPONMLKJIHGFEDCBA" then BETA becomes "ƶYXWVU" (and ALPHA -- unlike a card deck -- remains unchanged).
6.4	GAMMA gets the same six letters, but rearranged. E.g., Gamma might be "ƶXUVWY".
6.5	It becomes the last letter of GAMMA; in this example, "Y".
6.6	By now this is clear.

7.1-7.6 Writes to each member, the letters it gets.

If GAMMA is	Z	X	U	V	W	Y
then 1 gets		X	U	V	W	Y
2 gets	Z		U	V	W	Y
3 gets	Z	X		V	W	Y
4 gets	Z	X	U		W	Y
5 gets	Z	X	U	V		Y

Notice that all get "Y", the sixth letter of GAMMA. (That's why IT = GAMMA(6).)

8.1-8.5 A short list of items to be tallied for each run of the experiment.

SUMMARY AND CONCLUSIONS: KEY AREAS AND APPLICATIONS FOR COMPUTER CONFERENCING EXPERIMENTS

There are at least three very fruitful sets of consequences which may flow from the replication of some classic communication studies using computer conferencing: 1) Knowledge about the consequences and characteristics of this form of communication itself; 2) a demonstration of the potential use of computer conferencing as a means for conducting new types of experiments which would be difficult without this technology; and 3) the standardization of group tasks for testing new kinds of hardware or software.

I. Classic Communication Experiments as a Mine of "Control" Data.

For several traditional areas of communication study in the social sciences, there exist dozens of series of experiments on hundreds of subjects. We propose that key experiments in these series should be replicated in every detail, except that typewritten communication via computer conferencing will be substituted for the mode of communication previously used (handwritten notes, face-to-face verbal, audio only, etc.). Any differences in outcomes (time to solve problems or reach decisions; errors; satisfaction of participants; number and pattern of messages sent, etc.) can then be attributed to characteristics of computer conferencing (and the software system being utilized). This will be an economical and widely understandable way of measuring and documenting some of the characteristics and consequences of the computer conferencing mode of communication. What it does is to utilize data already collected and experimental procedures already developed, rather than the more costly alternative of a) developing and perfecting new sets of problems, instructions, questionnaires, measures, etc. and b) running hundreds of "control" trials for the new type of experiment in order to develop a set of baseline data against which to measure the impact of the computer conferencing mode. We will be, as

in the words attributed to Newton, "Standing on the Shoulders of Giants" by putting to work for us the years already expended by top experimental psychologists in experimental design and data collection.

The experimental replications which are recommended are, in order of priority (as assessed by a combination of potential fruitfulness and ease of administration):

1. The original Leavitt communication network study.
2. The Bales Interaction Process Analysis (using his "standard" group problem-solving task).
3. One of the more complex communication network experiments, replicating the work of Burgess or Snadowsky.
4. A "risky shift" experiment such as Wallach and Kogan's (1965).

II. Facilitation of New Lines of Experimentation

This is seen as a second stage series of developments, which build upon the techniques and knowledge gained from "simple" replications. In contemplating such experimental series, it is important to remember that the "laboratory" for computer conferencing can be brought to wherever there are subjects and telephones. Thus, there is no need to rely on such convenient groups of subjects as students. The subjects and "laboratory" for an experiment need not all be marshalled in one place at one time, but could be scattered at various locations at their separate terminals.

A series of controlled experiments should be run which directly compare computer conferencing as a communication mode for group problem-solving with other available communication modes. These should be modelled after the work of Chapanis and his associates and the work by Van de Ven and Delbecq. Such an experimental series might be run using homogenous and heterogenous groups of five and ten members on two different kinds of "real life" problems which differ in the amount of dissent and strong emotion they are likely to generate. The groups could be compared using the following kinds of modes:

1. Computer conferencing; all eight conditions.
2. Face-to-face meetings; all eight conditions.
3. Making simulated individual telephone calls (voice channels only); selected conditions.
4. "Nominal Group Technique" face-to-face meetings (as described by Van de Ven and Delbecq); selected conditions.
5. Handwritten delphi technique; selected conditions.
6. Possibly, having participants handwrite or dictate notes or memos, and then having them typed by a secretary and checked before delivery (though here, the competence and personalities of the secretaries become uncontrolled factors); selected conditions.

Besides a series of controlled experiments designed specifically to assess the characteristics of computer conferencing, this medium can also be used to expand previous kinds of communications experiments in new directions.

As has been mentioned at the end of the first chapter on communication network experiments, computer conferencing's potential combination of automatic administration, data collection and analysis of experimental runs ("programmed in" as software options), plus the portability of terminals (so that the "laboratory can be wherever there is a telephone) offers some real opportunities for modifying and expanding existing experiments to test some new hypothesis. In other words, the effects of certain dimensions of communications (e.g., size of group) can be examined by computer conferencing and generalized to all communication media. Suggested lines of inquiry include:

a) Group Size: Expanding several existing kinds of problem-solving experiments to groups of 15 to 25 participants.

b) Lengthy Learning Times: Following Burgess, replicating earlier communication network studies using 600 trials per subject per network, to see if initial differences persist once the learning curve flattens.

c) Socio-Economic Diversity: Replicating experiments such as those by Snadowsky and by Van de Ven and Delbecq on very different kinds of subject populations, such as actual business executives, members of lower socio-economic groups (who have never been to college), and other cultural groups. For example, the instructions to subjects could very simply be programmed in Spanish, for use with Puerto Rican or Chicano subjects. To entice business executives to serve as subjects in an experiment, the terminals could be brought to their offices, and a free lecture-demonstration discussion of computer conferencing and its potential impact on business organizations given as "payment" afterwards.

d) "Canned" Confederates: Many experiments in social psychology employ "confederates" who are instructed ahead of time to say or do certain things to see how the experimental subjects will react. Among the problems of this kind of experimental manipulation is the question of whether the actors in the confederate role will continue to do exactly the same thing as instructed, time after time, with the same degree of verisimilitude. A computer conferencing experiment can include such things as fictional or psuedo-participants, whose statements have been programmed ahead of time to be released at certain times or events in the experiment. The subjects will have no way of knowing that the "canned confederates" are not "real" people, and the experimenter has complete control over their performance.

e) Realistic and Relevant Problems: Simulation and gaming routines can be built into computer conferencing experiments, to explore such things as crisis situations, behavior under stress, and competitive vs. cooperative strategies.

Some Specific Hypotheses:

The most important of the specific hypotheses suggested by the literature search and inferred from a knowledge of the attributes of computer conferencing are gathered below.

1. Though verbal-only and face-to-face communication modes may produce "faster" decisions for small groups or very simple "fact-finding" problems, computer conferencing will produce faster solution times for groups above a certain size (probably about 7) working on complex, value-laden problems.
2. For medium or large sized groups (5 or more) discussing complex problems with no clear solution, computer conferencing will produce a larger proportion of disagreement (Bales category 10) than the face-to-face mode. A corollary of this is that more underlying issues will be exposed than in a committee-type process.
3. There will be generally less pressure to conform to opinions of others or to defer to a single emergent leader, or for those with "latent verbal responses" to refrain from participating. These differences will be manifested by the following contrasts to face-to-face group problem solving:
   a) Less dominance by a single person or persons (measured by distribution of proportions of all statements made and received, as in the Bales experiments), or stated the other way, there will be more equal participation.
   b) A wider variety of ideas or solutions being introduced and discussed by at least two members.
   c) Less tendency for groups to generate a "risky shift".
   d) Higher-quality final decisions.
4. Computer conferencing will exhibit less specifically "social-emotional", non task-related communi-

cations (such as joking, compliments, or inquiries showing personal liking and concern ... or the opposite; personal attacks, put-downs, etc.). The result will be:

a) For fairly homogenous groups solving a generally agreeable problem, it will be less satisfying or personally enjoyable.

b) For markedly heterogenous groups composed of factions which dislike each other or have comflicting vested interests; and/or for very "unpleasant" tasks such as deciding which member of the group should be fired for economy reasons, computer conferencing will be more satisfying to participants.

c) A strong factor influencing these tendencies will be the degree of previous face-to-face communication and sociometric ties among participants. Those who already know each other well on a personal basis will engage in considerable* "social-emotional" statements, though these will tend to be in private rather than public messages.

4. For very lengthy problem-solving tasks requiring a face-to-face meeting in excess of about three hours, computer conferencing will generate more participant satisfaction, more sustained input, and better quality decisions. (This is particularly relevant to "crisis management" type problems, where information requiring a response may come in constantly for days.)

III. The Creation of Standardized Test Procedures

Once data has been collected establishing speed, accuracy, and user satisfaction norms for the various tasks in the original Leavitt- avellas network experiments, they would serve very well as standardized measuring instruments for evaluating alternative man-machine interface designs. These series are so simple that they can be utilized for any user population without having to worry about possible I.Q. or typing skill differentials being

*Bales categories 1, 12 (integration) and 2, 11 (tension management)

responsible for observed differences. Moreover, with the built-in administration and data-reporting features proposed for the software, trials could be run and analyzed very quickly and easily.

To reiterate and provide an example, if a series of data and experimental procedures for networking experiments were developed, then this might be utilized as a kind of standardized body of control data and testing procedures for proposed developments or "improvements" in conferencing hardware or software. For example, suppose one wanted to test a supposedly "user-oriented" terminal keyboard. One could simply replicate a networking experiment that had already been done with computer conferencing, substituting the new terminals. Differences in the data on comparative speed and satisfaction could then be attributed to the only factor that was different, the new keyboard.

CONCLUSIONS

Thus far, there has been little, if any, controlled experimentation with computer conferencing for the purpose of assessing the impact of this mode upon group communication and decision-making processes. Such a series of experiments ought to be one of the priority items on an agenda fo for near-future research related to the development and assessment of the effects of computer conferencing.

Computer conferencing as a tool for experiments in human group communication opens options previously unavailable to social scientists engaged in this activity. Besides the factors having to do with the greater range of parameters opened for experimentation it also provides for major possibilities of greater realism with respect to backgrounds of communication exercises.

In terms of requirements placed upon software to support such an endeavor, the capabilities appear to be within the state-of-the-art but would have to provide a higher degree of reliability than is exhibited on many time-sharing systems.

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