The FORUM project

Network conferencing and its future applications

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In the course of the FORUM project at the Institute for the Future, 28 experimental computer conferences were conducted on the ARPANET, then analyzed to understand user behavior in this new medium of communication. Examples of actual conferences are presented to illustrate the group dynamics and user reactions observed, and to project potential applications of teleconferencing through computer networks. Guidelines for these applications are derived from the identification of five distinct *styles* of computer conferencing that are best suited for specific research and management tasks.

Keywords: computer conferencing, teleconferencing, FORUM, evaluation, electronic media, communications, group dynamics.

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Introduction

For approximately two years, the Institute for the Future has been in the position of observing the early development of discussion and information exchange activities among users of the first computer conferencing system available through a network. The computer science issues related to the development of this system have been described elsewhere [5], as well as some of its first applications [7,6]. The purpose of the present article is to provide an overview of the potential applications of computer conferencing that have emerged from the analysis of 28 experiments performed on the ARPA network.

In these experiments, approximately 150 scientists used the Institute's FORUM system to participate in conferences via terminals in their offices or at home. A FORUM conference can vary from an open-ended discussion – in which the topic is simply introduced and the discussion evolves without prescribed direction – to a carefully preorganized discussion. In these more structured conferences, the FORUM program becomes a meeting hall with many rooms, dividing the conference into activities according to topic. For still more structured needs, FORUM will administer questionnaires or secret ballots and report the results. (As early as June 1973, one of the first versions of FORUM was used to link a dozen geological experts from the Office of Resource Analysis of the U.S. Geological Survey in three different cities with two large data bases [4].)

In some ways, even the most unstructured computer conferences are more structured than face-to-face communication. But in other ways, FORUM provides greater freedoms. It is difficult, for example, to compel a FORUM user to direct his comments. It is impossible to either shout down or interrupt any other person in a computer-based "meeting". And finally, all participants may "talk" at the same time; the computer simply records the entries according to the time at which the user began typing. This ability to make simultaneous entries in a computer conference compensates for potential limitations in typing ability. All participants can be thinking, reading, or typing based on their own preferences and abilities.

Given all of these alterations – physical isolation, dependence on the computer, suspension of time and space, reduced obligation to communicate, and a new set of communication structures – it is not surprising that computer conferencing might actually establish a state of communication in which the realities of

face-to-face communication are distorted and significantly new patterns of interaction emerge. These new patterns represent a major departure from the concept of "electronic mail" or "message exchange", which are usually examined solely from the standpoint of software performance. *Accordingly, we have assumed the view that computer conferencing is a unique medium of communication to be analyzed as such.*

The social aspects of communications media have rarely been evaluated, and starting points are not easy to find. However, the computer conferencing medium itself provides two powerful analytic tools for evaluating its social characteristics: (1) an up-to-date machine-readable transcript of every computer meeting and (2) usage statistics gathered automatically and unobtrusively by the computer, revealing patterns of communication among individuals, groups, and subgroups. Each of these points deserves elaboration.

The Transcript. A complete transcript of the public entries in every computer conference is always available, current, and machine-readable. This transcript is recorded exactly as it is typed, and members can automatically review the record by subject, author, and date, both during and after the conference. The possibilities for analyzing the content of the discussion are thus greatly improved over most other media. Using one analytic technique, for example, we have broadly classified entries by content, identifying them as regulatory comment dealing with the group process, comments on the substantive topics in the conference, humor, novel ideas, and similar classifications. In this way, it has been possible to evaluate a group's ability to focus on a particular task and also to study the actual allocation of time.

The transcript allows a tracking of specific discussion topics over time, and we have identified a strong tendency for "threads" or "chains of thought" to occur in the conference transcript. These topic threads are frequently labeled ("re comment 13"), but the tie is sometimes only implicit, requiring readers to review the earlier proceedings to find out what has been said on a particular topic. The review process is supported by the FORUM program: a participant can, for example, request the computer to search for any entries which mention a particular word, such as "energy". In general, our analysis of topic threads shows that it is possible to discuss several topics at the same time, occasionally dropping one thread and then picking it up again later.

In addition to tracking the content of discussions, the roles of different participants can be studied. We have found, for instance, that some persons tend to introduce many new ideas, while others are best at developing them, and still others function as synthesizers. The roles can vary greatly among persons and conferences, but we have noticed an apparent tendency for the "provocative" and "synthesizing" roles to be mutually exclusive. The "provoker" seems to push the discussion forward into new areas of thought, while the synthesizer ties the loose strands together. By examining the content patterns of a FORUM conference, then, one can usually identify both key persons and key ideas.

Usage Statistics. The computer iself can unobtrusively map many dimensions of the interaction that may or may not be evident from the transcript. The ability to map these interaction patterns within a conference may be the most powerful analytic tool available for any current communications medium. This capability of computer conferencing means that some of the detailed coding and painstaking observation that social psychologists must typically carry out in analyzing small groups can be done automatically here, without disturbing the normal communication process. Private message statistics, for example, may indicate the formation of subgroups, cliques, or coalitions. Similar statistics allow us to trace individual participation characteristics from one conference to another as a function of topic or task. In addition to individual characteristics of participation, we can evaluate group characteristics with growth curves. When plotted for the content categories, these curves can indicate if and when the conference has made a transition from the procedural questions inherent in any meeting to the solution of substantive issues.

Given this analytic approach, our research has produced a series of case histories. Over the period from May 1973 to December 1974, we have conducted 28 conference with FORUM (Fig. 1). Four successive generations of computer conferencing systems (FORUM-3, -4, -5, and -6) have been used in these conferences, which varied in task type from staff meetings and note exchange to crisis resolution; in length, from a few hours to four months; and in group size, from three persons to several dozen. These conferences are listed in Table 1. The overall case study effort has represented about 1,500 user-hours and a total of 9,000 entries. (In addition to this material, we have created many conferences for purposes of demonstrations, system tests, and special

Table 1. Conferences conducted on the ARPA network.

C1	A U.S. Geological Survey Conference designed to test the feasibility of linking computer conferencing with large-scale information retrieval systems.
C2, C3	An Institute staff meeting conference over a six-month period, with the FORUM medium serving as a continuous communication link, even during hours when the Institute offices were closed.
C4	A strategic planning conference held between the Institute for the Future and the staff at an organization which we shall refer to as XYZ; the goal was to investigate the problem of connecting several remote, local groups involved in the planning and coordinating of a major public event.
C5	A 30-day FORUM conference between the Washington State Planning Office in Olympia, Washington, and a consultant working with them in Palo Alto, California.
C6	A conference, jointly arranged with Bell Canada, in which 35 researchers assessed telecommunications as a substitute for physical travel.
C7, C8	Conferences made available to users who had a specific interest in expressing their reactions to FORUM, in documenting system errors, and in suggesting new features.
C9	A conference involving three persons who were engaged in planning a seminar, writing letters, assigning tasks, and generally accomplishing goals of their project during a period when the group leader was confined to his home.
C10	A collective notepad conference involving members of the Automatic Programming Group at Information Sciences Institute of the University of Southern California.
C11	A continuing exchange of research ideas with the Communications Studies Group (CSG) in London, England.
C12	A simulation of an international working group meeting on the future of digital data networks. Eighteen students played the roles of delegates to a Geneva meeting of the International Telecommunications Union and defended actual positions of the countries involved. Negotiation and bargaining behavior were monitored.
C13	A conference running in parallel to C12 to gather user comments and reactions from the students involved, who were supported by communications experts.
C14, C15	An internal Institute working group; activities devoted to planning future teleconferencing research.
C16	A special conference with CSG (London) to design with them a questionnaire for the assessment of user reactions to electronic media.
C17	A planning conference on policy research in education, linking Institute researchers and the staff of Lilly Endowment, Inc.
C18	An international conference organized by the Brookhaven National Laboratory of the Atomic Energy Commission to study the effects of sulphur pollution on humans. Twenty participants contributed to this activity.
C19	A conference devoted to the study of experimental learning, linking Dartmouth, Stanford, MIT, and other research centers, sponsored by the National Institute of Social Sciences.
C20	An exchange with planners in the Southern California Association of Governments.
C21	A short-term forecasting experiment with the USGS at the occasion of the Circum-Pacific Energy Research Conference, Hawaii, August 1974.
C22, C23	Staff conferences at the Institute.
C24	An international experiment of brief duration.
C25	A social simulation trial in which participants were asked to use computer conferencing to simulate collaborative planning of a freeway.
C26	A continuation of the conference on policy research in education (C17).
C27	A crisis negotiation simulation where six participants played the roles of national leaders in defending the interests of their countries in a "World Organization" emergency (CRISIS-1).
C28	Another experiment in social simulation with slightly altered rules, involving a range of decisions from total war to peaceful resolution of a conflict involving access to scarce resources (CRISIS-2).

tasks that were not directly related to the analysis of FORUM usage.)

The 28 experimental conferences have provided us with a set of case histories to which we can refer in describing the specific characteristics of the medium and the behavior of its users. In addition, they provide a basis for preliminary generalization about the nature of computer conferencing. Specifically, they lead us to identify five styles of computer conferencing which reflect the duration of the conference, the synchronous or asynchronous nature of the interaction (in synchronous interaction, there are several users in the conference at the same time), the degree of interpersonal interaction and structure, and the purpose. These can be characterized as follows:

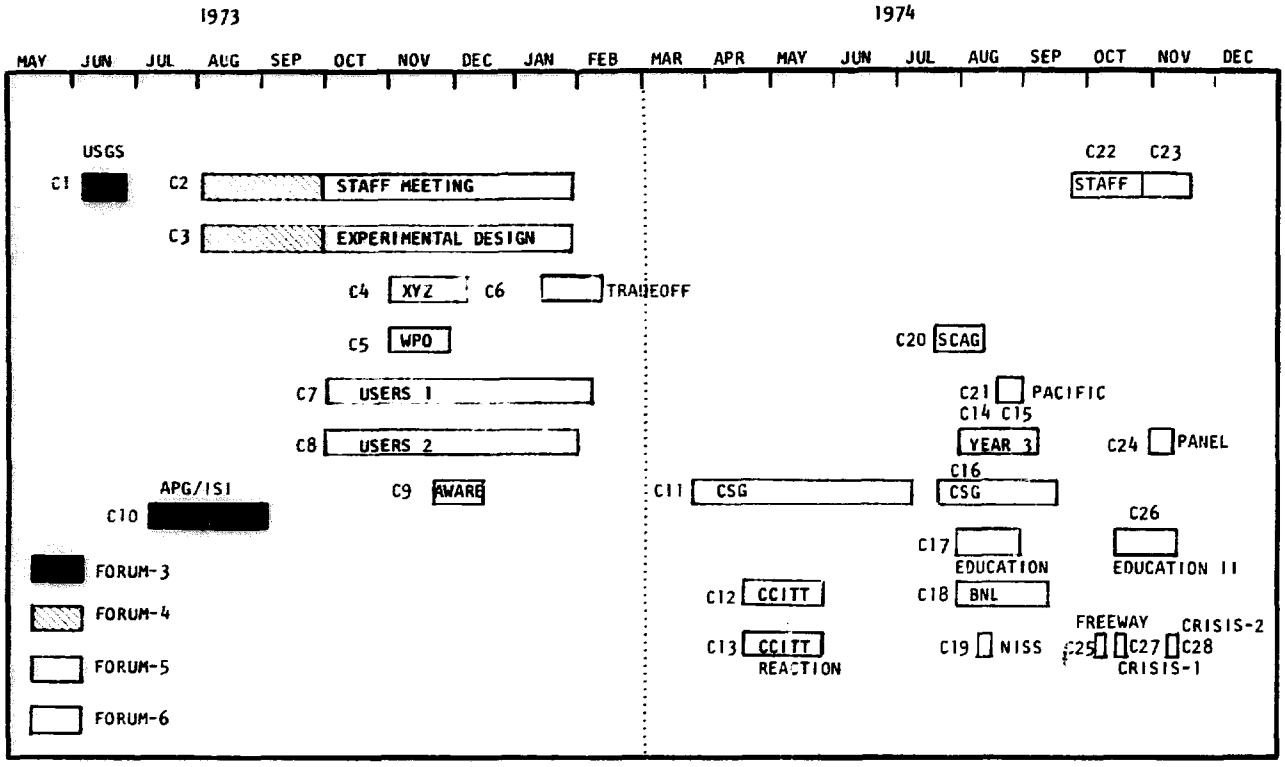


Fig. 1. Schedule of FORUM conferences.

Style 1: "The notepad"

Style 1 conferencing typically involves unstructured groups and a discussion with multiple topics lasting several weeks or even months. It is almost entirely asynchronous with little interpersonal interaction. The simplest example of this conferencing style is the "notepad" activity of scientific research groups.

Style 2: "The seminar"

Style 2 conferencing addresses a specific topic. The most common example is the research seminar or open conference which involves asynchronous usage, possibly with periodic synchronous interaction, and which lasts approximately two weeks to a month.

Style 3: "The assembly"

Style 3 conferencing is an extension of Style 2. The group can be very large (up to hundreds or even thousands of users), and multiple topics, all related to a single general theme, are considered in separate parts of an agenda. This is the style of a "general assembly" of a major professional society, in which papers are presented, panels respond to questions from an audience, and general discussion takes place.

Style 4: "The encounter"

Style 4 conferencing represents the closest computer analog of a face-to-face meeting, in which participants are synchronously discussing a topic for a short time (usually a few hours), possibly with role assignments among the participants (as in simulation and gaming) and with some degree of intensity.

Style 5: "The questionnaire"

Style 5 conferencing involves an unlimited number of participants in a structured question-and-response format. The most common application of this conferencing style is the questionnaire survey, with Delphi and open voting at opposite ends of the spectrum of possibilities. Typically, no direct message exchange is allowed among participants, whose responses are entered anonymously. The conference may last from a few hours to a few weeks.

Most of the interactions we have observed have been in the first two styles, but we have also given our attention to synchronous meetings and some highly structured activity of Style 5. These observations, reviewed below, have uncovered a number of communication opportunities that can lead to interesting generalizations.

Applications

Style 1: The notepad

The "notepad" conference was the first style of computer conferencing to emerge in our study; it was an ideal starting point for the identification of important variables to be examined more closely.

During the earliest stages of our research, an Institute staff meeting was conducted via FORUM (Conferences C2 and C3). The purpose of these conferences – in which nearly a thousand entries were recorded – was to use the Institute itself as an initial test of computer conferencing in long-term group communication. Also, FORUM was still being developed, and I felt it was important for us to have direct experience with the medium as it evolved. The use of FORUM was both synchronous and asynchronous, and access was from both home and office terminals. In addition, two staff members who traveled extensively during the period of this conference took terminals along with them on their trips and submitted into the FORUM conference reports from their activities. All of the staff, at one time or another, made entries outside of normal working hours; in fact, 28% were made from users' homes after 5.00 p.m.

Other notepad-style conferences were held with groups outside the Institute. Examples include a 30-day conference between the Washington State Planning Office in Olympia, Washington, and a consultant working with them in Palo Alto; a 30-day conference between members of the Institute and the Lilly Endowment to support educational policy research; and a conference among nine members of the Automatic Programming Group at the Information Sciences Institute (ISI) of the University of Southern California (Conference C10). Of these, the use of FORUM at ISI best characterizes "notepad" conferencing [1].

During July and August of 1973, the Automatic Programming Group of ISI was pursuing advanced work in the area of automatic computer programming. The research was exploratory, and the general approach was unstructured. The group used several modes of communication:

(1) Formal face-to-face meetings of small groups on specific topics (usually held daily) and of the entire research group;

(2) Informal face-to-face meetings (most of the group members had adjoining offices and saw each other daily);

(3) FORUM transcripts printed on a high-speed printer and edited before distribution at least every few days; and

(4) FORUM in an online environment using cathode ray tube terminals (for skimming the text of other conferences and inputting reactions to hard-copy transcripts).

In this environment, the role of FORUM was quite specific. It was used primarily to store and distribute progress reports, working notes, and thought pieces requiring review and comment. These entries consisted of summarized thoughts, notes of meetings, and synopses, as well as additions, corrections, and comments which referred to the summaries. The notes were not particularly polished, but were generally the "filtered" results of longer, more intense face-to-face meetings. Group members reported:

> "FORUM is used as a reference material and does not include the arguments involved in getting to a particular point."
>
> "Only the good stuff got into FORUM. FORUM was our public relations face."

The ISI conference lasted approximately 42 days and included an estimated 300 entries. This ratio of messages to conference duration is typical of the notepad style. It reflects a low level of interaction and a communication function similar to that of an electronic mail system, except that it supports a group process. Public and private messages are routed to their destination and are stored. Personal interaction is minimal and without formal structure. This is the profile of a Style 1 conference.

(Note: The FORUM-5 program – with minor modifications – is now used at ISI under the name NCONFER and continues to support research interaction under this notepad style.)

Style 2: The seminar

Style 2 conferencing introduces more group interaction and resembles a seminar in which 5 to 30 people – who may be strangers – get together electronically for a period of days or weeks to discuss a single subject. Structure is provided, not by the system, but by a chairman who guides the discussion and establishes the agenda, and who may determine when the objectives of the conference have been met. Nine of our test conferences have been in this style. Two of them – Conferences C6 and C12 – are particularly illustrative.

Conference C6, entitled "Travel/Communication Tradeoffs", was jointly organized with Bell Canada. It was the second generation of a discussion among

researchers which had been conducted in previous years by using telephone conference calls. About 35 researchers were involved, all of whom were in some way engaged in work related to travel/communication tradeoffs, though they were not all previously acquainted. The subject of the conference, which lasted 21 days, was the assessment of telecommunication as a substitute for travel.

The growth curves for public and private messages in Conference C6 show that there were actually more private messages sent that public messages, though the growth curves are not dramatically different. This pattern might be expected to contrast with the interaction in Style 1 for several reasons. The primary objective of most Style 1 conferences is to record information for a larger group, though informally. While anonymous messages might be useful in such situations, private messages are not particularly important. Furthermore, Style 1 conferences tend to link smaller groups of people who are working together closely and who frequently communicate using other media as well. By contrast, Style 2 conferees are not usually in regular contact (they may never have even met each other prior to the conference) and thus may depend more heavily on the private message mode. Also, they may feel restricted in the content of their public messages.

Conference C12 provides a second example of Style 2 conferencing. It was a simulation of a working group of the Consultative Committee of International Telephone and Telegraph (CCITT). CCITT is a powerful standardization organization whose members meet in Geneva on a regular basis. In the actual work of this committee, national delegations come prepared to defend the positions of their countries on subjects such as the interconnection of telephone systems or the standardization of service. Our simulation conference was chaired by Mr. Gerd Wallenstein (who is the chairman of one actual CCITT working group). It simulated an international debate on integrated digital networks, using teams of graduate students to defend the actual position papers available from eight major countries. The role of the CCITT secretariat was played by a NASA communications expert. In all, there were 23 participants.

Fig. 2 shows the growth of public and private messages for Conference C12 over time. The conference shows a negatively accelerated growth in public and private messages sent with more public than private messages. In general, however, when there was growth in public messages, there was also growth in private messages. Fig. 3 shows the public and private message-sending activity of individual participants in the conference.

The striking difference between Style 1 conferences and Style 2 conferences is the increase in both the amount of message sending per unit of time and in the number of synchronous sessions. Conference C12 had a total of 236 messages over 18 days; Conference C6 had 1,070 messages over 22 days, with 81% of the messages sent synchronously. (It should be noted that participants in C6 had much easier access to terminals than did those in C12.) In contrast to Style 1 or "notepad" conferences, Style 2 conferences have either a prespecified duration of a particular goal which tends to produce more concentrated interaction. Also, synchronous interaction tends to increase the amount of message sending per unit time.

A total of 44% of the messages sent during the CCITT simulation conference were sent synchronously. From a review of the transcripts, one can observe that response to questions is usually more immediate in this mode than in the asynchronous mode. In terms of character sending, participants send about twice as many characters per minute in synchronous as in asynchronous interaction (in both private and public messages). Also, asynchronous messages tend to be 50% longer than synchronous messages, with the greatest difference in private messages. Finally, synchroneity encourages private message sending in relation to public message sending, though the effect is quite small. Fig. 4 illustrates this pattern. The majority of messages in this conference (57%) were sent asynchronously. Only 41 percent of public messages were sent synchronously, while 51% of private messages were synchronous.

In general, Style 2 conferences are designed to take advantage of FORUM's asynchronous capability, linking people across long distances, time zones, and variations in work schedules. But they may also include spirited synchronous sessions, typically involving small groups of participants. They provide an opportunity for *guided, purposive discussion* of a subject of common interest as well as a get-acquainted mode. And these functions are reflected in the interaction, which is characterized by similar levels of public and private participation.

Style 3: The assembly

Style 3 conferences are more structured than Style 2 conferences, having many parts within a single conference. Because of this structure, they can both

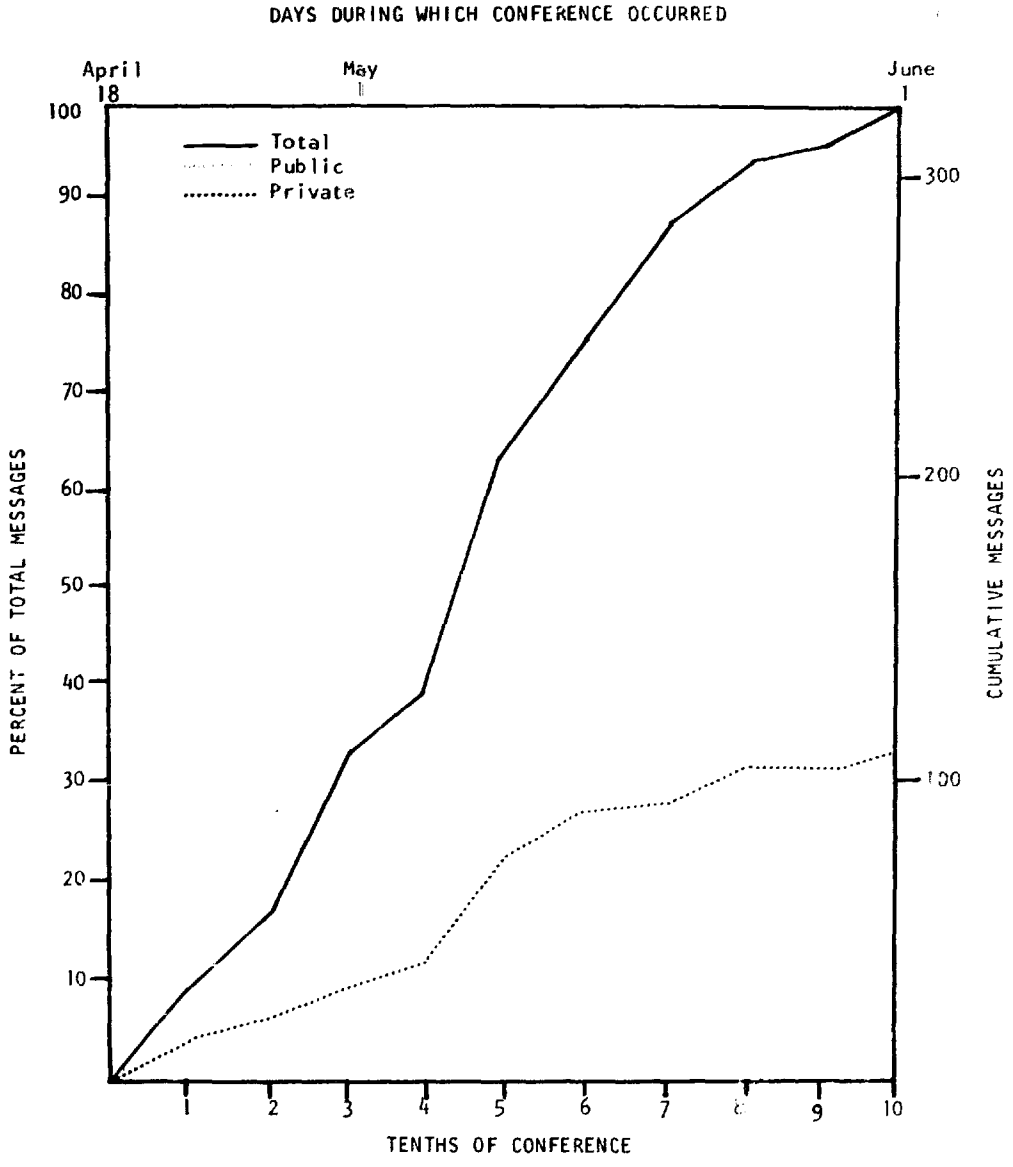


Fig. 2. Growth curves for the CCITT conference (C12).

attract and support many more participants than Style 2 conferences (which would typically be unmanageable with significant participation by more than 30 participants in a single conference). Style 3 conferences thus resemble more closely than any other style the face-to-face professional meetings with which scientists are familiar.

The FORUM-6 program was designed to support the complex structure of assembly-style conferences. The organizer of the conference could divide the activity into any number of parts, each of which would be presented to the participants as they entered the conference. This structuring capability was used successfully in two staff conferences (C14 and C15) as well as in Conference C18 sponsored by the Biomedical and Environmental Assessment Group (BEAG) at Brookhaven National Laboratory from September 20 to November 9, 1974.

The objectives of Conference C18, entitled "The Human Responses to Sulfur Pollutants", were twofold. In the words of the conference organizers:

"BEAG is charged with the development of a quantitative assessment of the biomedical and environmental effects of the energy system. Thus, the problems explored in this conference are of fundamental importance to the BEAG mission. Second, BEAG, as well as a number of other energy research and assessment groups in the AEC laboratories, must work in close cooperation with an extended collection of other investigators if

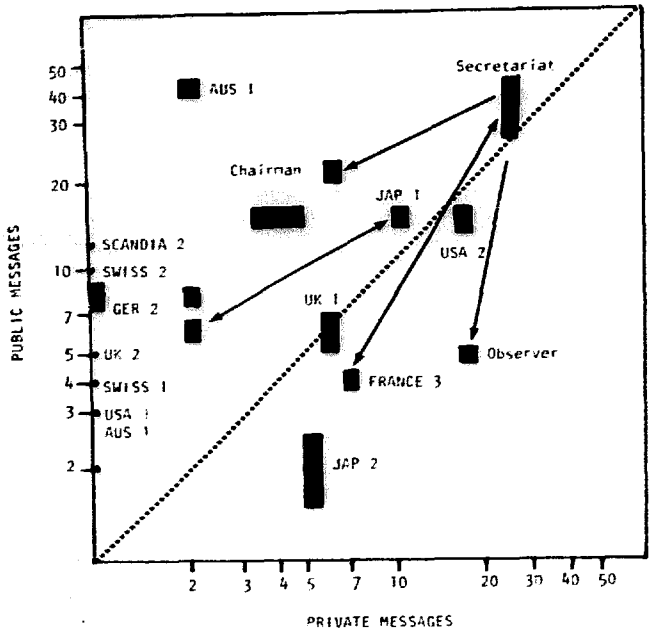


Fig. 3. Participation map for the CCITT conference (C12).

they are to satisfactorily integrate the most current scientific understanding and techniques into their assessments. Computer-based conferencing is a medium which BEAG is anxious to explore and evaluate as a potential way to conduct at least some of these communication and collaborative research activities." [3]

The conference was set up with a seven-part agenda that gave participants an opportunity to introduce themselves, to participate in four substantive discussions, to record bibliographic references, and finally, to discuss their reactions to the system itself.

Activity in all seven parts was tabulated in terms of public and private messages, total number of sessions, and participation rates. Many participants experienced difficulties in gaining access to a terminal and in obtaining a reliable connection to the ARPA network. Computer unreliability posed an additional problem. In spite of these difficulties, the conference

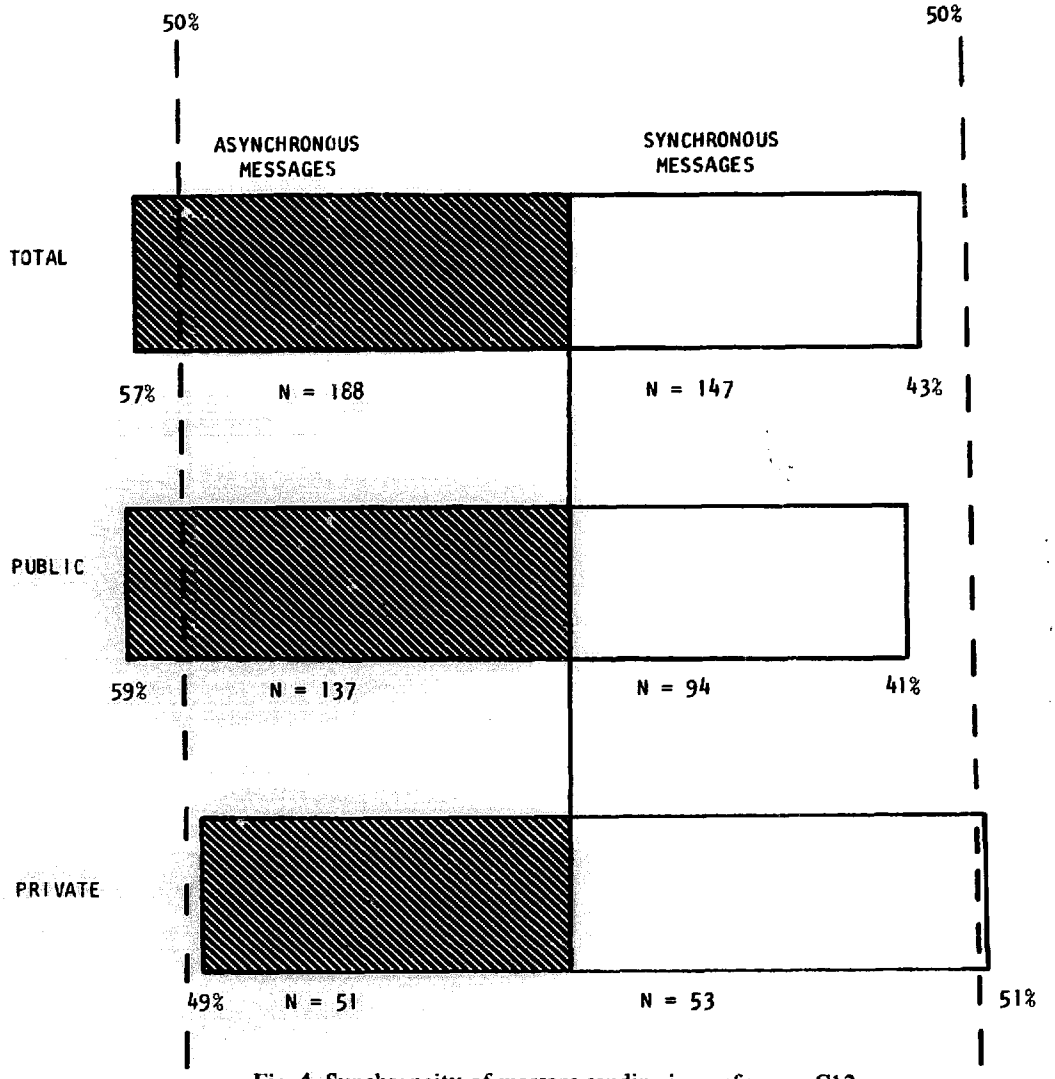


Fig. 4. Synchroneity of message sending in conference C12.

grew rapidly and was generally felt to have demonstrated the feasibility of using computer conferencing in supporting interaction among this typical expert group. Morris and Morgan have summed up the substantive outcome of this conference as follows:

> "A reading of the transcript will reveal that despite the strangeness of the medium to most participants, problems with terminal access, and various reliability problems, a significant amount of technical discussion and communication did take place. Several of the things we learned had direct impact on the BEAG assessment work. The conference yielded valuable technical results."

Style 4: The encounter

Because computer conferencing affords a view of social interaction that is, in some ways, more quantifiable and more flexible than any other experimental setting, we felt that it might lead to a new type of simulation study. Thus, during October 1974, we discussed these possibilities with Dr. Garry Shirts of Simile II (La Jolla, California) who accepted our invitation to serve as a consultant to this project. We reviewed with him the range of social simulations that were amenable to synchronous conferencing on a computer. For the purposes of our initial experiments, the search was narrowed to collaborative planning and to crisis resolution situations.

In a *Science* article devoted to crisis management [2], Kupperman, Wilcox, and Smith have pointed out that computer conferencing might provide a suitable tool for the improved resolution of conflicts:

> "We assume that it will take a decade or so for such systems to develop internationally in such a way that many nations of the world gain sufficient planning experience to engage in computer-assisted crisis management. Nations will then be able to enjoy rich methods of communications that will offer them deep understanding of each other's socioeconomic institutions."

The application of computer conferencing in this environment involves questions of the nature of the communication interface between man and machine, some of which we have already recognized in the course of our own work. It also raises complex problems of social interaction, and *our experience teaches us to be careful in selecting a range of tasks to which computer conferencing can currently be applied with profit.* While the medium has proved excellent in many research and management situations, and promises to serve as an effective substitute for some business travel, emotionladen discussions. which arise frequently in international crises, are not so simply amenable to technological solutions. In particular, there is no guarantee that the medium's ability to support a greater information flow than is currently possible in face-to-face, telephone, or TELEX communication cannot be used to *confuse* rather than enlighten an adversary. Its potential as a *disinformation system* is as great as its current capability as an information system.

To begin a study of crisis situations. we adapted a social simulation game named CRISIS (developed by Dr. Shirts) for synchronous interaction among eight participants. In this game, six of the participants represent nations, while the other two play the roles of "Director" and "World Press". The nations vary in size and military strength, and each has goals of securing a resource of vital importance, as well as striving for the preservation of world order and preventing their own destruction. The game typically begins as the four largest countries (Axiom, Burymore, Camelot, and Dolchaveet) notify the Director of their decisions and actions toward the crisis situation. These decisions, made at the beginning of each of three structured periods, range from a policy of neutrality to committing units of armed forces to take over the mines. The Director notifies all countries when a session period begins and ends, and as a result of their decisions, what consequences have developed relative to the probability of war, their potential loss of office by revolution, and other related possible outcomes.

Two conferences were run on FORUM-6 under these conditions, and the resulting files were analyzed with the help of a special statistical program. All countries exchanged messages among themselves, some using this facility considerably more than others. The participants interacted through the private message mode to form coalitions, and transmitted public messages in attempts to clarify procedures or present national policy statements, which did not necessarily reflect (and often contradicted) their statements made in the private mode.

In the first simulation (CRISIS-1), the Director was informed by two large nations and a small one, toward the middle of the last period, that an alliance had been formed among them. This coalition, based upon the Index of Relative Overall Strength, was enough to preclude the other three nations from any further action. With the coalition formed, the Director announced that the game had ended.

In the second crisis simulation conference (CRISIS-2), the experiment was modified by adding an additional player as Secretary of the World Organization and by structuring more rigidly the three periods of the game. As this conference ended, two distinct coalitions had formed. The two largest nations in terms of military and technological strengths had agreed to an alliance and a commitment to equally invade and control the area of contention; and the two small countries that bordered that mining region joined together in an effort to maintain the resources for themselves. The remaining two, though respectively nonaligned, tended toward more passive and intermediary roles throughout the simulation. With the above relationship established, the Director ended the conference.

Both of these conferences were analyzed for several parameters. First was information flow. As we have already indicated, a characteristic of group interaction during a computer conference, which is not possible with other media, is the ability for each participant to "speak" without restrictions. Unlike face-to-face, audio, or video interaction, in which only one person may speak at a time, computer conferencing allows each person to make statements whenever he or she desires. Theoretically, the total amount of information transferred during the conference is limited only by the typing skill of the participants and the computer terminal printing speed, as well as the ability of the participants to read and process the proceedings.

In CRISIS-1, using the total number of characters transmitted by the group divided by the length of the conference (180 min) and assuming a word length of five characters, we found an information exchange rate of 67 words per minute during the conference. Since the average typing speed was only 27 words per minute for the group, it is obvious that there was a high degree of simultaneous message transmission. (Note: In an analysis of dyadic problem-solving, Chapanis has reported information exchange rates ranging between 10 and 18 wpm for teletype communication, 17 wpm for handwriting, 171 wpm for voice, and 190 wpm for a "communication-rich" environment. See Alphonse Chapanis, "The Communication of Factual Information through Various Channels", *Information Storage and Retrieval*, vol. 9 (1973) p. 224.)

Coalition behavior was another important parameter. Fig. 5 shows the percentage of private messages each nation sent to and received from its allies and adversaries, and reflects the two coalitions that were

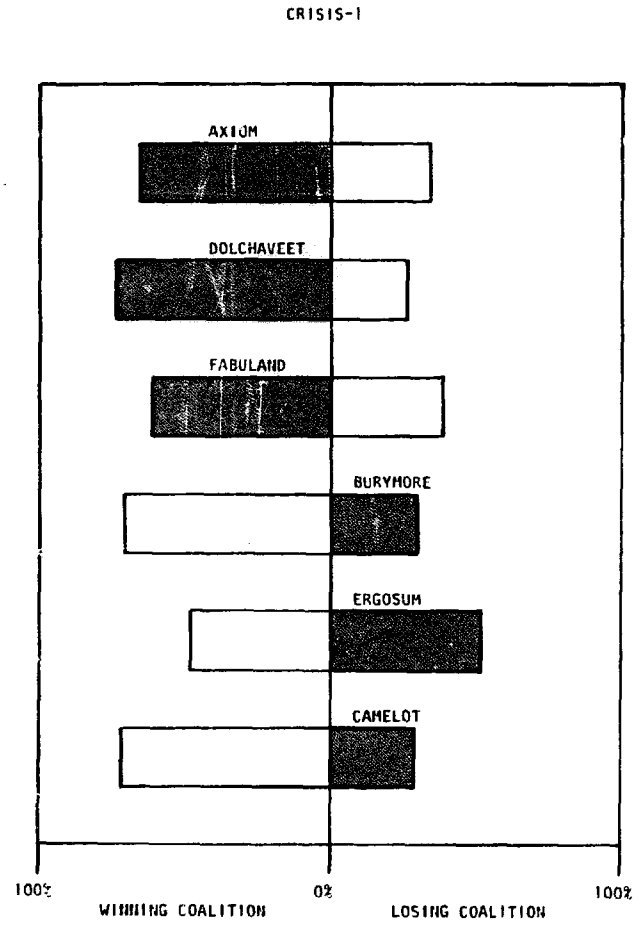


Fig. 5. Percent of private messages sent and received by each nation in CRISIS-1 (C27). The shaded area indicates the percentage of messages sent by each nation to its allies. The message behavior of the losing coalition is dominated by communication with its adversaries.

formed in CRISIS-1. The nations of the "winning" coalition interacted significantly more among themselves than did the "losing" nations (which interacted more with their adversaries). Fig. 6 further displays the private message exchange activity of the six countries. In this graph, the size of each circle is proportional to the number of messages sent by the player *in private mode*, and the thickness of each link between two circles is proportional to the traffic between them. The winning coalition is clearly identifiable in this graph.

In both CRISIS conferences, there was a significantly larger number of private than public transmissions as attempts were made by each nation to solicit support from others and develop alliances and compromises. The participation map for CRISIS-2 shows a marked difference in message-sending behavior between the three "staff" roles (Director, Secretary, and World Press) and the six nations: staff activity tended to be more public, while the rectangles repre-

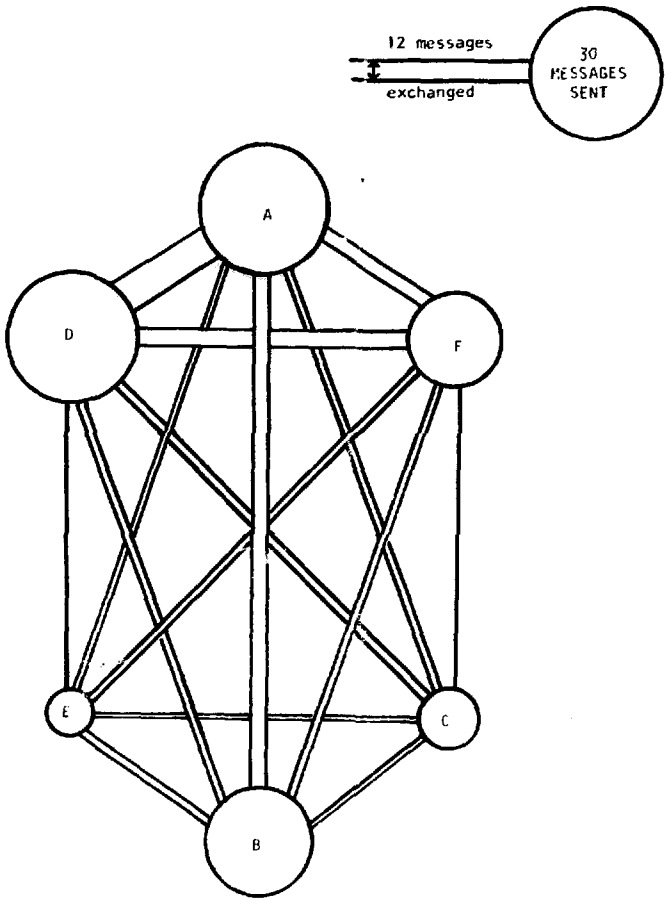


Fig. 6. Private message exchange in CRISIS-1 (C27).

senting the nations clustered together in the "private" region (Fig. 7).

It is of interest to review the similarities and differences between the CRISIS game as it was observed in computer conferencing and as it is known by the game designers to behave in face-to-face interaction. Dr. Shirts has reported:

> "As director [of the FORUM-based simulation] I felt a great deal more control of the game than in the face-to-face mode. I felt confident that if I put something on the machine, it would be read by everyone, or if it weren't read, it would be available for them to read when they had time. I felt in closer contact. In face-to-face games, one is never sure that the verbal requests are heard, and the players have the advantage of "not hearing" in order to gain time or do what they want."

While we have not attempted controlled comparisons, Dr. Shirts notes that face-to-face groups, like computer conferencing groups, start out slowly, with each participant exploring possible alliances with all others while the group is seriously attempting to find a peaceful solution. The turning point takes place when one country makes a secret suggestion for coalition to another country. Face-to-face groups discover such activity faster than computer conferencing groups because each country team can observe the behavior of the other players. (On the other hand, their initial level of trust may be lower.) The deterioration of trust in the computer conference takes place when someone makes the first public accusation that a secret coalition is being formed by others, or when a "secret" message is intercepted – not unlike real world events.

In both media, the trust level then begins to decline; coalitions from rapidly; and "hard" action is taken. The winning coalitions formed by FORUM users have not been typical of the face-to-face coalitions, which usually form along "historical" lines. In about 90% of all face-to-face outcomes, such a coalition ends the game. In only a few cases does the World Organization succeed in establishing an international police force.

In a "control" simulation organized by Dr. Shirts on 2 April 1975, the game was played by 10th and 11th graders at Torrey-Pines High School in Del Mar, California. After two rounds, one country persuaded the four major powers to award it 40% of the resources in return for access to 15% each. The sixth country was entirely crushed and left out of the agreement. This was an unusual ending, obtained after approximately 75 minutes of game.

All private messages among nations were written on paper notes, which were retained and analyzed in the same manner as FORUM exchanges, with the results shown in Table 2 and tabulated side by side with those of the two computer conferences. Considerably more messages were exchanged through the computer than face to face; and the average computer message was longer than the average handwritten message, suggesting greater richness of communication. Although it is clearly not possible to generalize, this type of preliminary experiment establishes the fact that accurate measurements and reliable experimentation using simulation and gaming are now well within the state of the teleconferencing art.

In summary, Style 4 activities represent the fastest, most intense form of interaction possible in computer conferencing. Overall information flow is very high because the interaction is synchronous, and any number of participants may type at the same time. This is the style most conducive to crisis management, to discussion of emotional issues, and to other types of intense interaction.

Style 5: The questionnaire

Conferencing in Style 5 is best characterized as one form of an "electronic questionnaire" – a severe-

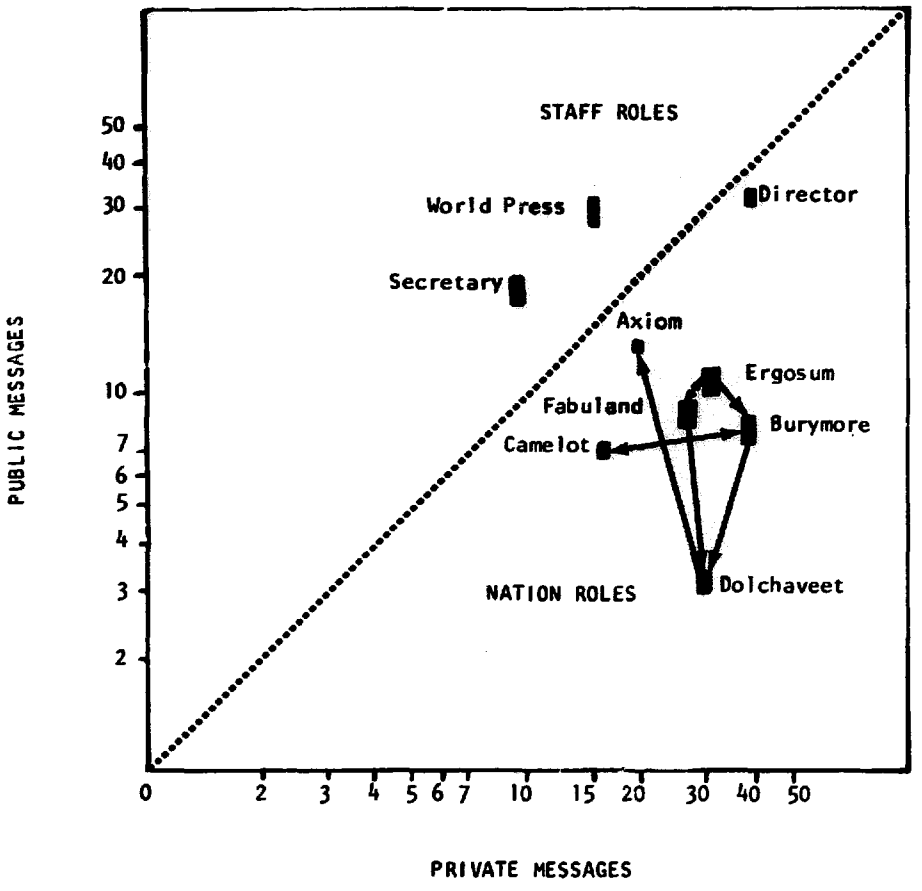


Fig. 7. Participation map for CRISIS-2 (C28).

ly restricted and structured question-and-response interaction which barely resembles communication in the other styles, or even other forms of Delphi. It is made possible in the FORUM program by a series of response-elicitation services. An "ask" command allows any user – but typically the organizer – to ask a question for which FORUM will gather responses in one of four forms (as specified by the inquirer): essay; votes (yes, no, or abstain); number responses; and probability estimates in the form of a range of positive numbers indicating the uncertainty of a respondent with respect to a value of an unknown variable. Such a question, or series of questions, will be presented to the participant whenever he enters the conference.

Table 2. Private messages sent in three CRISIS simulations

Medium	ARPANET						FACE-TO-FACE		
Conference	C27			C28			COMPARISON		
	Messages	Total characters	Average length	Messages	Total characters	Average length	Messages	Total characters	Average length
Nations A	43	6,330	150	20	1,090	54	25	1,165	47
B	44	6,010	136	38	6,830	180	24	1,290	53
C	20	1,270	64	18	1,600	178	12	780	65
D	36	7,530	209	30	3,280	109	11	680	62
E	13	5,610	430	33	6,730	204	18	1,345	75
F	22	4,015	182	29	7,065	244	18	1,520	84
Total	178	30,765	173	168	26,595	158	108	6,780	63

The author of the question may review the responses in one of two forms. He may see the answers identified by participant name or he may simply see a summary of the answers without the identity of the respondents. He may also display the responses in either of these forms for all participants.

The use of FORUM in this style thus resembles a questionnaire survey, with Delphi and open voting at opposite ends of the spectrum of possibilities. While many of our conferences have used this system capability as a part of less structured formats, only one has been devoted entirely to a question/response format which would characterize Style 5 conferencing. This was a conference to test the feasibility of short-term forecasting via FORUM.

Conference C21 was cosponsored by the Institute and the Office of Resource Analysis at the U.S. Geological Survey. It was conducted during the Circum-Pacific Energy Resource Conference attended by mineral economists and energy experts from many countries and was held in Honolulu between 22 and 29 August 1974. Nine experts, who were unequally familiar with the different subjects of the inquiry, were asked to estimate the average December 1974 price for gold, silver, copper, aluminum, and gasoline; these experts included:

a mineral economist from the USGS,
a geologist from the USGS, active follower of gold prices,
a commodity expert,
a geologist, USGS, well-read consumer,
a USGS branch chief, mineral resource expert,
a geologist with a Canadian mineral resource company, formerly a metals commodity specialist,
a USGS geologist, specialist on South America,
a mineral resources expert from Mexico,
an economist on the Institute for the Future staff.

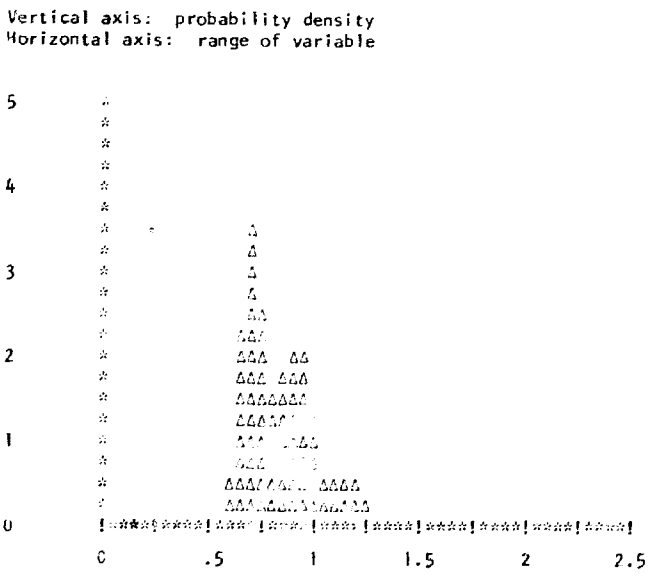
All participants were provided with information on current price history, including average prices for June 1973, December 1973, March 1974, and June 1974. The probability elicitation function of FORUM-6 was used to prompt them for future values in the manner shown in Fig. 8.

The results of the conference told more about the limitations of the Delphi technique than about future commodity prices. A typical example here is the case of gasoline, for which even the low forecast is about 30% above the actual value. The same trend is observable for all commodities we studied. In retrospect, several procedural improvements would have helped to better encode the state of information available to

[1] Askevold Friday 23 August 74, 12.26p.m.
Past history (U.S. refinery) $/lb:

6/73	$0.59
12/73	0.66
3/74	0.63
6/74	0.86

[2] Askevold Friday 23 August 74 12.29p.m.
I would like you to forecast the average December 1974 price of copper in dollars per pound.



Summary of probability estimates:

No. of responses: 3

10% projection	0.6565217
50% projection	0.815
90% projection	1.05
Expected value	0.8375
Standard deviation	0.1569567

Fig. 8. Sample transcript from the circum-Pacific conference (C21).

the experts:

(1) experts who knew more about the subject in question could have been given more weight;

(2) the experts' opinions could have been corrected for their assessing ability; such a correction typically would have spread their estimates by a factor of at least two;

(3) information exchange between the experts would have helped – assuming that there was at least one member of each respondent panel who could have explained which variables might affect the future price.

When we later asked the participating experts to explain the process by which they arrived at their individual estimates, the results were seen more gen-

erally as illustrating some of the basic problems inherent in group forecasting. There was a widespread tendency in mid-1974 to overestimate all future price rises because of the strong inflationary pressure of the previous months; and it is doubtful that, short of a discussion between the experts, this bias could have been eliminated by more Delphi "rounds". As can be appreciated, the structuring of forecasting questionnaires and the identification and calibration of experts are processes which go beyond the effects of computer conferencing.

In terms of group interaction, Style 5 conferences are fundamentally different from other computer conferencing styles. Synchroneity is largely irrelevant since the structure does not encourage variations in rate of participation or length of entries – factors which are related in other styles and, in fact, characterize them. Anonymity, on the other hand, may be all-important in the results.

Other dimensions inherent in computer conferencing are important for forecasting procedures, and the availability of this medium opens the door to a detailed, quantitative study of their significance. Following the criticism of the procedures used, one might ask, for example, whether a group operating synchronously would work better with a predetermined, debate-terminating algorithm than with a chairman alone. Does the positive aspect of anonymity (for results of a decision-making problem) depend on all participant's having knowledge of the skill or expertise of others? Is elicitation of distributions more time-consuming, but more accurate than elicitation of point estimates?

Such questions properly belong in a long-range study of the medium in an environment where Style 5 activities are a matter of everyday routine, rather than a laboratory exercise. The availability of FORUM in such operating environments (notably at the U.S. Geological Survey, which has funded the implementation of a tailored version of the FORUM program by our group for its own computer; and at NASA [8]) promises to lead to new data in these areas.

Conclusion

Since the completion of the experimental conferences reviewed here we have implemented two new teleconferencing systems (PLANET-1 and PLANET-2) on commercial time-sharing networks. We have thus had the opportunity to observe the behavior of users in an environment where cost became a significant variable. We will report on these experiments when detailed analysis is completed.

Applications of computer conferencing in the future are likely to center on activities of Styles 1 and 2. We expect them to be used to *supplement* face-to-face meetings more than to replace them. The most obvious applications lie in the area of task force management, of contract negotiation and monitoring, of topic-oriented seminars, and in the management of international scientific projects.

In an effort to assess the long-term significance of computer conferencing as a medium of communication, we are now planning new simulation and gaming experiments of Style 4. We expect that such use of computer networking will lead to completely novel forms of group behavior and may, in time, represent one of the most important contributions of the networking community to the changing structure and climate of human organizations.

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