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Computer-Based Communication In Support of Scientific and Technical Work

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Prepared for
National Aeronautics
and Space Administration

Prepared by
Institute for the Future

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COMPUTER-BASED COMMUNICATION IN SUPPORT OF SCIENTIFIC AND TECHNICAL WORK

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SUMMARY

This document reports the results of the first experiments in computer conferencing at the National Aeronautics and Space Administration. Between August 1975 and March 1976, two NASA projects with geographically separated participants used the PLANET conferencing system for portions of their work. The first project was a technology assessment of future transportation systems. A group of 13 experts located throughout the country used the system to prepare and critique a series of documents dealing with inter- and intracity transportation. The second project, unrelated to the first and funded separately, involved 15 principal investigators of experiments with the Communication Technology Satellite (CTS). As part of this project, pre- and postlaunch operations were discussed in a computer conference which is continuing at the time of this writing.

The Institute for the Future, which had developed the PLANET system in the course of its earlier work, provided assistance in organizing the conferences, instructing individual participants, and facilitating the various activities. In addition, it collected monthly usage statistics. These statistics permitted an examination of the group and individual participation patterns for all conferences. They revealed an active use of the medium, as demonstrated by the rapid rate of growth of the conference.

In addition to monitoring usage, the Institute coded the entries according to five content categories: learning, procedural, social, substantive, and administrative. Learning and procedural activities were similar in both projects (about 8 percent and 20 percent of all messages, respectively). However, the transportation group, which was discussing successive drafts of a technical report external to the conference, promoted a greater concern for administration, while the CTS group used the conferencing system for its substantive work.

On 19 November 1975, the transportation study group used PLANET for a management teleconference among 10 participants from 8 organizations. A month later, the same group used the NASA audio-conferencing facility for the same purpose. Participation rates, message length, and other parameters were compared for both media. The distribution of messages among participants was more "democratic" in the computer conference, while technical and social factors tended to make participation in the audio conference uneven. In the computer conference, contributions were equally divided among East and West Coast participants, while the West Coast made 80 percent of all entries in the audio conference.

An analysis of the transcripts provides several observations about the use of the medium to: (1) integrate the communications activity into the workday, (2) provide precision and timeliness of information, (3) replace other media, (4) support other media, (5) handle emergency situations, (6) promote an effective management style, and (7) extend communications beyond working hours. With respect to the last point, it is noteworthy that a quarter of all sessions occurred outside of West Coast office hours; over half of all sessions occurred outside the three East-West "telephone windows."

These conferences also provided the context for an analysis of the cost of computer conferencing. Total expenses amounted to $91 per user per month; *PLANET therefore enabled each of the participants to engage in joint work with other research groups for less than $100 per month.* In particular, six cost components were identified: terminal equipment, communication with a network port, network connection, computer utilization, data storage, and administrative overhead. The PLANET system itself was used by the two projects under study at a rate of $16.33 per user hour; total cost, including communications, terminals, and network overhead, was about $26 per user hour. We expect that this figure can drop as low as $5 per user hour in the next four years *for the NASA environment.* However, training and facilitation are the key to cost-effective teleconferencing and to successful teleconferencing in general.

Based on these observations, this report makes three recommendations to the National Aeronautics and Space Administration:

1. To complement our analysis of system usage with an extensive in-house evaluation of user attitudes and of the potential impact of this medium on research patterns;

2. To include computer conferencing among the array of new communications media that NASA is planning to investigate; and

3. To promote a reduction in the cost of computer conferencing through active investigation of alternative designs.

I. OVERVIEW OF THE PROJECT

The National Aeronautics and Space Administration began using computer conferencing for the first time in August 1975, when a series of teleconferencing experiments between the Ames Research Center and the Institute for the Future were begun. The Institute made available to NASA its PLANET-1 computer conferencing system, which operates on the network of Tymshare, Inc. This system allows people who are geographically separated to engage in group planning and information retrieval, either by agreeing in advance to a particular "meeting" time or simply by running the program at their convenience to review each other's comments. The program is accessible in all major metropolitan areas in the continental United States as well as in London, Paris, Brussels, Lausanne, the Hague, and several Canadian cities.

A. DESCRIPTION OF THE MEDIUM

Let us assume that you are a participant in one of the experimental conferences organized by NASA. You have access to a computer terminal, and the organizer has indicated that the conference is open. The first time you enter, PLANET-1 asks you to type your last name and a personal password. This password may consist of any three letters or numbers and is needed to prevent others from reading private messages that are sent to you or from making entries under your name. If you are registered in only one conference, you are automatically placed in that conference. However, if you are registered in more than one conference, PLANET prints the title of each of them and asks you to choose which one you wish to enter. (An asterisk indicates those conferences in which new entries have been made since you last participated.) PLANET then prints an informational heading and the full title of the conference you select as well as a list of participants. Finally, it tells you if anyone else is present at that moment

and prints all the messages that have been made since you last entered, notifying you when you are up to date. For example:

> [6] Mascy 18-Nov-75 11:57 PM
> Good morning. Welcome to the mini-conference. As the chairman, I will try to keep the discussion moving so that we can cover all of the agenda topics. We will start promptly at 9:30 AM, PDT and end at 11:30. Although we should limit our private messages, they can be used as well as anonymous messages when it is considered in the best interest of the mini-conference. An agenda of today's mini-conference follows momentarily.
>
> You are up to date.

Once you are in a conference, you can make an entry at any time, even if someone else is already typing. As you type, PLANET automatically assigns a number to your entry, prints your name, and then begins displaying the text as you enter it:

> [17] Whorf
> Concerning the summary, a number of comments are left open-ended. For example, P.3 [of the draft] concerning intercity bus service--what regulatory and political barriers are involved--and don't they go far beyond matters related to vehicle width? Again, bottom P.3, what is the argument to support the notion that less economic regulation could lead to fewer but more profitable carriers?

All messages are sent to you automatically as they are finished. If you are not present, they will be reprinted the next time you enter the activity. In this case, each entry will include the date and time it was started.

PLANET also offers a number of services for experienced users who wish to perform specialized tasks. For example, the STATUS command prints the names of all the participants, the time they last entered, and the last entry they have seen:

> (to PLANET)
> STATUS (of participants)

NAME	LAST TIME ENTERED	LAST ENTRY SEEN
Wilson	26-Nov-75 8:51 AM	82
Wood	29-Oct-75 2:46 PM	44
Rollins	21-Nov-75 12:15 PM	79
Bartholow	19-Nov-75 9:28 AM	76
Gibbs	Present	82
Spaeth	26-Nov-75 5:15 AM	82
Mascy	25-Nov-75 10:01 AM	80

Other PLANET services allow you to review previous entries, to submit entries into a private computer file, to join another conference, and to leave the PLANET system.

A person may participate in as many as 32 separate PLANET conferences if the organizer of each one has registered that person's name. The number of active participants in any single conference at any one time is limited to 36. The number of registered participants in a conference is limited to 100. There is no limit on the length of an entry or the number of entries in a conference. Once an entry is in the transcript, it cannot be altered, although it can be deleted by the organizer.

B. THE CONFERENCING PROJECTS

Two unrelated projects were conducted at NASA using this new medium. The first was a technology assessment of future transportation systems; a group of 13 experts located throughout the country used the system to prepare and critique successive drafts of a joint document dealing with inter- and intracity transportation. The second project involved 15 principal investigators of experiments with the Communication Technology Satellite (CTS); pre- and postlaunch operations were discussed in a computer conference which is continuing at the time of this writing.

The Institute for the Future provided assistance in organizing the conferences, instructing individual participants, and facilitating the various activities. In addition, it collected monthly usage statistics. These statistics show a high level of interest in the conferences. Table 1 summarizes the usage statistics, and Figure 1 graphically displays the growth of message sending in each conference for the duration of the project.

C. THE OUTCOMES

A complete assessment of the accomplishments of the two groups during the project is beyond the scope of this report. However, the users themselves have offered their own appraisal of the progress made in the activities.

TABLE 1. USAGE STATISTICS FOR ALL CONFERENCES COMBINED

	August	September	October	November	December	January	February
Number of Participants	8	15	20	29	29	29	30
Number of Sessions	79	132	756	1,125	907	798	686
Number of Hours	11.53	13.11	103.30	128.59	112.42	88.34	71.66
Number of Messages	157	136	941	928	907	691	432
Cumulative Number of Messages	157	293	1,234	2,162	3,069	3,760	4,192
Number of Characters (Thousands)	24	19	178	215	216	155	136
Sessions per Participant	10	9	38	39	31	28	23
Hours per Participant	1.44	.87	5.17	4.43	3.88	3.05	2.39

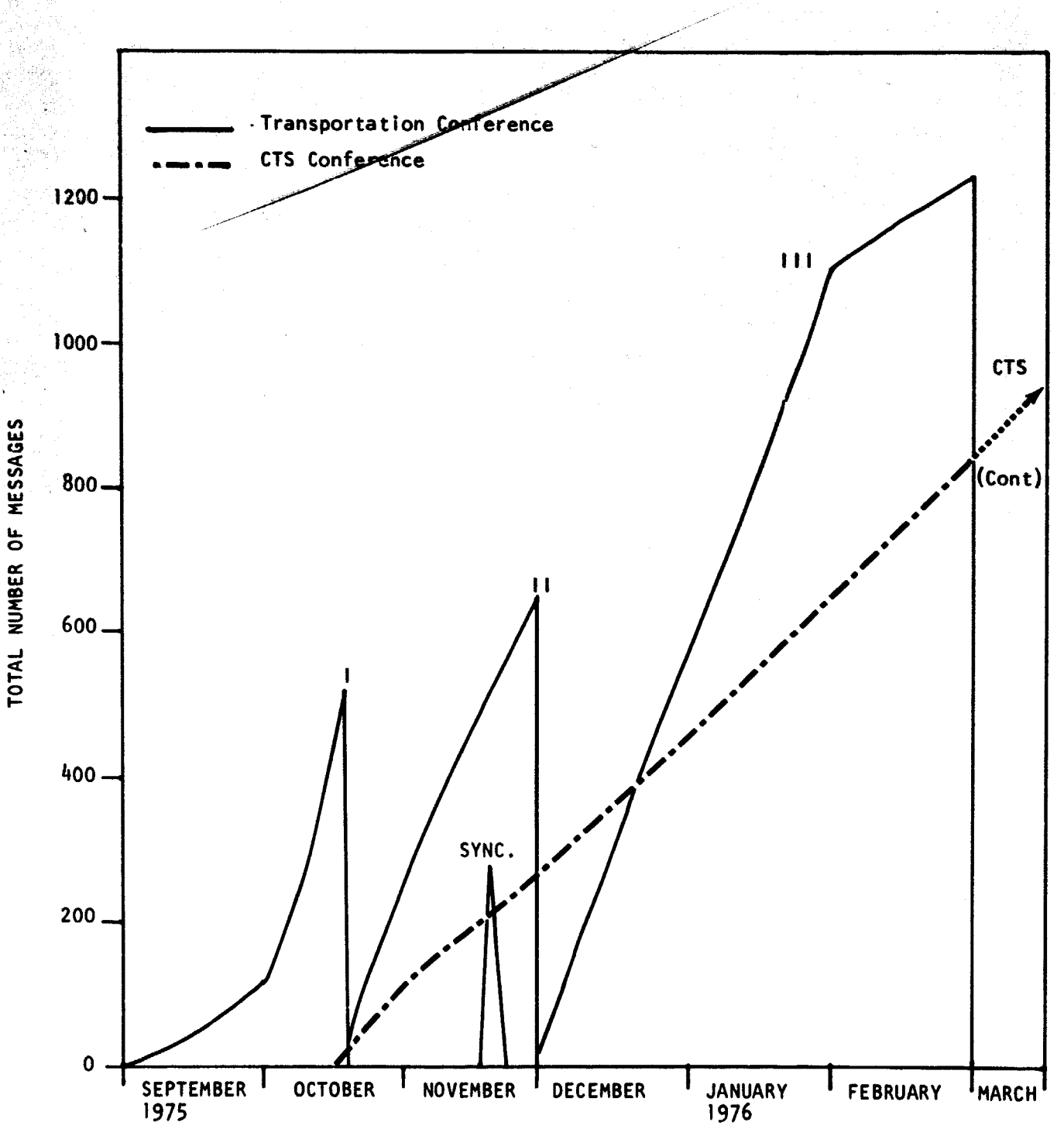

Figure 1. Overview of Conferencing Growth

The chairman of the transportation study group summarized a synchronous conference as follows:

> [201] Mascy 19-Nov-75 12:27 PM
> A brief summary of 200 messages will take a while. Suggest everyone reread transcripts when they are cooled down. Messages 187 and 193 give a partial summary of topics 1 and 2. Topic 3 vote suggested that wide distribution of present critique is undesirable. Opinion is that some of the material should be included in formal report (perhaps appended to workshop report) and some of the critique should be kept in memo format. Most agreed that some cleansing is needed.
>
> Topic 4 went over very good without controversy (I wonder why).
>
> Topic 5 seemed to be resolved in favor of an electronic meeting (probably by telephone amplifiers, model 50A) to take place on December 17 starting at 9:30 AM PDT (and lasting until 2:30 PM ?). The subject--content of preliminary findings and recommendations--requires receipt of draft from PMM prior to the Dec. 17.
>
> Topic 6--not much miscellaneous. (I guess most of us appear to be better critics than creators.) Suggestion that we might call four or five participant friends and see how they are doing on their responses to proceedings report and eventually the recommendations draft report.*

At the end of January, the technology assessment of future transportation systems had compiled the sections of a major document:

> [333] Mascy 30-Jan-76 9:15 AM
> Looks like all reports will have been mailed by today, except for report 9. I have already received reports 2, 3, 4, 6 and expect to return Ames review to PMM on these shortly. Advise all reviewers to get their reviews of these lesser controversial reports in as soon as possible. We should aim for giving PMM our government review of as many reports as possible when we all meet February 11 here at Ames. OK, Bob, Brooks, Bill?

Final arrangements were being made to complete the document and conduct a full review:

---

*Topic 1 was a workshop summary review; topic 2 was a study of findings and recommendations from the group; topic 3 was the disposition of the study; topic 4 was the definition of a schedule for the remaining effort; topic 5 was concerned with the date, mode, and agenda of the next meeting; and topic 6 was open for any suggestions and new business.

[351] Mascy 30-Jan-76 2:22 PM
To all, it is my intent to review report 8 once through on Monday, February 2. If there are no glaring difficulties and if by close of business Monday there are no major and substantive objections raised by the other team members, I am recommending that PMM mail copies of report 8 draft to the study participants.

In the meantime, the CTS project had successfully completed its first two phases; namely, the prelaunch discussions and the coordination of activities of the experimenters during the launch (a critical role for the PLANET system as the date and time of the launch were postponed several times, requiring a great deal of flexibility in everyone's plans). The conference is now in its third phase, promoting the exchange of information on current tests and on satellite availability:

[461] Baker 17-Feb-76 8:37 AM
Nunnally sends to all concerned, primarily to Hunczak. We have not received any direction relative to certain parameters on our S/C time SCD for 10 PM - 4 AM on February 17 and February 18. Assume the time is still valid. Westinghouse personnel will arrive in Baltimore and Lima at approximately 8 PM EST on February 17 if any one wishes to talk with us prior to transmissions. The NC will be located at Baltimore at the telephone numbers previously supplied. The following assumptions will guide our initial transmissions unless we are told otherwise by LRC. This will give a basic insight into our operations plans for this initial test. If different conditions are desired prior to test, please contact the Westinghouse NC by 8:30 PM EST on February 17.

The S/C will be configured with paramp in and no attenuators. Therefore, the Baltimore station will track the beacon signal and start transmissions of carrier with color bars at LRC go ahead. We may shift to video tapes at some point in the evening. Audio will be on the 5.79 MHZ subcarrier.

On receipt of the Baltimore signal in Lima, alignment of their antenna will be made. Transmissions originally from Lima will also be color bars and will probably remain for the duration of the tests period. Lima audio will also initially be on the 5.79 MHZ subcarrier. And away we go. . . .

II. FUTURE TRANSPORTATION SYSTEMS: A TECHNOLOGY ASSESSMENT CONFERENCE

A. CONFERENCE HISTORY

When the conference on Future Transportation Systems began in September 1975, all the participants knew each other. They had worked together for about six months and had recognized a high need for exchange of views among individuals working on the project. A pilot study using the PLANET system offered an opportunity for improved exchange of information. The study was jointly conducted by the Ames Office of Planning and Analysis and the Communications Branch to evaluate the concept of computer conferencing in an application involving an ongoing inter-agency/university/industry assessment of transportation technology.

The objective of the group, whose members are listed in Table 2, was to make a series of recommendations concerning research and development for intercity air and ground transportation through the year 2000. Prior to the start of the computer conference, the group met at a conference in Hershey, Pennsylvania, and began circulating drafts of various sections of the report. The purpose of the computer conference, then, was to promote the orderly critique and integration of these documents while keeping face-to-face interaction to a minimum.

Once the conference began, communication among group members rose rapidly. The rate of private message exchange was particularly high, prompted by the existence of two distinct subgroups--government and contractors. The charter under which the group was formed specified that each subgroup would exchange views among its own members in preparing drafts. This mandate encouraged the use of the private mode until integration in the public mode could take place. It also led to the creation of a new activity for the exclusive use of government personnel on 9 October 1975. On 20 October, the first part of the main conference was terminated, and the second part began.

TABLE 2. PARTICIPANTS IN THE TRANSPORTATION CONFERENCE

Participant	Affiliation	Location
Bob Rollins	NASA Headquarters	Washington, DC
Doug Alexander	NASA-Ames Research Center	Mountain View, CA
Brad Gibbs	NASA-Ames Research Center	Mountain View, CA
Fred Mascy	NASA-Ames Research Center	Mountain View, CA
Dick Wood	NASA-Ames Research Center	Mountain View, CA
Aaron Gellman	Gellman Research Associates, Inc.	Jenkingtown, PA
Robert Whorf	Gellman Research Associates, Inc.	Jenkingtown, PA
Dick Hall	Peat, Marwick, Mitchell & Co.	San Francisco, CA
Dan Haney	Peat, Marwick, Mitchell & Co.	San Francisco, CA
Richard Shevell	Stanford University	Stanford, CA
Bill Spaeth	Transportation Systems Center	Cambridge, MA
William Garrison	University of California	Berkeley, CA
Bill Horonjeff	University of California	Berkeley, CA
Ed Sullivan	University of California	Berkeley, CA
Brooks Bartholow	U.S. Department of Transportation	Washington, DC
Thad Wilson	Institute for the Future	Menlo Park, CA

On 19 November, the study group conducted a synchronous management meeting over PLANET. Figure 2 shows a "time slice" of this conference which demonstrates the capability for simultaneous message generation by conference participants. This activity is analyzed in greater detail in Section IV, where it is compared with an audio conference conducted by the same group for a similar purpose one month later.

On 1 December 1975, the final part of the conference (Part III) was created, and all participants were informed of the tasks before them:

> [5] Mascy 2-Dec-75 8:56 AM
> . . . To all. . . . At this time there is only one activity available to all participants. . . . There is no separate government channel, and the mini-conference of November 19 has been erased. . . . (I have copies of all public messages on all activities if anyone wishes a copy.)

This conference continued until the end of the project on 29 February 1976.

B. PARTICIPATION PATTERNS

We have examined the group and individual participation patterns in this series of conferences. Figure 3 shows a "map" of group participation. This map is constructed by computing four quantities for each participant: the number of private messages sent, the number of public messages sent, the average length of private messages, and the average length of public messages. Such a map allows us to associate various roles with different characteristic participation patterns.

Participation can also be analyzed by examining the relative rate of participation by each conference member. Such a participation ranking is shown in Figure 4 for the main conference and for the special synchronous meeting of 19 November. (Note: facilitators are not included in the calculations for this figure.)

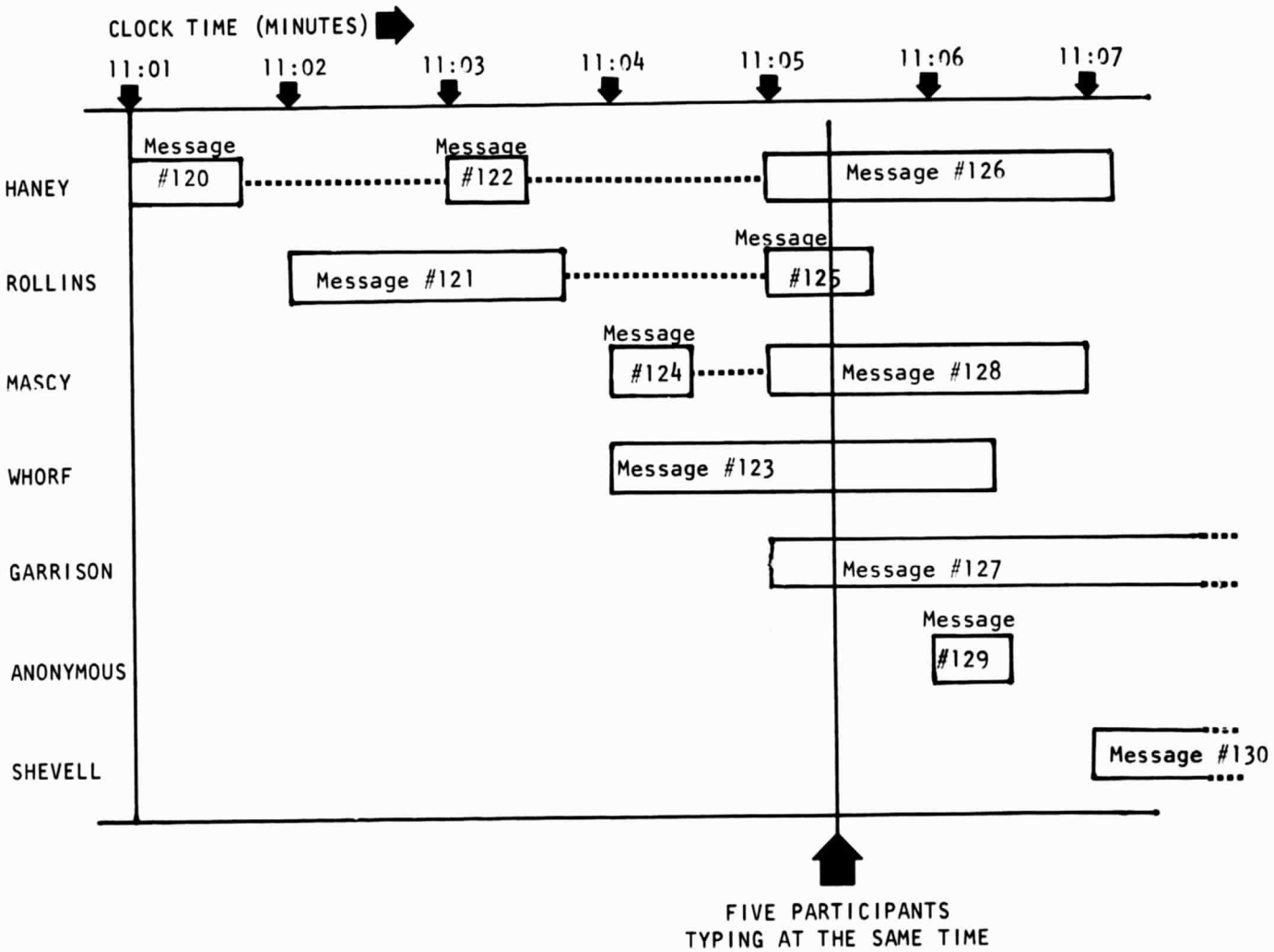

Figure 2. Message-Sending Times in a Synchronous Computer Conference (Showing Simultaneous Message-Sending Capability)

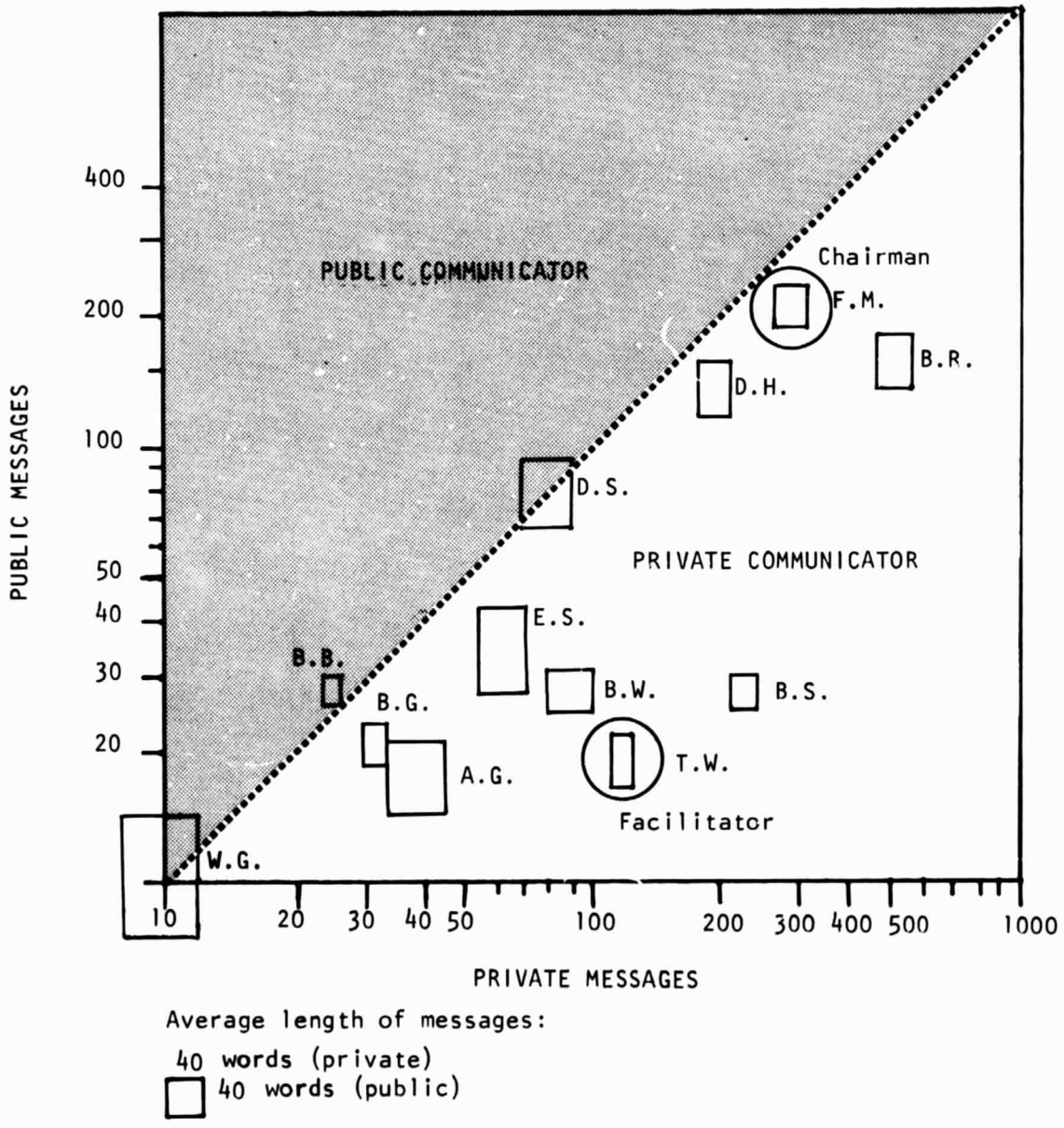

Figure 3. Participation Map for the Transportation Conference, Parts I, II, and III. On this map each active participant is shown as a rectangle. The location of the rectangle reveals whether the participant was a public or private communicator. The size of the rectangle reflects the average length of the participant's messages; the vertical dimension corresponds to the length of public messages, while the horizontal corresponds to the length of private messages. Notice the positions of the Chairman and Facilitator (circled). The chairman made the greatest number of public messages; the facilitator is a distinctly private communicator.

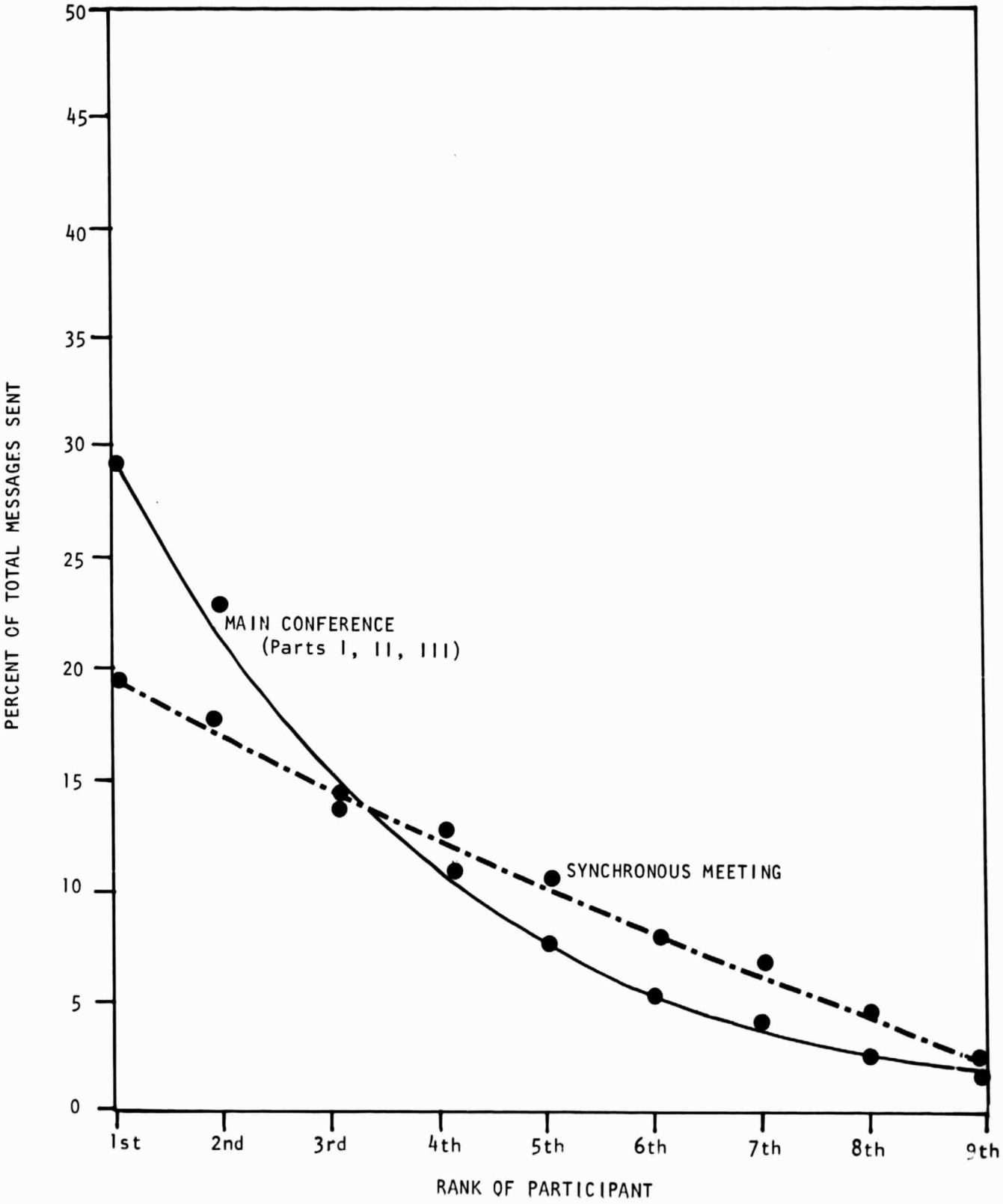

Figure 4. Participation Ranking for the Transportation Conference. This figure shows that the first- and second-ranked participants (i.e., those who sent the most messages) tend to dominate the asynchronous conference more than the synchronous conference.

C. CONTENT ANALYSIS

In an effort to evaluate the use of the conferencing medium for different tasks, we have coded the public entries made during all three parts of the conference into five content categories. These categories include:

1. Learning. Learning entries include all those which are made inadvertently, which deal with the use of the terminal or the software, or which contain "garbage." Some examples are:

[37] Gellman 5-Dec-75 3:19 PM
QUIT

LOGOUT

[48] Rollins 9-Dec-75 5:45 AM
AAF\

} messages made inadvertently

[4] Rollins 2-Dec-75 5:17 AM
To Gibbs, Wilson, or anyone who might know: according to the instruction book on PLANET and my earlier experience, PLANET would interface with a CRT terminal (mine is a Tektronix 4012) in a manner which would allow me to copy a page at a time as it came up on the screen. As the machine no longer asks terminal type, I assume that the capability no longer exists. / ?? ??

2. Procedural. An entry which deals with the mode of group interaction, its structure, and its timing is categorized as a procedural entry:

[219] Hall 14-Jan-76 2:10 PM
Is it customary to invite the non-selected proposers? Based on the workshop experience, I don't think it is a good idea.

[22] Mascy 3-Dec-75 9:32 AM
Reference message 15, Hall. . . . Re: Dec 9 Comcon. . . . Until 9:30 AM is everyone entering views, critiques, etc. or just Hall? If everyone is entering, then they will need draft material before Dec 9.

3. Social. Social entries include those intended to convey humor, feelings, or a personal statement not directly related to either the medium or the substance of the discussion. There were many examples of this type of entry around the holidays:

[3] Anonymous 1-Dec-75 12:53 PM
Looks like the turkey and stuffing dulled everybody's interest in this system. It's so quiet.

[138] Mascy 24-Dec-75 3:27 PM
. . . Gentlemen, I have sincerely enjoyed working with you all thus far. . . . It has been a good year and I look forward to the successful completion of our technology assessment. . . . Have a Merry Christmas. . . . And if I don't see you on the terminal before then . . . have a Happy New Year. . . . Fred

4. Substantive. An entry that deals specifically with the topic of the conference is coded as substantive. Such messages have tended to be much longer than those in other categories, sometimes reaching a page or two in length.

[19] Hall 3-Dec-75 9:25 AM
Re preparations for Dec 4/5 mtg. . . . Draft text has been written for many of the topics in the "A" group of recommendation areas--about 1+ page each. However, we didn't get anywhere with: OMNI rentals, intermodal companies, passenger/freight interactions, role of subsidy, energy sources, or continuing issues research. Hope others will come with ideas on these; otherwise, they go to the "C" group.

5. Administrative. This category deals with the management of the project rather than its research substance. In the transportation conference, most of the substantive material was transmitted through the mail and critiqued in PLANET, which was used to acknowledge receipt of various drafts.

[247] Rollins 20-Jan-76 12:52 PM
To Haney: Where are reports 2, 3, and 4? Were they not supposed to be mailed by Jan 16? What is current schedule for draft report distribution? When will reports 5, 7, and 1 be mailed?

Administrative entries also include those dealing with financial and budgetary reporting:

[57] Hall 11-Dec-75 7:27 PM
To the contractor team. Per discussions last week, let's take another cut at level of effort for study elements. Please report percentage of man-hours in following categories--

1. Planning For and Attending Workshop
2. Issues
3. Technology
4. Scenarios (all types)
5. Evaluation
6. Findings/Recommendations
7. Other

It will be assumed that expenses follow man-hours unless you indicate otherwise.

[59] Hall 11-Dec-75 7:38 PM
To contractor team . . . an administrative matter. . . . Please insure that your next invoice to PMM includes a cumulative total of billings to that point.

Figure 5 shows the percentages of entries in each content category for the three parts of the transportation conference. Figure 6 shows the total distribution of entries for the three conferences combined.

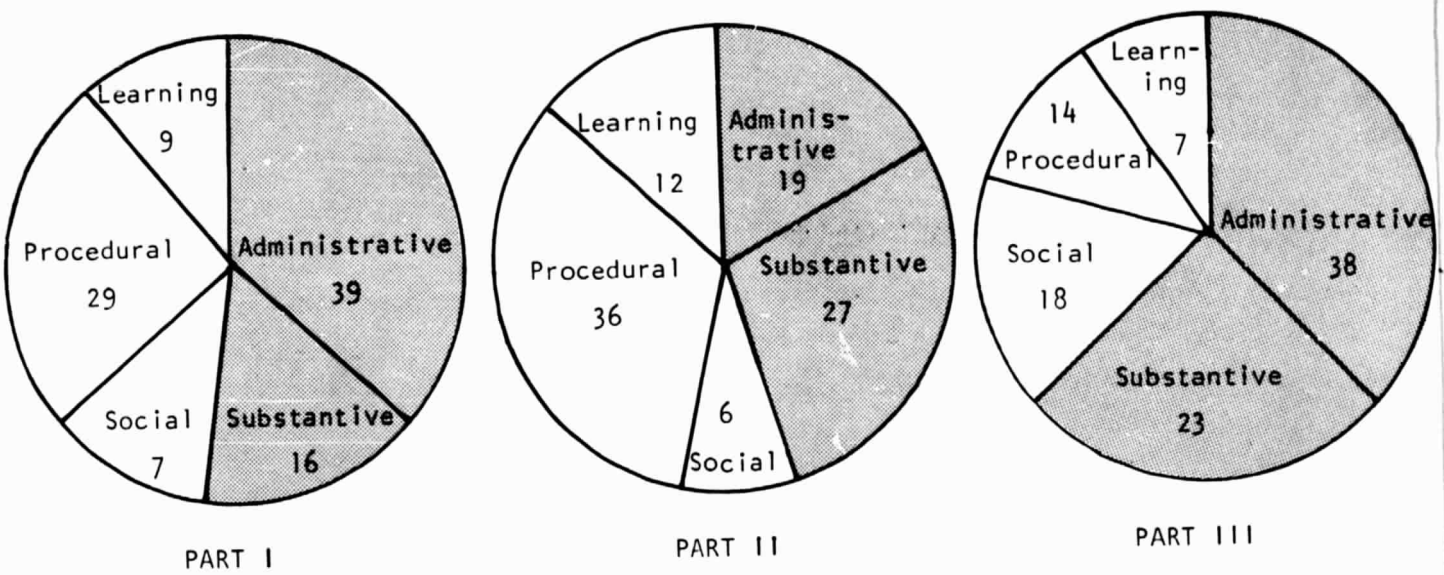

Figure 5. Content Categories for the Three Parts of the Transportation Conference (Percent in Each Category)

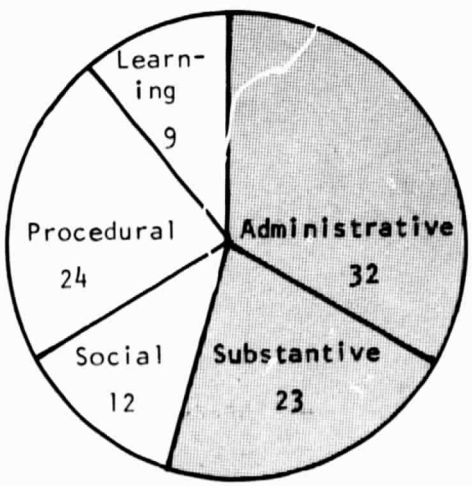

Figure 6. Content Categories for the Transportation Conference, Parts I, II, and III Combined (Percent in Each Category)

III. THE CTS MISSION: A MANAGEMENT CONFERENCE

A. CONFERENCE HISTORY

The Communications Technology Satellite (CTS) is a joint U.S.-Canadian mission involving government and industry teams in a series of experiments with advanced communications systems. The initial objectives of the computer conference were defined in an entry by Mr. Brad Gibbs at NASA:

> [90] Gibbs 29-Jul-75 10:01 AM
> We are planning a two-part study on a limited basis, and if it were successful, it would be expanded to a much greater number. My questions at this time only refer to the initial conference for information; we have a CTS users meeting in Cleveland the last part of August at which time all participants in the first conference will be in attendance, which would be a good time to brief them all at once. . . . Specifics for the two sessions are:
>
> 1. Will include 6 participants, 1 at Washington, D.C., 1 at Goddard, 2 at Lewis, and 2 here at Ames; will last until October 28, and the system will be used for scheduling of experiments, discussions and reviews of general action items, and the planning of a teleconference experiment involving the four centers.
>
> 2. By the users meeting in October, we would have had enough experience to know whether or not we should expand the conference to include all CTS experimenters for such things as:
>
> A. Scheduling of Experiment Time
> B. Status of the Spacecraft
> C. Reviews of Action Items

Figure 7 illustrates the conferencing arrangement. Table 3 is a list of the participants.

This initial conference, which lasted from 17 August 1975 to 16 October 1975, was successful enough to justify support of a continuing conference. In particular, its usefulness was dramatized by the communications which resulted from successive postponements of the satellite launch date. Some typical entries during this difficult period follow:

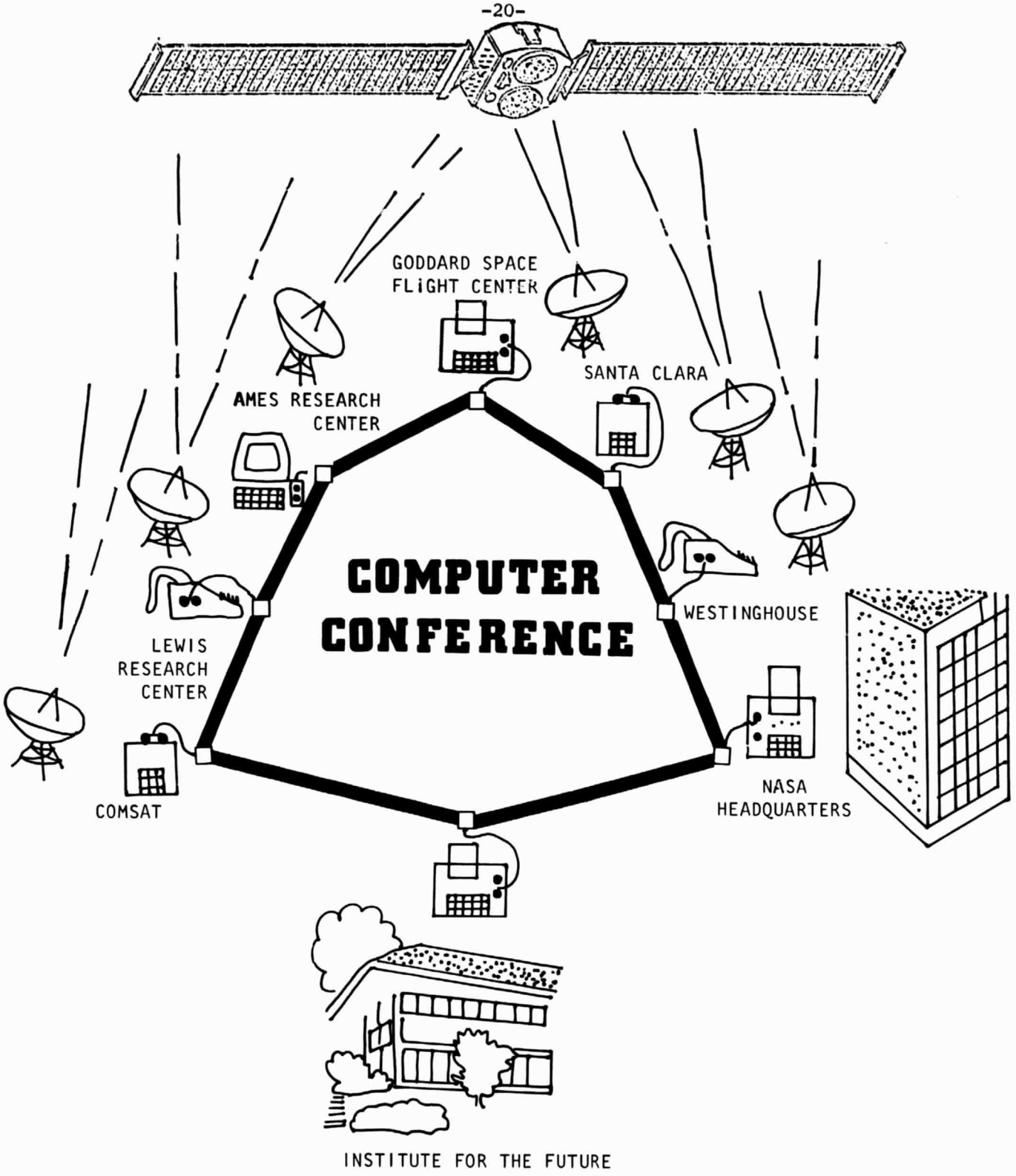

Figure 7. Function of the Computer Conference in the CTS Mission

TABLE 3. PARTICIPANTS IN THE CTS CONFERENCE

Participant	Affiliation
Pat Boyce	NASA Headquarters
Wasyl Lew	NASA Headquarters
Brad Gibbs	NASA-Ames Research Center
Larry Hofman	NASA-Ames Research Center
Dale Lumb	NASA-Ames Research Center
Grayson Gibbs	Archdiocese of San Francisco
Kim Kaiser	COMSAT Laboratory
John Chitwood	Goddard Space Center
Lou Ippolito	Goddard Space Center
Al Whalen	Goddard Space Center
Pat Donoughe	Lewis Research Center
Guy Gurski	Lewis Research Center
Hank Hunczak	Lewis Research Center
Buzz Jackson	Lewis Research Center
Jerry Kennard	Lewis Research Center
Elwood Baker	Westinghouse Corporation
Thad Wilson	Institute for the Future

[96] Lumb 13-Nov-75 9:15 AM
Hunczak. To answer your questions of yesterday. For experiments 16, 17, and 18, the subcarrier frequencies we have hardware for in the analog FM TV mode are 5.14, 5.36, 5.79, and 6.2 MHZ.

For experiment 16, 17, 18, the ARC transmit frequency is 14.2471666 GHZ.

For experiment 4, the ARC transmit frequency is 14.0521666 GHZ with a 25 MHZ subcarrier service channel.

[97] Kaiser 14-Nov-75 9:00 AM
This one is for whoever from NASA is looking. I am working on the link budget calculations for the tech. managers meeting. I have some of it done; the rest will follow. Kim.

I see from the latest entries that people are watching this.

[333] Lew 12-Jan-76 2:47 PM
********** To all! **********
In view of the short turn around between the time that the decision is made (anticipated at noon EST, January 13) and a launch as early as 1821 EST, January 16, it is suggested that all PLANET folk check into PLANET on an hourly basis on January 13, 1976, starting at about 1000 EST.

After the launch, it was decided to continue using computer conferencing to more effectively manage the various experiments. In this phase, the discussion took the form of a "collective notepad." Frequent entries broadcast the satellite status and updated experimental schedules to keep the entire group informed. These entries are typified by the following:

[382] Hunczak 27-Jan-76 9:26 AM
CTS mission status. The station acquisition maneuver conducted yesterday to correct the orbit perigee and which changed the S/C drift to 1.54 degrees west (see message 377) was executed on time. S/C location is now slowly approaching its 116 degrees west station. Two maneuvers remain:

1.	January 28, 1976	6:56 GMT	to 0.37 degrees/day
2.	January 29, 1976	6:53 GMT	to 0.00 degrees/day on station

Handover of the S/C to Canada will be early in the afternoon (17:00 to 19:00 GMT) on January 29, 1976.

[402] Baker 30-Jan-76 12:49 PM
H. Hunczak . . . Here is information you requested from Westinghouse. Lock on the 16-foot antenna step track system at 19:41 GMT on February 3. For those who are looking for other signals, the first planned tests of Transponder will start February 5.

[513] Grayson 1-Mar-76 1:29 PM
Notice to anyone and everyone!!!!!!!!!!
Experiment 16 completed a very successful first checkout period this date from 1700 to 1900 GMT. All systems worked exceedingly well, and problems were minor. My sincere thanks to Ames Research Center and to the EC people who helped make this first transmission so successful. Also thanks to NASA headquarters staff and anyone else who has been involved with us. To so many of you out there, I owe so much. Regards, and I'm on my way to the nearest watering hole. Grayson Gibbs and experiment 16 staff.

B. PARTICIPATION PATTERNS

The usage growth in the CTS conference is displayed in Figure 8; the number of sessions and number of terminal hours are plotted here with the cumulative number of messages. As in the case of the transportation conference, we have mapped participation patterns to reflect the different roles played by different participants. As Figure 9 shows, Wasyl Lew, who was the project leader, is a high public communicator, as is typical of the chairman's role. Wilson has assumed the typically private position of group facilitator.

Figures 10 and 11 show the participation rank (percent contribution to the conference) for participating individuals and organizations, respectively.

C. CONTENT ANALYSIS

The public entries in the CTS conference were categorized in the same manner as the entries in the transportation conference. Figure 12 shows the distribution of categories over the entire conference to date. The percentages of entries in various categories can be compared for the Transportation and CTS conferences. Learning and procedural entries are quite similar (9 percent and 8 percent for learning, 24 percent and 19 percent for procedural, respectively). The transportation study, however, involved a higher degree of social activity, the smallest of all categories for CTS. The relationship between the two main categories, namely administrative and substantive, was reversed for the two conferences. This reversal could be expected since the transportation group was discussing successive drafts of a substantive report external to the conference, promoting a greater concern for administration, while the CTS group used the computer conference for its substantive work.

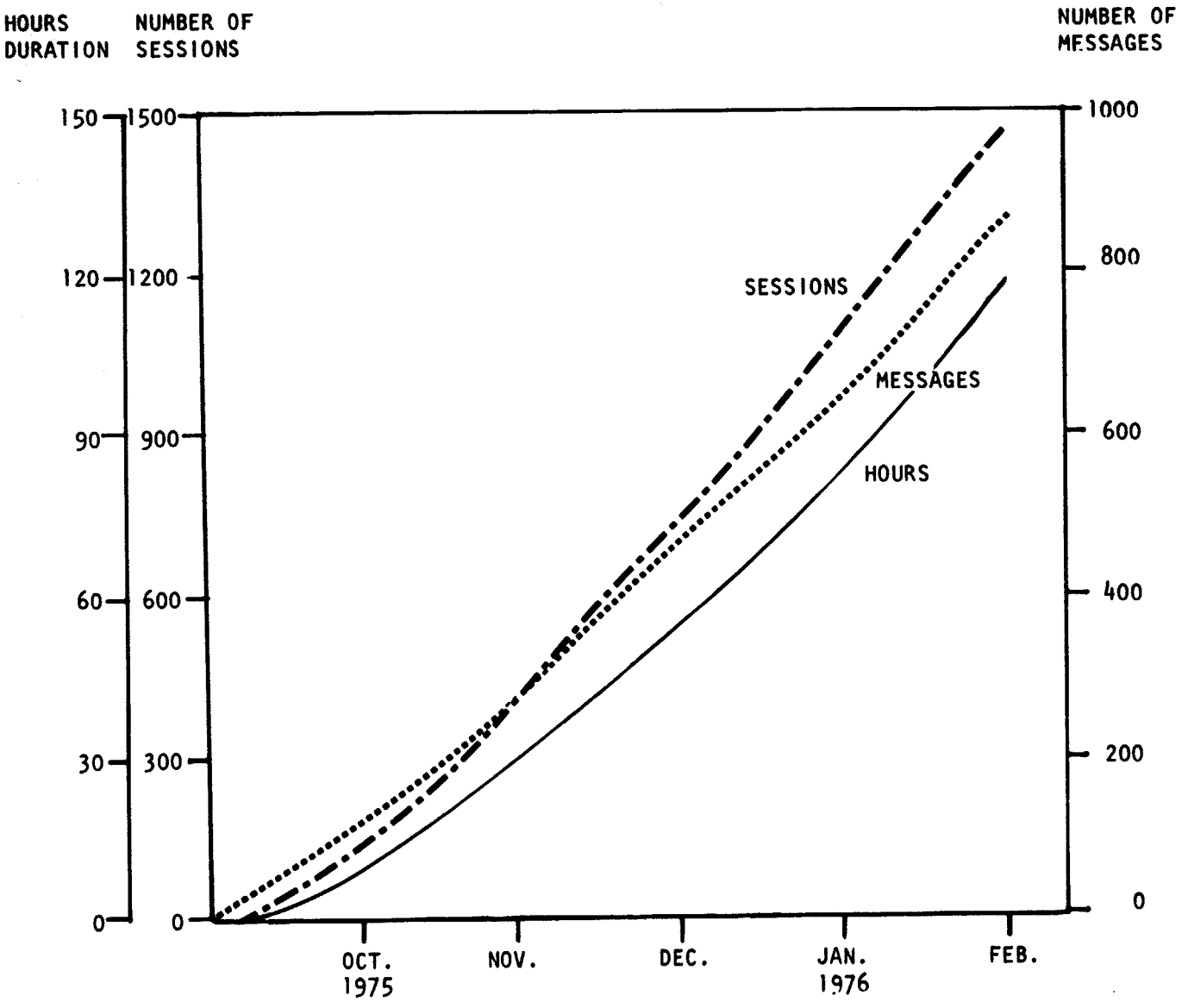

Figure 8. Usage Growth in the CTS Conference

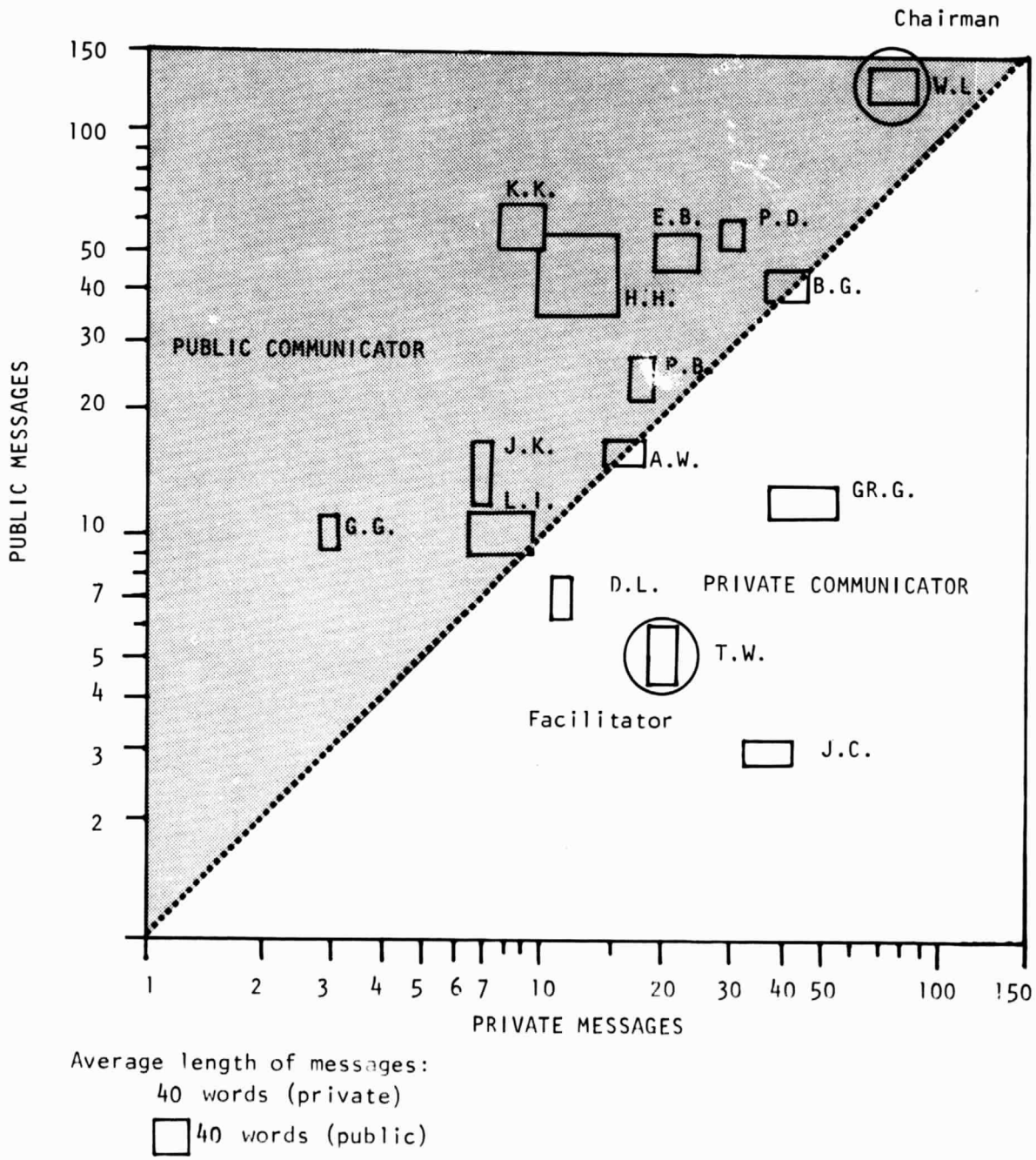

Figure 9. Participation Map for the CTS Conference. As in Figure 3, the Chairman (circled) has the highest number of public messages (and private messages); the Facilitator is again in the private region of the map. Compared to the transportation group, the CTS conference is much more public.

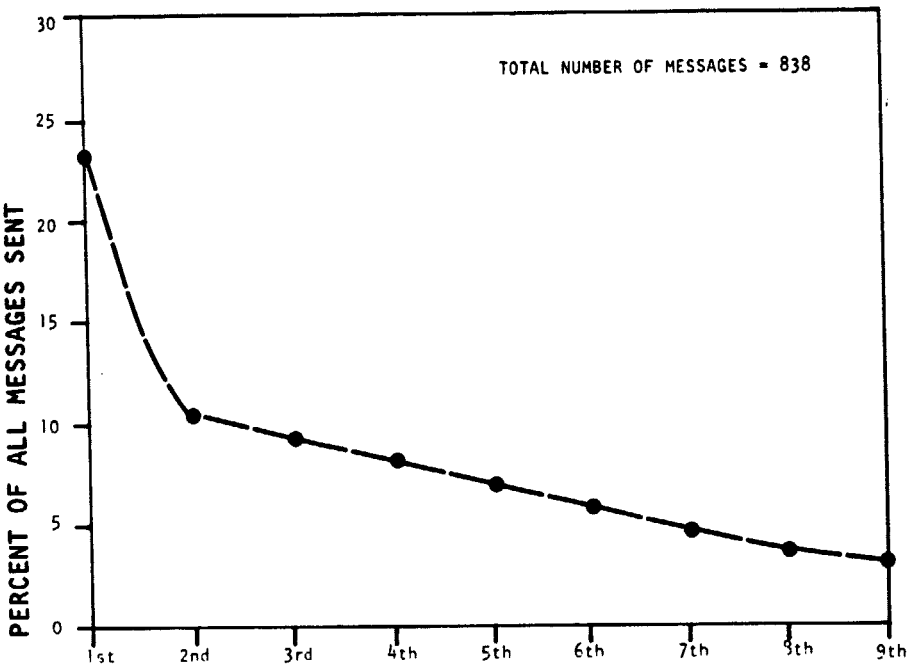

Figure 10. Participation Ranking for the CTS Conference (by Individual). One participant tends to dominate this group, sending 23 percent of all messages. The rest of the group follows a linear decline in participation.

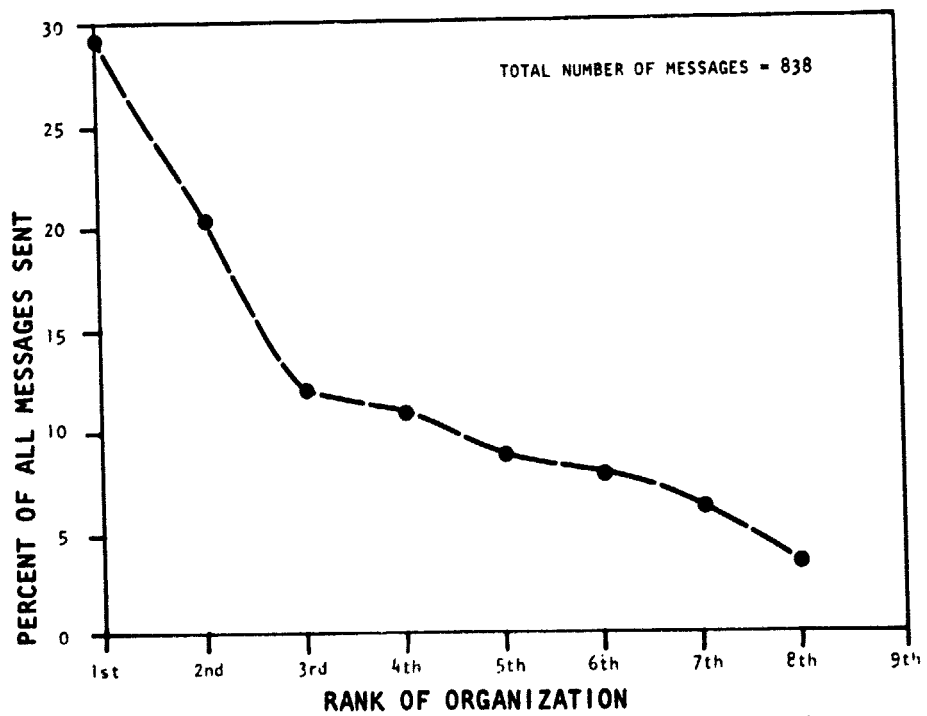

Figure 11. Participation Ranking for the CTS Conference (by Organization). Here again, we find one organization dominating the conference with 30 percent of all messages. The second-ranked group contributes 20 percent. The remaining six organization contribute 50 percent. This pattern is not unlike face-to-face communication.

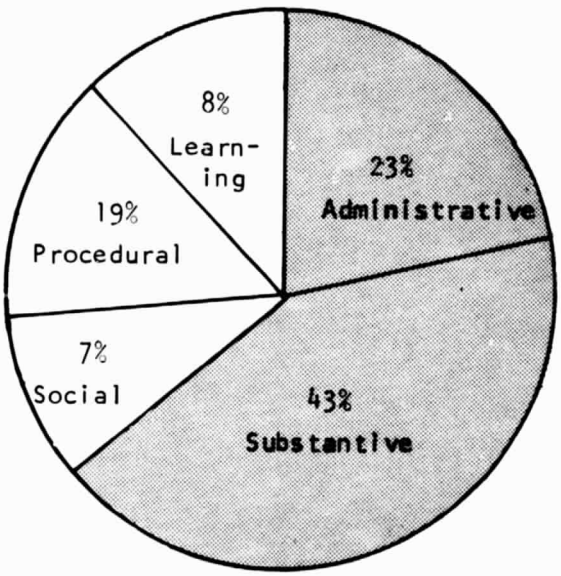

Figure 12. Content Categories for the CTS Conference

IV. COMPARATIVE ANALYSIS OF TWO TELECONFERENCING MEDIA

In Section II, we noted that one of the objectives of the transportation study was to experiment with substitution of electronic communication for face-to-face management meetings. To this end, we have performed a comparative analysis of the synchronous computer conference of 19 November 1975 and an audio conference a month later. The methodology and results of this analysis are reported here.

A. THE SYNCHRONOUS COMPUTER CONFERENCE

This conference of 19 November 1975 linked 10 persons from 8 organizations for two hours, as shown in Figure 13. We have collected statistics on the number of messages, number of words per message, and total time spent typing for each participant in this conference (Table 4). Using these statistics, it is possible to plot a graph which displays each individual in terms of percent of total time typing and percent of total messages (Figure 14). It is also possible to plot the participation rank of each individual, both as a percent of the total messages and as a percent of total time typing (Figures 15a and b).

B. THE AUDIO CONFERENCE

On 17 December 1975, the audio teleconferencing facilities of NASA were used by the same people who participated in the synchronous computer conference described above. Thad Wilson attended the meeting and recorded the entire session on tape. This recording was transcribed and provides the data for this analysis.

The audio conference lasted from 8:30 a.m. to 1:00 p.m., Pacific Standard Time. The seating arrangement at NASA-Ames is shown in Figure 16,

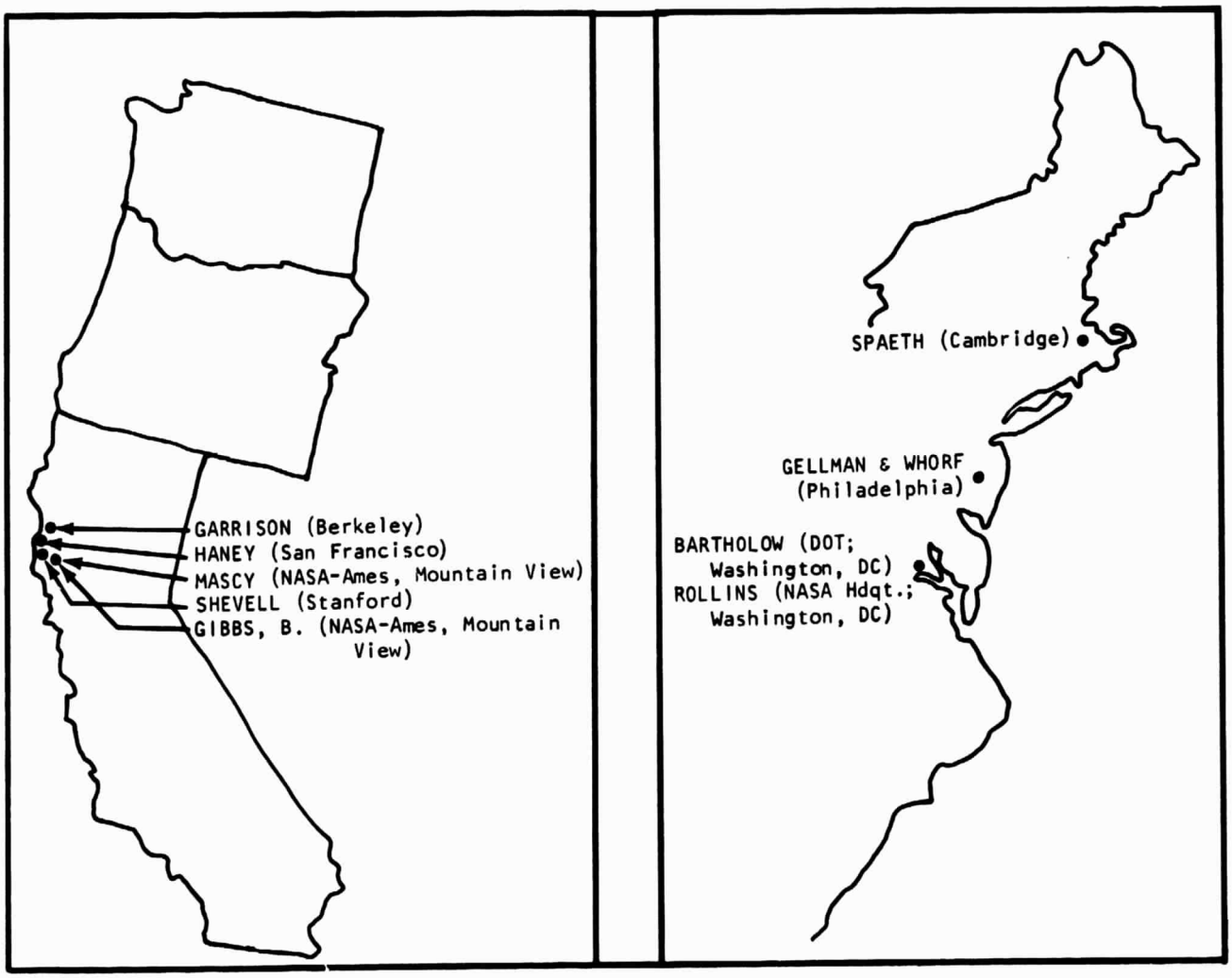

Figure 13. Location of Participants in the Synchronous Computer Conference of 19 November 1975

TABLE 4. USAGE STATISTICS FOR THE SYNCHRONOUS COMPUTER CONFERENCE OF 19 NOVEMBER 1975

Participant	Number of Messages	Number of Words	Total Time Typing (Seconds)	Percent of Total Messages	Percent of Total Time
Mascy	26	927	2,782	18.8	18.5
Rollins	25	803	2,409	18.1	16.0
Shevell	7	406	1,217	5.1	8.1
Whorf	16	518	1,555	11.6	10.3
Haney	18	597	1,790	13.0	11.9
Garrison	18	991	2,974	13.0	19.7
Bartholow	10	448	1,343	7.3	8.9
Gellman	2	22	65	1.5	0.4
Spaeth	3	74	223	2.2	1.5
Gibbs, B.	4	127	382	2.9	2.5
Anonymous	9	112	335	6.5	2.2
Total	138	5,025	15,075	100.0	100.0
Average Length of Entry: 182 Characters (36 Words)					

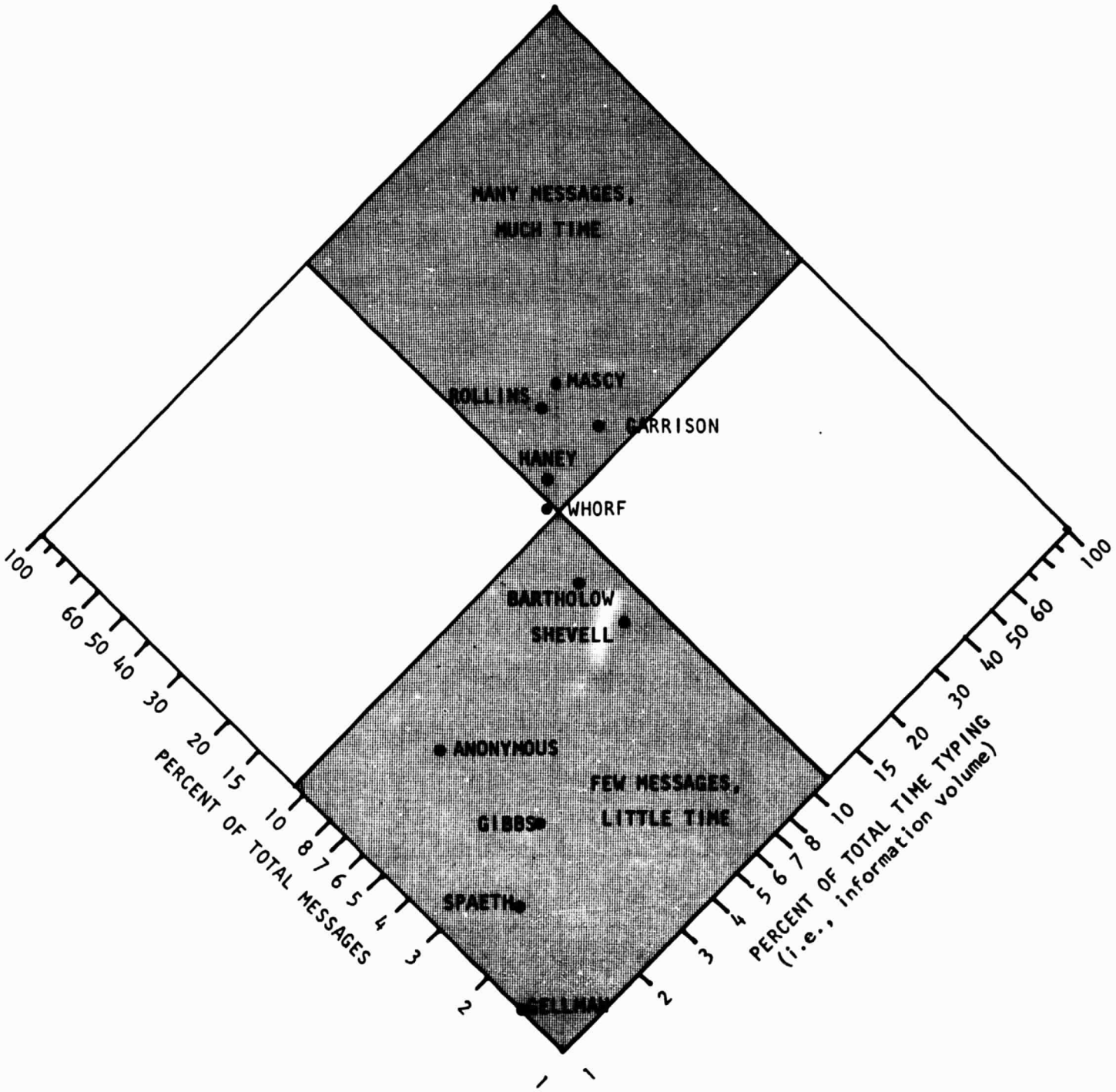

Figure 14. Individual Use of Time in the Synchronous Computer Conference of 19 November 1975

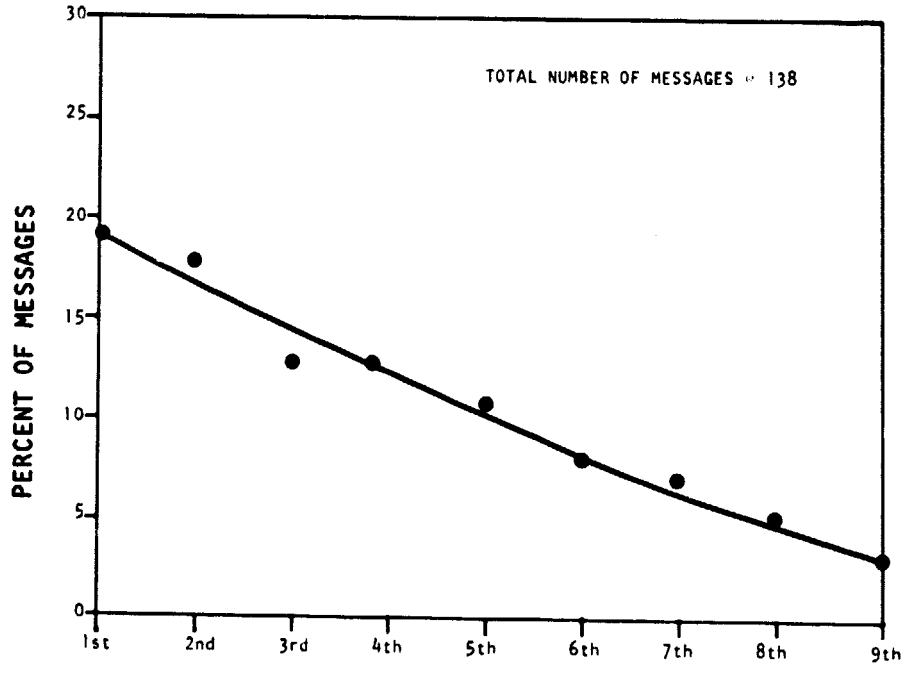

Figure 15a. Participation Ranking for the Synchronous Computer Conference (Based on Percent of Total Messages). Participation here is distributed much more linearly ("democratically") than in Figure 10, for example.

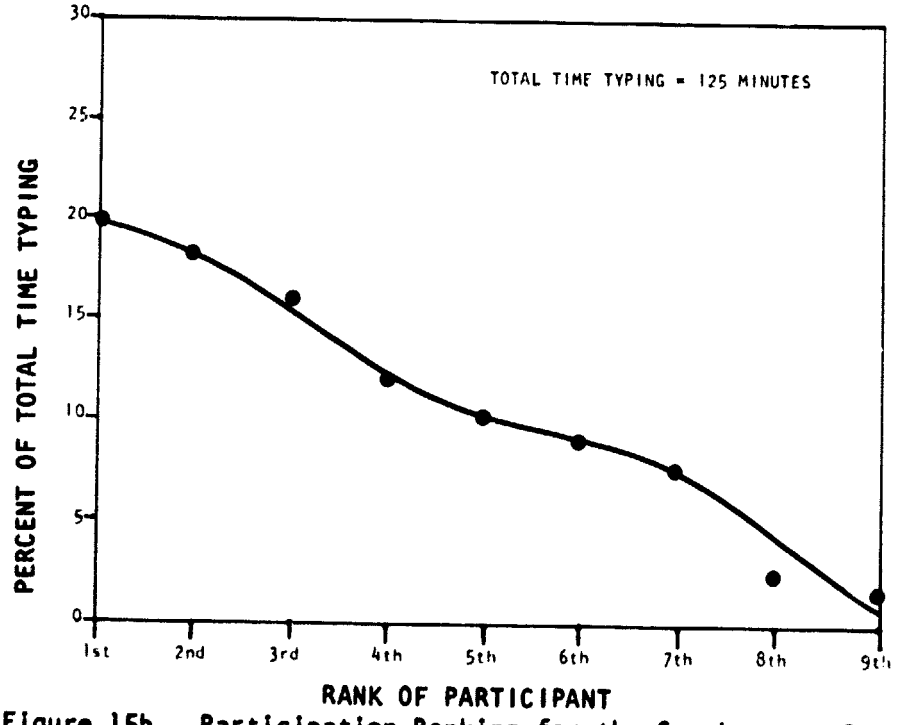

Figure 15b. Participation Ranking for the Synchronous Computer Conference (Based on Percent of Total Time Typing). Here the distribution of participation is computed on the basis of volume of information rather than number of messages.

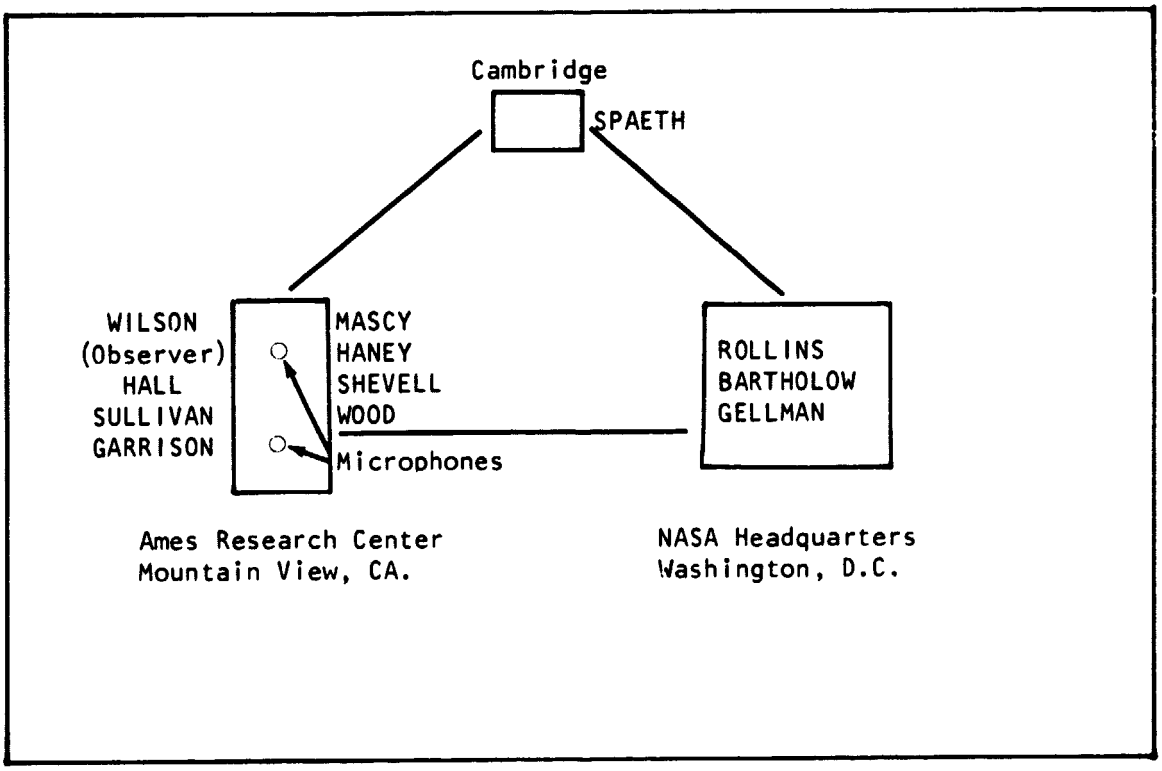

Figure 16. Arrangement of the Audio Conference

together with the locations of other participants. In order to analyze the conference, two samples were selected from the transcript in the following manner:

The conference was divided into nine sections of approximately 30 minutes each. A preliminary analysis yielded the following information for each section:

Section	Number of Messages	Remarks
1	24	Opening statements
2	26	Participants get coffee
3	27	Group discussion
4	37	Ends with the break
5	26	Group discussion
6	11	Lunch
7	23	Group discussion
8	24	Mascy leaves, several others come and go
9	10	Lasts 11 minutes only

Those sections that were nonsubstantive or atypical in some way (namely, sections 1, 2, 6, 8, and 9) were eliminated. Next, two samples of 15 minutes each were chosen from the remaining sections: Sample 1 came from section 4, which has the highest degree of interaction with 37 messages. Sample 2 was drawn from section 5, following the break. It is during these two sections that much of the substantive discussion of the conference took place. Finally, the two samples were analyzed in the same way as in the public transcript of the computer conference. The results of the analysis are shown in Table 5. The information exchange rate here is 135 words per minute (assuming 1 word = 5 characters), and the average length of a message is 212 characters. Again, we are able to plot participant positions, based on their percent of total time talking and their percent of total messages (Figure 17). Participant ranks are shown in terms of percent of messages and percent of total time talking in Figures 18a and b, respectively.

TABLE 5. ANALYSIS OF TWO DISCUSSION SAMPLES

Participant	Sample 1		Sample 2		Total		Percent of Messages	Percent of Characters
	Messages	Characters	Messages	Characters	Messages	Characters		
Mascy	17	2,997	7	3,407	24	6,404	25.0	31.5
Rollins	6	1,545	10	1,887	16	3,432	16.7	16.9
Shevell	12	2,636	10	2,121	22	4,757	22.9	23.4
Hall	8	1,030	7	1,371	15	2,401	15.6	11.8
Haney	3	740	6	1,529	9	2,269	9.4	11.2
Bartholow	2	274	--	--	2	274	2.1	1.4
Garrison	2	80	--	--	2	80	2.1	0.4
Gellman	--	--	2	105	2	105	2.1	0.5
Sullivan	--	--	4	583	4	583	4.1	2.9
Total	50	9,302	46	11,003	96	20,305	100.0	100.0

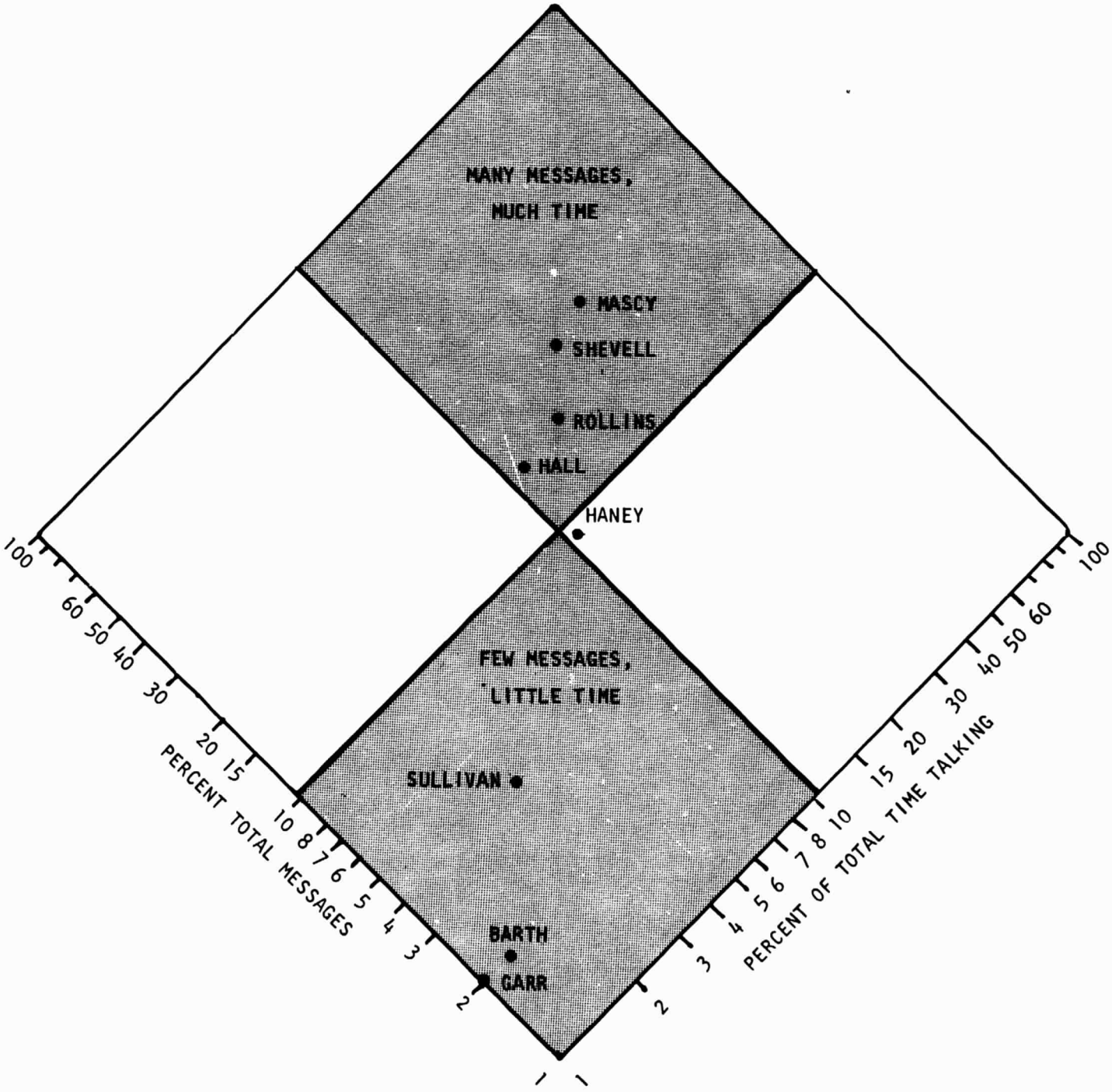

Figure 17. Individual Use of Time in the Audio Conference

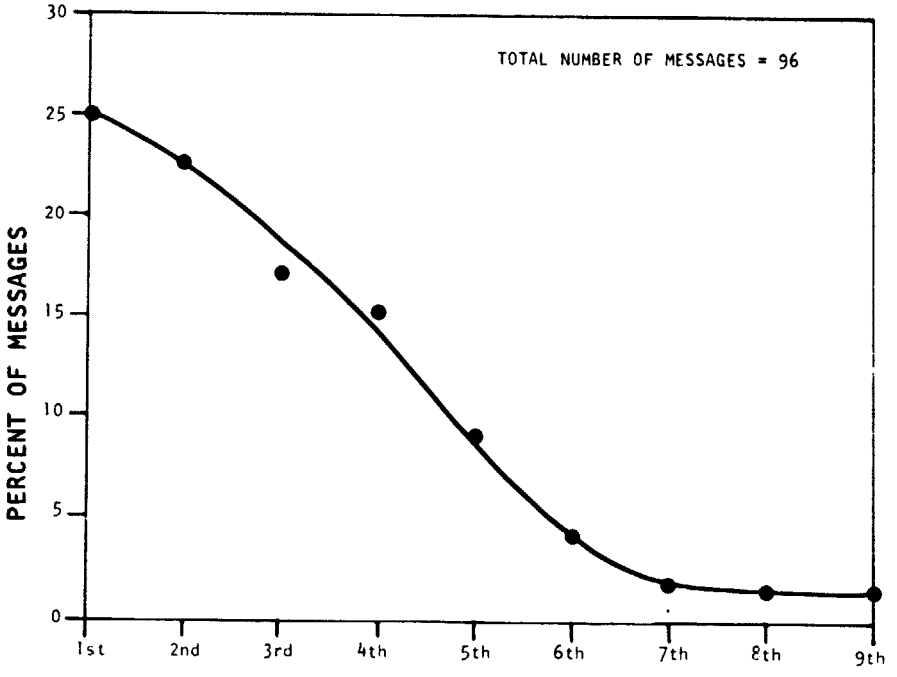

Figure 18a. Participation Ranking for the Audio Conference (Based on Percent of Total Messages). The audio conference is less linear ("democratic") than the synchronous computer conference; two participants account for nearly half of all messages.

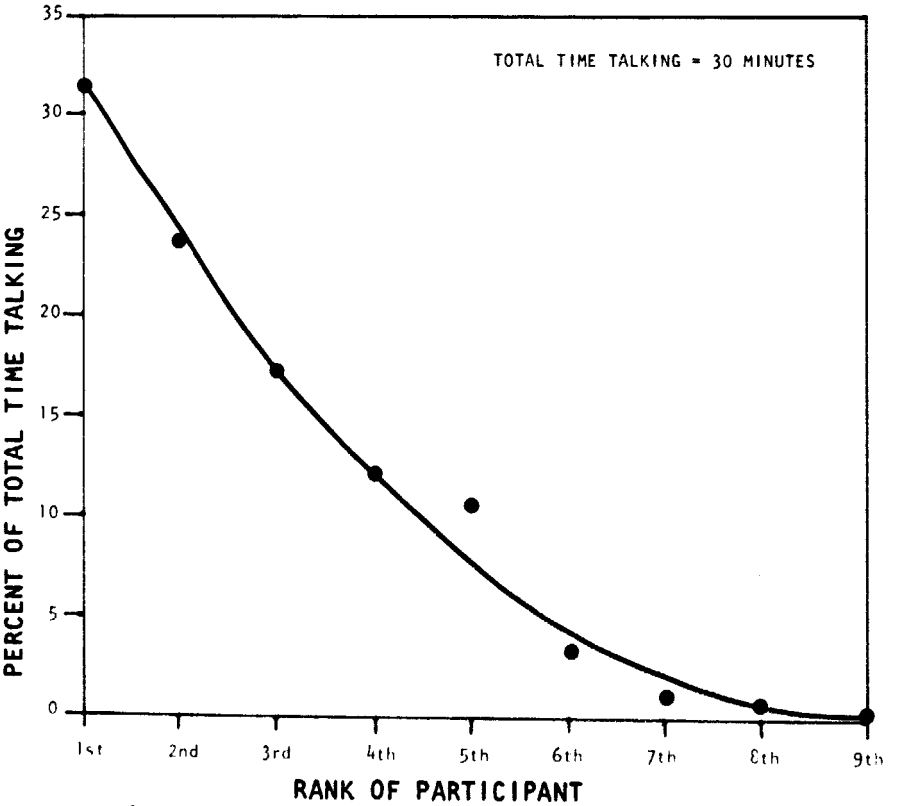

Figure 18b. Participation Ranking for the Audio Conference (Based on Percent of Total Time Talking)

C. INTERMEDIA COMPARISON

In comparing the two "meetings," we are not here examining the volume of information discussed or the quality of the ideas offered. We will rather restrict our comparison to participation patterns, length of messages, and number of messages. Figure 19 shows the distribution of message lengths in both media; they are quite similar, although PLANET may encourage slightly shorter messages. (The average PLANET message was 182 characters long compared to 212 characters in the audio conference.) In both media, 75 percent of the messages had fewer than 250 characters.

The participation ranks in both meetings are compared in Figure 20, showing the more "democratic" distribution of messages among participants in PLANET. Simple technical considerations make this observation obvious: the participants in a computer conference have equal access to the medium and can speak at any time. The nature of the medium also tends to reduce restrictions created by accent, shyness, or voice level. In the audio conference, the microphones adjust to the ambient level of noise and have a higher probability of locking on a voice from the noisier site in case of conflict. In addition, the participants within the same room naturally have to take turns speaking and must conform to conventional face-to-face rituals.

If "equality of participation" is used as a barometer in comparing audio and computer conferencing, the two conferences show marked differences. In the computer conference, 50 percent of the public entries were made by the four organizations on the West Coast; 40 percent, by the four East Coast participants. (The remaining messages were entered either by the facilitator or anonymously.) The audio conference data reflect different participation rates: the West Coast organizations contributed 80 percent of the group interactions; the East Coast accounted for the remainder. As was suggested, the audio transmission was based solely on "who spoke the loudest"; the ambient noise level at one site, if high enough, would tend to mute transmission from the other links. Eight people were seated in the Ames Research Center conference room; they made frequent personal exchanges, activating their transmitter to the exclusion of the

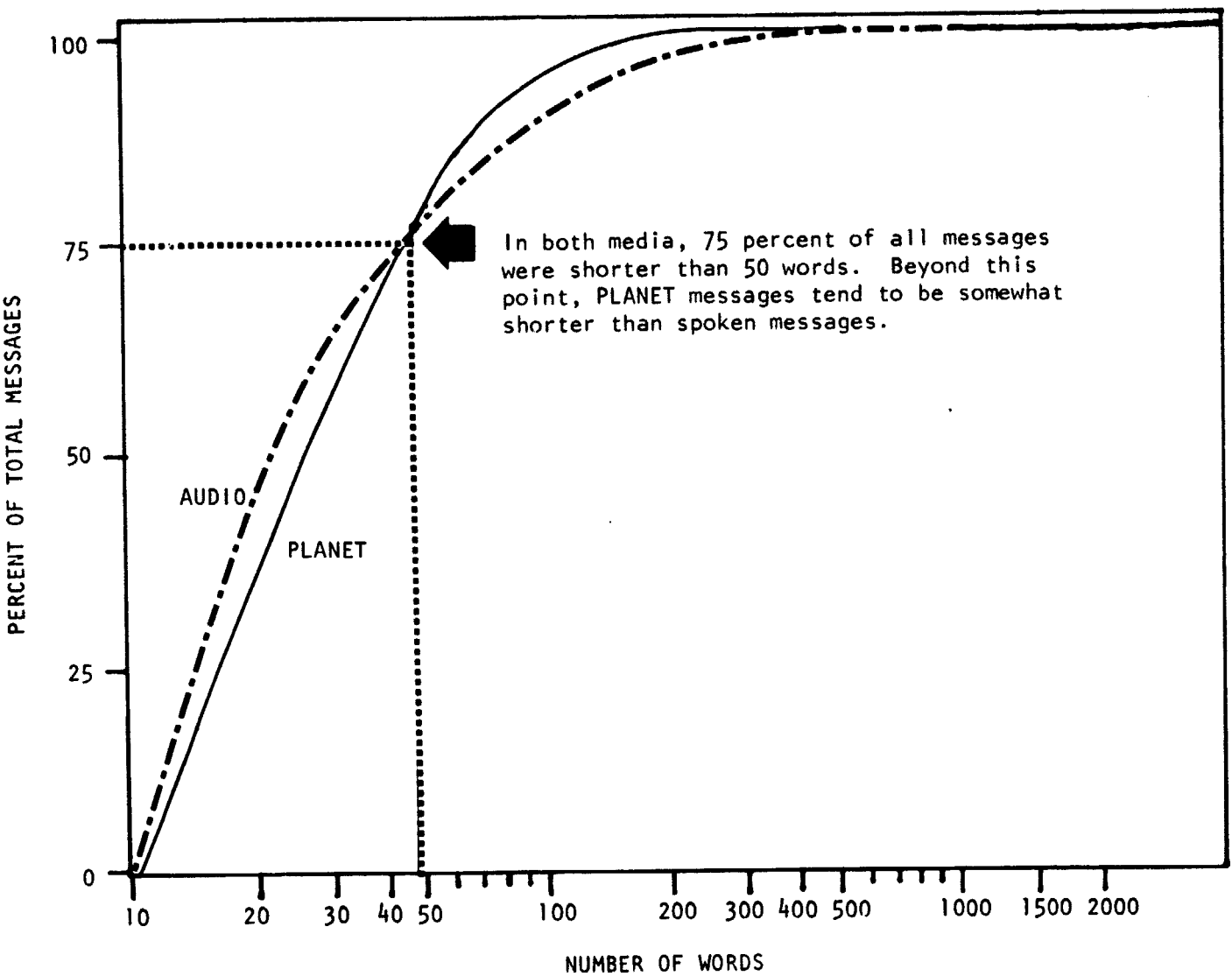

Figure 19. Distribution of Message Lengths in the Audio vs. Synchronous Computer Conferences

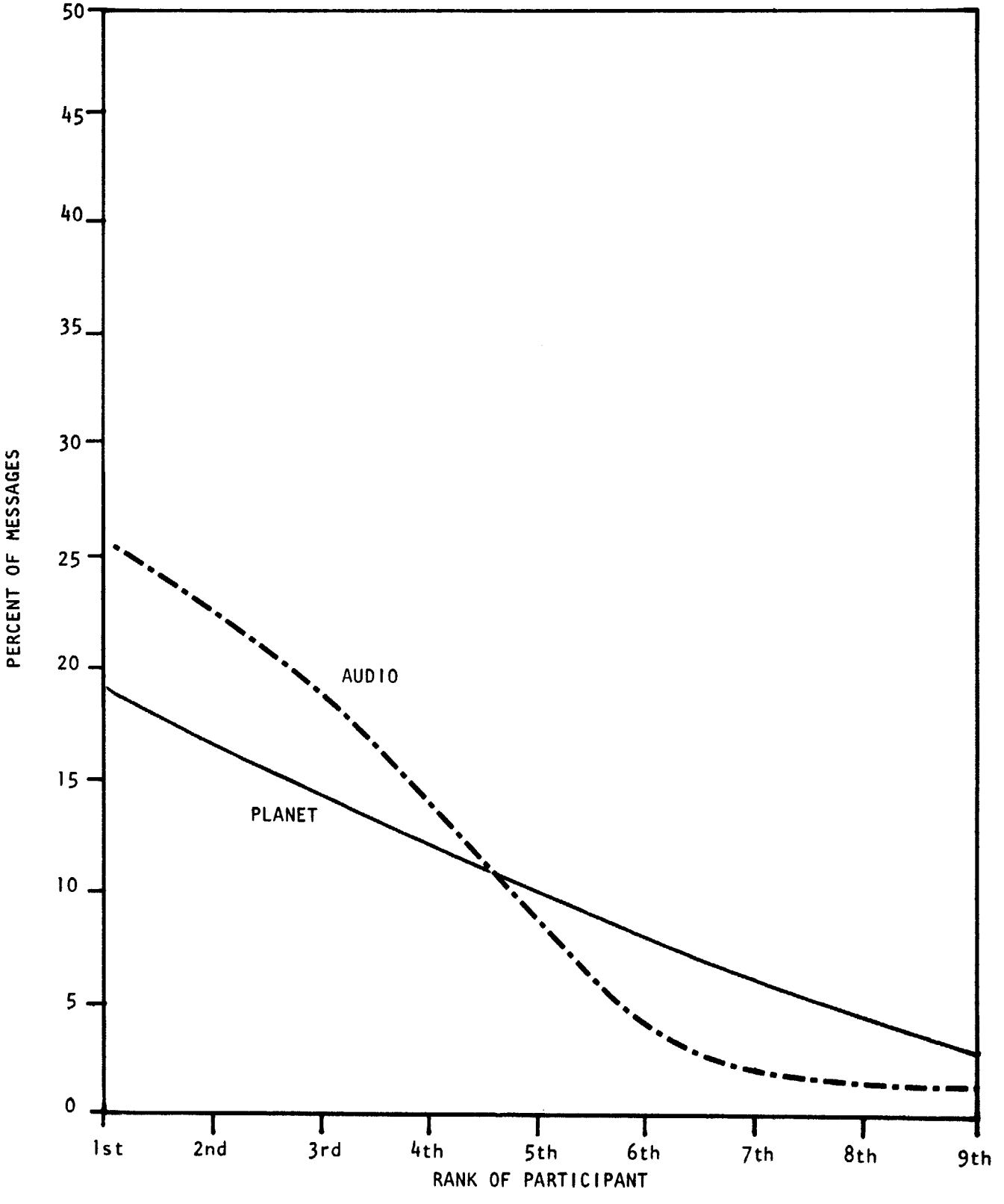

Figure 20. Comparison of Participation Ranking in the Audio and Synchronous Computer Conferences. When we superimpose the participation rankings for these two conferences, we find that participation in PLANET is much more balanced (i.e., more people contribute to the discussion) than in audio conferencing.

other sites. Thus, of the top six participants (as defined by percent of total messages and total time talking), only one participant is not from the group located at Ames during the audio conference, while an even distribution of three and three is shown for the computer conference.

This difference in participation by geographical location is further noted in Figure 21.

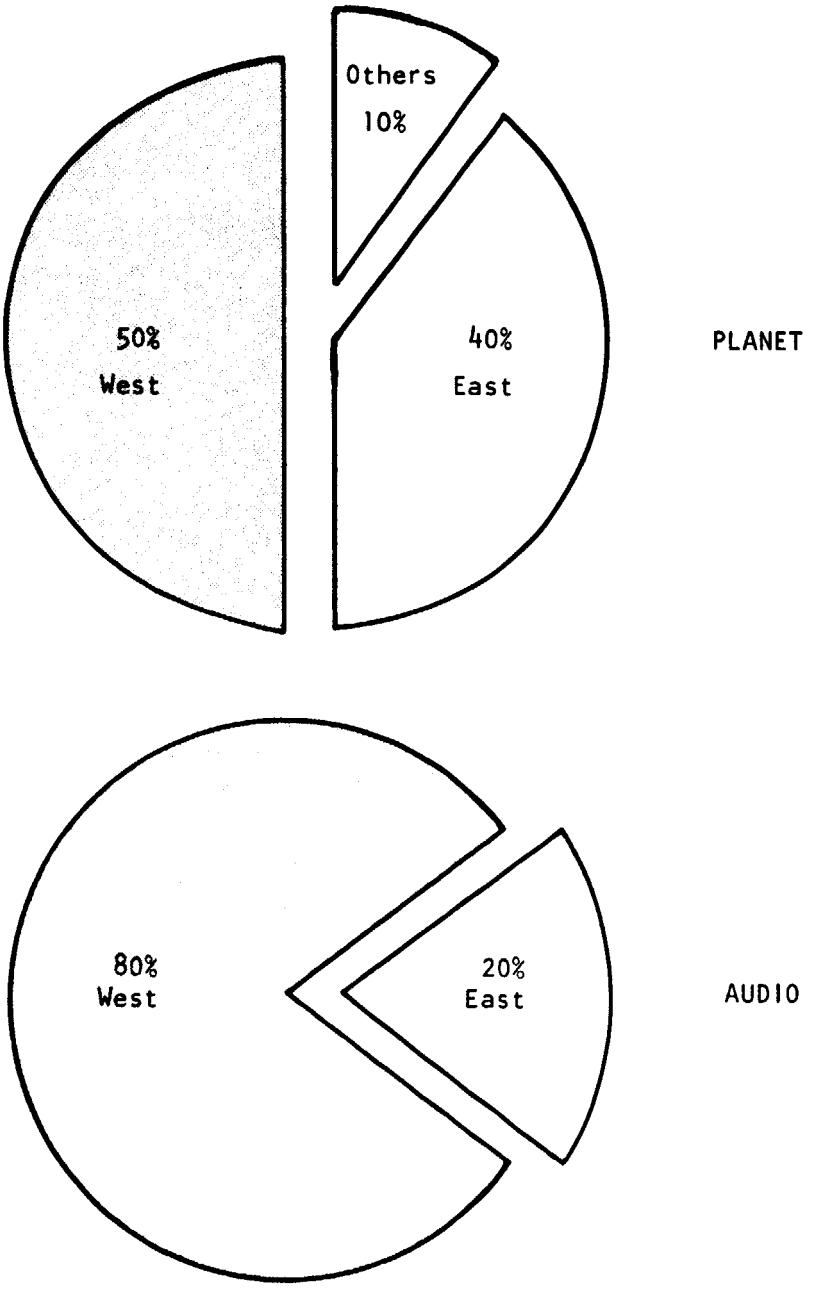

Figure 21. Relative Participation of East and West Coast Organizations in the Audio and Synchronous Computer Conferences

V. OBSERVATIONS OF MEDIA USAGE

With the completion of this project, NASA has provided the first large-scale field test of computer conferencing in an operational setting.* Though the project lasted only six months, a review of the transcript provides a basis for making several observations about media usage:

1. Integrating the Communications Activity into the Workday. Researchers in the transportation study adapted their workstyle to the system. One user actually described how he was relying on PLANET to obtain an update early in the morning and late in the afternoon:

[154] Whorf 13-Nov-75 1:11 PM
One of the features that I particularly like is that of being able to come in the first thing in the morning and get updated. Also late in the afternoon, I can check on what has transpired during the day.

[161] Whorf 14-Nov-75 8:11 AM
I suspect there is a lot of capability that we only find out about by accident. For example, I find use of the status report useful as a way of checking whether someone has received certain messages or not.

2. Providing Precision and Timeliness of Information. Requests for data and updates on the status of the spacecraft or the experiments were crucial to the CTS group. Many entries illustrate this use of the system:

[380] Baker 26-Jan-76 3:22 PM
Is the scheduled time of turning on the beacon (S/C) known at this time? If not, would H. Hunczak please put it on PLANET as soon as it is known? Thanks.

[385] Lew 27-Jan-76 12:13 PM
Pat: Could you please provide me with the following dates for each experiment: conditional acceptance, final acceptance, scheduled start.

---

*Similar field tests are in progress at the U.S. Geological Survey and will result in detailed evaluation; furthermore, other organizations are now undertaking conferencing activities on a scale that promises to be comparable to the NASA effort.

[386] Hunczak 27-Jan-76 1:13 PM
To Baker and all concerned--re message 380: The best estimate of SHF beacon turn-on is February 6, 1976, at approximately 13:00 to 14:00 GMT. If any change occurs, this message will be updated. Good luck.

Entry No. 386 is the response to the request at 380 but is addressed to "Baker and all concerned." Here, the conferencing system is used to keep the whole group informed of the dialogue between two members.

3. Replacing Other Media. The system represents an economical alternative to telephone or telex when information of a technical nature needs to be communicated to several people at once. It also offers a retrieval capability:

[401] Grayson 30-Jan-76 10:35 AM
Kennard and Chitwood. The subject of a CTS checkout time allocation switch has been agreed between experiment 16 and experiment 20. Chitwood has confirmed this switch for experiment 20. The new schedule should read:

Experiment 20	April 13	1800-1900 GMT
Experiment 16	April 13	1900-2100 GMT

Jerry, please confirm to both Chitwood and myself that you have entered this change in your computer. Thanks to you and experiment 20.

Another person felt that use of PLANET made it possible to keep the group up to date without resorting to conventional media:

[151] Shevell 13-Nov-75 12:28 PM
I think the system has some value in keeping us all up to date and in making it possible to query people when the thought strikes without having to phone or write a letter.

4. Supporting Other Media. In some cases, the system has served to confirm and support information transmitted through other channels, as in this entry:

[458] Hunczak 13-Feb-76 1:09 PM
The spacecraft was ranged by Goddard on February 10. Orbital elements were received at Lewis this morning, processed, and the new S/C ephemeris and AZ-EL angles for your ground sites mailed this afternoon at 20:30, February 13. Would like to know when each receive them in the mail.

The author of this message needs confirmation that a certain document has been received. PLANET can thus provide a record of the

communications events taking place in the group. This use represents a more sophisticated choice among media.

5. Handling Emergency Situations. We have observed instances of reliance on PLANET for crisis management among CTS projects and for decision-making in urgent situations:

[521] Donoughe 4-Mar-76 8:06 AM
To all PIs and experimenters: a problem has developed with the spacecraft. The problem may be in the experiments power converter. All experiments are canceled until the problem is resolved. You will be updated as pertinent information becomes available.

[527] Lew 4-Mar-76 8:27 AM
To all!!!!!!!!!!!!
Please do not promulgate conjectures re message 521!! Make sure your information is up to date before informing.

6. Promoting an Effective Management Style. The following entry shows the use of the public mode to confirm private communications giving a number of participants a specific time allocation:

[516] Kennard 2-Mar-76 12:46 PM
Ippolito, Kaiser, Nunnally, Miller. Time allocations for the week of 3/7-3/13 follow by private message. Please let me know any corrections promptly.

Notice that the whole group is now informed that four experiments have been allocated time (although exact times are not made public).

The two groups made effective use of the system in classical management tasks, such as communicating information, requesting data, giving assignments, and making sure deadlines were met. Such use is apparent in the following entry:

[317] Hall 28-Jan-76 9:33 AM
For the record, Mascy's questions of yesterday discussed by phone. Reports 2 and 8 and parts of 7 and 1 will be mailed in the next 3 days. As previously suspected, report 9 will be late (and won't reach Spaeth by next Wednesday). Berkeley or PMM will mail report 5 this week. To repeat: report 8 was never intended to be "the" final report. See proposal, contract, and Admin. Report #2.

A similar situation occurs in a series of requests by the group chairman:

[303] Mascy 27-Jan-76 12:16 PM
To PMM and UCB . . . Has TR 2 been mailed yet?

[304] Mascy 27-Jan-76 12:16 PM
To PMM and UCB . . . Has TR 5 been completed yet?

[305] Mascy 27-Jan-76 12:18 PM
To Whorf . . . Will you be joining the team in Washington on February 18?

[306] Mascy 27-Jan-76 12:19 PM
To GRA . . . Will Aaron be joining us here in the West on February 11?

7. Extending Communications beyond Working Hours. Figure 22 shows the distribution of conferencing sessions as a function of time of day. It can be seen that 26 percent of all sessions occur outside of West Coast working hours. Of special significance to NASA is the expansion of the narrow "telephone window" between the East and West Coasts. This greater flexibility in the use of time was noted by one participant in the transcript:

[173] Mascy 7-Jan-76 9:46 AM
. . . Just in passing, I noted the timeline of message 171 at 6:40 PM PST and message 172 at 5:25 AM PST . . . for what it is worth, the computer terminals have opened up the communications day to about 12 to 13 hours. . . . This might be compared to telephone day between East and West Coast of about 3 or 4 hours. . . .

Over 55 percent of all sessions took place outside the normal telephone windows.

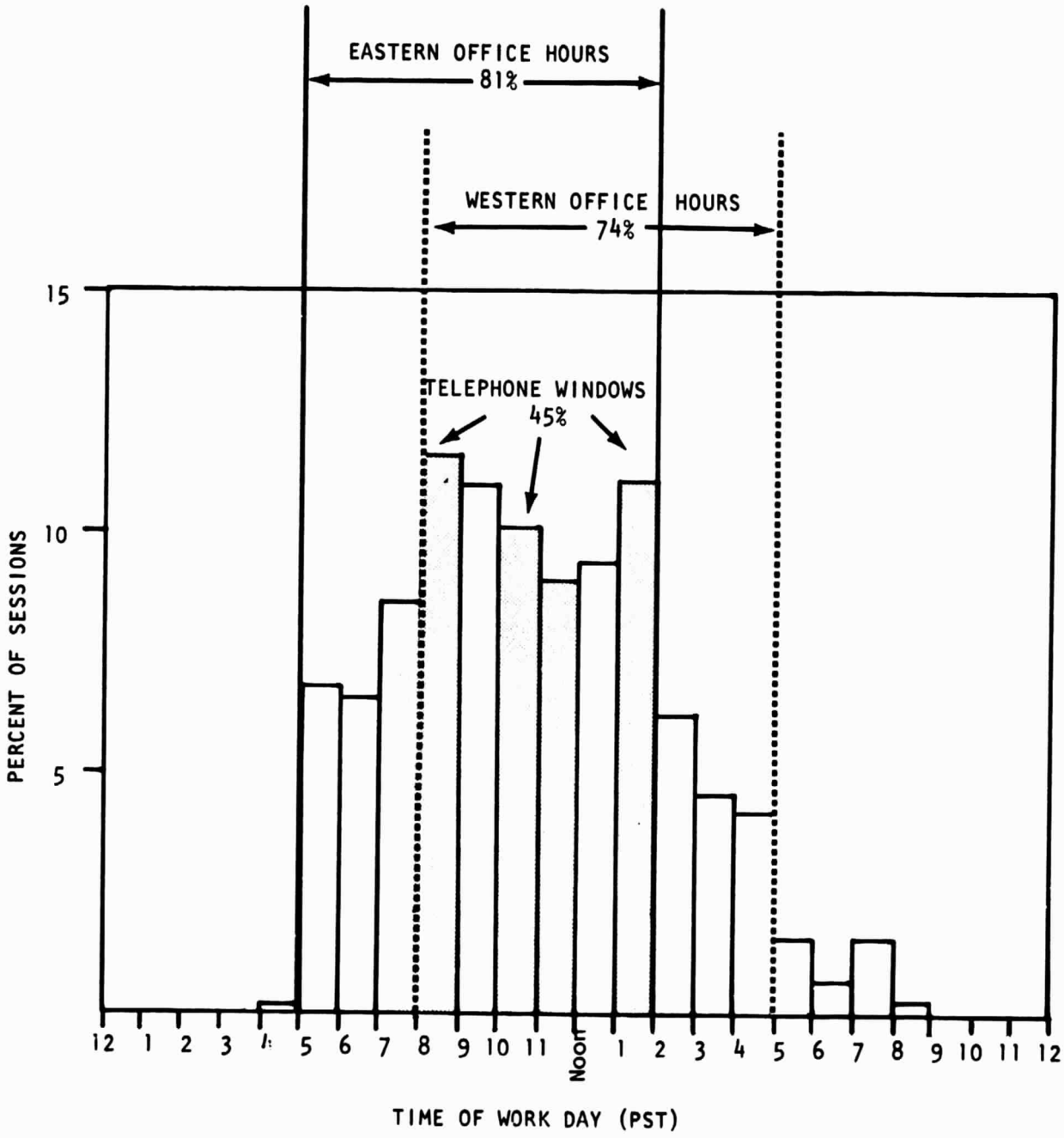

Figure 22. Distribution of Sessions as a Function of Time of Day

VI. COST CONSIDERATIONS

The cost of computer conferencing is an important variable in the evaluation of the potential "market" for the medium, and reliable information is becoming available as real-world usage of systems like FORUM* and PLANET are reported by participants. No cost statistics have been computed for earlier systems, and the literature is quiet regarding the economic considerations of applications at the Office of Emergency Preparedness, of the use of MAIL on the Tymshare network, or of SNDMSG ("Send-Message") on ARPANET.

A. SIX COST COMPONENTS

The PLANET-1 system has been running on TYMNET since October 1974 at an average hourly cost which is under $16; this cost includes a $10 flat hourly charge for the time of terminal connection and is expected to drop rapidly in the future as networks lower their rates for both connect and computer time. The true costs of such a system, however, involve more than just computer utilization. Six major components** should be considered, both in computing current costs and projecting future costs of a computer conference (see Figure 23):

1. Terminal Equipment. It is possible to rent or lease terminals from manufacturers and from the networks. Tymshare, Inc. and Texas

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*On the cost analysis for the FORUM system, see Report R-35, *Group Communication through Computers, Volume 3*, available from the Institute for the Future.

**These do not include considerations of participant salaries, editing of transcripts, and royalty on the use of a program package (not applicable here, but to be taken into account with future commercial systems). Nor do they include the costs of training and facilitation, which should also be considered at some point.

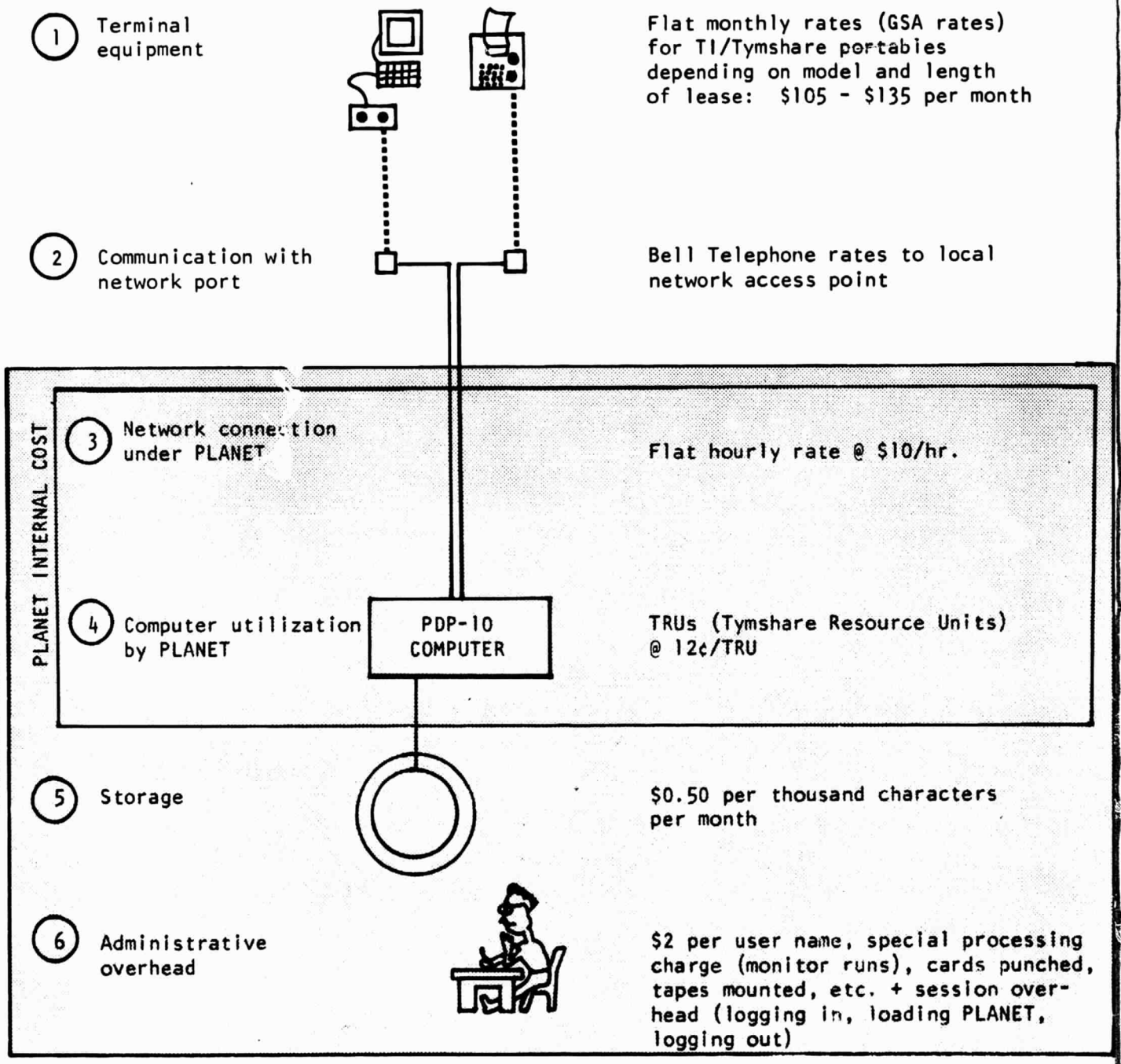

Figure 23. Six Components of Cost in a Computer Conference

Instruments, Inc. offer the same equipment at comparable rates, as shown in Table 6. As the use of computer conferencing becomes more common, the cost of terminals can be spread among more users and more projects; it is expected that, within five years, terminals will become an overhead item (like a typewriter or a telephone) at most research institutions. This component of the cost will thus tend to decrease.

2. Communication with a Network Port. The cost of accessing the network may be quite significant to users outside of metropolitan areas served by commercial networks. In the NASA conferences, most participants could access the network with a local phone call; a few users in areas not served by the network (such as Berkeley) had to make toll calls. The geographic coverage of the major networks is expanding rapidly, however. In addition, future technology could eventually make networks available to rural areas. This cost component, too, will thus decline in importance in years to come.

3. Network Connection. The network we used in these experiments currently charges $10 per connect hour. Since this is the largest component of the conferencing cost, the connect time rate must decrease dramatically in order for teleconferencing to make a commercial breakthrough. Network rates are expected to decrease slowly with more efficient technology for message or packet processing to a figure possibly as low as $1.50 per hour for most U.S. access points by 1980.

4. Computer Utilization. The use of the computer in the NASA conferences has been billed according to the number of "Tymshare resource units" used in a given session. This charge has averaged about $6 per hour. In the future, more efficient time-sharing systems, an expanded number of ports into the computer, and the use of mini- or microprocessors will decrease the cost of computing, possibly to about $2.50 per hour in 1980. Some systems, of course, may cost less, and most will cost more. We are presenting these figures as "typical" rather than "optimal."

TABLE 6. TERMINAL RENTAL RATES*

Terminal Type	Company	Installation Charge	Monthly Rental
TI 725 (100)	Tymshare	$75	$165
TI 725	Texas Instruments	30	125
TI 735 (110)	Tymshare	75	135
TI 735	Texas Instruments	30	135
Haz. 2000 (+ coupler)	Hazeltine	--	134
TI 745	Texas Instruments	--	125

*All of these are full-duplex ASCII terminals, obtainable with upper/lower case keyboards. Rates are based on a one-year lease.

5. Storage. A conference is a file that resides on a mass storage device. The participant is charged for this file at a rate of 32 cents per "block" of 624 characters, or 50 cents per 1,000 characters.

6. Administrative Overhead. The bill received by the user from Tymshare each month covers not only the computing and connection charges but also a number of other items, such as:

- a flat charge of $2 per user name;
- a charge for special handling of tapes or cards and the runs of the monitor program that computes and lists the statistics; and
- session overhead at a rate of about two TRUs per session, representing the amount of computer resources used to log-in and to load the PLANET program.

The need for the computer supplier to break even on the use of the system will demand that storage and administrative charges remain significant. However, there is still room for improvement with larger, less expensive memories and more efficient handling of user accounts and secondary services. One should keep in mind that when conferencing usage spreads, the files holding the discussions will become much larger than anything currently observed, distorting many usage patterns.

Given these components of the cost, we have listed in Table 7 the actual expenses incurred monthly under this project so that a detailed appraisal of the economics of computer conferencing could be made by NASA. Figure 24 shows the distribution of costs among the six components. Table 8 shows the sessions, messages, and PLANET costs broken down by participant. When all components are taken into account, the cost of conferencing in this series of experiments is $26 per user hour, or $91 per user per month. *Thus, PLANET enables researchers to engage in joint work with other research groups for less than $100 per month.*

In contrast to Table 7, the cost components for computer conferencing at NASA in 1980 might resemble those in Table 9. Here, the projected cost is only $5 per hour. This cost assumes no commercial profit, no royalty for system use, and no external communication cost. Thus, while it is *typical of conditions expected at NASA,* it does *not* reflect those that may prevail in the commercial world of 1980.

TABLE 7. COMPONENTS OF COST IN THE NASA CONFERENCES

	August	September	October	November	December	January	Total	Cost per User Hour
1: Terminals	$161	$ 45	$ 64	$ 675	$ 442	$ 442	$ 1,829	$ 4.00
2: Communications	--	--	24	73	46	--	143	.31
3+4: PLANET Cost	170	205	1,675	2,103	1,812	1,497	7,462	16.33
5+6: System Overhead	--	158	195	713	705	672	2,443	5.35
Total Computer Costs	$331	$408	$1,958	$3,564	$3,005	$2,611	$11,877	$25.99
User Hours	11.5	13.1	103.3	128.6	112.4	88.3	457	

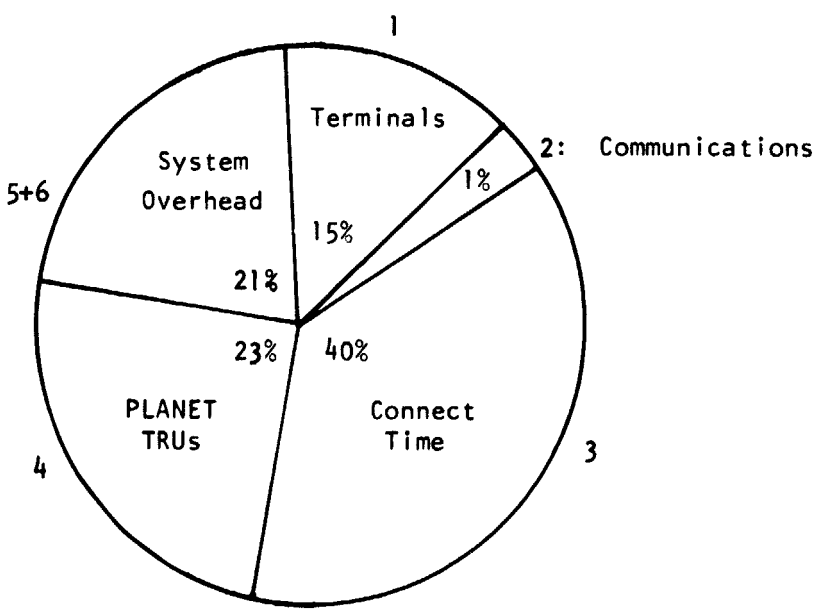

Figure 24. Distribution of Conferencing Costs in the NASA Conferences

TABLE 8. COSTS PER PARTICIPANT IN THE NASA CONFERENCES

Participant	Total Sessions	Total Messages	Total Hours	PLANET Cost	Cost per Message	Cost per Hour
Rollins	507	848	104.08	$1,575	$ 1.86	$15.13
Mascy	416	635	72.96	1,094	1.72	14.99
Hall	187	363	35.25	619	1.71	17.56
Gibbs, B.	395	205	31.14	587	2.86	18.85
Spaeth	173	334	28.83	479	1.43	16.61
Wilson	409	248	27.73	531	2.14	19.15
Whorf	316	156	30.25	485	3.11	16.03
Shevell	123	206	24.75	372	1.81	15.03
Sullivan	126	116	20.05	304	2.62	15.16
Lew	174	209	19.42	314	1.50	16.17
Bartholow	68	80	14.81	228	2.85	15.40
Gellman	165	62	13.04	214	3.45	16.41
Donoughe	216	87	12.70	241	2.77	18.98
Hunczak	100	57	14.26	215	3.77	15.08
Chitwood	132	41	6.66	136	3.32	20.42
Lumb	100	51	7.20	130	2.55	18.06
Baker	53	73	9.13	139	1.90	15.22
Ippolito	73	18	6.54	110	6.11	16.82
Kaiser	96	75	5.10	103	1.37	20.20
Boyce	73	42	4.43	89	2.12	20.09
Haney	51	38	4.58	77	2.03	16.81
Garrison	27	62	6.38	94	1.52	14.73
Connors*,**	12	5	1.99	68	13.60	34.17
Whalen	78	34	4.33	83	2.44	19.17
Gibbs, G.	49	57	4.45	102	1.79	22.92
Wood	18	15	3.08	43	2.87	13.96
Gurski	21	13	4.12	67	5.15	16.26
Vallee	22	10	1.94	30	3.00	15.46
Kennard	20	21	4.17	65	3.10	15.59
Alexander*	5	3	.70	24	8.00	34.29
Hofman	7	21	1.21	19	.90	15.70
Johansen	1	1	.19	4	4.00	21.05
Horonjeff	2	--	.21	4	--	19.05
Jackson	1	--	.19	4	--	21.05
TOTAL	4,216	4,186	525.87	$8,649	--	--
AVERAGE	--	--	--	--	$ 2.07	$16.45

*The higher cost per hour for these users reflects their frequent use of special features (such as long "reviews" of text); this pattern of usage may be traced to their infrequent participation.

**Mary Connors observed both of the NASA conferences as part of her evaluation of the PLANET system for NASA.

TABLE 9. PROJECTED COST PER HOUR OF COMPUTER CONFERENCING FOR NASA USERS IN 1980

1: Terminals	Already available at most sites	$0
2: Communications	Local calls only	0
3: Connect Time		1.50
4: Computer Time		2.50
5+6: System Overhead		1.00
Total Cost Per Hour		$5.00

TABLE 10. THE EFFECTS OF SYNCHRONEITY ON COST

Group Size	Number of Sessions	Ratio (Private/ Public)	Hours	Cost	Cost per Individual Session	Cost per User Hour
1	3,213	.887	248.70	$4,442	$ 1.38	$17.86
2	758	2.500	154.88	2,446	3.23	15.79
3	177	1.872	70.66	1,032	5.83	14.61
4	53	1.430	22.18	322	6.08	14.52
5	10	.608	8.52	114	11.40	13.38
6	0	--	0	0	--	--
7	1	0	.12	2	2.00	16.67
8	3	.400	1.04	15	5.00	14.42
9	18	.358	20.49	294	16.33	14.35

B. OTHER COST FACTORS

In addition to these six components, the cost of computer conferencing is also closely tied to participation patterns such as synchronous interaction or private message exchange. It was striking to find in the NASA conferences that more than half of the total time was spent in synchronous interaction. Over the duration of the usage of PLANET by NASA, there were more than 650 "meetings" of two people, 160 meetings of three, 50 of four, and more than 30 of five to nine participants. The costs of these "meetings" are shown in Table 10 as a function of group size. This table shows that cost per hour and per user actually tends to *decrease* as the size of the group is increased. This decrease may be partially explained by the change in the ratio of private to public messages shown in Figure 25. As interaction changes from asynchronous to synchronous, the number of private messages rises; but when more users join the "meeting," this ratio decreases again as social pressure forces the participants to make their views known publicly.

As noted earlier, the NASA conferences were generally characterized by a high level of private message exchange. We have heard the argument that such private communication could be conducted more inexpensively over the telephone, and it has even been suggested to us that the private message feature of PLANET should be inhibited. These arguments miss an important point by ignoring the nature of such private messages. Even if the telephone were available at the time when a private message was sent, it would not generally fulfill the needs of the user at that time. Many private messages were sent asynchronously when a single user was in the system and the intended recipient of his messages was asleep, eating lunch, or away from the terminal for some other reason. The sender clearly had the option of picking up the telephone and decided not to use this option. In most cases, he wanted the recipient to have a record of the private message. Why not send a telegram then? Aside from the question of convenience and cost (PLANET costs only about 92 cents for 20 words of text, as opposed to $2.50 for a mailgram), the fact is that private messages are an integral part of the substantive discussion although they are invisible to the

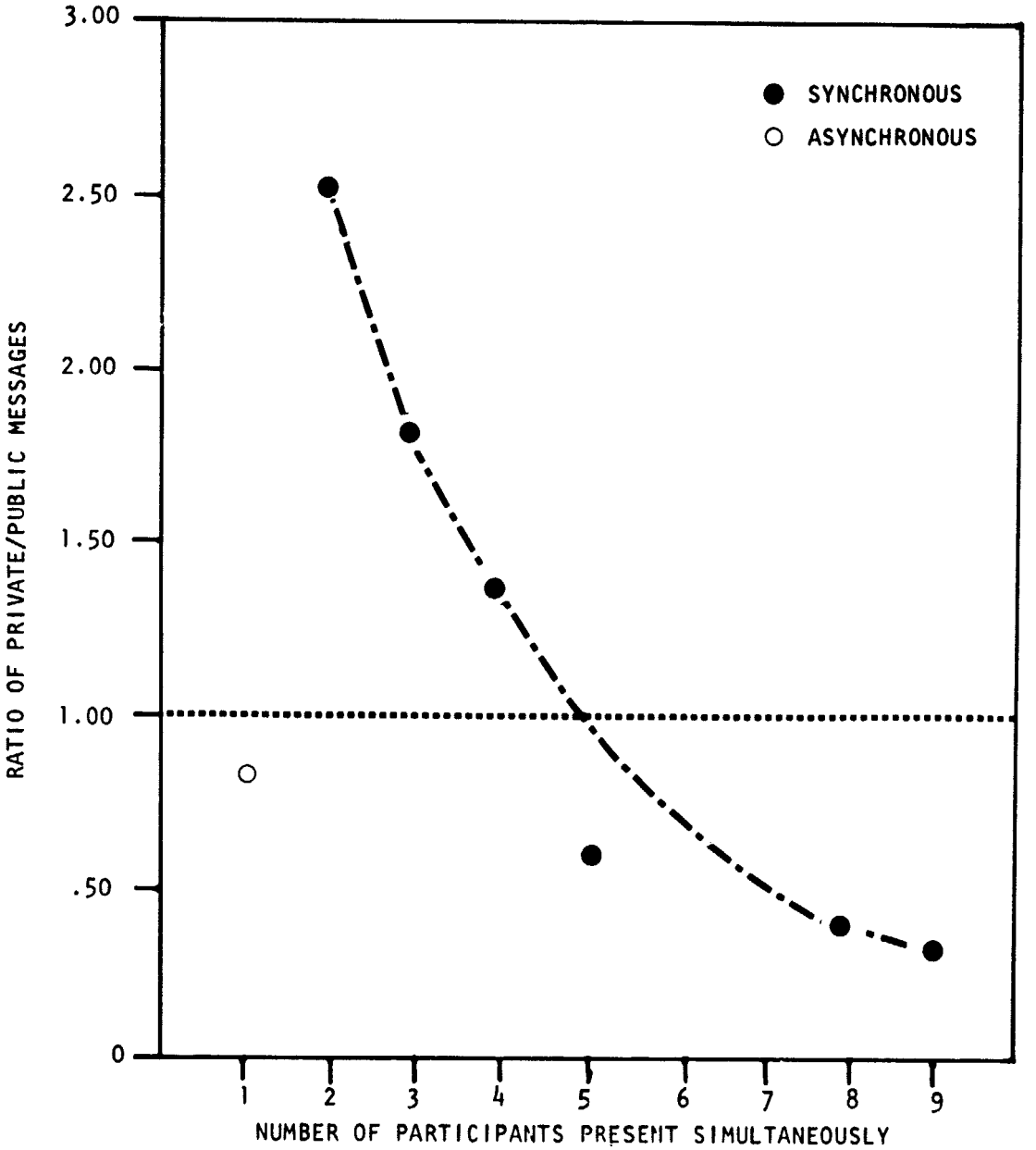

Figure 25. Privacy of Messages as a Function of Synchroneity. When a user is alone in the conference, he tends to send as many private as public messages. The most "private" discussions take place when two people are online at the same time. As more participants join them, the meeting becomes more public.

reader of the public transcript. Several examples given in this report refer to such use of the private mode. Many private messages also involve training and technical support information that simply does not belong in the public transcript.

Finally, a few words should be said about facilitation. It is easy at this point to fall into a familiar pitfall, planning future computer conferences on a purely economic basis. In our view, the much larger question of training and facilitation must be included in such a plan from the beginning. This aspect is so critical to the success of the medium that it must not be swept under the rug of budgetary convenience.

If participants are to solve real-world problems through computer conferencing and if the organizations to which they belong are to pay for their usage of the system with real money, a continuous structure must be provided for learning and facilitation activities. Such a structure cannot be improvized for each conference, nor can it be expected to arise naturally among a group of users. It should be provided from the start. Not only do new participants need training in the use of the system, but group leaders require continuous guidance. The conference as a whole must be nurtured by someone who may not be a substantive contributor but who offers a rich set of social skills. Such facilitators should ideally belong to the same organization as the conference participants (in this case, they should be NASA employees or contractors). But they, too, need to be trained. A new role is thus emerging as we consider future communications situations.

VII. RECOMMENDATIONS

On the basis of the observations of the two groups we have studied over this six-month effort and given the behavioral differences among the various conferencing media they have used (face-to-face, audio-conferencing, and computer conferencing), we offer the following three recommendations to NASA:

1. The analysis of PLANET usage presented here should be complemented with an extensive in-house evaluation of user attitudes and of the potential impact of this medium on research patterns.

2. Computer conferencing should be included among the new electronic *communications* media that NASA is planning to seriously investigate. We believe that we have demonstrated that this medium is ready to serve scientific and management groups in its present form and that it serves the needs of researchers as well as audio-conferencing.

3. A reduction in the cost of computer conferencing should be promoted by actively investigating several system implementations.

The first two recommendations are straightforward. The third one requires some amplification. Should NASA decide to keep the CTS conference alive and to expand its experimentation in this area, the choices open to it are:

Choice #1. Continue to use PLANET-1 on the Tymshare network under NASA's own account. If no monitoring is required and if NASA is prepared to conduct its own training and facilitation, the cost of running these conferences should remain about $26 per user hour, with a PLANET "internal cost" of $16.

Choice #2. Pursue experimentation with new systems that will be offered on other networks. As commercial competition among networks develops, rates for connection time are expected to decrease and

several companies are already charging less than Tymshare for connect time (rates between $3 and $9 are typical). The Institute for the Future is currently evaluating such alternate services and will seek to make future computer conferencing systems available through the most cost-effective network. Other systems, both business- and research-oriented, will also appear on the market and could be evaluated by NASA.

Choice #3. NASA could study the feasibility of implementing its own computer conferencing system, either by transferring a version of PLANET to one of its PDP-10 computers or by investing in the development of a new program.

We suggest that the latter choice is premature and that a logical next step for NASA would be a deliberate but careful expansion of its computer conferencing activities. This expansion should take place in a relatively "controlled" environment meeting the conditions for reliable observation of changing work patterns among the scientists using the system.