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ABSTRACT

This is the last of four reports of the Interactive Group Modeling project--an undertaking designed to extend group communication through computers to support the more task-focused communication required by those building computer models. The report focuses on the HUB system--a system that facilitates communication in four modes: computer conferences, shared visual spaces, program workspaces, and document workspaces. Specifically, the report assesses the communication process in structured tests of the HUB system and proposes a future research agenda. (FL)

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INTERACTIVE GROUP MODELING:

PART 4. SOME PRELIMINARY TESTS OF THE HUB SYSTEM

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This report was prepared under Grant No. MCS77-01424, National Science Foundation, Division of Mathematical and Computer Science. The project is under the direction of Hubert Lipinski and Roy Amara. Other staff members who contributed to this report include Roberta Edwards, Jeanne Muzzicato, Robert Plummer, John Tydeman, and Carol Westberg.

This report is the fourth in the *Interactive Group Modeling* series. The other reports are:

Part 1. *Extending Group Communication through Computers* by Hubert Lipinski, Robert Plummer, and Kathleen Spangler Vian, Report R-44

Part 2. *An Interactive Monitor* by Kathleen Spangler Vian, Hubert Lipinski, Robert Plummer, and Sara Spang, Report R-45

Part 3. *HUB and the Modeling Process* by Kathleen Spangler Vian, Hubert Lipinski, Sara Spang, and John Tydeman, Report R-46

The HUB User Guide, a manual for users of the HUB system

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The Tests: An Overview

HUB is an experimental computer-based system, designed to address communication problems in the modeling process. Over the next two years, we plan to test and evaluate the HUB system with a number of user groups. In testing out our design, we want to see how HUB addresses communication problems among model builders and between builders and users, as well as problems in documentation and validation. We know that HUB in practice will differ from HUB in theory. In practice, many unexpected problems and concerns are bound to arise--technical problems of system design or specific effects of HUB on group communication.

Before presenting HUB to user groups, we have been testing its capabilities in a series of structured tests. The object of these pretests is twofold: to exercise the system and to identify guiding questions for the field tests. The structured tests range from artificial games to real-world problems. While they do not address modeling problems per se, the activities were all chosen with modeling and communications issues in mind.

In order to test all of the submodules, we selected four different activities. In the first test, which focused on the use of the program workspace, a group leader taught other participants about a programming language called LISP. The leader had to run the LISP system and lead a group discussion about it in the comment mode. The types of communication patterns produced might easily occur among model builders or between model builders and users. The second test looked again at the use of the program workspace. This time, the topic was a group demonstration and discussion of the NETED editing program. The third test used a simulation game called Adventure, which required the use of both a PLANET conference and the program workspace. Playing the game created a sequence of activities and corresponding communication patterns that might also occur among model builders. The fourth test involved using the document workspace. Three Institute staff members attempted to write a paper, "4004 Futures for Teletext and Videotex in the

U.S.,"* using HUB's system for documentation. Again, the kind of communication needed to write this paper jointly might be similar to the kind needed to document a model or to produce a formal report.

All but one of our tests were carried out in synchronous mode, and all took place in a relatively short period. Also, all participants were located at the Institute for the Future. In field tests involving modeling groups, participants will most likely be geographically separated, and communication is more likely to be asynchronous. Therefore, communication patterns may be quite different from those observed here.

We drew participants for all these structured tests from the Institute staff in order to implement this preliminary testing of HUB in an efficient way. Not only were willing users immediately at hand, but the staff members represented a variety of disciplinary backgrounds and different degrees of familiarity with HUB--and computer conferencing in general. Therefore, we could expect to see a variety of different reactions in these tests. Most important, however, was that we could easily arrange synchronous participation. In these tests, the participants remained in their separate offices with their own terminals, but they were all using HUB at the same time.

In exercising the system in this manner, we have uncovered a number of technical and design problems--which we expected, although not in the forms they assumed. The attempt to write "4004 Futures for Teletext" using the HUB system resulted in major changes in the software design of the document workspace. The Adventure run revealed a minor problem in the instructions for adding a program to the program workspace. Another technical problem appeared in all of the tests in the program workspace that required a change in the computer code. The pretests, then, resulted in important design changes.

Realizing that these structured tests are both artificial and limited, we have tried not to generalize too much from a small sample. Yet they have triggered important questions. How would communication patterns differ when

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*Robert P. Plummer, Robert Johansen, Michael J. Nyhan, and P. G. Holmlöv, "4004 Futures for Teletext and Videotex in the U.S.," *IEEE Transactions on Consumer Electronics*, vol. CE-25, no. 3, July 1979.

members of the user groups came from different institutions and perhaps did not know each other on a personal level? What patterns might emerge under asynchronous conditions? How much were the attitudes and expectations of our participants influenced by the fact that HUB is an Institute project?

The guiding questions we have identified for the field tests anticipate the possibility of different reactions from future user groups. Our analysis of these structured tests and the insights we have gained from them will influence the direction of our research over the next two years.

Method of Analysis

In this report, we describe and analyze the communication patterns revealed in the structured tests. Our primary source of data about these patterns is the conference transcripts. Since each conference involved three or more participants, several transcripts were available for analysis. We chose to analyze the three most complete transcripts for each test. Although we did not solicit or collect responses in any systematic fashion, we also received several comments from participants.

We have developed a method of transcript analysis tailored to these structured tests. We decided not to use the form of content analysis that looks at each message or line in terms of predetermined categories of communication, for several reasons. First, it may be difficult for two or more analysts to decide what the precise definition of categories like "procedural" or "problem-solving" messages should be. Second, if they do settle on a definition, it may be so precise that it can only describe a very limited set of messages. Third, it is difficult to apply these categories consistently since subtle changes in the content of a category, and in the flow of communication, occur constantly.

We have chosen instead a form of analysis that gives us a broad overview of the total process of communication in a conference. Part of this overview entails looking at the context in which all HUB communication takes place. The hardware is more than a part of the setting; it helps to shape the content of the communication as well. In order to use HUB, a person needs a telephone and a terminal. Simply dialing a number connects the user via TELENET with the PDP-10 computer at Bolt Beranek and Newman in Boston, where HUB resides.

The use of this hardware imposes certain conditions on communication. Any information conveyed through the system must be typed; therefore no visual cues or other nonverbal information will add to the understanding of a message. Typing also slows the pace of information exchange.

Because paper-printing terminals were used in all these structured tests, each person received an immediate printout, which provided a record of the conference.

In analyzing the transcripts, we can view the content of a conference as a series of phases in a developmental scheme. We divided the transcripts of the tests into numbered *entries*, which we distinguished according to the source of the information. For instance, two consecutive messages from the same person or program were counted as one continuous entry. The appearance of a message that was not from that same person or program marked a new entry. A sequence of entries (e.g., 1-20) forms a *phase*.

In each entry or sequence of entries in a phase, we wanted to describe multiple facets of communication and to select facets that were particularly relevant to these conferences. After reading over the available transcripts, we could distinguish four dimensions of communication:

- Directionality
- Social interaction
- Task orientation
- Reflection

In exploring the *direction* of communication, we want to know who is interacting with whom, or what, in the case of a program. This study of directionality can serve as the basis for a network analysis of the conference. The *social* dimension of communication involves processes of group organization and individual role definition. Social relations develop not only among participants but between the participants and the programs as well. The *task-oriented* dimension of communication involves the accomplishment of tasks. Both the participants and the program are engaged in defining specific problems, goals, and methods. A fourth dimension of communication may or may not be involved: *reflective* comments show how the participants perceive their own interactions with each other and with the computer system. In these structured tests, reflection is a human expression only. Participants often comment on their own communication patterns; the programs do not.

These dimensions of communication are distinct only in an analytical sense. In any message, be it from participants or a program, the first

three dimensions of communication are expressed simultaneously.

For each preliminary test, we examined one transcript at a time. We divided the transcript into entries and then described each entry in terms of the four different dimensions of communication. After all three transcripts of a conference had been described, we compared them to find phases common to all. We found that in any one conference, each participant's transcript differed slightly from the others'. Variation in the number of entries on a transcript was caused by the extra procedural steps certain participants would take to run a program or correct a mistake. Also, because participants typed and sent messages at different times, they received messages and program information in slightly different sequences.

The developmental scheme of the series of phases provides an overview of the process of communication in each conference. We did not set out to look for any universal stages of group development in computer conferencing or to impose theories positing a set pattern of group phases.* Instead, we tried to find processes unique to each computer conference situation, each with its own context, participants, and tasks at hand. When we study a series of phases, a picture emerges of the development and change in communication patterns over time. We will now examine each of the tests more closely.

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*Such theories have been presented by Bales, Bion, Schutz, Parsons, Tockman, Mann, and others. For a summary, see A. Paul Hare, *Handbook of Small Group Research*, New York: The Free Press, 1976.

The Tests: A Closer Look

While the structured tests develop differently, the first two phases are the same in all of them. Phase I involves GAINING ACCESS to the network (TELENET), HUB, and the subsystems of HUB. At the social level, the first phase is characterized by a one-to-one communication pattern between the user and the computer system. At the task-oriented level, each user faces the problem of gaining access to some computer program. Two different variations of this general pattern appear.

Subphase A begins at the social level with a rote exchange between the user and TELENET. Each person must give and receive from TELENET a predetermined sequence of coded information. Every user supplies the same type of information. While the user may or may not understand what this code means, he or she does understand its significance at the task-oriented level: without it access to the desired activity is impossible. The information must be given correctly and in the right sequence.

Subphase B begins when the user gives the command to run HUB. Unlike Subphase A, Subphase B gives the user the illusion of a social context. Therefore, this communication is *quasi-social* in nature. Also in contrast to Subphase A, this exchange is in English rather than code, in question-and-answer form rather than rote response, and in personalized rather than depersonalized form. The user is asked to state his or her own name and set a personal password. At the task-oriented level, the goal of establishing personal identity is to gain access to HUB activities. HUB prints out what activities are available in the different workspaces. The user then must choose which one he or she wants to join by entering the number of that activity.

Phase II is called INTRODUCING THE ACTIVITY AND THE GROUP. At the social level, communication takes place only between the user and the program of the chosen workspace. Therefore, as in Phase I, the exchange establishes a one-to-one relationship between the user and the computer system. Unlike Phase I, however, the program dominates the interaction and serves to

introduce and coordinate the group around a specific activity. The program introduces the name of the activity in the workspace; it lists the names of all participants and tells which ones are present. At the task-oriented level, Phase II is distinct from Phase I because it involves the problem of group introduction and coordination rather than individual access.

After Phase II, each test unfolds in a different series of phases. There is one feature of HUB, however, that begins in Phase III and continues to appear in the following phases of all the conferences. This feature is programmed into all workspaces in HUB. For each participant, the program prints out who is currently typing, joining, or leaving the conference. Therefore, it provides an update of all participants' activities. At the social level, this update allows each participant to anticipate other participants' messages. It also serves to coordinate group communication by giving each participant an overall view of group interaction. These updates appear continuously from Phase III to the end of a conference.

We have presented the analysis of each test by first giving a summary of the subject of the test and an overview of its phases. This brief summary page is followed by two graphs: one illustrates the number of entries in each phase; the other gives our analysis of the network of communication in the test. Finally, a detailed content analysis of each phase describes the social, task-oriented, and reflective dimensions of interaction.

TEST 1

LEARNING ABOUT LISP

LISP is a programming language used for various projects investigating artificial intelligence. This language deals primarily with symbolic information. We decided that one staff member would try to teach LISP to several others using HUB. This instruction would serve as a structured test of the kind of communication patterns that might develop when modeling groups used the program workspace. The LISP system functions as a "command interpreter." That is, it is an interactive system that accepts commands from the user, executes them, and outputs the results. To use this system in the program workspace, a program called LISP was created. Its only job was to activate the LISP system. In particular, this test applies to training in the use of a modeling program. In this test, the organizer of the session added the program LISP to the workspace. When the other participants entered HUB, he discussed LISP with them in the comment mode and then ran the program to illustrate its problem-solving capabilities. Only the organizer could run and give commands to the program. The others were "looking over his shoulder" and commenting on the fun.

* * * * * * * *

LEARNING ABOUT LISP took place at the Institute for the Future on May 22, 1979 at 1:30 p.m. Four participants were involved. Three transcripts were analyzed. The test lasted approximately two hours.

PHASE I GAINING ACCESS

PHASE II INTRODUCING THE ACTIVITY AND THE GROUP

PHASE III LEARNING THROUGH LECTURES
The organizer dominates communication as he lectures about LISP. He takes the role of teacher and others fall into the corresponding role of student; communication is slow and tedious.

TRANSITION TAKING A BREAK

PHASE IV SOLVING PROBLEMS USING THE PROGRAM
The organizer runs the program to show how LISP can be used to solve problems. Other participants address a few questions and comments to the organizer but not to each other.

PHASE V TESTING THE GROUP
The organizer gives the group a quiz on LISP, which increases group participation. The group's responses suggest that they do not fully understand LISP.

PHASE VI WRAPPING IT UP
The organizer decides that the session should end. The others tacitly agree.

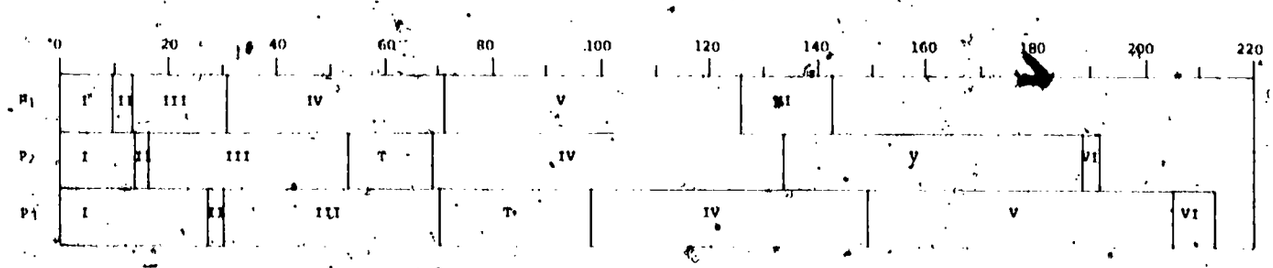
LISP NETWORK

Number of entries

Sent by:	Received by: P_1	P_2	P_3	P_4	All	TELENET	HUB	Program Workspace	LISP
P_1	0	1	2	4	17	3	2	14	13
P_2	13	0	3	3	0	12	6	3	0
P_3	8	0	0	0	0	17	9	3	0
P_4	9	1	1	0	0	?	?	?	?
TELENET	3	10	14	?	0	0	0	0	0
HUB	2	6	9	?	0	0	0	0	0
Program Workspace	32★	55☆	58✪	?	0	0	0	0	0
LISP	0	0	0	?	13	0	0	0	0

★29 updates
☆45 updates
✪50 updates

LISP NETWORK: LENGTH OF PHASES IN ENTRIES



Phase I — Gaining access
Phase II — Introducing the activity and the group
Phase III — Learning through lectures
Transition — Taking a break
Phase IV — Solving problems using the program
Phase V — Testing the group
Phase VI — Wrapping it up

TEST 1

LEARNING ABOUT LISP

PHASE I. GAINING ACCESS

Rote exchange with TELENET/COMPUTER.

```
TELENET
415 DK9

TERMINAL=T165

@c 617 20c

617 20C4 CONNECTED

BBN-TENEX 1.34.40, BBN-SYSTEM-C EXEC 1.54.56
@LOG SIMMS
(ACCOUNT *)
JOB 28 ON TTY160 16-APR-79 17:35
PREVIOUS LOGIN: 16-APR-79 17:34
[JOBS 7, 29, 36 ALSO LOGGED IN UNDER SIMMS]
```

Quasi-social exchange with HUB.

```
@HUB

Welcome.

Please type your last name (and then strike the CR key).

- McPherson

Please set a three character password.

- Mac

Good.  Are you using a terminal that prints on paper?

- Yes

Thank you.

You may attend any one of the following activities.
Planet Conferences:
* 1  Demonstration conference
Program Workspaces:
  2  Learning about LISP
Please type the number of the activity you wish to join.

# 2
```

PHASE II. INTRODUCING THE ACTIVITY AND THE GROUP

When the participants choose the activity "Learning about LISP," HUB takes them directly to the program workspace. Aside from the general functions of this phase, the program workspace also introduces the specific program being run, LISP, and the organizer who is running LISP.

[Comment 1] Porter (Org)
- I'll begin by telling you a little about the programming language LISP.
- It was invented by John McCarthy (then of MIT, now of Stanford) for
- use in various projects investigating artificial intelligence. He
- wanted a language that dealt primarily with SYMBOLIC information,
- rather than languages like FORTRAN or BASIC, which deal primarily
- with numeric information. LISP has some very interesting features
- that distinguish it from almost all other languages.
-

PHASE III. LEARNING THROUGH LECTURES

Social. The organizer immediately assumes the role of group leader. The group apparently recognizes and accepts his authority because he is the only one who knows about LISP. The leader dominates this phase of the instruction, lecturing about LISP. Therefore, he also takes the role of teacher. To complement this role, the other group members begin to act like students listening to him and occasionally asking him questions. The organizer's messages are directed to the group as a whole or to the participant who has addressed him. The other group members tend to address their messages only to the organizer and not to each other.

Task-oriented. The purpose of this structured test is for the organizer to teach the programming language LISP to several colleagues. He defines the basic elements of LISP and outlines the method needed to use this language. He presents this information in the form of a lecture, with participants interrupting to ask for concrete examples of using LISP. They also want to know: "What can I do with it?" The organizer never really answers this question. He puts it off, insisting that the purpose will be evident later. Still, his students' frustration shows in their attempt to bring up the question more than once. The degree of comprehension of the students in this phase is difficult to assess. At least they understand enough to ask questions.

[Comment 7] Porter(Org)
- Now let me tell you about lists. A list is a group of elements
- enclosed in parenthses, with the elements separated by one or more
- blanks. One thing that can be an element is any atom.
- So here is a simple list:
- (A B C)
- The list has 3 elements and the order of the elements is significant.
- Thus (B C A) is not the same list.

Now joining: Simms

Reflective. The organizer recognizes that communication is slow. He wants to keep messages short in order to speed up interaction. He also remarks that he should have typed in all introductory material before the conference actually began. The lecture-style introduction has been long and tedious, particularly for the other participants.

Throughout this phase, and all other phases of the conference, the program workspace provides its usual updates on participant activity.

TRANSITION: TAKING A BREAK

The organizer, who must attend to other duties, simply leaves his terminal and keeps the program running. The other participants log out of the system. At the *social* level, this sequence of events reflects the degree to which group interaction depends upon the organizer. The other group members do not continue to interact with each other over the system. At the *task-oriented* level, the learning process is interrupted.

[Comment 20] Porter(Org)
- Brief time out--Bob is on the phone and wants to talk to me and Mike.

Now Leaving: Simms

Now typing: Andrews

The participants reenter the conference. They go through Phase I and Phase II again.

PHASE IV. SOLVING PROBLEMS USING THE PROGRAM

Social. The organizer again is the focus of the communication process (of 12 comments, 7 are made by the organizer). He directs his messages either to the group as a whole in order to explain features of LISP or to the program in order to demonstrate how LISP works. In this direct interaction with the other participants, the organizer assumes the role of teacher. The program has the role of problem-solver. It is quite clear that the organizer is in control of the program and not vice versa. While as a teaching tool the program presents a structure, it determines neither the order nor the direction of the organizer's communication. Meanwhile, the other members of the group retain their student role. They ask the organizer about the use of certain terms and about certain responses given by the program. They continue to address their comments to the organizer and not to each other.

Task-oriented. The organizer now uses LISP to solve certain problems. He suspends the comment mode and communicates directly with the program, which prompts him for a statement. The organizer responds by typing in a LISP expression, and the program then prints out the value of the expression. Although the organizer explains the value to the group, their questions about definition of terms and program logic indicate that the group does not thoroughly understand LISP yet.

```
[Comment 22]  Porter(Org)
- Now I'll go into LISP and try a few CAR's. Notice that after the
- system prompts me with - , I just type an expression, and it auto-
- matically evaluates it and gives me the value.
-

Resuming program
(CAR '(A B))
A
-(CAR '(X Y Z))
X
-(CAR '(((X))) )
((X))
-(CAR
Now joining:  Sfmms/(CAR '((A B)) )
(A B)
-(CAR (A B))
u.d.f.
A
```

-
Suspending program

[Comment 23] Porter(Org)
- The lines beginning with - are the ones I typed (we missed the first -),
- the value of the expression follows on the next line. The last example
- shows what happens if we leave off the quote; u.d.f. means unbound
- function--it's telling us that A is not defined as a function, so it
- doesn't know how to evaluate (A B). Let me know when you've caught up
- to this point. Any questions?

Reflective. One participant tells the others she has line noise. She logs out and logs in again going through initial TELENET and HUB access phases.

PHASE V. TESTING THE GROUP

Social. The organizer maintains his role as leader and teacher by deciding what process of learning LISP is the best: a quiz. The "students" follow his lead. The frequency of their communication is higher than in Phase IV (of 27 comments, 19 are made by the group members, and only 8 by the organizer). The organizer gives the participants a great deal of approval for correct answers and thus encourages responses. The group members continue to direct their messages to the organizer. At the end of the quiz, two participants make statements to the group that indicate a feeling of competitiveness. One group member misses two comments completely because they fail to appear on her transcript. Consequently, she misses a quiz question and sees only a series of non sequiturs for a while. The program continues to play the role of problem-solver.

[Comment 50] Porter(Org)
- Now here's your next quiz question:
- What combination of CARs and or CDRs can be applied to (X Y Z) to
- give the value Y?
-

Task-oriented. The organizer decides to quiz his students on the LISP logic they have learned. He introduces the first quiz question without a formal warning. Two students give correct answers; one gives an incorrect answer. At least two participants seem to have understood, although perhaps superficially, the LISP instruction. Throughout the quiz, however, all participants ask the organizer for clarifications. One question is unintelligible

to the organizer; he says the content is unclear and lets the question drop. The participant who asked the question tries to rephrase it, but ends by canceling the text. Another participant also cancels one of her questions, perhaps due to uncertainty about the legitimacy of the question. These cancellations show that two members of the group were unsure about their grasp of LISP and that this uncertainty was not communicated to the teacher.

Reflective. At the reflective level, one participant recognizes that line noise causes the incorrect printing of symbols in LISP. This noise, she sees, is the source of some of her confusion about LISP.

PHASE VI. WRAPPING IT UP

Social. The organizer still controls group communication. He suggests that they wrap up this session and begin again tomorrow afternoon. The other members tacitly agree. Without comment, they log out. Leaving involves another rote exchange with the program workspace and HUB. The organizer has the longest exchange, as he requests special services.

[Comment 62] Porter(Org).
- Maybe we'll wrap this up for now and have another session tomorrow
- afternoon. I'll be able to show you more of the language now that we
- have gotten these preliminaries out of the way. Go ahead and log out,
- then I'll store the transcript. Cheers.

Now leaving: McPherson, Simms

Now typing: Andrews

Task-oriented. The group now deals only with the problem of leaving the system. Each member leaves without instructions or discussion. They apparently know the necessary procedures. Only one member has difficulty communicating with the program. The organizer moves from the program workspace back to HUB. When HUB asks him if he wishes to store the transcript, he responds, "Yes." He also asks to review the last comment and then leaves.

TEST 2

NETED: LEARNING ABOUT THE EDITOR

NETED is a simple, line-oriented editing program controlled by a wide variety of commands. Teaching NETED to staff members was chosen as a structured test in order to experiment again with the use of the program workspace in HUB. This activity of simultaneously running and discussing a program would probably be a very common occurrence in any modeling effort. The organizer of this session entered the workspace and typed out all his introductory information before other participants had arrived. He ran the NETED program to demonstrate most of its editing features and he suspended the program to hold group discussions. In the program workspace, only one person at a time can run the program; the others can observe and comment.

* * * * * * * *

LEARNING ABOUT THE EDITOR took place at the Institute for the Future on May 22, 1979 at 4:18 p.m. Three participants were present. All three transcripts were analyzed. The test lasted approximately one hour and ten minutes.

PHASE I GAINING ACCESS

PHASE II INTRODUCING THE ACTIVITY AND THE GROUP

PHASE III SETTING THE SCENE
The organizer comes into the workspace and enters introductory material just prior to the other participants' entry. When the others come in, they see these messages.

PHASE IV LEARNING THROUGH LECTURES AND DEMONSTRATIONS
The organizer describes NETED by lecturing and running the NETED program to demonstrate specific features. Other participants make only a few comments.

PHASE V TESTING THE GROUP
The organizer gives a quiz on NETED, which increases the other group members' level of participation. They direct all their messages, however, only to the organizer and not to each other.

PHASE VI PLANNING IT BETTER NEXT TIME
The organizer decides that the session should end; things are moving slowly. Participants comment that it would be easier to learn if they could run the program themselves and work with only one feature at a time to avoid information overload.

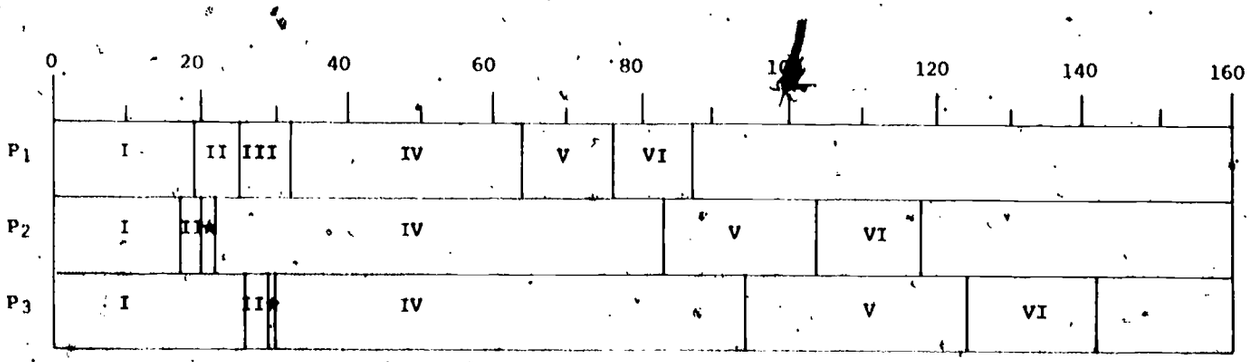
NETED NETWORK

Number of entries

Sent by:	Received by: P_1	P_2	P_3	All	TELENET	HUB	Program Workspace	NETED
P_1	0	3	2	14	5	4	6	7
P_2	7	0	1	0	10	3	4	0
P_3	8	0	0	0	4	4	4	0
TELENET	6	10	4	0	0	0	0	0
HUB	4	4	4	0	0	0	0	0
Program Workspace	7★	43☆	38☆	0	0	0	0	0
NETED	0	0	0	9	0	0	0	0

★no update (transcript obtained by review procedure)
☆39 updates
☆33 updates

NETED NETWORK: LENGTH OF PHASES IN ENTRIES



Phase I	Gaining access
Phase II	Introducing the activity and the group
★Phase III	Setting the scene
Phase IV	Learning through lectures and demonstrations
Phase V	Testing the group
Phase VI	Planning it better next time

TEST 2

NETED: LEARNING ABOUT THE EDITOR

PHASE I. GAINING ACCESS

Rote exchange with TELENET/COMPUTER.

Quasi-social exchange with HUB and the program workspace.

PHASE II. INTRODUCING THE ACTIVITY AND THE GROUP

Once participants enter the activity, the workspace begins to provide participant activity updates for each user.

Porter(Org) is runnihg the program NETED. Do you wish to see the run also?

- Yes

NETED [4] run by Porter(Org) 22-May-79 7:18 PM

Porter(Org), Sanchez are present.

PHASE III. SETTING THE SCENE

Social. The organizer enters the workspace and types in several messages, which the other participants receive as soon as they enter the workspace.

Task-oriented. The organizer's comments consist primarily of introducing the participants to NETED. He provides background material on what the program is and what it is designed to do.

[Comment 1] Porter(Org)
NETED is a simple, line-oriented text editor. "Line-oriented" means that the text being edited is thought of as consisting of LINES, rather than pages, paragraphs, or whatever. NETED is controlled by the use of simple commands. Some are just a single letter, such as the command T, which means move to the top of the file. It is useful to think of the editor having a "pointer" which indicates the current position. Thus, after the command the pointer is pointing to the top (beginning) of the text.

PHASE IV. LEARNING THROUGH LECTURES AND DEMONSTRATIONS

Social. Participant interaction during this phase is basically limited to receiving information from the organizer. The organizer provides an introduction to the activity as the other participants remain passive, offering only perfunctory comments/questions in response to the organizer's request for acknowledgment.

Task-oriented. The organizer provides participants with background information on how to use NETED editing features. He also demonstrates some features by running the NETED program. Discussion proceeds much like a classroom lecture presentation. The organizer presents information and occasionally participants ask questions or make comments.

```
[Comment 7] Porter(Org)
I'll go back to the program now.

*T

*P 1 00

(Top of file.)
Some words of wisdom:
Whoever has the gold makes the rules.
Pure drivel tends to drive out ordinary drivel.
 End of file reached by 'P 100'
```

Reflective. One participant acknowledges his grasp of the basic principles of using the editing features. However, he indicates that it would take some time to become accustomed to using the program.

PHASE V. TESTING THE GROUP

Social. Communication now becomes more interactive; participants offer more comments and ask more questions about NETED. The organizer responds to each inquiry individually, generally referring to the participant by name. Participants in turn direct their comments to the organizer. There are no comments that appear to be group responses--simply two sets of one-to-one interactions between the organizer and each participant in turn. The two participants do not exchange comments.

Task-oriented. At this point, the organizer begins to quiz the participants on their understanding of the previous material. To answer his questions, the participants must understand the mechanics of using NETED features. The participants' responses are hesitant or incorrect, indicating lack of comprehension.

[Comment 28] Porter(Org)
Here's a quiz: what commands would let me change "whoever" to "whomever"?

[Comment 29] Nielsen
- *c
-

Now typing: Porter(Org)

[Comment 30] Porter(Org)
What I mean is, what commands would I type in. Just typing c wouldn't do it.

Now typing: Sanchez

[Comment 32] Nielsen
- *c /whoever/whomever/
-

Now typing: Sanchez; Porter(Org)

[Comment 33] Porter(Org)
I'll try your answer, Mike.

Reflective. One participant expresses some confusion when one of her messages stops being printed in mid-sentence. The organizer and other participants do not respond to her query.

PHASE VI. PLANNING IT BETTER NEXT TIME

Social. The organizer abruptly indicates his intention to end the session. His rationale for ending the session is that things are moving a little slowly. Although the participants offer no objections to this decision, it is clear that they did not take part in the decision-making process.

[Comment 40] Porter(Org)
Things are a bit slow--why don't we call it a day. Tomorrow or the next day, we'll try it again, but this time with one of YOU running the editor and me looking over your shoulder (electronically).

Task-oriented. The participants' subsequent comments indicate that they are still not very well versed in using NETED features. One participant asks the organizer for a clarification regarding the last quiz question, for which no correct answer has been offered. The organizer answers briefly and continues with directions to the participants on how to leave the activity.

Reflective. Both the organizer and the participants agree that the session might have been handled in a different way. One participant indicates that learning NETED features may require actual running of the program rather than watching as someone else demonstrates how it is done. She feels that offering too many program features at once was overwhelming and that working with one feature at a time may be more conducive to learning to use the program.

[Comment 41] Sanchez
OK. I think its a good idea to work with the commands one at a time like you were doing. Having the whole list print out like that is overwhelming. I think you actually have to work with it....

TEST 3

ADVENTURE

Adventure is a computer game. It was used as a structured test because the program is interactive and useful in simulating small group decision-making. The communication patterns involved in this decision-making might easily take place in modeling conferences. In playing Adventure with a group, two types of decision-making were necessary. The first type related to the problem of choosing a group leader. This interaction took place in a PLANET conference called Preparation for Adventure. Here the group had to choose a leader in order to play the game. Only the leader could run and give commands to the game program. After a leader was chosen the group moved to the program workspace where Adventure was located. Then began the second type of decision-making, which focused on task-oriented objectives. The game program set up a number of problematic situations that required the group to decide on an appropriate course of action. The leader would run the Adventure, then suspend the program and enter the comment mode to poll other participants about their choices. The group had to reach a common decision. Then the leader resumed the program and gave the appropriate command.

* * * * * * * * *

Adventure was played at the Institute for the Future on April 16, 1979. Five participants were involved and three transcripts were analyzed. The game lasted approximately one and one-half hours.

PHASE I	GAINING ACCESS
PHASE II	INTRODUCING THE ACTIVITY AND THE GROUP
PHASE III	SETTING THE SCENE Group receives instructions from an organizer who is not online.
PHASE IV	FORMING THE GROUP Multiple and subtle roles develop that reflect staff relationships. Decision-making moves quickly. An implicit leader suggests a leader and everyone agrees. A technical expert urges group on to the game.
TRANSITION	BREAKING OFF AND REENTERING The group moves to the program workspace but a problem arises in running the program. The correction shows on only one transcript.
PHASE V	GETTING ON THE WITH GAME Decision-making is slow and tedious as the leader seeks unanimity.
PHASE VI	PHASING OUT A system difficulty arises and group members give up and leave the game.

ADVENTURE NETWORK

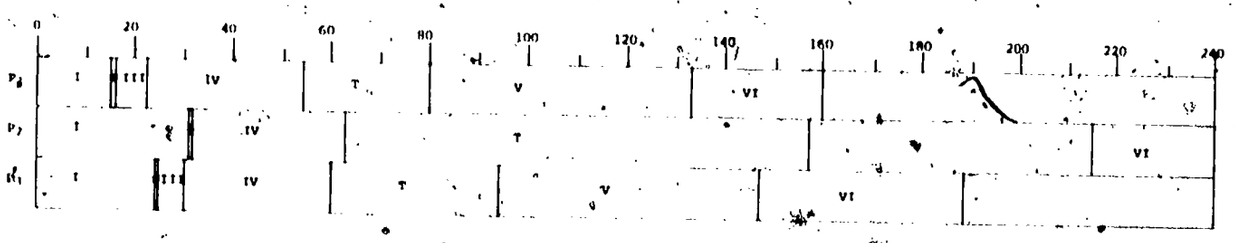
Number of entries

Sent by:	Received by:											
	P_0	P_1	P_2	P_3	P_4	All	TELENET	HUB	PLANET	Program Workspace	ADVENTURE	System Developer
P_0	0	0	0	0		1	0	0	0	0	0	0
P_1	0	0	5	1	2	11	8	9	2	6	0	0
P_2	0	1	0	0	1	18	17	8	2	14	3	0
P_3	0	0	5	0	1	7	6	14	3	3	0	0
P_4	0	5	1	1	0	6	7	7	7	7	7	2
TELENET	0	8	21	8	?	0	0	0	0	0	0	7
HUB	0	8	8	14	?	0	0	0	0	0	0	5
PLANET	0	16*	17*	14O	?	0	0	0	0	0	0	0
Program Workspace	0	39**	39**	36OO	?	0	0	0	0	0	0	15
ADVENTURE	0	0	0	0	?	4	0	0	0	0	0	3
System Developer	0	0	0	0	0	0	8	5	0	17	0	0

P_0 organizer not online

*15 updates **32 updates
*15 updates **23 updates
O 9 updates OO32 updates

ADVENTURE NETWORK: LENGTH OF PHASES IN ENTRIES



Phase I — Gaining access
Phase II — Introducing the activity and the group
Phase III — Setting the scene
Phase IV — Forming the group
Transition — Breaking off and reentering
Phase V — Getting on with the game
Phase VI — Phasing out

TEST 3

ADVENTURE

PHASE I. GAINING ACCESS

Rote exchange with TELENET/COMPUTER.

Quasi-social exchange with HUB.

PHASE II. INTRODUCING THE ACTIVITY AND THE GROUP

The title of the activity is:
preparation for the adventure

The participants in the activity are:

Simms McPherson Porter
Andrews Abrams

Porter, Andrews, Abrams are present.

You have seen none of the 9 entries made so far. Please indicate the entry number at which you wish to begin. If you do not wish to see any of the past entries, strike only the CR key.

PHASE III. SETTING THE SCENE

Social. In this play of the game, the organizer is not actually online. Three days before the play of the game, the organizer enters HUB and leaves instructions about how to play the game. One group member enters HUB several hours before the game begins and leaves a comment on these instructions. When they actually enter the game, other members of the group have varying perceptions about with whom they are communicating: the program or the person. In any case, whatever they perceive as the source of the message, they all receive the same set of messages in the same order.

Task-oriented. These messages from the organizer set a social task. She tells the members of the group to introduce themselves and to choose a group leader. Then, she also gives instructions about the procedures needed to move from the PLANET conference to the program workspace where the Adventure game program is located.

[1] Simms(Org) 13-Apr-79 11:03 AM
Welcome. I'm glad that all of you adventurers could gather here on this foggy morning to seek treasures and excitement.

[2] Simms(Org) 13-Apr-79 11:04 AM
Before you begin your adventure, I would like all of you to introduce yourselves to each other and say a few things about the skills you bring to this expedition.

[4] Simms(Org) 13-Apr-79 11:07 AM
When you have chosen a leader, give him or her a few minutes lead to get into the activity 2. Then the rest of you can join him/her there. To join activity 2, type control P, followed by join (activity) 2. Once you are there, you can talk to the leader at any time by simply typing your messages.

PHASE IV. FORMING THE GROUP

Social. Synchronous group communication begins at this point. Each individual shows a certain style of communication related to his or her role in group process. The participant who has been chosen leader hesitantly accepts her role. She tends to send fewer messages than the others and indicates that she is relying on the other group members for assistance. Through the frequency, aggressive tone, and directional content of his messages, another participant assumes the role of an implicit leader. Two other participants quickly accede to his suggestions. The content of their messages shows some impatience and eagerness to get on with the game. One of these two participants assumes the role of technical expert. He tells other participants what procedures are necessary in HUB to move from one activity to another.

You are up to date.

Now typing: Abrams

[10] Abrams 16-Apr-79 5:36 PM
I already have introduced myself. Let's get the show on the road.

[11] Andrews 16-Apr-79 5:36 PM
I still have not heard from McPherson or Porter. Hello Abrams.

Task-oriented. A decision-making process has begun. The implicit leader strongly suggests who the leader of the group should be. The other

participants seem to accept his authority and concur with his suggestion. A leader is chosen who coordinates group introductions but who has no clear plan of action. The technical expert speaks up and urges that the group move on to the task. The other members agree and follow his instructions.

Reflective. One member notices that there seems to be an undue amount of activity going on. Why, she asks, is everyone typing at once? In face-to-face interactions such activity might imply a lack of group coordination; while it is functional in a computer conference, it may seem confusing to a newcomer.

In this phase, the HUB update feature prints out who is typing, joining, or leaving the activity. This feature continues to appear throughout all following phases.

TRANSITION: BREAKING OFF AND REENTERING

Communication completely breaks down. Each participant successfully leaves the PLANET conference and moves to the program workspace. At this point, however, the program terminates because the instructions to run the program had been entered incorrectly. Each participant is forced to log out of the entire system. They must then repeat the proper sequence of entry protocols described in Phase I and Phase II. (In the meantime, the organizer has been called in to enter the correct instructions for running the program.)

[24] Porter
Let's give Cynthia a couple of minutes to get into the game, then we can join her.

Andrews is running the program adventure. Do you wish to see the run also?

- Yes

Adventure [1] run by Andrews 16-Apr-79 5:42 PM

Andrews is present.

OPENF or RNAMF: file open
COMPATIBILITY LOCATION = 703320
USER LOCATION 62060
INSTRUCTION = 256000000000

EXIT.
^C
@

[Comment 1] McPherson
- What was all that stuff I got as soon as I joined? Included was an
- exit and control c?

PHASE V. GETTING ON WITH THE GAME

Finally, all participants have been able to get in and stay in the program workspace. They are ready to play Adventure.

Social. The Adventure program takes a very human form; it directly addresses a player in a conversational tone. This program acts as both an expert and a guide, describing the nature of the game and telling how to use the program. In this game, only the leader communicates directly with the program. She gives the program the commands needed to play the game. The participants spend most of their time communicating with each other. One participant leaves to take a break.

WELCOME TO ADVENTURE!! WOULD YOU LIKE INSTRUCTIONS?
Yes

SOMEWHERE NEARBY IS COLOSSAL CAVE, WHERE OTHERS HAVE FOUND FORTUNES IN TREASURE AND GOLD, THOUGH IT IS RUMORED THAT SOME WHO ENTER ARE NEVER SEEN AGAIN. MAGIC IS SAID TO WORK IN THE CAVE. I WILL BE YOUR EYES AND HANDS. DIRECT ME WITH COMMANDS OF 1 OR 2 WORDS. I SHOULD WARN YOU THAT I LOOK AT ONLY THE FIRST FIVE LETTERS OF EACH WORD, SO YOU'LL HAVE TO ENTER "NORTHEAST" AS "NE" TO DISTINGUISH IT FROM "NORTH". (SHOULD YOU GET STUCK, TYPE "HELP" FOR SOME GENERAL HINTS. FOR INFORMATION ON HOW TO END YOUR ADVENTURE, ETC., TYPE "INFO".)

YOU ARE STANDING AT THE END OF A ROAD BEFORE A SMALL BRICK BUILDING. AROUND YOU IS A FOREST. A SMALL STREAM FLOWS OUT OF THE BUILDING AND DOWN A GULLY.

[Comment 1] Andrews
What does everyone suggest for the first move?

Task-oriented. The program has set up the assumptions, goals, and rules (or methods) of the game. It also sets up problematic conditions and seeks directions from the players. The leader gives one- or two-word commands to the program. The commands, however, result from group decisions. In this game, it seems that the leader wants a unanimous decision. She waits until everyone has agreed on a particular move before she gives any command to the

program. The first command is received and processed by the program. The second command is not recognized. The leader suspends the comment mode in order to communicate with the program.

PHASE VI. PHASING OUT

Social. The leader indicates that she is having problems communicating commands to the program. The participant who took the expert role in Phase IV takes over the discussion in order to solve these technical problems. The leader and the other participants respond to the expert.

[Comment 27] Andrews
I'm having a problem telling the program that we will take the key.

[Comment 34] Porter
I think you need to go back to the program with a CTRL-Z before giving the command.

[Comment 42] Porter
In the words of the astronauts "I think we have a problem."

Now leaving: Andrews

[Comment 44] McPherson
- Shall we all leave?
-

Your current participation is ended.

Task-oriented. The expert finally acknowledges that a real problem exists. Each participant then logs off the system individually with no apparent discussion. (Actually, the conference organizer goes to each participant's office and asks him or her to end the session.)

TEST 4

TEAM WRITING

The document workspace in HUB provides an environment in which a group of people can jointly write and edit a report, paper, or other document. A test of this use of the document workspace was attempted over a period of three weeks. The objective was for three members of a research team to write a conference paper on the future of teletext. One member of the team wrote the first draft in the document workspace and others were encouraged to work on successive drafts by using the EDIT service in the document workspace. This produced the following type of transcript:

> The title of the document is:
> IEEE Paper
>
> The participants in the activity are:
>
> Porter Chun Nielsen
>
> and the document is stored in the file:
>
> IEEE.TXT
>
> You have not seen 1 comments and 9 changes made since 1-May-79. Please indicate the date at which you wish to begin. If you do not wish to see any of the past entries, strike only the CR key.
>
> - 1-May-79
>
> PAGE 1 LINE 16 Porter(Org) 1-May-79 4:59 PM INSERTED
> In this paper we address the following question: What are the key issues surrounding the development of teletext and viewdata in the U.S.? Some of these issues come readily to mind, such as the adoption of standards. Our thesis, however, is that the number of issues involved is in fact large, and that taken together they represent a great deal of uncertainty about the future of teletext and viewdata in this country.
>
> PAGE 5 LINE 37 Porter(Org) 3-May-79 4:22 PM REPLACED
> also provides access to information. Rather that a passive medium, today's
> WITH
> also provides access to information. Rather than a passive medium, today's

This test was not a structured test like the previous three tests; it was a test of the system for a real problem. It also encountered a number of fundamental communication problems that led us to redesign the document workspace. We have thus not analyzed it as we have the structured tests; we do, however, want to note the changes that it inspired in the document workspace.

The design of the document workspace proved too cumbersome. First, there was not a clear focus on the editing process. Changes were unnumbered and difficult to retrieve. Comments, on the other hand, were numbered. This created competition for the focus between an ordered transcript of comments and a less ordered series of changes. In the revised workspace, the changes are numbered and comments are attached to changes (that is, they appear next to and reference the change to which they refer).

Another problem that arose in our initial design was the length of changes. We had not anticipated the long insertions that, in fact, occurred in this test. A participant, reviewing changes, would be expecting a quick review of changes and find instead that one change was five pages long. Thus, we have given users the option of seeing a summary of changes: if a change is ten lines or less, it is printed in its entirety; if it is more than ten lines, only the first line is printed.

Another design modification concerns sorting of changes. Originally, changes were displayed in the order they were made. Now, they are sorted by page and always displayed with other changes on the same page.

Finally, we have added a summary of changes for each session. Since the changes are not actually numbered until the session is complete, it was not possible to attach comments to one's own changes. Now the user can get a list of numbered changes and make comments on these changes as the conclusion of an editing session.

A Research Agenda

In the process of analyzing these structured tests, we have looked closely at the hardware, the social processes, the tasks, and the participants' own reflections on their experience with HUB. Our analysis raises several issues about the ways in which the HUB system might influence, whether directly or indirectly, the communication patterns of groups involved in computer modeling. Major issues include: the distinction between information exchange and understanding of that information, the flow of information in the HUB system, the development of social roles in HUB, the social role of the HUB system itself, and the reliability of communication. These issues provide an initial agenda for our research over the next two years.

ISSUE 1. INFORMATION EXCHANGE VS. UNDERSTANDING

Our structured tests have brought out an important distinction to be made in analyzing communication via any system: a system's capacity to increase the amount of information exchanged cannot simply be equated with its capacity to promote the genuine understanding of that information. This distinction was central to our objectives when designing the HUB system: we wanted to develop a system that would provide access to more computer resources for more people. And at the same time, we wanted a structure that would help people to better understand those resources.

The two structured tests dealing with instruction hint at some of the problems that might arise in using the HUB system to promote understanding of computer-based resources in modeling. In both the LISP and NETED tests, a great deal of technical information was presented. One might assume that this type of material would be more easily digested along with the real-time demonstration of the programs being explained. However, the participants seemed to understand relatively little at the end of the tests.

Several factors in the "style" of using the program workspace may account for this: the speed of presentation, the lecture-style format, the lack of hands-on interaction with the program, and the brevity of the test. In both tests, the organizer ran the program as a demonstration tool. Most information was given either by the organizer or the program. The other participants addressed their questions and comments only to the organizer; their participation was minimal. At the end of the NETED test, participants noted that they might have learned more if they could have had a more active role in running and interacting with the program themselves. One participant in NETED also suggested that dealing with only a small amount of information seemed a better way to learn the NETED commands. This may simply be a problem of information overload, related to the synchronous use of the system in the tests. Increased participation may have helped; the quizzes the organizer gave in both LISP and NETED seemed to increase the group's participation, as well as their understanding of the information presented to them.

The quiz results are misleading, however. In spite of a majority of correct answers in the LISP test, for example, the participants expressed confusion about the overall process of using LISP, including a basic lack of understanding about what it might be used for. This raises a fundamental concern for us--HUB might actually obscure a lack of understanding when it exists.

No communication system can guarantee that its users will understand each other. But the structured tests have suggested some specific patterns for us to watch for as we test the HUB system over the next two years.

THINGS TO WATCH FOR:

INFORMATION EXCHANGE VS. UNDERSTANDING

- The potential of HUB to obscure a lack of understanding when it exists.
- Better understanding when discussion is less structured.

- Communication that focuses on the technical details of the modeling process but not on underlying assumptions.
- HUB's tendency to foster the "selling" of one perception rather than a comparison of a variety of perceptions.
- Information overload in synchronous uses of the system.
- Discussions that raise a lot of issues but do not resolve them to anyone's satisfaction.
- Better understanding when participants all have direct interaction with programs in the program workspace.
- The use of HUB to achieve a false consensus.
- Better understanding with group discussion than with structured teacher-to-pupil communication.

ISSUE 2: THE FLOW OF INFORMATION

The flow of information in any communication environment can be measured in terms of: the pace of communication and the integration of information, the exchange of information among different activities and different roles within those activities, the incorporation of information from outside of the immediate environment, and the processing of this information. One objective of the HUB design was to promote the integration of information from the many activities that constitute the modeling process. Our previous experience with PLANET conferences most often leads to a diverging flow of information--hence, its value for activities such as brainstorming. However, in the HUB system, we hoped that the workspaces would facilitate the integration process by focusing the flow of information on a program or a workspace; we also hoped that the HUB "switcher" would serve to integrate activities.

Of our structured tests, only the Adventure test involved both a PLANET conference and a program workspace. Because this was a synchronous test in which the participants were instructed to accomplish certain tasks in PLANET in preparation for the exercise in the program workspace, we could expect a high level of integration of the information in the two activities. Most of this information concerned role definition and the use of the system:

two roles that were defined in the PLANET conference (group leader and technical expert) were transferred without further discussion to the workspace. Also, everyone entered the workspace with the same information about the activity to occur there. The transition was not smooth, due to technical problems, but these problems did not inhibit the flow of information. In real-world tests, of course, we might expect a wide variation in flow of information.

In all three tests, the flow of information between the program being run and participants using the program was funneled through a single person. Yet in the Adventure test, there was much more exchange of information among all the participants than in the two instructional tests. This pattern may be linked to (1) the group task, (2) the leadership style, and (3) the type of program being used. We suspect that the characteristics of the computer programs used in HUB will play an important role in the integration or lack of integration of information. For example, many of the programs designed to support structural modeling may prove to be integrative, However, one task for us in our field tests will be to define better those characteristics of programs that tend to foster integration.

Regarding pace of communication, participants in all the structured tests complained both during and after their sessions about the frustration of communication "in slow motion." The facts that most users were not skilled typists, that the output speed of the terminals is fixed, and that transmission of a message does not begin until the message has been completely typed all help to explain the perceived slow pace of communication. At the same time, it is worth pointing out that this perception of slow communication in HUB is actually a relative judgment. In all these structured tests, communication was synchronous. Therefore, participants might instinctively compare HUB with other more familiar forms of synchronous interaction such as face-to-face or telephone conversation. In asynchronous communication, or in synchronous communication in which the program plays a more active role in generating information, the pace of communication may be perceived differently.

A final question related to information flow arose in the course of the structured tests: What stops the flow of information in HUB? How do

sessions end? In Adventure, the game ended due to system failure. In LISP and NETED, however, the organizer suggested ending the sessions, partially because of the slow pace of communication. Although a computer-based medium of communication is supposed to relieve the time constraints of face-to-face meetings, it may have time constraints of its own. And these time constraints may ultimately halt the flow of information in HUB.

The structured tests have provided hints of the patterns in the flow of information in HUB--hints that suggest some items our research agenda should include.

THINGS TO WATCH FOR:

THE FLOW OF INFORMATION

- More integration of information among activities when synchronous communication is emphasized.
- More division of information among workspaces when asynchronous communication is emphasized.
- A greater tendency for information to be funneled through one person when communication is primarily synchronous.
- In asynchronous uses of the system, a tendency for the program to generate more information than do people.
- A tendency for one person to dominate the flow of information if he or she is more skilled in the use of the program.
- Less structured flow of information among participants when the program is simple and highly specific.
- More structured flow of information among participants with complex, general-purpose programs.
- A tendency to perceive the pace of communication as slow when information flow from the program to the group is low; a tendency to perceive the pace of communication as fast when the program generates a lot of information; and a tendency for these perceptions to be exaggerated in synchronous communication.

ISSUE 3: THE DEVELOPMENT OF SOCIAL ROLES

The development of social roles is crucial to the modeling process because such roles will determine who shares what information with the group and how decisions about the use of this information are made. The roles adopted will influence both the flow of information and the degree to which that information is understood. HUB was designed to allow people to express themselves in a variety of different roles and to develop and change these roles. This flexibility in group process is necessary if HUB is to help overcome some of the social barriers in modeling that arise among individuals who are from different institutions and different disciplines and who have different habits of social interaction.

Our developmental mode of analyzing the structured tests has proven well suited to questions of social roles. By studying each phase, we have been able to see what roles existed. By studying each series of phases--the developmental scheme--we have watched these roles change through time in a particular situation.

In the Adventure test, we found a variety of roles developing in Phase IV in PLANET: an implicit leader, a chosen leader, a technical expert, and a follower. To some extent, these roles reflected the work relationships among these participants at the Institute. In NETED and LISP, however, roles were not as numerous: in all phases, there were a teacher (the organizer) and students. These students did not create new roles when interacting with each other. Unlike the roles formed in the Adventure game, those adopted in the LISP and NETED tests did not reflect normal relationships among the staff members. The structure of the HUB activity may influence the nature of social roles. The PLANET conference used in preparation for the Adventure game, which seemed to encourage a variety of roles, created a very unstructured environment; the more structured program workspace used in the LISP and NETED tests produced a more rigid pattern of interactions.

The question of change and development of roles also arose in the structured tests. In LISP and NETED, we saw very little change in the initial teacher-student hierarchy established in the early phases of the session. In Adventure, however, we found two distinct patterns developing. In Phase IV, Forming a Group, an almost autocratic hierarchy existed. Essentially

one person, the implicit leader, seemed to influence most of the decisions. Yet later on, in Phase V, Getting on with the Game, a more "democratic" set of relations developed when the chosen leader took charge. This shift in role relations was essentially determined by a change in leadership--a shift that was the result of the chosen leader's special access to the Adventure program.

In future field tests, we intend to watch how roles, and consequently role relations, change. As a starting point, we will pay particular attention to possibilities the pretests have suggested.

THINGS TO WATCH FOR:

THE DEVELOPMENT OF SOCIAL ROLES

- Greater variety of roles in PLANET than in the workspaces.
- Different roles in different activities.
- A tendency for a technical expert to take a leadership role if the program is difficult to use.
- A tendency for conflict to arise between the technical expert qua-leader and the formal leader of the project.
- A tendency for roles to be defined by access to a program.
- Difficulties in maintaining a leadership role if everyone has knowledge of and access to the program being used.
- More structured roles and role relationships in synchronous than in asynchronous communication.
- Greater variety of roles when the program is simple and specific; a tendency for a single dominating role with complex, general-purpose programs.
- Likelihood that roles and relationships formed outside the context of HUB will be more easily recreated in PLANET than in the program workspace.
- Likelihood that the development of roles and relationships in HUB will follow a different process according to whether participants do or do not already know each other.

ISSUE 4. THE SOCIAL ROLE OF THE HUB SOFTWARE

We tried to design HUB to be as transparent as possible; we wanted people to feel that they were communicating within a group rather than with a computer system. At the same time, we hoped HUB would structure communication in a way that would both encourage participation and guide people through complex activities. These objectives might seem almost mutually exclusive. However, we have attempted to achieve them by designing a system that structures communication in ways that would be analogous to more familiar forms of human interaction.. Our hope was that participants would not find these structures disruptive in interpersonal communication.

The HUB system appears to play specific roles in structuring communication. In Phase I, or Gaining Access, when TELENET demands a mechanical exchange of coded information, the user is probably very much aware of interacting with a computer system. In the second part of Phase I, however, HUB creates a more "human" exchange. In Phase II, the workspace program chosen plays the role of a group coordinator. In Phase III of some tests (Setting the Scene), the review feature of HUB can be perceived either as direct communication with another participant or as communication via a computer program that is "reporting" what other participants said. Finally, we should emphasize one more feature of HUB: the continual updates of participant activity. Our analysis of the structured tests suggests that these updates tend to increase each participant's awareness of communicating with a group.. These updates give participants information in "verbal" form that is often expressed in nonverbal form in ordinary face-to-face interaction. For example, they signal who is about to send a message, who is joining the group, and who is planning on leaving. In an inconspicuous way, these updates add another dimension to HUB communication: aside from just sending and receiving messages one at a time, each participant continually receives information about the total group. This function of HUB externalizes something that is normally done internally--and even subconsciously--by each individual.

The importance of the social role of HUB software in the modeling process is an unknown. We suspect that it might influence users' perceptions of the credibility and accessibility of the various activities. It might

also influence users' perceptions of their responsibility in carrying out those activities. From the limited data of these preliminary tests, we have made some speculations.

THINGS TO WATCH FOR:

THE SOCIAL ROLE OF THE HUB SOFTWARE

- More conscious attention to group process as a result of information provided by HUB.
- A tendency to think of HUB as a human-like participant capable of initiating--and therefore taking responsibility for--some of the activities.
- A tendency to assume that HUB will "manage" the communication process, with frustrations arising when it does not.
- A tendency for users to "blame" HUB for limits on the flow of information that are actually imposed by style decisions of the users (or one of the users).
- A belief that HUB does not influence the understanding of information.
- Different roles for HUB in different situations; HUB will probably be most conspicuous as a social actor in synchronous communication.

ISSUE 5: RELIABILITY OF COMMUNICATION

How people perceive the reliability of the HUB system will greatly affect how much it is used, when it is used, how information exchanged in HUB is percieved, and how reliable the social relationships maintained in HUB seem to be for the task at hand. In choosing a computer operating system, our objective was to find one with as few restrictions as possible for interactive communication. Therefore, we implemented HUB under TENEX on a PDP-10 computer at Bolt Beranek and Newman in Boston (accessed through TELENET). Throughout the structured tests, we were continually reminded that in making this choice we had achieved flexibility but sacrificed reliability.

The network's lack of reliability did affect attitudes toward communication in HUB. Participants in the structured tests found the computer's unpredictable behavior frustrating and inconvenient.. It also influenced the development of a social role: the technical expert gained considerable power as a result of system failures.

Although the role of the transcript was never directly discussed by participants in the structured tests, their perceptions of reliability of HUB communication may be enhanced by the availability of transcripts. Regardless of disruptions that might occur in the process of communication, users can always turn to a transcript to find a record of what has gone on. This record allows users to confirm, synthesize, and reflect on the information exchange through HUB. When a paper-printing terminal is used, these transcripts are immediately available. If a terminal that displays the interaction on a screen is used, a transcript can be requested through the review procedure in HUB.

Based on our experiences of the reliability of communication in the structured tests, we expect certain patterns to emerge with future use of the HUB system.

THINGS TO WATCH FOR:

RELIABILITY OF COMMUNICATION

- More status for technical experts when system reliability is low.
- Improved perception of reliability when a technical expert is present.
- Lower credibility of the computer programs being used when system reliability is low.
- Improved perceptions of reliability when interaction is predominately asynchronous; poor perceptions of reliability when it is primarily synchronous.
- A tendency for perceived reliability to improve as users become more experienced.

- A proportional relationship between the perceived reliability of the system and the frequency of its use.
- More emphasis on problem solving as opposed to "notepad" uses of the system when perceived reliability is high.
- Improved perceptions of reliability when the group uses the REVIEW feature frequently.
- A tendency for those who are unfamiliar with the substantive issues of the activity to be more concerned about reliability than those who are very knowledgeable.

AN AGENDA-IN-PROGRESS

The purpose of these preliminary tests has been to provide a focus for our research over the next two years. The five issues discussed above constitute such a focus--an initial agenda for our research. But even before we begin to observe the use of HUB by modeling groups, we realize that this focus is perhaps too narrow. The structured tests were designed to bring out *communication* issues primarily; but our overall analysis will also need to include issues of modeling *methodology*. Also, we suspect that several other issues will emerge once we step into the "real world." And the list of "things to watch for" in each issue will expand, too. Thus, our research agenda is an agenda-in-progress. Our approach to evaluation will be constantly to revise our concerns and expectations as our experience grows; we feel that this "evolutionary" design will ultimately provide a very rich picture of effective and ineffective ways to use HUB in the modeling process.