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ABSTRACT

The extension of computer based communication to the more task-focused communication required by groups involved in joint problem solving is discussed in this paper. Specifically, it addresses three areas: (1) the aspects of the joint problem solving that are most suited to computer based communication support, (2) the computer based communication facilities that are needed to undertake the problem solving tasks, and (3) the facilities that might best be structured to promote communication through the display of information, group interaction, and the storage of information. In particular, it discusses the capabilities of the HUB system, which has been specifically designed to support such communication. In conclusion, it presents some preliminary findings from a continuing evaluation of the system based on the experiences of a number of user groups. (Author/FL)

SUPPORTING TASK-FOCUSED COMMUNICATION

by

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Abstract. This paper discusses the extension of computer-based communication to the more task-focused communication required by groups involved in joint problem solving. By analyzing the types of communication involved in each stage of the problem-solving process, we select the aspects of joint problem solving most suited to computer-based communication support. In particular, we discuss the capabilities of the HUB system, which has been specifically designed to support such communication. Finally, we present some preliminary findings from an ongoing evaluation of the system based on the experiences of a number of user groups.

INTRODUCTION

Various forms of computer-based communication have been developed to aid communication among a group of people. Electronic messaging (or electronic mail) and computer-based conferencing have been the principal communication modes to date. (1) Their uses have varied from message exchange to group discussions. Yet, for groups with highly defined objectives, their usefulness has been limited.

However, the computer also offers the promise of supporting more task-based communication. Two examples of such structured communication are the development of computer-based graphics and its extension to multiple users (2, 3), and the ability to write and edit documents jointly. (4) While these types of communication may at first appear rather disparate, in fact they are examples of different modes of computer based communication that could be used by a group involved in joint problem solving.

In this paper we address three specific questions at the core of extending computer-based communication to a more task-focused context.

- What aspects of joint problem solving are most suited to computer-based communication support?
- What computer-based communication facilities are needed to undertake these problem-solving tasks?
- How might the facilities best be structured to promote communication through the display of information, group interaction, and the storage of information?

COMMUNICATION AND JOINT PROBLEM SOLVING

To answer the questions we have raised, it is instructive to focus on the joint problem-solving process and on the various forms of communication (verbal, textual, mathematical, and visual) involved. (5) A number of taxonomies have been proposed to describe group problem-solving processes. Briefly, the generally agreed upon tasks in joint problem solving include:

Conceptualizing. An essentially verbal communication activity that attempts to shape a diverse series of concerns into a tractable, agreed-upon format;

Searching. A task, either structured or unstructured, in which problem boundaries, key issue areas, possible approaches or methods, and important variables and constraints are delineated;

Structuring. A formal or informal process to determine the extent and type of interactions among the set of variables. It is also a first step toward providing a framework or structure for the proposed problem methodology;

Implementing. All problem solving involves implementing a proposed design against a known or postulated situation. This process may range from formal prediction to replicating an existing state;

Evaluating. The results of the implementation are formalized to include model validation, refinement of approach, and testing;

Documenting. An ongoing task in which the procedures, algorithms, assumptions, limitations, variables, and constraints are recorded and, if necessary, commented upon.

To assess the feasibility of computer-based support systems in such a process, it is necessary, first, to match various communication forms or information flow processes to the group problem-solving tasks and then to identify a number of modifying characteristics that describe each basic communication form. These characteristics include:

- Communication channel options -- face-to-face; audio only (telephone); audio-textual (facsimile/telephone, audio conference electronic blackboard); textual-visual (meetings); textual (mail).

- Level of participation -- one-to-one; one-to-many (formal, organized meeting); many-to-many (fully interactive).

- Time delay in responding to a message -- zero time delay (synchronous); large time lags (e.g., one-to-one and asynchronous).

- Frequency of information exchange.

- Complexity of information content.

Computer-based communication is best suited to those tasks for which face-to-face contact is not essential but an interactive capability is required; time delays are acceptable in responding to input; and highly structured, written responses are appropriate. In terms of the basic group problem-solving tasks, then, structuring, evaluating, and documenting appear to be highly amenable to computer-based approaches. Implementing, unstructured searching and conceptualizing, however, appear to be less amenable. Given this context, a computer-based communication system, HUB, has been developed to test these hyptheses.

THE HUB SYSTEM: SUPPORTING PROBLEM-SOLVING TASKS

The HUB system provides four types of computer-based group communication support: unstructured communication similar to that of the PLANET conferencing program (6), graphical communication through its shared visual space, communication focused on the running of computer programs through its program workspace, and communication focused on the creation and editing of a document in its document workspace.

HUB provides the communication overlay and information storage structure for task-focused communication. It is independent of the type of graphics package used in the shared visual space (aside from the fact that the graphic image must ultimately be stored as a file of primitives); of the type of programs used in the program workspace; and of the editor used in editing a document. This makes the HUB system both extremely flexible in the tasks for which it can be used and adaptable to the particular computer-based resources available to each user group. Its relationship to the various communication forms is shown in Table 1.

Table 1. Problem-Solving Tasks, Communication Forms, and Hub Modules

Problem-Solving Task	Communication Form			Most Appropriate HUB Module
Conceptualizing	verbal	--	unstructured	
	textual	--	free form	PLANET conferencing
Searching	verbal	--	structured	
	verbal	--	unstructured	
	textual	--	free form	PLANET conferencing
	visual	--	pictorial	Shared visual space
Structuring	verbal	--	structured	
	textual	--	formal	PLANET conferencing
	mathematical	--	symbolic	Program workspace
	visual	--	graphic	Shared visual space
Implementing	textual	--	formal	PLANET conferencing
	mathematical	--	numeric	
	mathematical	--	symbolic	
Evaluating	mathematical	--	numeric	Program workspace
	visual	--	graphic	
	visual	--	pictorial	
Documenting	verbal	--	structural	
	textual	--	formal	Document workspace
	visual	--	graphic	
	visual	--	pictorial	

The specific communications capabilities supported by the HUB modules include:

PLANET Conference. Exchange public, private, or anonymous messages in real time or on a delayed basis; ask questions to be answered as a "yes-no-abstain", vote, an essay, a number, or an uncertain number; feed back answers to questions with or without names; submit files as entries and save entries as files; review by entry number, author, date, or keyword, and display the full text by first n lines, no headings, or headings only.

Shared Visual Space. Modify (or create) pictures jointly; exchange public, private, or anonymous messages while modifying; store the resulting picture primitives and comments as an entry; review by entry number, picture name, author, date, or keyword and display the picture (or primitives) and comments, the picture alone, or the comments alone.

Program Workspace. Run local or remote programs jointly; exchange public, private, or anonymous messages while running; record the transcript as an entry; review by entry number, program name, author, date, or keyword and display the full transcript, with no comments or comments only.

Document Workspace. Edit (or create) documents jointly; exchange public, private, or anonymous messages while editing; record the document changes and comments as an entry; review by entry number, document name, author, date, keyword, or page number of changes and display all the changes and comments, or by first n lines with no comments or comments only; print document pages.

TESTS WITH USER GROUPS: PRELIMINARY FINDINGS

Tests of the HUB system, begun in 1979, have included both preliminary in-house applications and field tests with external user groups. For the preliminary trials, staff members were given tasks that required the same kinds of information exchange that might occur in group problem solving. In addition, a computer-based workshop involving planners and researchers from four geographically distant corporations was held. While these in-house applications have proven useful, the field tests are serving as the basis of our formal evaluation.

Participating user groups include a Chicago-based firm with outlets in California and Massachusetts that are using HUB to do a joint translation of a computer language; a network of Navy Laboratories, NALCON, in which representatives from each laboratory jointly discuss and write reports using the PLANET and document workspace modules of HUB; and two groups in the Computer Science Department of the University of Utah, who work in the Data Driven Research Project and the Computer-Aided Geometric Design Project.

These applications, while not immediately generalizable, are providing major insights into the difficulties and principles of designing a system for tasks involved in group problem solving. As problem solving involves both free form and highly structured thinking, the design of the computer-based facilities must encourage both kinds of thought processes. It must be highly integrated, yet flexible enough to ensure a creative context for the use of all specific functions. The functions themselves--i.e., the workspace modules and particularly the program workspace--must, however, be highly structured. We found that without much internal structure, users had no idea how to apply the capabilities of a workspace to their own task. In earlier versions of HUB, for example, there was an actual separation of modules. However, even though the switching mechanism was very simple, results of user test groups indicated that such a separation of communication modes hindered the problem-solving process. People had difficulty moving from module to module. They found it awkward to switch, for instance, from the conferencing module to the program workspace module in order to carry out a different aspect of the same task. When communication was synchronous, the group leader had to coordinate the movement of an entire group at the same time, at the same pace, through a string of commands necessary to enter a new module. Even when communication was asynchronous, some participants expressed the desire to be able to use predominantly the conferencing module, switching only to illustrate a particular point. If movement to the other module demanded too many steps, the module simply was not used.

Further, users place a high value on system integration. They felt that an integrated system should rely on commands at the same level with as few modules as possible. This would make shifting from one kind of task-focused communication

to another smooth, flexible, and easy to learn, and more importantly, it would subordinate the various types of communication to the task rather than vice versa.

It was also recognized that a more integrated system would be a more flexible system. Flexibility can obviously be a positive feature of design. A design should not impose artificial structures on the users but rather allow users to impose their own habits and thought processes on the design. Yet there is a fine line between too much and too little structure. If a software design is too unstructured, people do not always know what to do with it. While the overall HUB design is loosely structured, the specific workspace capabilities had to be well defined. The conferencing capability and the document capability posed no problems. Users, however, did have some difficulties in incorporating the program workspace in their activities. This presented an additional design problem: providing specific tools to make the program workspace useful.

CONCLUSION

The trials to date have influenced the conceptual design of the system: from distinct modules to an integrated, flexible structure. Current developments involve matching specific computer-based tests and methods to the various problem-solving tasks and evaluating user response to these tests. The most promising areas of application are in the searching and structuring stages of joint problem solving. (7)

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