A structured data base computer conferencing system

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ABSTRACT

A system called CBIE (Computer Based Information Exchange) is described, whose function is to facilitate communications among groups of people who cannot conveniently meet face-to-face. Each individual, at his own convenience, examines the existing conference records, via a terminal connected to the computer by a telephone line, and adds his own comments. A key feature of CBIE is that the conference record is structured by the users in the form of a network of elements systematically related to one another. The system is designed so that, utilizing a simple set of commands, users can peruse the stored information in an orderly way in accordance with their own interests. Applications include meetings of faculty committees, governmental committees, people engaged in joint research or development projects, and seminars or courses. An initial version of CBIE has been implemented under the RSTS time sharing system running on a PDP 11/50. A general outline of the implementation is presented.

INTRODUCTION

A major occupation of modern man is attending meetings. Few vocations are exempt from large doses of this activity; some—such as the academic and governmental professions—are notorious for overindulgence. If one thinks of meetings as including all occasions on which two or more people exchange significant amounts of information on one or more well defined topics often with the object of making decisions, then we are indeed discussing an important matter.

Certain basic problems arise when frequent meetings are necessary in a fast paced, mobile 20th Century environment. The necessity for such meetings places a severe drain on the time of those who are frequently involved, and this, in turn, causes scheduling problems. That is, it is often difficult to find a time that is mutually convenient for each member of a set of busy people. The necessity for interactions among widely dispersed individuals often makes it difficult to find a suitable place for a meeting. The need for people to travel to the meeting place constitutes an additional burden on their time—as well as entailing financial costs.

In a broad sense the necessity for many meetings, particularly those suffering from the above mentioned difficulties, is a consequence of our complex, technologically based society. Fortunately technology can also be part of the solution.

The most obvious and widespread form of technologically assisted meeting is of course the two-way telephone conversation. Many serious two-person meetings are held via telephone, and at a modest price the problem of distance is solved. Much less widely used is the multi-person telephone conference. Using standard equipment, telephone conferences involving up to 30 locations can be set up. At present, with commercial telephone systems, these must be arranged in advance through a special telephone conference operator, who calls each party involved. This is a high cost operation in comparison with directly dialed two-person calls. However, conferences involving up to four parties can be dialed up directly by people served by the most modern telephone central offices, and military versions of the same equipment are used for direct dialing of even larger conferences.

Contrary to earlier beliefs, two-way telephone conversations are quite satisfactory for most purposes, despite the lack of non-verbal cues that we use to facilitate communications in face-to-face situations. Furthermore, experiments with conference calls involving nine or more people have shown that they are also quite satisfactory to the participants; such problems as identification of speakers and orderly access to the floor are not as serious as had been anticipated.

Video conferences would be still more satisfactory in general, and where pictorial displays are required, such facilities are particularly important. But video conferences are quite expensive and awkward to arrange. This will undoubtedly remain the case for at least a decade. Less expensive techniques for conveying pictorial data in restricted forms are, however, becoming available, for example, the remote blackboard and the scribblephone.

* This author is a member of the technical staff of The Bell Telephone Laboratories and his work on this project was partly supported by that organization's graduate tuition reimbursement program.
It thus appears that the telephone plant now in existence and new facilities rapidly being brought online can be effectively used for many meetings, both two-person and multi-person. Where the main problem is the spatial dispersion of the participants, this can be a very satisfactory solution.

A very different approach has been taken to deal with the problem of temporal dispersion as well as certain other problems not yet discussed. This is to use a computer to buffer information fed in by conference participants from (usually) remote terminals. Basically the computer is used as a bulletin board on which participants can write messages and read those posted by others. A key point is that each conferee can, at any time, dial up the computer to review the status of the conference and to add his own input as desired. Thus it is not necessary that all participants be available at any particular time. This non-real time feature is a principal advantage of computer conferencing. Anyone with a terminal that can be linked to a phone line can participate, and since an ordinary voice channel is quite adequate for such transmissions, the cost for remotely located conferees is not excessive.

The idea of computer conferencing seems to have been first implemented by Hall and Turoff. They were particularly interested in implementing Delphi systems (a technique for arriving at quantitative estimates of difficult to assess factors by interweaving the estimates of a number of individuals), but they also implemented general purpose systems. Facilities are incorporated for directing messages to specified subsets of the participants and for the casting, tabulating and displaying of votes. A number of other people have also explored the general concept.

The subject of this paper is an enhancement of the computer conferencing idea, whereby the items entered are not simply recorded as a linear sequence, but can be structured in a meaningful manner by the conferees. The system, called CBIE (Computer Buffered Information Exchange), which has been implemented under the RSTS time sharing system of the PDP-11, will be described from the user’s point of view in the next section and from the implementation point of view in the third section of this paper. It has been tested via an ongoing conference, on the development of the system, which has significantly aided cooperation between the authors, who are able to meet face-to-face only once a week.

A USER’S VIEW OF CBIE

Basic concepts

A conventional meeting whether face-to-face or via telephone takes place in real time, that is, every event occurs and is simultaneously observed by all participating members. The computer conferences mentioned are not taking place in real time, since different participants may ‘tune in’ at different times to review past events. However both classes of conferences may be considered as linear, in the sense that each input to the conference is added to the end of a linear list of items. This is obviously true for conventional meetings. It is also true for the computer conferencing systems referred to earlier, in the sense that each new item is entered, and subsequently displayed, in sequence, immediately after the previous new item.

When a conference is long and ranges over many topics, it is very useful to have the discussion, and the record at any time, structured according to topics and subtopics. Each participant (we refer henceforth to computer conferencing systems) can then review, in a systematic manner, those portions that are of immediate interest to him and append comments, questions etc. to the precise portions of the record that they pertain to. Cross references should also be possible.

Instead of being a linear list of items, the structure of the conference becomes a directed linear graph, in which each item is a node with arcs directed to other items (successors) that are related in the sense of being subtopics, elaborations, refutations, etc. (Actually, since the successors to each node are ordered, there is somewhat more structure than is generally true for linear graphs.) It should be convenient to peruse this graph, or network, moving back and forth among related items, and appending or deleting items as appropriate. Jumps to arbitrary items on some personal list should be possible. Since the type of network under discussion does not completely order the items sequentially, it should also be possible for a participant to ask the system to specify which items have been entered or altered recently. Other desirable features include arrangements for voting, bulletins broadcast to all participants and the ability to direct private messages (side remarks) to specified subsets of participants.

As will be discussed later, such a system, properly implemented, could be useful in a wide variety of situations including joint research projects, seminars, courses at many levels, faculty meetings, software development, or even as a means for an individual to accumulate an organized data base on some set of topics. It should be emphasized at the outset that no information is generated or structured by the computer. Both the content and structuring of the data is specified by the users. The role of the computer is to facilitate the inputting, structuring, storage and retrieval of data by a multiplicity of users.

An example

The operation of CBIE will now be illustrated thru an example. The implemented version, currently under revision, has most of the features to be discussed.

Assume now that you are a member of the Southwoods Board of Education, and that the school year is about a month old. Several times a week, perhaps as often as every evening, you connect your home terminal (either CRT or hard copy type will do) to your telephone data set and dial up the municipal computer center, logging on to the ongoing School Board Meeting. You identify yourself to the system by entering your personal password and are then presented with the initial “frame” of the conference. Let us pick up a typical session at this point (Figure 1).
The first line of the frame is the title. After the descriptive phrase, the parenthesized symbols indicate whether there is text and/or a successor list associated with the item. In this case, there are both, and the fact that the S appears first indicates that a successor list is being displayed. The "#2" indicates that the reference number of the current item is 2. (At any time, the command #2 will result in the display of this frame.)

The six numbered successors are the titles of topics under discussion. Each of these has a successor list and some also have text associated with them—as indicated by the parenthesized symbols.

Suppose you would like to review the discussion of budget matters, and assume that you've already seen the text directly associated with this item (this might give the total budget figure and a reference to a detailed document on the budget). In order to see the list of subtopics under budget, you give the command S2, which results in the display of the frame shown in Figure 2. Seeing this, you might then wish to examine issue number 5, pertaining to the superintendent's salary. Hence you follow up with the command T5 (each command is terminated by a carriage return) to obtain the text associated with that item. After reading this material (Figure 3), you might then wish to examine issue number 5, pertaining to the superintendent's salary. Hence you follow up with the command T5 (each command is terminated by a carriage return) to obtain the text associated with that item. After reading this material (Figure 3), you might then wish to follow the ensuing arguments and thus you call for the predecessor list by striking the S key (see Figure 4). Note that each frame can, on command, be accompanied by a line (not shown in our examples) called a heading, that gives such information as the author (if he wishes), the date entered and the date of the most recent change.

Reading the assertion that appears as the title of successor 1 of Figure 3, one might wish to examine issue number 5, pertaining to the superintendent's salary. Hence you follow up with the command T5 (each command is terminated by a carriage return) to obtain the text associated with that item. After reading this material (Figure 3), you might then wish to examine issue number 5, pertaining to the superintendent's salary. Hence you follow up with the command T5 (each command is terminated by a carriage return) to obtain the text associated with that item. After reading this material (Figure 3), you might then wish to examine some of the other portions of the record. As you progress thru the network of items, the reference numbers of the items examined are pushed onto a stack. The command B (for back-up) pops the top number off the stack, and displays the corresponding item. The effect of n applications of B (for any positive integer n) is obtained by the command Bn. Thus, continuing our example, the command B2 would restore the frame of Figure 5. One might then examine successor 1 or 2 etc.

At some point in the debate over the superintendent's salary, the item shown in Figure 4 may have added to it a third successor as below:

3. VOTE ON THE QUESTION (Q).

The Q indicates a question to be voted on, and the "ballot" is then displayed (Figure 6) in response to the command Q3. In order to vote no, for example, one would enter VOTE N. Each participant is permitted only one vote, and such matters as to the closing time (if any), whether the vote is secret or roll call and whether intermediate tallies are to be made available are specified, in response to queries by the system, at the time the balloting is opened.

More CBIE commands

Other CBIE commands, not illustrated in the example can be used to

(1) Delete or change items or lines of text or members of successor lists.

BUDGET ITEMS (S, T) #21
1. APPROVAL OF ROUTINE APPROPRIATIONS
2. REPLACEMENT OF OIL BURNER IN HIGH SCHOOL (S, T)
3. ENLARGEMENT OF MIDDLE SCHOOL LIBRARY (S, T)
4. RENEWAL OF CONTRACT WITH TRASH REMOVAL COMPANY (T)
5. SALARY INCREASE FOR SCHOOL SUPERINTENDENT (S, T)

Figure 2—Result of S2 command when Figure 1 is on display

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SALARY INCREASE FOR SCHOOL SUPERINTENDENT (S, T) #32
1. IT IS PROPOSED THAT, IN ORDER TO KEEP IN LINE WITH
2. SALARIES PAID ELSEWHERE IN THIS AREA BY COMPARABLY
3. SIZED COMMUNITIES, WE INCREASE THE SUPERINTENDENT'S
4. SALARY FROM $30,000 TO SOMEWHERE BETWEEN 35K AND 45K.
5. (SMITHVILLE PAYS 41K, LINDEN 38K AND NEW RIVER 43K.)

Figure 3—Example of text (line numbers are to facilitate editing)

(2) Display a predecessor list for the current item.
(3) Display a list of items that have been added or changed since a specified date.
(4) Transmit a message to a specified subset of conference participants. As they next log in to the conference they will be notified that they have a message and can then call for its display. If currently logged in, they will be notified at once. Messages received can be saved if desired.
(5) Post a bulletin which will be displayed to all conferees as soon as they log in or at once if they are already logged in.
(6) Compile a stack of item reference numbers, each of which may be accompanied by a comment. This data can be appropriately displayed and used to call for displays of the items involved.
(7) Call for a list of all commands, with short descriptions, or for a detailed explanation of a specified command.
(8) Specify who may read or modify any item or set of items.
(9) Specify whether the items one is generating should be signed or anonymous.
(10) Change the number of lines in a frame. Where a text or successor list exceeds this size, it will be displayed in appropriately sized pages, each of which, except for the last, terminates with "-more-.” A carriage return then commands display of the next page.
(11) Control whether heads should or should not be displayed.
(12) Stop further printing of a display either irrevocably or until a resume command is given.

Still other features have been implemented or are under consideration, but enough has been said to indicate what the system is like. A principal goal is to keep the command structure as simple as possible so as to facilitate use of the system by technologically unsophisticated people, with a minimum amount of instruction.

Other aspects and problems

The problem of security is important. Access to certain conferences, or even to selected portions of conferences must often be restricted to certain sets of individuals. Voting privileges must also be controlled. Where very confidential matters are being discussed (e.g., personnel questions in the Board of Education example) it is important to ensure a high degree of protection against attempts to breach security. The problem is by no means unique to conferencing systems and known techniques employing passwords and the encrypting of stored information are applicable.

Some special problems arise if it is proposed to use computer conferencing for meetings of public bodies such as legislative committees, zoning boards, or boards of education. Care must be taken to avoid blocking the general public out of the process. Several remedies are possible. Since one of the principal advantages of a CBI/E conferencing system is that a complete, well-structured record of the proceedings is stored at all times, provision should be made to have appropriate printouts made available to the public on a regular basis. Complete records could be made available in public libraries and issued to the press, while summaries (perhaps all titles of items) could be printed in the newspapers. In order to allow direct public participation, terminals open to public use could be situated in post offices, libraries, schools, etc. Public participants might be allowed to read all items not of a confidential nature and to insert questions and comments—that might be appropriately labelled or located to indicate their origins. Finally, in cases where public meetings are now being held, there is no reason not to continue that practice—perhaps on a somewhat reduced scale—for the primary purpose of letting the public have its say and to inject into the discussion some of the non-verbal elements missing in a remote system. In the somewhat longer run, it may be that home terminals, installed mainly for other purposes, may become so widespread as to allow private citizens to participate even more directly and conveniently. For this and other reasons it is essential to maintain simplicity in the command structure and compatibility with simple terminal equipment.

SYSTEM IMPLEMENTATION

CBIE has been implemented under the DEC RSTS/E timesharing system and runs on the Columbia University

SALARY INCREASE FOR SCHOOL SUPERINTENDENT (S, T) #32
1. SALARY INCREASE ESSENTIAL TO ATTRACT TOP CANDIDATE(S)
2. HOW MUCH ARE WE TALKING ABOUT? (S)

Figure 4—Associated successor list
Structured Data Base Computer Conferencing System

The CBIE processes run as an ordinary user program under the timesharing system. The program is divided into four functional categories: an upper level user interface, a lower level interface which controls user interactions within conferences, command execution modules, and a data management module. The upper level interface is the module invoked on entry to the system. Its function is to request and authenticate the user’s identity and determine what he wishes to do. He may wish to perform any of several “housekeeping” functions, such as creation of a conference, seeing a list of conferences in progress, changing conference membership, etc. These functions are also handled by the upper-level interface. In most cases, however, the user wishes to enter a conference and control is passed to the conference interaction controller.

This module accepts and interprets user commands, which fall into three broad categories: item retrieval and display, item modification, and miscellaneous functions. Item retrieval commands include requests to see an item’s text, a successor list, or various other information associated with specified items. Item modification commands include requests to edit an item’s text, add a link to another item (i.e., insert an element in a successor list), create and possibly link to a new item, change a title, etc. Examples of miscellaneous functions include sending private messages to other users, asking for tutorial information on system features, asking which users are logged on the conference, etc.

Item retrieval operations are handled by a retrieval and display module. Retrieval of information associated with an item is accomplished through communication with a conference data base manager, which extracts the requested information from the conference data base. The item retrieval module may also request portions of items not explicitly requested by the user in anticipation of a forthcoming request. For example, if the user requests a display of the first frame of a given item, the retrieval module asks the data base manager for all the item’s text and retains the information in a buffer for subsequent display.

The data-base manager extracts data associated with specific items and incorporates requested changes to them in the data base. Because multiple users must be able to interact with the conference simultaneously, the data-base manager must ensure exclusive access to affected portions of the data-base during up dates. This can be accomplished if the host timesharing system has a record locking mechanism. Due to the logically linked structure of conferences, modifications requested in one item may require changes in related items. For example, a request to remove an item from a successor list also requires a modification to the successor item’s predecessor list. Update commands which operate on subnetworks rather than individual items also require exclusive access to many items simultaneously. The possibility of deadlock therefore arises if two or more users simultaneously attempt updates on the conference. The data-base manager must either prevent deadlocks from occurring, or detect and break them.

In a system which allows processes to request exclusive access to resources dynamically during execution, there are essentially two methods of avoiding deadlock. The first is through a hierarchical ordering of resources which constrains the order of requests. In CBIE, determining which items to reserve often requires traversing a subnetwork of the conference during which the required reservations become known. Imposing an ordering on the sequence of reservations would require first traversing the subnetwork to construct an ordering reservation list, followed by a sequence of requests in the allowable order to lock the appropriate records. The second method of avoiding deadlock is through preemption of resources when a deadlock situation occurs. An algorithm is required to detect deadlocks, and an algorithm such as Chamberlin’s is required to manage preemptions. The preemption approach in con-

Figure 5—Elaboration of argument in Figure 4.

Figure 6—Example of a ballot item

VOTE ON THE QUESTION (Q) #173
SHALL THE SALARY OF THE SUPERINTENDENT OF SCHOOLS
BE RAISED TO $40,000 PER YEAR
Y: YES
N: NO
A: ABSTAIN
VOTING WILL CLOSE AT 12:00 11/3/76.

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junction with a very simple scheme for detecting potential
deadlock situations, has been used in the initial version of
CBIE.

There are a number of ways in which the data base
management module can physically structure the confer­
ence data base. The following structure is used in CBIE.
Each conference item consists of certain information which
is of fixed size. Most of the information is variable in size,
however. Space is therefore allocated to items as needed in
noncontiguous, linked records. To avoid the need for
occasional compaction of storage, which would introduce
undesirable delays in the interactive system, fixed size
records are used. The penalty is less efficient utilization of
space, but this penalty tends to diminish as users add
information to items and they grow in size.

One or more linked lists comprise an item, depending on
what information is associated with it. These lists are
pointed to by the directory record, which also contains all
fixed-size information associated with the item. Some of
the variable length information (e.g., text or successor list) is
also contained in the directory record. Brief items, there­
fore, may consist of only a single directory record. To
reduce the number of I/O operations needed to display a
successor list, item titles are stored redundantly, not only in
the corresponding item's directory record, but also in the
successor list of any predecessor item.

Several types of files are associated with CBIE. There is
a global directory of conferences in progress. Each confer­
nce has a file of directory records and a file containing the
remainder of the linked structure. Also associated with the
conference is a file containing member names and other
global information. Each conference member owns an indi­
vidual system-created file which contains a scratch-pad
memory and other information needed to provide continuity
between the user's sessions in the conference.

CONCLUSIONS

In addition to making meetings involving people who can­
not conveniently find common places and times to meet
face-to-face more convenient, computer conferencing has
certain other unique advantages. Problems often arise in
conventional meetings as a result of mismatches among the
styles of participants. Those whose minds and tongues
operate swiftly must often sit, drumming their fingers
impatiently, while others are expressing themselves at a far
slower pace. Some enjoy participating in the exploration of
tangential issues, or listening to or relating humorous anec­
dotes that they feel add depth to the discussion—while this
may exasperate the more businesslike, "get to the point"-
types. A CBIE system makes it possible for each confer­
ce to operate according to his own style and at his own pace.
Some may quickly scan the item titles, select the texts they
wish to read in detail, make their terse remarks and exit.
Others might carefully work thru all that has been said,
ponder over each item, enjoy the digressions, perhaps even
dress some side remarks (in the form of messages) to
some particular colleague and carefully compose their own
additions. Both extremes can find satisfaction with the
same proceedings.

Obviously the elapsed time of a computer conference will
be relatively long (some may never actually end, as new
topics are occasionally added and old business completed).
A compensating aspect is that, unlike a conventional meet­
ing, where topics are dealt with serially, in a CBIE confer­
ence, all agenda items whose consideration is not depend­
ton the outcomes of discussions of as yet unresolved
items may be discussed in parallel. Note also that the
power of the chairman is greatly reduced. This is because
there is no need for rulings on who has the floor. A more
subtle point is that, when frequent meetings are inconven­
ient, chairmen are often assigned interim authority to make
certain decisions. The power to call a meeting may indeed
fall in this category. Such delegations are less necessary
with computer conferencing.

People who, because of physical handicaps, find it diffi­
cult to get around easily, are obvious beneficiaries of
remote conferencing techniques. Those who are hard of
hearing or who have speech impediments derive special
advantages from computer conferencing.

Reference was made earlier to the ease of producing well
organized transcripts and summaries of CBIE conferences.
Methods for accomplishing this in a flexible manner are
now under development.

There are two modes of perusing a CBIE conference.
One is to enter at the head node and then systematically
follow selected paths of successors, and the other is to call
for the display of specific items identified by their reference
numbers. At present, these reference numbers can be on
some list compiled by the user from previous excursions
thru the network, or they may have been retrieved from the
system by a command requesting those items that have
been changed or added since some specified date. Tech­
niques for retrieval on the basis of logical functions of
author, date and key words in the title are under considera­
tion.

At least one computer conferencing system,15 which is
related to the PLATO system,11 has some graphics capabil­
ity, and certainly it would also be desirable to allow speech
input. Both of these features will probably be available in
future systems.

In addition to the kinds of meetings discussed thus far,
there may be great value in using a CBIE type system for
educational purposes at all levels ranging from elementary
school subjects thru advanced seminars. Unlike conven­
tional teaching machine programs, which rigidly dictate the
actions of the student and accept only stereotyped re­
sponses from him, a CBIE system can be used to set up
structures that allow genuine dialogue between instructor(s)
and student, and which allow the student considerable
leeway in selecting the order in which he wishes to learn
the material and to some extent, what material he wishes to
explore in depth. This reflects the basic concept put for­
ward by Theodor Nelson16,17 whose ideas were influential in
motivating the CBIE concept.
ACKNOWLEDGMENTS

The authors wish to thank Professor Christian Gram of Danmarks Tekniske Højskole for stimulating discussions during the initial stages of this development. Dr. Howard Eskin of the Columbia University Computer Center has been most helpful with advice and cooperation concerning the implementation.

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