CONNECT*
A User-Oriented Communications Service

Donald R. Oestreicher
John F. Heafner
Jeffrey G. Rothenberg

USC Information Sciences Institute

ABSTRACT

The technology exists to produce systems for automated communication within one office or among separate offices. What does NOT exist is a methodology for making such systems EFFECTIVE and ATTRACTIVE for computer-naive users, attributes that should be considered highly important to the sucess of an office-automation system. This paper presents the generalized user's environment and the functional specification of a message communication system, outlining an appropriate combination of existing hardware technology and required human-factors methodology. A User Profile backed by the appropriate software is proposed for adaptively individualizing the user-interface at all levels in real-time, including feedback responses, names and formats of commands, and files and macros. In addition, it stresses the importance of system-wide homogeneity as well as integrated help, tutorial, and error-handling features.

KEYWORDS AND PHRASES: message processing, man-machine communication, human factors methods, user's performance modeling

I. INTRODUCTION

Our economy depends as heavily on the transmission of information as on the transportation of people and goods. Many large segments of the economy are heavily involved in or dependent on the dissemination of information, including telephone, telegraph, and mail service, banks and stock exchanges, insurance companies, and large portions of the military. These communications are handled by a variety of manual, semi-automatic, and automatic methods.

While the hard technology is available today to produce automated communication services, the methodology to allow computer-naive people to make effective use of on-line computer systems is lacking. This paper describes an effort by the Information Automation (IA) research project staff at USC/Information Sciences Institute to develop that methodology using as a medium a communication service called CONNECT (COmmunications Network Nodes Effected by Computer Terminals).

---

*This research is supported by the Defense Advanced Research Projects Agency under Contract No. DAH15 72 C 0308, ARPA order No. 2223/1, Program Code No. 3D30 and 3P10. Views and conclusions contained in this study are the author's and should not be interpreted as representing the official opinion or policy of the University of Southern California or any other person or agency connected with it.

Section II describes the prospective users and functional capabilities of CONNECT. Following that discussion, brief mention is made of the existing technology upon which CONNECT is based. Finally, the paper lists the innovative techniques being investigated by the IA Project, demonstrating that they provide the necessary human-compatible interface.

II. THE CONNECT PROJECT

CONNECT is designed to serve the needs of personnel in distributed office environments, which make up a part of most organizations (obvious examples being military communications, insurance companies, and geographically distant researchers). CONNECT expects to service users with varying communication needs. A priori needs have been identified as completely automated sender-to-receiver message preparation, transmission, and reception (messages include memoranda, letters, and reports).

A. PROSPECTIVE USERS

Many candidate organizations for automated message handling have some or all of the following classes of users:

1. Administrative/Managerial Staff
2. Professional Staff
3. Clerical/Secretarial Staff

1. Administrative/Managerial Staff - Administrators, the smallest user group, dictate letters and reports and obtain information from files. However, this important group is the most difficult to serve, since administrators relegate most clerical tasks to their assistants. The ways in which this class can be served directly are not as well defined as for other classes.

Clearly, administration requires processing large quantities of information. Since the screen of a computer terminal cannot present information as fast as an executive leafing through papers, CONNECT attempts to overcome these bandwidth limitations by providing functions to sort and order information and offer personal ways to access it. These functions recognize incoming correspondence files and priority delivery, and allow quick scanning of routine communications.

Special functions aid query and retrieval, such as "refer message to," "request status of message," and "indicate message has been read." The administrator will probably use the service to receive messages while his assistant handles message creation, editing, routing, and transmission.

2. Professional Staff - Each organization or department contains those people who perform the basic functions of the organization, such as salesmen, accountants, engineers, and custodians. We define "professional staff" as consisting of these kinds of employees, excluding only the managerial or clerical types belonging to groups 1 or 3. While some departments are not concerned with information except in a trivial sense (punching time cards, receiving written instructions, or reporting the status of their jobs), other departments are directly involved with processing information in fulfilling their primary function; CONNECT must satisfy the information and communication needs of the latter group.

In general, each professional group will require a particular application module, one which "speaks" its language and understands its procedures. Such modules might involve logistics reporting or change-order dissemination. However, it should be pointed out that the central

concern is communication: the CONNECT Service does not replace existing accounts receivable, inventory, or payroll services.

3. Clerical/Secretarial Staff - The third class includes secretaries, typists, clerks, filing personnel, and perhaps librarians who act as agents for persons in the other two classes. These individuals may be under-motivated with respect to this technology. Often their initial attitude is that a computer will make their job more difficult, and all too often their suspicions are confirmed. CONNECT includes computer-aided instruction and user modeling techniques to alleviate their anxieties and improve their performance.

CONNECT also simplifies the secretary's job by making it easier to maintain correspondence files, with functions to discard or archive outdated messages and sort them in various ways: chronologically, by author, by subject, etc. Also, less retyping is necessary to edit drafts and change documents.

B. FUNCTIONAL SPECIFICATIONS

Specifications include both on-line functions and connection to off-line facilities. For the purpose of discussing the following functions, "message" loosely refers to any formal or informal written document. The message service functions can be partitioned into five functional classes:

1. Message Preparation - text creation and coordination;
2. Message Transmission - routing and status queries;
3. Message Reception - user alerts, scanning, redirection, and action indications;
4. Information Maintenance - archives and files; and
5. Off-line Services - printed document generation.

1. Message Preparation - Preparation entails composing text and obtaining approval for sending it. The user corresponds with the message creation function through a simple dialogue that can handle standard formats and can prompt users for necessary completion of operations. When the message is authored or authorized by several people, the hand-carry phase of coordinating the message for approval is automated.

2. Message Transmission - The message transmission function has facilities to verify destinations and to maintain the message's status. When the originator provides a list of message recipients, their addresses are validated. In the case of a message sent to a person not currently accessible, CONNECT is usually able to deliver the message to a responsible alternate. CONNECT users can query the service to ascertain the status of a message. Examples of queries are: "Has it been read?", "By whom?", "Is action pending?", "By whom?". Query rights of addressees can be limited by the message originator.

3. Message Reception - Several modern systems provide adequate message transmission facilities; however, few adequately consider the receiver's needs. Some of the many functions required by the receiver are discussed below.

* The service provides some audio and/or visual alarm to alert a receiver of a newly pending message.

* Messages are automatically ordered to reflect priority, originator, subject, etc., as determined by the receiver. The user can scan the

messages by these criteria.

* Browsing is provided for large messages, or to familiarize new personnel with a particular correspondence file. Aids for increasing efficiency in scanning large numbers of messages, such as key word searches, are included.

* Users can forward or copy messages to others. In special situations the sender may limit this fanout and re-direction.

* Recipients can automatically generate feedback to senders. Types of feedback include: "message not read," "read but no action," and "action pending." Group or individual action lists include the status and are maintained as an important side effect.

* Messages received can be edited and incorporated into other documents.

4. Information Maintenance - Information structures such as archives, correspondence files, name and address files, and schedule files are maintained. All information is automatically archived to provide a reliable repository for messages.

Users may create specific correspondence files for all messages pertaining to a particular subject. Subsequently, other users may direct messages to an addressee's particular correspondence file, rather than his general delivery file. The addressee's mail can be automatically sorted into his particular files on the basis of the discriminators mentioned under "message reception."

Name and address files are maintained to assure proper addressing for on-line and off-line delivery. Users may also employ these files as an on-line address book.

5. Off-line Functions - CONNECT supports the generation of documents, such as reports and letters, destined for off-line distribution. These include report preparation, editing, and formatting. Letters and mailing labels are also handled.

III. PREREQUISITE TECHNOLOGY

The CONNECT service is superimposed on existing network and time-sharing technology. The main thrust is to develop complete and consistent methods which accommodate computer-naive users as they interact with an on-line computer-based service. The methods will stress transparency of the system to the user, self-contained interactive documentation, and automatic, though limited, adaptation to users' needs and styles.

A. TECHNOLOGY

CONNECT will be implemented using proven technology; some components are unique, others have functional equivalents throughout the industry. The CONNECT components, most of which were chosen because of their accessibility to the project, are as follows:

1. ARPA Network (ARPANET) [1]
2. TENEX Time-Sharing System [2]
3. Xerox Graphics Printer (XGP) [3]; and
4. High-bandwidth/Soft-copy Terminals.

1. ARPA Network - The ARPANET is a network of computer resources spanning the nation and extending to the European continent and Hawaii. Its modularity allows the total system to expand or contract incrementally as requirements change over time.

2. TENEX Time-Sharing System - CONNECT will initially reside in one host computer which is a DEC PDP-10 with TENEX. In a later test environment the user will communicate directly with CONNECT and omit the TENEX Executive dialogue, which will provide a totally contained, consistent interaction.

3. Xerox Graphics Printer - The XGP provides the necessary hardcopy facility to disseminate messages and reports outside the service.

4. High-bandwidth/Soft-copy Terminals - One of the many suitable terminal types in the $2,000-$5,000 range will be selected.

B. USER INTERFACE TECHNIQUES

Among the human engineering techniques commonly used, the following are emphasized in CONNECT:

1. Feedback Responses,
2. Homogeneity,
3. Help Features,
4. Error Handlers, and
5. Personalized Interfaces.

1. Feedback Responses - In its simplest form, a response tells the user that CONNECT is operational and understands his request. However, many of the feedback responses also prompt the user for input; they might differ as the user changes state. Other responses include ways for the user to request the expansion of an abbreviation, in order to confirm the service's recognition of his intentions.

2. Homogeneity - To insure natural use, actions common to services are carried out in a consistent way. If the user knows how to do something (i.e., specify someone's name or refer to a file) he can do it the same way in any context, which increases the user's confidence and reduces both errors and learning time. Homogeneity does not interfere with natural operation. Recognition of abbreviations, for example, may be highly context-dependent. To enforce consistency would require prohibiting such recognition. Rather, CONNECT is consistent in asking for further specification when necessary.

3. Help Features - Help features aid the user in determining his choice of actions at any given time and the consequences of those actions. They are of two varieties: one initiated by the user, the other by the service.

User-initiated help features include requests such as the status of an operation or a tutorial on some service.

CONNECT-generated help features are triggered by user actions. For example, if the user is making repetitive errors, assistance is offered, perhaps in the form of an explanation of the service's current expectation from the user. Also, if the user is doing something inefficiently, CONNECT can teach him a new command to improve performance; for example, CONNECT may suggest a composite command to replace a frequently repeated command sequence.

4. Error Handlers - The proper response to errors is of major importance in a well-designed user interface to an on-line service. CONNECT is concerned with prevention, detection, correction, and making known to the user any detected errors. When an error is detected, the cause is explained in detail; terse, coded error messages are avoided.

When an error is detected, the offending command is aborted. When the user discovers a semantic error, he has convenient ways to remedy its effect by specific commands which undo the effects of previous commands. In concert with

error correction, he has powerful intra-command editing features.

5. Individualized Interfaces - An important part of the CONNECT philosophy is to treat each user as an individual. Users can select personal designations for commands or create macro commands to expedite their work. CONNECT maintains a profile of each user in order to tailor its prompting and feedback responses to suit the user's familiarity with the service.

IV. INNOVATIVE METHODOLOGY

In addition to the existing techniques, the IA project personnel are developing other methods to deal with the problems of the nontechnical user. These methods fall into three areas:

A. Adaptive Processes
B. Program Structures
C. Integrated Tutorials

A. ADAPTIVE PROCESSES

A common fault of many man-machine systems is that while they provide the necessary functions, they fail to fit any particular application well. This may be due to a rigid command structure that requires overly complex commands to perform often used functions. In this sense, CONNECT can be adapted to each application. It supports a wide range of message-like functions determined by studying potential user environments. Consequently, the user interface is incompletely specified except with respect to a particular group of individuals. The interface is solidified "on site," so to speak, by adjusting the command language to suit the individual user environment.

In addition to this site-dependent preadjustment, the service/user interactions and intraservice dependencies are instrumented. Data samples, collected through real-time measurements, are analyzed "on-the-fly." Immediate adjustments are made to parameters that influence the user's working practices. The purpose of such dynamic evaluation is to further refine the total performance--in particular the user effectiveness--as a component of the service.

B. PROGRAM STRUCTURE

Many large programming systems minimize interactions between modules to provide clean intermodule interfaces, which tends to produce vertical partitioning, where each module decides and provides for itself in all situations, resulting in an uneven, heterogenous system. CONNECT is partitioned horizontally, with each module responsible for a single service-wide function; all other modules which need this function use the designated module.

Horizontal structuring exhibits several advantages. Firstly, no application module interacts directly with the user. All input or output with the user is handled by a collection of interaction modules, which in turn insures that each implementer will give more thought to the user interface standards. Secondly, each module (several may be active simultaneously) maintains state information in a data table, which allows CONNECT to know its total state, a requisite for monitoring interaction with the user. Finally, on return all modules must indicate how to reverse their side effects, which allows the user to abort or undo previous actions.

C. INTEGRATED TUTORIALS

There are numerous examples of either CAI or computer systems with help features. CONNECT integrates the two into a tutorial service with novel capabilities. When the

user requests help, he is automatically connected to the tutor module. Aside from exhibiting fixed dialogues, the tutor module can act as a user/observer of the CONNECT Service.

This last feature is expected to increase the effectiveness and efficiency of tutorials. As a "user", the tutor can demonstrate commands to the user. As an "observer", it can ask the user to try something in a guarded mode and observe any problems. In fact, a novice user might spend his first sessions totally under tutor observation.

V. SUMMARY

The main goal of the Information Automation Project is to extend the availability of computer technology and methodology to users of written information. These capabilities must be delivered to the end-users in a way they find convenient and helpful. The primary emphasis is on human engineering and people efficiency, rather than machine utilization policies. This can be accomplished by applying existing computer technology to produce an integrated hardware, software, and user system. The research goal is to advance the necessary methodology for such problems. Finally, it is the conviction of the project personnel that general-purpose but nontunable services do not solve these problems. Hence, CONNECT makes it possible to efficiently generate specialized simple services for communications applications through continuous measurement and adaptation.

Though the above ideas are not new, they have not been successfully combined into an integrated service for use by computer-naive people. In fact, the goal of providing a human-engineered service aimed at such users is a relatively recent one. Attempts in this direction are prone to many pitfalls:

* Failure to identify and study a range of user domains before specifying the service framework;

* Failure to study a particular user group and environment before implementing a specific service within this framework;

* Failure to give high enough priority to the question of how natural and consistent the service appears to the end-user and the smoothness of the changeover from manual operation;

* Failure to consider the social and psychological problems of introducing such a service into an existing organization; and,

* Failure to tailor the functional capabilities of a particular implementation to requirements perceived and verified by the users.

CONNECT should avoid these pitfalls by using the techniques suggested above, by deferring decisions where possible, and by careful attention to human factors at all levels in the context of specific target user groups.

The IA Project expects to have a prototype CONNECT Service available on the ARPANET early in 1975. Since the time of writing this paper, the CONNECT system has been defined and an implementation specification is in progress.

VI. REFERENCES

1. Roberts, L.G., and B.D. Wessler, "Computer Network Development to

Achieve Resource Sharing," Proceedings of 1970 Spring Joint Computer Conference, Vol. 36, 1970, pp. 543-550.

2. Bobrow, D.G., J.D. Burchfiel, D. L. Murphy, and R. S. Tomlinson, "TENEX, a Paged Time Sharing System for the PDP-10," Communications of the ACM, Vol. 15, No. 3, March 1972, pp. 135-143.

3. Annual Technical Report, May 1973 - May 1974, USC/Information Sciences Institute, ISI/SR-74-2, pp. 89-90.

VII. BIBLIOGRAPHY

Abbott, R. J., "A Command Language Processor for Flexible Interface Design," USC/ISI report in preparation.

Heafner, J.F., "A Methodology for Selecting and Refining Man-Computer Languages to Improve User's Performance," USC/ISI report in preparation.

Mandell, R.L., "An Executive Design to Support Military Message Processing Under TENEX," USC/ISI report in preparation.

Rothenberg, J.G., "An Editor to Support Military Message Processing," USC/ISI report in preparation.

Rothenberg, J.G., "An Intelligent Tutor: On-line Documentation and Help for a Military Message Service," USC/ISI report in preparation.

Tugender, R., and D.R. Oestreicher, "Basic Functional Capabilities for a Military Message Processing Service," USC/ISI report in preparation.