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INFORMATION-SHARING SYSTEMS IN SUPPORT OF COLLABORATIVE WORK, I

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"EXPRES: Research Issues in Building and Implementing a Platform for Collaboration Technology"

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While computing technology has influenced many aspects of business, there are still many new avenues to explore. Communication, collaboration, and information acquisition and dissemination still rely on technologies such as paper and printing, video and audio tape, the mail, the telephone, and face-to-face interaction. Many businesses have discovered text-only computer mail, and special software has been developed to make possible either synchronous or asynchronous text-only computer conferencing. While electronic mail has had a significant impact on the communication patterns of certain businesses, traditional technologies still dominate.

To what extent can present and near-future technology have a major impact on the communication, collaboration and information acquisition and dissemination habits of businesses? What problems must be overcome to make this technology a viable alternative?

The most effective way to encourage electronic communication is to get a high-performance workstation into the hands of individual business people with easy-to-learn and easy-to-use powerful software that can send and receive information from a variety of hardware and software environments. It is clear that businesses are ready for this technology; current developments within the computer industry suggest that now is the time to concentrate our efforts in order to make electronic communication a reality.

To this end, the National Science Foundation created and funded the EXPRES project. **EXPRES**, EXPerimental Research in Electronic Submission, is a three-year $6 million project awarded to the University of Michigan and Carnegie Mellon University. The goal of EXPRES is to create and propagate a system that helps people collaborate in work, and generate and send compound documents (documents with spreadsheets, graphics, voice, and images as well as text) among dissimilar hardware and software environments. The compound document that is sent will not be just a "flat" printable document. The recipient of the document will be able to *edit* the text, spreadsheet models, images, etc., and send the revision back for further editing. Furthermore, collaborators will be able to simultaneously work on the same document, conversing by telephone while alternately editing the work, seeing the other's changes in real time.

At present, the research on EXPRES focuses on how to shape two core systems, Diamond and Andrew, to be useful for a rich prototype task, that of preparing, filing, retrieving, electronically mailing, printing, and reviewing documents like NSF grant proposals. Diamond is a multimedia mailer developed by Bolt, Beranek, and Newman (project partners with Michigan). Andrew is a computing environment under development at Carnegie Mellon. Both are systems with powerful multi-media editors; each is intended to grow into a full, multi-media mailer that will function across heterogeneous hardware and software. The fact that there are two core systems encourages development and testing of their interoperability.

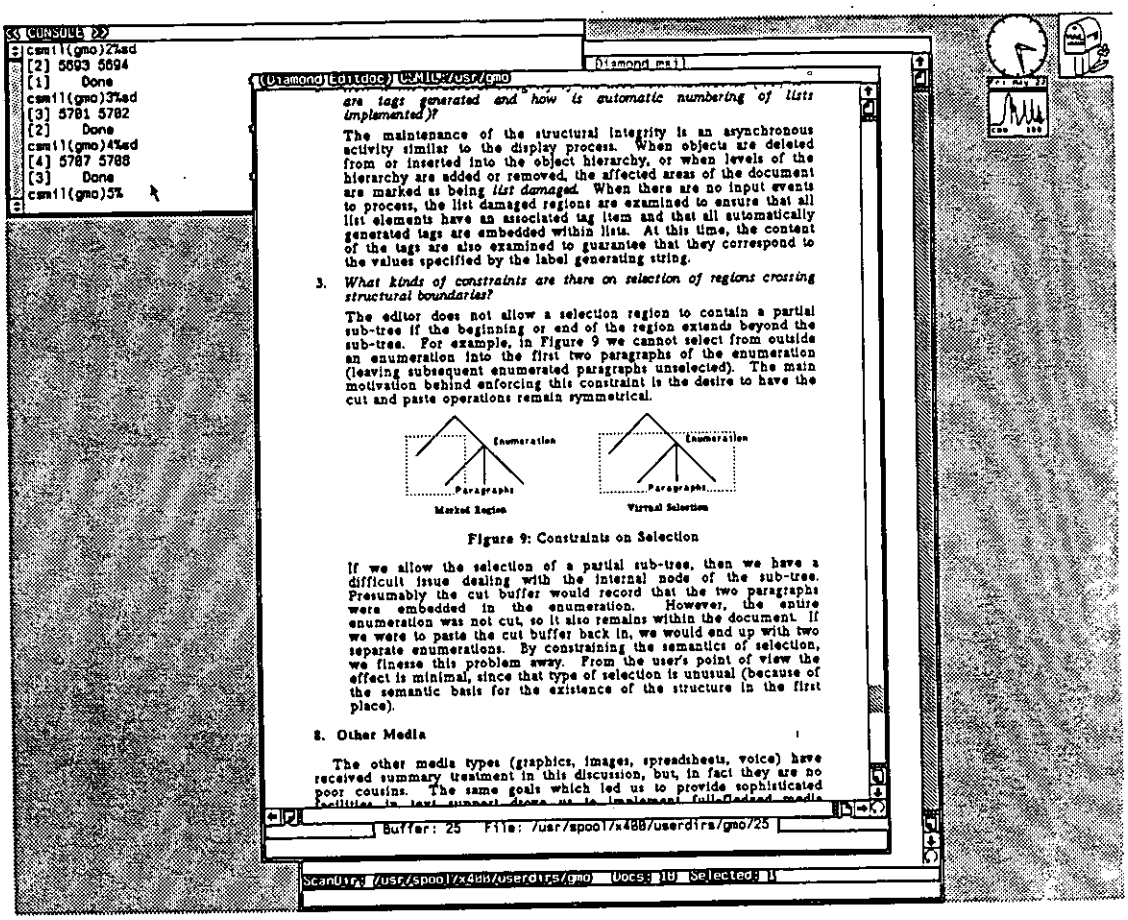

Figure 1. A Sample Diamond Screen

Currently, the Diamond system, whose interface is shown in Figure 1, can mail compound documents among Suns that run UNIX. Work is proceeding on expanding the types of media that can be included (e.g., charts, equations, tables, and annotations), to include a more powerful printing capability (that will allow page previewing capabilities and TeX printing processes) and to expand the kinds of systems that documents can be sent among.

The Andrew system, whose interface is shown in Figure 2, is the campus computing environment at Carnegie Mellon. Andrew is designed to support multi-media document preparation, electronic mail and conferencing, and instructional software development. Andrew runs on IBM-RT, Sun and MicroVax systems; IBM-PCs have limited access to Andrew. A central component of Andrew is Base Editor (BE2), which can be used to combine text, diagrams, and mathematical equations as well as customized, user-defined objects. Andrew already has a mail and bulletin board system and is connected to the major academic networks. Carnegie Mellon plans to extend and enhance the editor so that it can accommodate spreadsheets, annotations, footnotes, cross-references, indices and bibliographies.

Initially, EXPRES is being built for "high end" workstations such as the Sun, Apollo, MicroVax, and the IBM-RT. However, both Carnegie Mellon and Michigan are committed also to creating access to EXPRES software for users of PCs and Macintoshes. The X-Window system (from MIT's Project Athena) has been adopted as the windowing platform for EXPRES. X is the front running candidate for an industry standard for windowing. EXPRES project team members are additionally participating in meetings to expand existing Office Documentation Architecture (ODA) standards to encompass the complexities of multi-media document exchange.

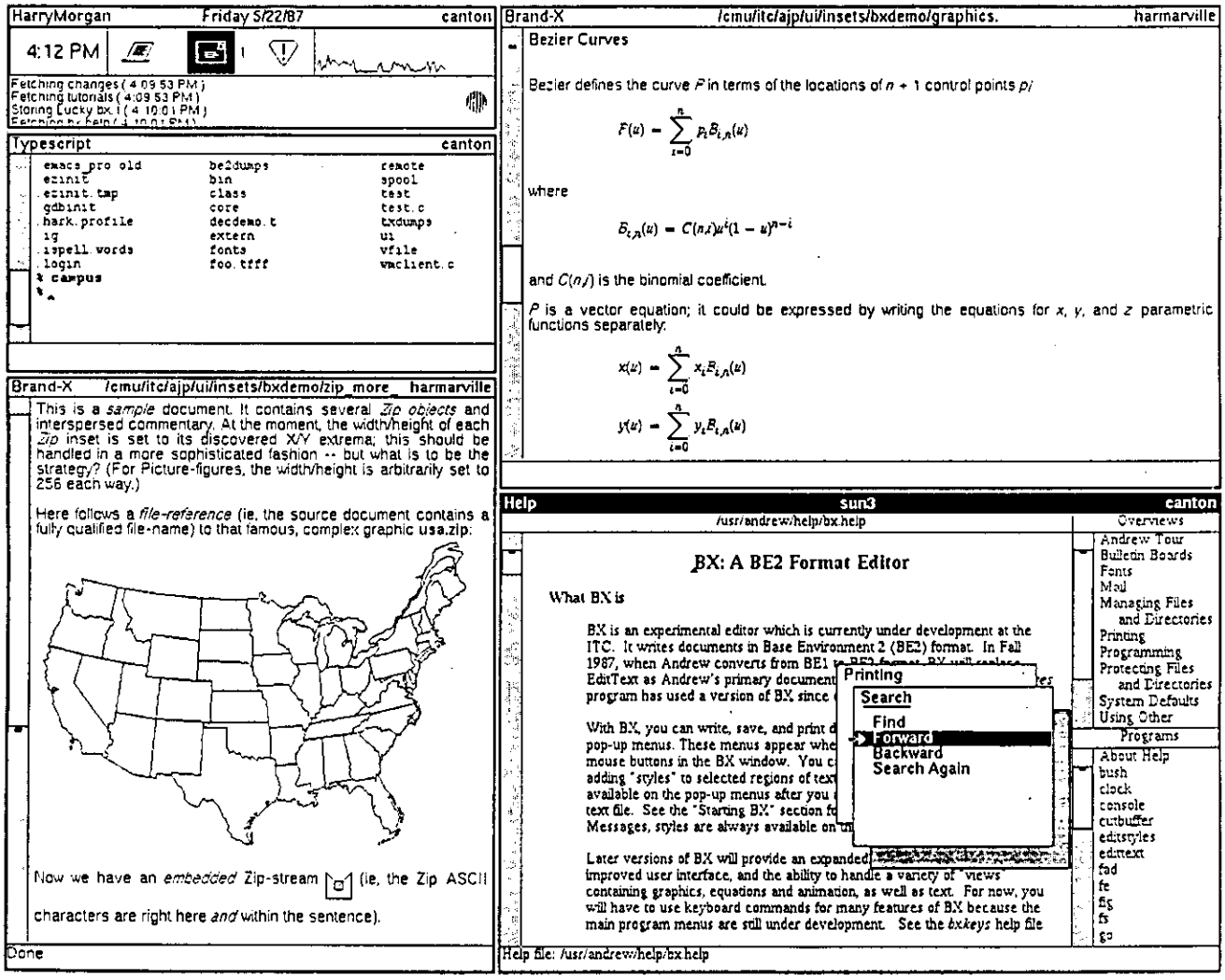

Figure 2. A Sample Andrew Screen

A number of research studies are underway in the EXPRES project. This research has to do with the growth of standards for interoperability, design of the user-interface to complex systems, development of principles of instructional and reference documentation, design of systems to have full functionality for *real* work, and assessment of the impact of deploying EXPRES.

1. **Standards for Development.** Currently, there are no standards for sending multi-media documents across networks among different software/hardware environments. Several candidate frameworks for standards have emerged, but industry has not adopted one of these universally. After extensive analysis, EXPRES researchers at Michigan and Carnegie Mellon have decided to work

with the ODA standards. However, since these are currently incomplete, EXPRES is committed to participating in the international movement to expand the standards and develop the details.

2. **The Design of System Functionality Sufficient for Real Work.** Because the target tasks for which EXPRES is being designed (the creation and review of NSF proposals) are real work, issues arise about whether the system can support the full set of functions required. A particular concern about the kinds of systems that are accessible to a large number of people within and between corporate boundaries is the issue of security, authentication, and privacy. Systems that support collaboration also need to concern themselves about how they support the power balance among the participants in both cooperative work and negotiations. There are both technological and user-interface issues focused on assuring that the system *can* support the full functionality.

3. **The Design of a Consistent User Interface to a Complex System.** The number of functions available in a multi-media editor and mailer is far greater than that for any software for a single media type. Complexity could be an overwhelming hurdle for the user. Research is under way to reduce the complexity by designing the user interface to be consistent across media types and by making the number of *rules* the user has to learn and remember small. Issues about the mechanics of the command dialog also emerge: How deep or broad should the menus be (they contain a large number of functions or options in this complex system)? How do users manage many windows to keep track of what they are doing?

4. **The Design of Documentation for Both Instruction and Reference.** Another major hurdle for the acceptance of the EXPRES system involves the ease with which the casual user can learn the system. Documentation *guidelines* are being researched as part of the EXPRES project in the course of writing and testing documentation for EXPRES. They will be based on research here and elsewhere on how to conform the documentation to both the various phases of learning (initial introduction, full instruction, later reference) and to the variety of potential users of this system (e.g., secretaries, engineering collaborators, and managers).

5. **Measurement of the Impact of EXPRES on Work and Collaboration.** EXPRES is expected to change the way work is done. Research is under way to measure the impact of EXPRES on collaboration. In academics, collaboration has increased steadily since the 1940s, some of it perhaps attributable to the growth of technology to speed and ease of transmission of information over distance. We are currently measuring baseline information on how many people collaborate on NSF proposals; we will compare these baseline measures with those obtained after EXPRES is deployed. There is a pilot study of impact under way: We are deploying an early version of UM-EXPRES at several sites whose workers now communicate heavily by electronic mail and Federal Express paper mail. We will monitor the change in activity among these sites as they learn and use EXPRES over the next two years.

These studies are expected to contribute significantly to practical and academic goals:

- o to the development and propagation of EXPRESS itself,
- o to the information technology community concerned with building complex interoperable systems that are not only technically sound but also *usable* and *functional*, and
- o to the general business community so they can prepare their organizations to capitalize on the emerging new technology to support communication and collaborative work.

INFORMATION-SHARING SYSTEMS IN SUPPORT OF COLLABORATIVE WORK, II

Chair: **Lee Sproull**
Carnegie Mellon University and
Stanford University

"Beyond Personal Computing: Computer Tools for Interpersonal Work"

This panel will report three of the most recent developments in building computer tools for interpersonal work. One suite of tools helps people manage and process their electronic mail. A second helps people comment electronically on their colleagues' or students' papers. A third helps people manage collaborative work such as project meetings. The speakers and their projects follow.

"Information Lens: An Intelligent System for Information Sharing and Coordination"

Thomas Malone
Sloan School of Management
Massachusetts Institute of Technology

This report will describe an intelligent system that (1) helps people filter, sort, and prioritize electronic messages they receive, (2) helps them find useful messages or other documents they would not otherwise have seen, and (3) supports common actions they may take on receiving certain kinds of messages. The system exploits concepts from artificial intelligence such as frames, production rules, and inheritance networks, but it avoids the unsolved problems of natural language understanding by providing users with a rich set of semi-structured message templates.

In addition to electronic mail, bulletin boards, and conferencing, this basic framework supports a surprising variety of other applications including a simple calendar management application demonstrated here. The user interface for the system is based on a consistent set of "direct manipulation" editors that expose the underlying knowledge representations in a way that is simple for non-programmers to use and that can be incrementally adopted and enhanced by members of a group.

"Comments: Computer Support for Response to Writing"

Christine M. Neuwirth
College of Humanities and Social Sciences
Carnegie Mellon University

Written comments constitute one of the most widespread means of providing writers with response. Carnegie Mellon's Center for Educational Computing in English has created the Comments program in order to study computer support for response to writing. Underlying the development of the Comments program is the following design principle: a program to support response to writing should be a communication-support program. Writers and readers can use the Comments program to "talk" about a piece of writing asynchronously over a campus-wide network of advanced-function workstations. Besides facilitating written dialogues, computer-based comments may be more effective than handwritten comments for several reasons. First, handwritten comments in the margins of hard copy documents are limited by space and tend to be somewhat "telegraphic" and difficult to interpret. On the other hand, comments at the end of documents are less closely tied to specific locations in a document and tend to be correspondingly less specific. In

contrast, computer-based comments allow readers to respond to specific locations in a document without space restrictions. A second reason computer-based comments may be more effective than handwritten comments is that computer-based comments can support multiple purposes. A reader may want to make comments on a text that are intended as personal reminders rather than as messages to the document's author. It is more difficult to support multiple purposes with handwritten comments on a hard copy document than with a computer. Finally, computer-based comments can support multiple readers more easily than handwritten comments. The long-range goal of the Comments project is to conduct research on how computer tools affect response and to make response to writing more effective.

"Colab: Electronic Laboratory for Collaborative Work"

Dr. Mark Stefik
Palo Alto Research Center
Xerox Corporation

Colab is a project about the technological support of collaborative work. It is a room, some software and a collection of ideas. The Colab room is equipped with four workstations and a very large, touch-sensitive screen that is intended to provide at least the functionality of a chalkboard. Users can flip a switch to display work on the screen at the front of the room. The software tools express our current understanding of what helps people work together on different tasks whether in the Colab itself or, less formally, in other situations where computers are available.

Our primary concern is how to support people working on complex design issues of the kind that have traditionally required face-to-face communication. Rather than replacing existing techniques, we are concerned with augmenting them. Colab can be used to support a meeting facilitator or a record keeper and it may be used to let people make personal meeting records and gain easy access to data. Our most developed Colab tool, Cognoter, starts from the idea of a whiteboard by allowing the unconstrained use of space. However, Cognoter boards are expandible, permanent and rearrangable. Additionally, Colab opens itself to new possibilities by insisting that each person have a computer and have equal access to the public display. Crucially, this means that the computer can be a channel of communication in its own right. Therefore, when Cognoter provides open-ended support for a brainstorming process, it changes our understanding and experience of the particulars of brainstorming.

A major part of the Colab project is observation and experimentation. We are creating and using the "video analyst's workstation," a tool to allow social scientists to create and study the synchronized computational and video records of what happens in the Colab.

We are considering a variety of ideas about what collaboration is, when it is useful, and how to make it richer and more extensive.