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ANALYSES OF THE PROBLEMS OF USER
SYSTEMS-INTERACTION

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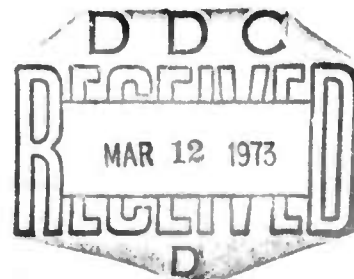
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SUMMARY

Work under the ARPA study contract was done primarily by the Principal Investigator with occasional assistance from consultants and support personnel. The study effort focused on three areas:

Social Science Usage of Network Resource
Network Protocol
Computer-Based Instruction (CBI)

Following is a list of the key accomplishments, activities, and recommendations:

1. A special network group on CBI was formed.
2. Contributions were made to the early work on the TELNET protocol.
3. Studies were made of: social science data bases in a network environment; specialized hardware possibilities for the network environment; CBI requirements in a network environment.
4. Further study is recommended in the following areas:
 - a. Interfacing PLATO and PLASMA terminals to ARPANET.
 - b. The relationship between privacy and social individual differences data bases.
 - c. Standards for social science data and descriptors of that data.
 - d. Efficient large data storage devices for data retrieval with efficient compare and count capability.
 - e. Optimum distribution of CBI functions in a network environment.

This report is an expanded summary of the above accomplishments, activities, and recommendations.

INTRODUCTION

This is the final report covering the activities carried out under the ARPA contract with Raytheon Company.

The report summarizes the significant activities covered under the contract and describes the conclusions reached as a result of the work. The summary covers three areas:

- Social Science Usage of Network Resources
- Network Protocol
- Computer Based Instruction (CBI)

In some cases the report will reference draft papers which have been forwarded to ARPA. In other cases, relevant notes and trip reports have been generated and these have also been forwarded to ARPA.

No further work is anticipated to be required by Raytheon under this contract.

SOCIAL SCIENCE USAGE OF NETWORK RESOURCES

A number of active social science researchers were interviewed at academic and non-profit institutions to determine the kinds of utility for social scientists offered by a network that cannot be provided by a stand-alone machine. The responses point to three areas of interest:

- Convenience
- Data Bases
- Specialized Hardware

Convenience

While it was difficult to define unique social science utility in a network environment not available by dialing into a stand-alone computer, the convenience of gaining access to other computers suggested that social science applications will be supported in the ARPA network primarily because of the convenience of access. These applications involve: the use of old programs to be run at a remote site because the machine for which they were written is no longer available locally; use of other researchers' data reduction programs; use of specialized hardware.

There was a spectrum of feeling about social science use of the network typified at the extremes by:

"Don't ask the social scientists how he would use the resource, he doesn't understand. Ask programmers familiar with social scientists' needs."

"Don't let the technicians take over the job of structuring my (social science) use. They don't understand my research and usually miss my needs or lock me out in an important way."

There was general reluctance to switch over to network use on the middle of a project. Extensive use may have to wait until projects are designed with the network resource in mind.

Data Bases for Social Scientists

There was a general approval of the idea of sharing data bases. When it came to putting specific data bases up for shared access there were objections that fell into two classes:

1. What, my data? No! I still have a lot of milking to do.

2. Why? I've worked hard to get this data together. I'm ready to start my research, my homework is done. Let the others do their homework. I don't have time to devote to their needs at the expense of my own project.

To make use of others data it will be important in several areas to have not only the data, but also description about the data such as source, demographic data about subjects, selective processes, collection processes, reliability checks, background on collectors, etc. The development of standards for data and data descriptors should be undertaken for various data domains and types of research that researchers can be more confident about other peoples data. Useful standards could be enforced by government agencies through the study and research contracts they let out.

Much concern exists about privacy and the protection of the individual and the relationship of data banks. Many solutions involve elimination of reference or even a track to the individual (name, social security number, or other identification.) This solution works directly against the research interests dealing with problems using individual differences. Unless the individual's identify is retained, the links across data bases will be impossible. Instead of assembling research data from across a number of data bases, it will continue to be necessary to laboriously collect and accumulate data for research projects. A draft paper was generated in this area.

Specialized Hardware

A large part of social science research is based on a few relatively primitive operations. While only a few research centers can afford to acquire (or develop) specialized hardware, the ARPANET makes it possible to distribute the advantages of specialized processing and take the special processes off of the general purpose machines which do the jobs today, but less efficiently.

Some researchers saw tomorrow's computer world being one of a few general purpose machines tied over a network to a

number of large, highly specialized machines. Much social science work involves comparing and counting words or numbers. Other social science work involves simulation and support of gaming, statistical and large matrix manipulations, and applications making heavy use of LISP processing.

Special purpose hardware to perform these functions seems more reasonable than tying up the resources of large general purpose processors. Some ARPA funds now support projects that will provide useful capability. These include better LISP processors, the ILLIAC IV, and the simulation laboratory at UCLA. Interviewing did not yield any information about work on a large file with ability to compare and count.

PROTOCOL

During the project, the principal investigator became familiar with a number of network resources, worked on-line on several of the available HOSTS, and participated in the Network Working Group.

Out of interest in seeing protocols developed in a way that is transparent to users and leaves the user a maximum of the remote HOSTS capability, work on the project focused on protocol development, especially TELNET. The principal investigator acted as chairman of the TELNET protocol committee until the first version was distributed to the active HOST sites.

COMPUTER BASED INSTRUCTION

Several activities were undertaken in the computer-based instruction (CBI) field, i.e., use of computers for management of the instructional process and direct use of the computer in that process. Key sites, both in academia and the military, were visited by the principal investigator to determine their method of operation and their research and operational requirements that might be aided by using ARPANET. The visits resulted in three other studies or activities:

- CBI and Large General Purpose Networks
- CBI Group
- Specialized CBI Hardware.

CBI and Large General Purpose Networks

Computer based instruction can be serviced by access to a large general purpose network. There are four areas where such access promises high utility:

- design and development of course ware

- field tests

- distribution and operational use

- evaluation and modification.

During course ware design and development, authors could access a system in anticipation of receipt of their computer hardware and begin to build their materials. This can both overcome delays in hardware delivery having an effect on development schedules, and permit delay of delivery on a planned basis to save money until such time as the load is sufficiently high to warrant a full dedicated system.

For field tests, the extensiveness of the ARPANET provides a convenient way of selecting student populations for testing course material with less regard for problems of telephone line installation and the location of the support computer.

In distributing CBI for operational use, there may be a number of situations where, because of using a small cluster of terminals for an extended period, or a larger cluster for a brief period, the network can provide a better solution to the communications problem than dedicated lines from public utilities.

A network environment should make it easier to gather data, reduce it, and make the results accessible to a team of evaluators, as well as aid in keeping configuration central over released version of course ware. Based on course performance evaluation, modification can be made, giving system access to both course designer and programmer (authors) even though they may not be co-located with the support computer. Evaluators could also use ARPANET to access competitive systems to determine their relative effectiveness for some specific applications.

Because of the high current interest in University of Illinois' PLATO System, ARPA should consider linking PLATO to the Network and interfacing Plasma Displays to TIMPs -- both hardware and over phone lines to permit experimental use of PLATO.

A paper, more detailed in discussion, was distributed through the Network Information Center (RFC 313, NIC Note 9343) to Network people and to selected CBI specialists at universities, in the military and in industry.

CBI Group.

Based on interviews and visits to both research and operational CBI sites, special network group was founded and responsibility for distribution of materials was assigned to the Network Information Center at the Stanford Research Institute.

The purpose of forming the group was to establish and facilitate dialogue between CBI people from the military, academia and in the Network to strengthen CBI people's understanding of Network resources and to strengthen Network people's understanding of the CBI application.

The group was initially 30 CBI people plus Network people. The group is now international, has about 50 people plus Network people, and approximately 20 articles, papers, and notes have been distributed to the CBI group.

Specialized CBI Hardware

As in the case of social science use of the Network, the CBI applications in a network environment might benefit from the development of special purpose hardware. A systematic analysis and tradeoff study should be undertaken in this area. The combination of data staging with the possibility of look ahead algorithms raises the question of where should what functions for CBI be performed. At a terminal cluster new technology might be applied (chip processors, shift register memories, new terminal display materials, new storage media, etc.) in a way to increase reliability and reduce cost, and make use of Network resources (central data and course storage, central management records, distributed processing, etc.).

The use of virtual terminal concepts (graphics or alpha-numeric) could make it possible for a single cluster of a single type terminal to access multiple systems even though those systems may each normally expect different types of terminals.