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# **Innovations in Engineering Publications**

Augmentation Research Center

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**STANFORD RESEARCH INSTITUTE**  
Menlo Park, California 94025 · U.S.A.



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Proposal for Research  
SRI No. ISU 77-72

INNOVATIONS IN ENGINEERING PUBLICATIONS

Part One--Technical Proposal

Prepared for:

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Washington, D.C. 20550

Attention:

Division of Science Information  
Program Solicitation No. 76-51  
Category 1

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## Innovations in Engineering Publications

## ABSTRACT

Publishers of brief, time-valued information for engineers will be provided the means to publish their material online. Engineers in numbers suitable for statistical analysis will be provided with a means of reading this online material as well as with some simple information management tools. Data on the usefulness of the system will be gathered both by pretests and posttests administered to the subject and a control group and by real time recording of the engineers's behavior online.

The computer support will be the Online System developed at SRI over the last 14 years, which includes information retrieval, publication, and monitoring functions and sophisticated communication facilities in an integrated system. The publications available to the engineers will include SRI's Datalog abstract service and a time-valued engineering publication such as Aerospace Daily.

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## Innovations in Engineering Publications

## PROJECT DESCRIPTION

## Summary

## Overview

This proposal responds to NSF Program Solicitation NSF 76-51 "Improved Understanding and More Productive Use of Scientific and Technical Information (STI)." It addresses Category 1, Innovations in Engineering Publication.

We propose a cooperative project between SRI (the project team's source of technological innovation and analytic expertise), a commercial publisher of information for engineers, and at least two separate organizations that employ engineers who will receive the information and who will be subjects of the experiment.

We will secure the cooperation of companies that employ engineers and that are customers both of SRI's Datalog abstract service and a commercial publication that disseminates time-valued information to engineers. At each organization we will identify engineers who are interested in the experience of computer access to information. We will provide the participating engineers with CRT (television-like) terminals and training in a simple set of commands that will allow them to scan titles and ask to see the entire item when they are interested, to send telegram-like messages, and to establish a list of key words which the system will use to automatically exclude items not of interest to each individual.

In addition to the services discussed above, we will provide the publishers with training in the use of the computer system and an appropriate work station.

Researchers will base their evaluation of this project upon information gathered from two sources: surveys and automatic monitoring of the engineers in action on the computer system. An existing SRI software facility will monitor and record the engineers as they work. We will administer pretests and posttests to the engineers to determine the usefulness of the system to them, their change in attitudes, and the like. The information gathering and analysis will take into consideration already existing studies on the use of Datalog and the SRI information handling services involved.

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## Background

## The Computer System

NLS (the Online System) is proposed as the computer medium for all aspects of this experiment. It is a general-purpose system for handling and communicating textual information. NLS is highly appropriate to support this study because it combines facilities to:

Publish documents

View information flexibly on a cathode ray tube

Monitor the activities of users

Bind together scattered users

Tailor commands to applications

## Publication

Complete facilities for creating, editing, and formatting printed documents exist in NLS.

## CRT Viewing

The small size of CRT screens is a serious handicap to browsing and fluid reading in many computer-based information systems. NLS goes a long way toward overcoming this problem, and related problems of maneuvering in information space, by providing the user with many ways to display selected, evocative parts of information. An example related to this proposal is the ability for a user to display only headings, only first lines, or only paragraphs that contain given words and then to move freely among such views and full views.

## Monitoring Users

A monitoring program permits us to record exactly what NLS users do when they work on the computer and creates record files suitable for statistical manipulation.

## Binding Scattered Users

NLS has proved highly successful in various efforts that include organizationally and geographically scattered individuals such as the engineers, publishers, and researchers who will be involved in the proposed project. The tools of cooperation include access to

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common files, electronic mail which may be recorded and cataloged for recall, and simultaneous display and control of the same work material on different user's screens.

## Tailored Commands

A software mechanism, called the Command Meta Language, makes it easy for programmers working with NLS to create commands that provide selected functions to users. For a simple application like the activities of the engineers in the proposed study, it is possible to provide an effective set of commands that is easy to use and easy to learn.

## Datalog

SRI's entire Datalog will be entered into the computer. Datalog is a monthly bulletin, containing abstracts of recently completed SRI studies, that is sent to industrial and other organizations who subscribe to SRI's Long Range Planning Service (LRPS). (See attached sample in Appendix C.) The subscribers are made up of national and international companies in the Fortune 500 class, most of which have heavy engineering orientations. It is presently published by typists who prepare camera-ready copy manually, and is disseminated by U.S. mail. SRI has kept extensive statistics on the subscribers' use of the publication since the beginning of the Datalog program. These statistics on the past use of Datalog will provide a rich basis for comparison with its use when it is distributed via computer.

## A Commercial, Time-Valued Publication

To widen the range of information involved and to provide practical experience that will interest and stimulate the publications industry, SRI has sought cooperation from a commercial distributor of time-valued information to engineers. Although the uncertainties of the time frame have prevented any commercial publisher from making a firm commitment, a keen interest has been expressed by Kenneth Koppel of Ziff-Davis, who oversees several such publications. Mr. Koppel is interested in participating in this project mainly because he anticipates the growth of electronic publication and wants ground-floor experience.

Our conversation with Mr. Koppel has centered on Aerospace Daily, a typical time-valued publication. Aerospace Daily (see Appendix D) is six to eight 650-word pages long and is published daily in a one-column magazine format. It is presently published by typists who create camera-ready copy the evening before it is to be distributed by U.S. mail (at considerable disadvantage to many West

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Coast users). The subscribers are generally Fortune 500 class companies. Aerospace Daily is expensive; and a typical organization has a single subscription which goes to decision makers upon arrival, and is later circulated to engineers.

## Response To Current Issues

The proposed project will result in a prototype information dissemination system that may be of commercial interest, a computer-based test bed for further research on how people use information, and reports which should prove stimulating to research on the dissemination of technical information.

The services to be offered will respond directly to several problem areas in the use of engineering publications. Published information will be made more timely as the delay between publication and actual receipt by the engineers is reduced through use of the computer-based communication system. The filtering devices will enable engineers to use their reading time more efficiently. The ability to locate information quickly will be improved by applying automatic search routines to the information stored in the computer and by facilitating the collection and filing of information. Publications will become more valuable as two-way communication between authors and readers is made easy.

The proposed study should also provide a basis for progress in two problem areas in research on dissemination of technical and scientific information. It has been widely recognized that engineers depend on word of mouth to learn much more than do scientific researchers [2]. Although the usefulness of word of mouth systems has been elucidated, they have many drawbacks [1]. This system will allow engineers to seek information in a way that is neither paper shuffling nor word of mouth.

The facilities for monitoring how the subjects seek information is of interest beyond the problems specific to engineering information. Until now, it has been extremely expensive or impossible to monitor people's information seeking as they do it, and our knowledge in this field has been restricted to what we could find out in after-the-fact surveys, interviews, and the like, or through report sheets checked by the user. It is now possible to gather this information in detail in real time, without conscious activity by the subject.

## Continuity with SRI Interests

SRI welcomes NSF's program solicitation because it offers us a chance to synthesize activities in several areas of continuing in-

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terest to our staff. As detailed in Organizational Background, several departments in SRI have long-term commitments to the areas of specialization involved in the proposed study, such as electronic aids to publication, information science, office automation, and various strategies for increasing productivity in intellectual work.

## Organization of this Proposal

This proposal closely follows the structure of the Program Solicitation. The technical proposal is divided into sections according to the proposal format described by the solicitation. The longest section is the Project Description which discusses, point by point, the requirements spelled out in the third paragraph of Category 1. Actual cost figures appear in a separate cost volume.

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## Hypotheses

An important set of criteria for evaluating STI services is concerned with the usefulness of the services as perceived by the user population of engineers. Do these services improve their ability to locate and obtain relevant information? Is the speed of the delivery of time-sensitive information increased? Is it easier to file, reach, and retrieve published information?

In the paragraphs below these questions are related to a number of hypotheses. Verifying these hypotheses will constitute the major part of the evaluation effort. The experimental methodology to be used is outlined in a subsequent section of this proposal. In addition to questions directly related to our hypotheses, users will be asked about the value of the services, the strengths and weaknesses of the delivery system, desirable additional features, and related questions.

Information use and communications behavior of scientists and engineers have been studied extensively. Many hypotheses may be drawn from the body of literature. We have selected hypotheses, and referenced some of the relevant research, that most closely correspond to the goals of this program solicitation for exploration in our proposed experiment. A brief comment on each reference is included. The hypotheses are summarized below.

## Hypotheses:

Hypothesis 1: The delay between the publication and reading of technical news letters and periodicals will be reduced through the use of electronic information systems which automatically alert engineers to the existence of items of interest and make those items conveniently available.

Hypothesis 2: Engineers will find the timely availability of information more useful.

Hypothesis 3: Key word filtering of online information will increase the personal relevance of an information stream. Here, relevance is defined as the ratio of items judged to be of interest to the number of items scanned.

Hypothesis 4: Engineers will make greater use of automatic filters over time as they gain confidence that the filters are effective.

Hypothesis 5: The usefulness of periodic literature as a

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source of information will increase because online retention of abstracts permits easy search, retrieval, and personal filing.

Hypothesis 6: The asynchronous message capability of the abstract delivery system will be perceived as beneficial.

Hypothesis 7: The ability for any user to immediately attach a comment to any online article will result in:

- a) greater contact between users with similar interests, and
- b) more direct communication between users and publishers.

Hypothesis 8: Engineers will use the economic and business information contained in Datalog as much as the scientific and technical information. (The publication contains about an equal mix of each.)

#### Discussion and Related Research

**Timeliness of Information.** There is a considerable delay between the composition of periodic technical literature and its perusal by engineers. Contributing factors are the delay between the completion of an author's original composition and the availability of printed copy, and the significant delay between printing and eventual reading by the engineer. One aspect of this proposal is directed at reducing the second of these: the time spent in mailing and routing technical literature.

Hypothesis 1: The delay between the publication and reading of technical news letters and periodicals will be reduced through the use of electronic information systems which automatically alert engineers to the existence of items of interest and make those items conveniently available.

Hypothesis 2: Engineers will find the timely availability of information more useful.

#### Supporting Reference:

(Parker, 1970)

Surveys and interviews of the users of an STI service (SPIRES) unanimously emphasized the importance of timeliness. [39]

**Information Overload.** An engineer suffers from information

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overload partly because he has no mechanism for screening out irrelevant information in the literature he examines.

Hypothesis 3: Key word filtering of information stored in the computer will increase the personal relevance of an information stream. Here, relevance is defined as the ratio of items judged to be of interest to the number of items scanned.

Hypothesis 4: Engineers will make greater use of automatic filters over time as they gain confidence that the filters are effective.

Supporting References:

(Hall, Clague, and Atchison, 1972)

Scientists who use selective dissemination of information (SDI) services tend to value them despite a general decline in valuation among other scientists. A familiarity effect is suspected. [25]

(Scott, 1959)

Dissimilarity of styles in a group is important to high performance. [45]

(Wolek, 1970)

The phenomenon of information overload is a limitation on our ability to process information. This is a function of the complexity of the information received. [52]

Storage And Retrieval. Storage and retrieval of information in periodicals are currently hampered by the need to pass on the original or return it to a library and by the difficulty of filing the same article under several headings. Photocopying is an expensive and inconvenient solution. Because future needs can not always be predicted, information thought to be irrelevant may be discarded and then later be found valuable.

Hypothesis 5: The usefulness of periodic literature as a source of information will increase because online retention of abstracts permits easy search, retrieval, and personal filing.

Supporting References:

(Allen and Gerstberger, 1967)

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Accessibility, familiarity, and ease of use are more important than quality in determining which sources of STI are used first, although not in determining sources of information from which selection will be made. [4]

(Friedlander, 1973)

Ease of accessibility promotes use. [17]

(Gerstberger and Allen, 1968)

Ease of use and familiarity affect what source is used first, although not necessarily which information source provides the information a scientist or technologist ultimately uses in his or her work. [20]

(Rosenberg, 1967)

Accessibility and ease of use determine which source of information will be used first. [43]

Interaction and Communication. Interaction between users and publishers of abstracting and information services is hampered by shortcomings of the telephone and mail service. Relatively long publishing cycles make it very difficult to maintain any type of dialog resulting from a published article. Thus, articles having the potential to act as catalysts for the discovery of people with common interests or for the beginning of fruitful discussions often fail to achieve these results.

Hypothesis 6: The asynchronous message capability of the abstract delivery system will be perceived as beneficial both by publishers and users.

Hypothesis 7: The ability for any user to immediately attach a comment to any online article will result in:

- a) greater contact between users with similar interests, and
- b) more direct communication between users and publishers.

Subjects of Interest to Engineers. Research indicates that engineers seek as much economic and market information as scientific and technical information. This point has not been well established and more concrete information would certainly be valuable to publishers of materials for engineers.

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Hypothesis 8: Engineers will use the economic and business information contained in Datalog as much as the scientific and technical information. (The publication contains about an equal mix of each.)

Supporting Reference:

(Thompson, 1975)

Engineers use economic and business information to an equal extent with scientific and technical information. [49]

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## Administration

## Delivery System

Interactive computer terminals designed to display textual information will be installed in two engineering organizations where they will be readily accessible to the sample groups of engineers and engineering managers. A terminal will also be installed at the publishing office for "Aerospace Daily" in New York (or at the office of another similar publication). These terminals will be connected via dial telephone lines and the ARPA Network to a computer and additional terminals at SRI.

A general purpose office automation and publication software system, called NLS, is available on the SRI computer. This computer system allows textual material to be entered at any terminal and read electronically at any other, and it provides the tools necessary to implement the study proposed here. The system includes a message capability that will allow the participants in the study to exchange information, and provides a method for the experimenters to monitor the engineer's information seeking activities. We propose to employ NLS to deliver the two services that will aid engineers in their access to and use of published information.

## Services

## Service Number 1

The Ziff-Davis Publishing Company has expressed a keen interest in participation in this project. The company publishes a number of widely read services for engineers. It is aware of the growing demand for electronic delivery, and one of the Ziff-Davis publications, such as "Aerospace Daily," will be placed online by the publisher. Aerospace Daily is widely read throughout the aerospace industry. It contains time-sensitive information such as notice of major Federal policy decisions and contract awards. It is several pages long, simply formatted, typewritten, and contains no graphics, photos, or ads. Each news item is one paragraph long. (See sample, Appendix D)

For the proposed project, the news items will be entered into the computer when the Aerospace Daily editorial staff approves them for release, or when the newsletter is printed. They will be available instantly to engineers in our sample population. Each engineer on the computer distribution list will be able to establish his own key word and/or key phrase filter in the NLS comput-

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er. This filter will screen the publication automatically. When the engineer begins a new work session, the system will list by title only those items that have passed through the filter. A simple command will allow the engineer to read the entire item.

This automatic filter should help eliminate the irrelevant news items the engineer usually must check through before he finds items relevant to his particular interests. The process will also short circuit delay caused by the routing lists within the engineer's organization often attached to copies of publications such as Aerospace Daily to reduce copying or extra subscription costs.

Whenever an engineer reads the complete text of an item, his identity tag will be attached to that item and will function as a key word. A simple command will allow the engineer to search all old items by key words. If he uses his own identity tag in the search, he can recover all items he read previously. Although the engineer has the option of using his tags solely for his own (and the experimenter's) information, he may instruct the computer that other users in his organization or in the whole user community will be able to view his tags or use them for key word searches. This will provide a means for identifying a community with common interests. All items will be recorded for the duration of the experiment.

Any user may easily and simply direct a telegram-like message to the publisher or to other users.

## Service Number 2

SRI's entire "Datalog" will be entered into and distributed via the computer. Datalog is a monthly bulletin, containing abstracts of recently completed SRI studies, that is sent to industrial and other organizations who subscribe to SRI's Long Range Planning Service (LRPS). (See attached sample in Appendix C.) The subscribers are made up of national and international companies in the Fortune 500 class, most of which have heavy engineering orientations. SRI has kept extensive statistics on the subscribers' use of the publication since the beginning of the Datalog program. These statistics on the past use of Datalog will provide a rich basis for comparison with its use when it is distributed via computer. Normally these time-sensitive bulletins are sent by mail.

Making Datalog accessible through a computer will accomplish several things. First, delivery will be much faster. Second, the publication can be processed through individualized profile

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filters to reduce irrelevancy. Third, they will be stored in the computer to facilitate filing and searching through back issues. Finally, interaction between user, publisher, and author will be made easy.

Because Datalog is part of a larger service offered by SRI, clients may send messages to SRI seeking further details about any item mentioned in the bulletin. Thus, the NLS two-way message capability will provide a communications channel with distinct practical advantages over both the telephone or letter mail. The telephone obviously requires simultaneous availability of both parties. In practice, several days and several tries are sometimes needed to make contact, and the telephone cannot provide information in fileable form. Letters are slow, formal, and expensive. The ability of NLS to conveniently convey asynchronous, fileable messages fills a gap between phone calls and letters, and is particularly useful when several cycles of interaction are needed to satisfy a certain request.

## Implementation of Services

As mentioned above, Ziff-Davis, the publisher of Aerospace Daily, has expressed a strong interest in participating in this experiment. Its responsibility will be to enter Aerospace Daily or possibly a similar publication into the computer using a terminal loaned under this project. SRI's Long Range Planning Service has already agreed to enter the Datalog and perhaps selected source articles.

Although we have discussed the idea with Boeing and Ford Aerospace, no definite arrangements have been made with engineering groups willing to receive these services and serve as subjects for the evaluation. We believe it will be fairly easy to find two suitable engineering groups that subscribe both to Datalog and a publication such as Aerospace Daily. To limit travel and communication costs, we will seek organizations in the San Francisco Bay area whenever possible. We will require that each participating organization help us identify a subject and control group of engineers, cooperate in the conduct of the experiment (including pretesting and posttesting), and donate time for SRI to train one or more of the people in the subject group in the operation of the terminal. This individual will either operate the terminal for the engineers or assist them in doing so.

Terminals will be supplied to engineers, publishers, and SRI researchers according to a staggered schedule based on need. (See "Schedule Budget" below.) A day or two of training in NLS as ap-

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appropriate will be provided for one person at each engineering site and for the publisher's staff who will use the system. In addition, brief training will be provided to engineers for using the simple information handling tools.

Datalog and engineering companies within a local call of SRI will have direct access to the SRI computer. If necessary, we propose access to NLS computing facilities operated by SRI via the ARPA Network. Use of the ARPA Network reduces communication costs to the price of a phone call to the nearest ARPA Network node. The operators of the ARPA Network, the Defense Communication Agency, have accommodated use of the network for various NLS-based experiments, including two by the National Science Foundation, and we anticipate no difficulties in this matter.

Access to computer power will be through purchase of SRI-KL Computer Utility service from SRI as described in the sections entitled "Budget" and "Schedule." A number of government agencies, including NSF, presently subscribe to this service, and contractual arrangements are well established.

## Administration of Experiment

Within the participating engineering organizations, subjects will be selected by canvassing for engineers interested in participating in an online experience, as discussed in the section entitled "Research Design."

For the engineers' use, SRI will program a simple command interface which will allow them to login easily and identify themselves, and create and update a key word profile of their interests. The system will list titles of new items of interest based on their individual profiles and allow them to display the full text if they choose. It will also enable them to send telegram-like messages to publishers as well as to each other and allow them to identify their specific interests publically or within their business organizations.

All the activities of the engineers will be recorded, command by command, for analysis, as described in the section entitled "Research Design."

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## Research Design

This section details the research design for evaluating the impact of a real time, interactive publication system upon engineers and their use of STI. Because many factors will contribute to the impact of the system, we are suggesting several kinds of measurement.

## Summary

The experimental design will be based on comparisons between the pretests and posttests of an experimental group and a control group. The independent variable is the use of the service. As an important enhancement to, and verification of, this testing, statistics providing an ongoing record of the behavior of system users will be automatically collected (without disturbing the users). The experimental design will guarantee users rights to privacy: no measurements will be made without each user's knowledge and consent. Both quantitative and qualitative measures will be employed to determine differences resulting from the use of the service and to measure exogenous variables.

Confounding effects well known in this kind of field study--for example, selection, maturation, and Hawthorne effects--will be addressed. Exogenous variables such as demographics, job assignments of the subjects studied, and physical and personal environments will also be measured. This data may be structured for correlation, analysis of variance, and factor analysis (as appropriate).

## Experimental Design and Analysis

The field experiment will be as rigorous as possible in a non-laboratory setting, with the resources available. Matched groups, an experimental and a control group, will be selected from the organizations willing to participate in the experiment. The experimental group will use the online service for a continuous test period of approximately eight months. Service usage, attitudes, and STI usage will be measured in pretests and posttests, while actual use of the system will be monitored online throughout the period of the experiment. The control group will be given a placebo treatment to counteract Hawthorne effect. Exogenous factors will be measured and the extent to which they are causal variables will be determined. The data will be analyzed to determine whether the basic hypotheses listed above are supported or must be rejected.

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There is no known method for measuring, quantitatively, the ability of persons to assimilate information into knowledge that is relevant to their needs. Therefore qualitative measures are necessary and will be balanced carefully against the quantitative.

Three kinds of qualitative and quantitative instruments will be used: (1) automatically monitored usage data, (2) attitude ratings (including relevance ratings), (3) and surveys (including job task type profiles and demographic profiles). The quantitative instruments include computer-collected transaction and usage data, such as connect time, commands used, computer resources used, and data bases accessed. Variables such as demographic factors, job task descriptions, information seeking behavior descriptions, training, and experience will be described and categorized for correlation analyses.

The validity of the hypotheses will be examined using standard statistical techniques applied to the quantitative and qualitative data collected both online through the system and offline in the questionnaires. At the same time, a thorough description of events and settings not measured will ensure that nothing is overlooked because of an overemphasis upon statistics.

#### Exogenous Factors

In any field study numerous factors other than the independent variable, such as individual differences, selection, and maturation, can influence outcomes. Six categories of exogenous factors are of special importance in this study: (1) population characteristics, (2) training and effectiveness, (3) equipment type and availability, (4) Hawthorne effect, (5) data base value, and (6) environment.

1. Population characteristics. A population will be selected from those members of participating organizations who respond favorably to a selection survey questionnaire about the proposed service. The population size will satisfy statistical significance requirements and be economically feasible. Half of the subjects will be allocated a placebo treatment and will not require online support. It will be explicit in this study that the service has an effect on the kind of person who chooses the service. Results may differ from those derived from experiments in which the subjects are randomly selected and required to use the service; the conclusions will be so adjusted.

Matched samples will be selected using the sample selection survey, based upon demographic characteristics and job assignments.

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This latter criterion must be examined carefully, since the particular tasks of a worker greatly determine his information needs.

2. Training and effectiveness. A priori experience with computer technology in general, and STI systems in particular, will be surveyed in the pretest. Training time will be recorded from questionnaires, and/or system-maintained usage records. User effectiveness will be judged by both the trainer and the subjects independently.

3. Equipment type and availability. The type of terminal used and the availability of the terminal and system will be noted, especially since previous studies have emphasized the importance of proximity of a service to its usage. Connect time to the system will be recorded automatically.

4. Hawthorne effect. The Hawthorne effect will be very strong in this experiment, caused by novelty, awareness that one is participating in an experiment, an environment modified by trainers, surveyors, and special procedures, and knowledge of results at different points. The length of the eight month experimental period will permit partial control of this effect. In addition, automatic monitors will capture usage data without disturbing the users.

A placebo will be administered to the control group during the experimental period to cause effects similar to the treatment. The placebo will include interviews and surveys of the information needs, and must not include any new STI information or services that would change the control group's performance.

5. Data base value. The data bases selected for this experiment will have different levels of value for each subject. The selection of the population based upon their interest and need as expressed in the selection survey will ensure a level of need sufficient for the use of the system.

6. Environment. Factors in the organizational and physical environments, such as management attitudes, terminal proximity, and visual and acoustical characteristics of the terminal area, will have an effect on the service usage.

In addition to the exogenous factors of special concern in this study, the design may account for others, such as history, maturation, testing, instrumentation, statistical regression, and experimental mortality, that generally affect the validity of experimental design [28].

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## Quantitative Measures and Collection

Quantitative data will be gathered where possible through the use of automatic monitors that are currently part of the NLS software. Data collection from the control group will be from questionnaires.

NLS provides a monitoring facility whereby data can be collected and maintained on almost every parameter of system operation, and in particular a subject's online use of the system. The programs also permit tabulation of the data in user-specifiable formats for analysis. If this facility is monitoring a user, it records her login time, her use of CPU, each occasion when NLS responds to a command word, recognizes an address, completes or aborts a command, each occasion when a user backspaces out of a command word, types in some text (but not the text itself), changes her view of the file, specifies something on the screen with the NLS cursor control, or asks for online help. It also records certain error messages from the system, invalid characters typed by the user, the total load on the computer sampled from time to time, and some other housekeeping information about the state of the computer and the software.

With this system it would be possible to reconstruct in detail the activity of a user at a given session of the proposed system, except the content of messages sent. The information is stored in special files constructed both to save space and to provide the basis of easy statistical manipulation of the results.

Quantitative measures obtained through system records are used to explore some of our hypotheses. The following discussion and table list the quantitative measures, sources of the data, intervals of collection, units of measure, and hypotheses to which the measures pertain.

**Timeliness.** The period between the origination of information and receipt by the end user will be measured both before the experimental service and during its full operation.

**Relevance.** Relevance is the ratio of items retrieved (the user peruses them) to the items judged relevant. It is by definition a subjective metric, although it yields a quantity that has been found to be valid in other studies [5]. Immediately following each session using the system, the subject will be asked to rate the relevance of each item retrieved.

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Retrieval-m. Each manual retrieval of a publication in any of the data bases will be recorded.

Requests. The number of data base interrogations made after the delivery of items selected by each subject's dissemination profile will be recorded.

Profile-chge. Each change to the online SDI profile maintained for each user will be recorded.

Retrieval-o. Online retrievals will be recorded automatically by the monitor, including an identification of the user.

Back ref. The number of searches of the online data bases containing previously issued items will be recorded.

Contact type. If through-system contacts are made, the sender and recipient will be recorded, along with the number of transactions.

Comment. Each use of the comment facility will be counted, including the subject originating the command and the destination.

Info-type. The number of online accesses and the subjects accessing each data base will be recorded.

Cost-1. The cost of each session will be computed, including a breakdown of labor support and computer resources.

Cost-2. Based upon cost-1 and publishing costs, the long term costs of the service will be computed, including projections for a service continuing beyond the experiment.

Logins. The number of times each subject uses the system will be tabulated during the experimental period.

Connect. The actual time spent online will be automatically tabulated by the monitor. The time connected to the system will be logged-in hours per subject.

Review-t. A description of the subject's time spent reviewing literature through the system will be recorded from the Job Task Profile survey (pretest) and the posttest survey. This is a subjective estimate on the part of the subject.

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Table of Measures

| METRIC       | SOURCE   | INTERVAL   | UNIT        | APPLICABLE<br>HYPOTHESIS |
|--------------|----------|------------|-------------|--------------------------|
| timeliness   | quest    | pre/post   | days        | 1                        |
| relevance    | quest    | periodic   | ratio       | 3                        |
| retrieval-m  | tabulate | occurrence | count       | 3                        |
| requests     | monitor  | ongoing    | count       | 4                        |
| profile-chge | monitor  | ongoing    | count       | 4                        |
| retrieval-o  | monitor  | ongoing    | count       | 6                        |
| back ref     | monitor  | ongoing    | count       | 6                        |
| contact      | monitor  | occurrence | proximity   | 7a                       |
| comment      | monitor  | ongoing    | transaction | 7b                       |
| info type    | monitor  | ongoing    | data base   | 8                        |
| cost-1       | compute  | ongoing    | \$/session  | **                       |
| cost-2       | compute  | ongoing    | \$/days     | **                       |
| logins       | monitor  | ongoing    | count       | **                       |
| connect      | monitor  | ongoing    | time        | **                       |
| review-t     | quest    | pre/post   | time        | **                       |

## NOTES:

Pre/post--Pretests and posttests.

Ongoing--Cumulative data that will be presented for various units of time (e.g., cost/hour).

Compute--The value will be computed from accumulated data.

Quest--Data will be accumulated from survey questionnaires.

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Monitor--An automatic collection and tabulation of data wherever the computer is used.

\*\*--These may have indirect relevance to the hypotheses that may appear, for example, in factor analyses of the data.

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## Survey Questionnaires

Questionnaires must be relied upon to collect data that cannot be quantitatively measured, either because in the field test setting there is no automatic monitor of the specific process, the response desired is subjective, or it is too expensive to gather the data more directly. Several questionnaires will be given in packages to minimize obtrusiveness and facilitate delivery. They include the population sample selection survey, the pretest questionnaires for determining demographic characteristics, job task descriptions, and the comprehensive posttest questionnaire directly addressing the effect of the experimental treatment.

Three types of questions will be included in the surveys:

1. Questions that provide a five-position scale to assess the effect of the system on specific daily information seeking routines.
2. Multiple choice questions. Redundant questions are included for internal validity checks.
3. Open-ended response questions will be minimized. However, items such as comments on the forced choice questions that enrich the data will be incorporated into the case record.

## Population Sample Selection Survey

The initial population for this survey should be between two to three times the size of the desired sample. The study population will be those respondents most interested in the experimental service and STI in general. The experimental group will be selected using stratified random sampling, which will match the groups on the basis of demographic characteristics.

This brief survey will describe the STI service and ask if the respondent would use it. The effort to use the system will be clearly outlined so that the engineer understands what will be required of him.

## Population Characteristics Survey

This survey data may be used to aid the selection of a representative sample of the engineers in the sample organizations. It will include age, sex, geographical location, education, native language, etc. It will be combined with the Job Task Type Survey.

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## Job Task Type Survey

An understanding of how the sample group allocates work time will clarify the group's need for information and their use of the system. In this pretest survey the experimental and control groups will determine the percentage of time spent on each job task type. For a list of job task types, see Appendix A.

## Posttest Survey Questionnaire

A survey will be administered at the end of the experimental period to determine the specific reactions to use of system by the experimental group. This includes questions on information availability, level of usage, kinds and sources of information most often utilized, the type of terminal, system availability, effect on workload, disappointments encountered, and particular uses.

## Attitude Change Measurement

It is proposed to measure attitude shift, not straight attitude toward the technology. The comparison will be between the pretest and posttest, with the control group comparison serving to isolate effects caused by maturation. The attitude test will incorporate an instrument design [14, 46, 50], in which the rated items correspond to dimensions describing information behavior (see Appendix B). Statistical tests for reliability and internal consistency will be used.

Certain methodological assumptions are made regarding the measure of attitude shift.

1. If the service has an effect (positive or negative), then that effect will result in a corresponding measurable change in the attitudes of users toward the service, the general technology that it represents, and the STI they receive.
2. Measuring the attitude of the population involved is one valid way of ascertaining the effects. Attitude change is strongly affected by self perceived effectiveness, and conversely, attitude strongly influences effectiveness. A priori attitude will affect the propensity to use the service.
3. Respondent reports are a valid means of ascertaining changes in performance/effectiveness. Although subjective, a user's

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judgements about the utility of a tool are meaningful when there is a significant number of users.

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## Potential Value

The proposed system will give us a carefully measured example of timely, filtered information delivered online to engineers. If the service proves attractive to the engineers and publishers and economic analysis is favorable, it can continue as a commercial enterprise which will make more information easily available to engineers and will enable them to receive the time-valued information more rapidly. (See "Service "below.)

Regardless of the commercial viability of the service, the rapid transmission of time-valued, filtered information in a thoroughly metered environment gives an unusual opportunity to learn more about the information needs and information gathering patterns of engineers. Substantial literature has been written on the information gathering of research scientists [35], including descriptions of many sophisticated methods of filtering information that is delivered to the researchers [38]. Unlike the previous studies, the information delivery proposed here is quick, oriented toward engineers, and allows detailed recording of what the subjects do with the information they receive.

It is widely accepted that engineers learn what they need to know rather differently from research scientists, mostly by word of mouth [3], with attending methodological difficulties in studying what happens. The description of the word of mouth process presented by Allen [1] ten years ago remains the model for research in this area. Current research by Gellam [19] may show some of the reasons why engineers work in this way, but it does not offer alternative methods for more efficient ways of working or more efficient ways of studying the work patterns.

We offer here an alternative method that is neither word of mouth nor paper shuffling. If, as we anticipate, it alters the behavior of the subjects, the unique ability of NLS to track the subjects as they read will enable us to develop a body of novel information on their behavior.

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## Service Extension

This experiment should provide sufficient knowledge to determine the feasibility, cost, and effectiveness of the delivery system and the services described above. Placing a terminal in the office of the publisher should enhance the possibility of having the publisher continue the service after the end of the experiment. There is no institutional or technical reason why the publishers involved could not continue to use and expand these services on a continuing, commercial basis [34, 36].

Uncertainties such as cost of the delivery system make it difficult to be explicit about future extensions of the service at this time. More definitive plans for continuing evolution and implementation will be developed during the experiment as appropriate. The system is undergoing technical improvements and hardware cost decreases that should improve the cost effectiveness materially during the next two years.

It should be noted that the computer system, NLS, proposed for use in this study is available directly from SRI, from a commercial service bureau, and as a software system suitable for running on a user's (e.g., publisher or EPC) in-house computer hardware.

Ziff-Davis is interested in this experiment primarily because it foresees the day when its service will be electronic and would like to get experience in this form of publication. We imagine that other similar publishers will feel this way, and this attitude will be even more widespread in two years. The combination of publisher interest, technical feasibility, and the improving cost picture should make it possible for the service built here in prototype to flourish on its own.

Month 5: Administer attitude pretest to both groups

## Innovations in Engineering Publications

## Final Report

SRI will prepare a final report describing the innovative distribution medium, the hypotheses tested, the results of the test, and reporting broadly the effect of the use of interactive communication on the engineers involved. The report will include both the results of statistical analysis of data from the surveys and automatated monitoring of system use, for example, data transformed for correlation, variance analysis, factor analysis (if appropriate), and case studies that explore processes, such as technology transfer and behavioral inertia.

The report will be available both online to users of NLS and printed in the conventional manner. We also anticipate that our results will be suitable for journal publication. We believe the publication of information about the tools used and the results of our research on the patterns of use by the engineers will serve as a stimulus to the publishing industry that serves engineers.

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## MANAGEMENT

## Organizational Readiness

SRI is unusually well qualified as an organization to support this project. It is one of the nation's most highly respected research organizations, with a long record of successful completion of similar projects for the National Science Foundation and other clients. In particular, SRI has been a center for study both of innovative publications methods and dissemination of scientific information. (See Institutional Information below.) An ongoing community of people committed to both topics is available here in an organizational setting with longstanding success at supporting such projects.

## Direction and Coordination

The principal investigator in this study will be Elizabeth K. Michael, who will direct and coordinate an interdisciplinary team drawn from the resources of SRI. She will be responsible to the National Science Foundation for successful completion of the study on time, in budget, and with excellent research and reporting. Ms. Michael has directed the preparation of this proposal and in particular is responsible for the administrative, budget, and schedule portions. We are fortunate that she will be available for this work since the project she currently leads, the closely related Document Production and Control System Design Study contracted by the Rome Air Development Center, will end about the time this work begins.

## Schedule

The schedule shown below lists only high level tasks in a rough time frame. A schedule listing tasks in detail and more precisely specifying time for each will be prepared during the first month of the project.

Month 1: Preliminary talks with Datalog and Ziff-Davis clients to get a better idea of environments, potential number of participants, communication facilities, etc.

Month 1: SRI work station installed

Month 1: Computer service on SRI-KL commences at 1 CRU level

## Innovations in Engineering Publications

Month 1: Prepare detailed work schedule

Month 1: Orientation and some training for BIP management

Month 1: Talk with publisher

1. Select the publication, possibly Aerospace Daily
2. Get letter of intent from the publisher to NSF
3. Obtain NSF approval of the publication

Month 1: Survey design

1. Population Sample Selection Survey
2. Population Characteristics Survey
3. Job Task Type Survey
4. Posttest Survey Questionnaire

Month 1: System orientation for SRI BIP management and planning for the experiment

Month 2: Order leased line for publisher

Month 2: Order work station equipment

Month 3: Design user interface for engineers

Month 3: Program user interface for engineers

Month 4: Administer Population Sample Selection Survey

Month 4: Install work station at publisher's site

Month 4: System orientation for publisher's management and planning for the experiment

Month 4: Train publisher's staff

Month 4: Trial publication put online at the publisher's and delivered to SRI

Month 4: On-going client and publisher support

Month 5: Administer attitude pretest to both groups

## Innovations in Engineering Publications

- Month 5: Administer the Job Task Type Survey
- Month 5: Select the study population and divide study population into matched groups, control and experimental
- Month 5: Train BIP secretary
- Month 5: Publish Datalog
- Month 5: Collect statistics on Datalog customer contacts and requests for both online and offline editions
- Month 6: Begin administering the placebo for the control group (survey and interviews)
- Month 6: Install work station at Client 1 site.
- Month 6: Train Client 1.
- Month 6: Client 1 uses system for one month
- Month 6: Make any indicated revisions to software and training for subsequent clients.
- Month 6: Begin online monitoring of system use for the experimental group
- Month 7: Computer service on SRI-KL increased to 2 CRUs
- Month 7: Install work station at site of Client 2
- Month 7: Train client 2
- Month 7: Client 2 uses the system
- Month 16: Administer the posttest survey to the experimental group
- Month 16: Administer attitude posttest to the control and experimental groups
- Month 16: Analyze the collected data
- Month 17: Write the final report

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Month 18: Deliver report, including recommendations for technology transfer to publishing industry

Grant Ends

## Innovations in Engineering Publications

## Budget Support

The proposed detailed budget and all supporting schedules are in Part II of this proposal. A budget summary in NSF format is included in Part I in the following section.

This budget represents an effort on SRI's part to make available economically a very large array of highly sophisticated computer and communications tools. Development of the equivalent tools would require on the order of 100 person-years of programming, not including the documentation and the background knowledge of user training and technology transfer necessary to this application.

Approximately two thirds of the proposed budget is the provision for the services of senior professional research staff. The bulk of the remaining third is for leased work station equipment for the widely distributed participants. A relatively small amount is for computer use, communications costs, travel, etc.

## Cost Sharing

The cost sharing assumed by SRI comes about from the fact that both Datalog and a commercially published engineering daily news letter will be processed twice during the research period, once by traditional methods and again in the online computer environment.

The total saving to NSF of this cost sharing will be approximately \$15,500. This estimate is based on personnel costs for typing and editing nine issues of Datalog and 270 issues of a daily engineering news letter, plus management orientation, planning, and coordination in both organizations.

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## INSTITUTIONAL AND BIOGRAPHICAL INFORMATION

## SRI's Background

## General Capabilities of SRI

SRI is an independent, nonprofit corporation that performs a broad spectrum of research, development, and services under contract to business, industry, and government. SRI's work is directed toward problem solving as well as research in the abstract. The staff of SRI numbers over 3,000. More than 500 SRI staff members hold Ph.D. degrees, over 600 hold Master's degrees, and approximately 800 hold Bachelor's degrees. Facilities at SRI's main offices include extensive data processing, library, and laboratory support. The comprehensive technical libraries are well supplied with literature in the fields of document generation and dissemination of scientific and technical information.

Research operations at SRI are organized into seven divisions representing major disciplinary fields. Overall supervision of research is vested in the Office of Research Operations which reports directly to the Office of the President. Both formal and informal arrangements of long standing exist to facilitate interdisciplinary research and development among the divisions and their subgroups. Work related to proposed the "Innovations in Engineering Publications" project has taken place in the Management and Economics Division and in the Information Science and Engineering Division.

## Management and Economics Division

We believe it is important to mention capabilities within the Management and Economics division here, although no member of that staff is specifically proposed for the initial team. Besides the general relevance of their work, their knowledge of business application of electronic aids to publishing should prove very useful in the analysis of the commercial use of the system. The Management and Economics Division is concerned with solving problems for business, industry, and government through the application of modern management and systems techniques. The division has over twenty years of experience in bridging gaps in effectiveness and efficiency and keeping client management current with useful, practical systems that support all aspects of management from research and development through operation and maintenance. They emphasize studies of the interaction of technology and business and the resultant problems of managing technological change.

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## The Electronic Industries Department

The Electronic Industries Department has conducted extensive research in the area of office automation from the marketing and technical viewpoints as well as the motivational and organizational perspectives. During the course of their multi-client study covering business equipment, which had 30 sponsors, several hundred personal interviews were conducted, supplemented by over 5,000 mailed questionnaires covering the fields of word processing, printing equipment related to data processing, and small business computers. In addition, they have conducted a number of proprietary studies on a wide variety of office automation products and markets.

## Information Systems Management Department

This department provides management assistance in the area of business electronic data processing and related planning and management. The department has extensive experience in the development and implementation of techniques and methods to improve the effectiveness of electronic data processing (EDP) requirements planning, systems development, computer operations, equipment utilization, EDP cost benefits, and systems analysis. They have helped many organizations plan their overall systems development, personnel training, project management, and EDP organization development.

## Information Science and Engineering Division

The activities of the Information Science and Engineering Division are carried out in several laboratories and research centers including three that are especially relevant to the proposed study: the Information Sciences Laboratory, the Telecommunications Sciences Center, and the Augmentation Research Center. Each of the laboratories is composed of a number of groups with complementary interests and skills.

## Information Science Laboratory

In general, ISL personnel plan, design, and develop computer systems for business and industry, and carefully mold them to meet management and operational needs. Current and long-term company goals, user requirements, corporate growth factors, functional EDP needs, applicable technology, and cost effectiveness are taken into account, so that the system will become an integral part of the organization and enhance the productivity of its users.

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Their objective is to provide clients with the complete services essential to the achievement of a responsive, growth-oriented computer system. Actively involved in concept formulation, design, implementation, and evaluation of computer systems, ISL has engaged in the development of large and small-scale data processing systems in a variety of fields, including publishing and information dissemination.

ISL work spans a wide spectrum of activities, from the preparation of performance specifications to the actual implementation of systems, with a dominating principle being the pragmatic synthesis of hardware, system software, and application software to form an integrated system that meets specific goals of their customers.

An important example of ISL's continuing interest in computer-based aids to publication is the National Science Foundation's Editorial Processing Center (EPC II) project. For NSF, ISL is developing a system to support academic journal production based on input at scattered sites connected to a central computer by telephone lines.

## Telecommunications Science Center

Typical projects in this center that relate to this project include:

Evaluation of Experimental and Operational Teleconferencing Systems. The objectives of this research, conducted for the National Science Foundation, were (1) to bring together in one document all the currently available information on audio, video, and computer teleconferencing systems that have been set up around the world for either experimental or operational purposes, and (2) to present this information in a primer or handbook form so that it can be used by government agencies and others as an aid to decision making. The kinds of information being gathered include: system costs (start-up and operations); purpose; transmission capabilities (voice, video, facsimile, text, and so forth); number of locations; user characteristics; effectiveness; and usage and evaluative data.

Evaluation of FORUM Teleconference on Travel/Communication Trade-Offs. This was a study of a recent international computer teleconference on the subject of travel/communication trade-offs. This conference, held over a two-week period in February 1974, included some 30 participants from the United States, Canada, and England. The conference was one of several taking place via the NSF-funded FORUM teleconferencing system.

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Assessment of the conference was a coordinated effort of SRI, Bell Canada, and the Institute for the Future. Among SRI's contributions to the document was a description and analysis of communication patterns among the participants.

Study of Regulatory and Policy Problems Presented by Interdependence of Computer and Communication Facilities. This study for the Federal Communications Commission investigated the growing interdependence of the computer and communications industries. As part of the study, it was necessary to estimate the extent of that interdependence by studying the trends in demand for telecommunications services through the use of data communications devices. This is one of the major uses of domestic telecommunications services to be expected in the next ten years.

## Augmentation Research Center

The Augmentation Research Center develops and applies a broad-based computer support system that improves effective use of human capacities in connection with textual information in a variety of forms. The following brief description of some of the accomplishments of ARC over the past 13 years will attest to its leading position in the development of effective services for people working with textual information.

Early explicit recognition of the potential that online computer and communication technologies have in areas outside of straight numeric or accounting computation in enhancing the effectiveness and efficiency of managers, scientists, technical writers, engineers, programmers, and their supporting staffs in their daily work.

Participation in the implementation of the ARPA Network, a nationwide network connecting over 3,000 remote terminals to 150 different computers.

Early explicit recognition of the importance to system building of an integrated system of text handling and system building tools.

Pioneered the two-dimensional text work to be the foundation of an intelligent terminal system, and developed many highly interactive tools and concepts for working and browsing in information space that is characteristic of engineers and scientists looking for information.

Pioneered input device and work station design.

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Pioneered in high-quality formatted publication of hard copy through line printers, typewriters, photocomposition, and computer output to microfilm.

Pioneered the concept of an integrated coherent workshop of many information tools with a uniform user interface.

First with a comprehensive system for electronic mail control, addressing distribution, delivery, individual and group identification, cross-linking, and indexing.

Over 100,000 hours of hands-on console experience with the use of NLS technology in daily work at a variety of sites.

Recognition of the importance of integrating into the system building process mechanisms for studying and facilitating technology transfer, including establishment of special user interfaces, training, and other application support services.

For the last three years, the Augmentation Research Center has offered a system of aids for information-based work through a time-sharing service, the ARC Utility. About 15 government and private organizations supporting about 300 users now subscribe. Their activities include both publication, such as Air Force Manuals, and small data base management, for example, management of failure reports for a world-wide Air Force computer system which are typed in for display and reference in a manner very similar to the proposed handling of Datalog and other engineering information. Utility services normally include substantial training and applications consulting, which we believe gives SRI unique insights into the problems of implementing this project at the publishers and engineer's sites.

One NLS Utility customer, the Long Range Planning Group of Bell of Canada, has been particularly interested in the measurement and survey of NLS use. Bell recently completed a year-long detailed survey of the attitudes of various users towards NLS [15]. Some of the results may be of use in the design and interpretation of user surveys in this study. More directly applicable is the system for measuring the behavior of NLS users described under Research Design, above. The aptness of this development, which was sponsored by another ARC client, to a wide range of research projects is an example of the useful synergy in the NLS community.

Biographies

## Innovations in Engineering Publications

RICHARD C. HARKNESS  
 POLICY ANALYST  
 TELECOMMUNICATIONS SCIENCES CENTER  
 INFORMATION SCIENCE AND ENGINEERING DIVISION

## Representative research assignments at SRI

- . Research and assessment of telecommunications-transportation interactions for purposes of forming future national policy

## Other professional experience

- . Design engineer, Ocean Science and Engineering, Inc.
- . Lecturer, University of Washington: course entitled "Innovations in Urban Transportation"
- . Transportation planning engineer, Puget Sound Governmental Conference: worked with computer network models, evaluation of new transportation technologies, and developed a systems-based management plan for PSGC's work program
- . Marketing manager, Boeing Aerospace Company: involved in various staff studies, including BAC's decision to enter ground transportation market, telecommunications as a substitute for travel, the market for personal rapid transit, Saudi Arabia's transport needs, BAC long range planning, and international business strategy planning; toured the United States and Japan to assess business and market opportunities for PRT

## Academic background

- . B.S. in electrical engineering (1964), Duke University, M.S.E. in urban transportation planning (1970), and Ph.D. in urban system planning (1973), University of Washington

## Publications

- . "Innovations in Telecommunications and Their Impact on Urban Life," in Innovations for New and Established Cities, G. Golay, ed. Praeger Publishers, Inc., New York (1975)
- . "Telecommunications Substitutes for Travel: A Preliminary Assessment of their Potential for Reducing Urban Transportation Costs by Altering Office Location Patterns," Ph.D. Dissertation, University of Washington (June, 1973); also published by Office of Telecommunications, U.S. Department of Commerce, through MTIS

Innovations in Engineering Publications

- . "Communication Innovations, Urban Form and Travel Demand, Some Hypotheses and a Bibliography," Research Report, Urban Transportation Program University of Washington; updated version published by the Council of Planning Librarians and Trans. (1973)
- . "The Transmodal Capsule Concept: An Alternative to Dual Node," paper presented at the 1973 Minneapolis PRT conference and published in conference proceedings (May 4, 1973)

## Innovations in Engineering Publications

ELIZABETH K. MICHAEL  
SENIOR RESEARCH ENGINEER  
AUGMENTATION RESEARCH CENTER  
INFORMATION SCIENCE AND ENGINEERING DIVISION

## Specialized professional competence

- . Design and development of large software systems; man-machine system analysis; interactive and batch management; information management and retrieval systems; tutorial database systems; office automation systems; text formatting systems; distributed computing systems

## Representative research assignment at SRI (since 1972)

- . Project leader for an extensive study in the area of information processing and documentation production. Study included online delivery and retrieval systems.
- . Program coordinator for the integration of a very large, interactive application system into a multi-computer network environment.
- . Extensive client consulting in areas of information systems, and large scale technical document production.
- . Design of information retrieval and tutorial help systems.
- . Development of the computer system and associated organizational techniques at the Augmentation Research Center.

## Other experience

- . Stanford Computation Center, Stanford University; design, implementation, and administration of system measurement and user accounting system for an IBM 360/70 computer supporting interactive terminals simultaneously with multiple batch processes
- . Manager, Programming and Analysis, Controllers Office, Stanford University; supervision and training of programmer analysts; design and implementation of all University administrative computerized tasks including student registration and records, alumni information, business, and accounting

Innovations in Engineering Publications

Academic background

- . B.S. in physical science/organic chemistry (1947) and M.A. in economic statistics (1948), Stanford University

Publications

- . Co-author of the Document Production and Control System Design Study
- . Various articles and manuals for SRI's Augmentation Research Center and the Stanford Computation Center; articles on computer measurement and accounting for the SHARE Computer Measurement and Evaluation Project

Innovations in Engineering Publications

DIRK H. van NOUHUYS  
RESEARCH ANALYST  
AUGMENTATION RESEARCH CENTER  
INFORMATION SCIENCE AND ENGINEERING DIVISION

Specialized professional competence

- . Technical writing; all types of writing; technical publications management; application of computer-based techniques to technical publications; teaching writing

Representative research assignments at SRI (since 1970)

- . Technical writer: developed an advanced, computer-based interactive text handling and information retrieval system; organized and participated in online composition and printing of reports and proposals; participated in design and debugging of the command language; taught and developed tutorial materials for the online language; developed and operated interactive retrieval and cataloging systems; coordinated and promoted development of computer-based text processing systems

Other professional experience

- . Management of the Resource Data Center, TRW Systems (Redondo Beach): wrote proposals
- . Technical writer and editor, Western Regional Research Laboratory of the USDA (Albany)

Academic background

- . B.A. in writing (1956), Stanford University; M.A. in contemporary literature (1957), Columbia University; additional study in physics, psychology, French, and English

Publications

- . Coauthor of three SRI technical reports on computer system development of text processing systems, training in use of online computer systems, and interactive question answering systems; coauthor of four technical movies or Video tapes

Professional society

- . Society of Technical Communication

## Innovations in Engineering Publications

JAMES H. BAIR, JR.  
 SENIOR INFORMATION SCIENTIST  
 AUGMENTATION RESEARCH CENTER  
 INFORMATION SCIENCE AND ENGINEERING DIVISION

## Specialized professional competence

- . Man-computer systems development and analysis; information system design and operation; psychology of human communication and group dynamics; organizational behavior research; teaching

## Representative research assignments at SRI

- . Senior Information Scientist: supervisor, Applications Development Group; leader, technology transfer program analysis; courseware design and user training for the Online System (NLS); analysis of man-computer interaction systems; coordination of user-system documentation; leader, ARC Seminar Program

## Other professional experience

- . Rome Air Development Center: Project Officer--Behavioral Scientist; evaluation and analysis of computer text processing systems (task leader); USAF Coordinator for R&D in man-computer communication; project monitoring for system development; research in human information processing
- . College instruction, Syracuse University, Mohawk Valley College, and Pennsylvania State University: conducted courses in social psychology, group dynamics, and human communication

## Academic background

- . B.S., mass communication (1965), Utah State University; M.A., psychology of human communication systems (1967), Pennsylvania State University

## Most recent publications and reports

- . "The Future Designers of Computer Systems: Social Scientists?," Telecommunications Policy, Spring, 1977 (in press)
- . "Strategies for the Human Use of Computer Based Systems," NATO Advanced Studies Institute on Man Computer Interaction, Mati, Greece, Sept. 1976 (Invited Lecture; to be published in NATO Proceedings)

Innovations in Engineering Publications

- . Coauthor with Jacque Vallee, R. Johansen, & G. Edwards, "A Time Series Approach to the Evaluation of Office Automation," Invited Paper for the XEROX Corp. Workshop on the Evaluation of Office Automation, May 1976
- . "Technology in Instruction and Education," In: Technology Transfer: A State of the Art Survey, T. Anyos and K. Hirschberg (editors), Stanford Research Institute Final Report, 1975, pp. 103-110

Professional association

- . Chairman, Human-Computer Communication Working Group, International Federation for Information Processing; American Society for Information Science (Session Chairman, Representative); International Communication Association (Officer, Session Chairman, Symposium Chairman); Speech Communication Assoc. of America (speaker); IEEE (Speaker); Human Factors Society.

## Innovations in Engineering Publications

HARVEY G. LEHTMAN  
RESEARCH ENGINEER  
AUGMENTATION RESEARCH CENTER  
INFORMATION SCIENCE AND ENGINEERING DIVISION

## Specialized professional competence

- . Design and development of large software systems; man-machine system analysis; software engineering tools and techniques; tutorial database systems; office automation systems; text formatting systems; distributed computing systems

## Representative research assignment at SRI (since 1970)

- . Development of the computer system and associated organizational techniques at the Augmentation Research Center
- . Software engineering: tools and techniques for aiding in the development of large software systems
- . Development of information retrieval and tutorial help systems
- . Two-dimensional display terminal formatting
- . Random file system revision: addition of property lists
- . Distributed operating system version of NLS
- . Report writing; languages and project reports

## Other experience

- . Teaching assistant in computer science and programming, University of California, San Diego
- . Research in experimental high energy physics, University of California, Berkeley and University of Chicago

## Academic background

- . B.A. in physics (with honors, 1966), University of California, Berkeley; M.S. in physics (1967), University of Chicago; work toward Ph.D. in physics (through 1969), University of Chicago; graduate work in Computer Science (1970), University of California, San Diego; MS in Engineering-Economic Systems (1976), Stanford University; current Ph.D. candidate in Industrial Engineering with specialization in man-machine systems, Stanford University

## Innovations in Engineering Publications

DAVID E. RAPHAEL  
 PROGRAM MANAGER AND SENIOR INDUSTRIAL ECONOMIST  
 BUSINESS INTELLIGENCE PROGRAM  
 OFFICE OF RESEARCH OPERATIONS

## Specialized professional competence

- . Economic studies in aviation, travel, personal transportation, international economics indicators, telecommunications, electronics funds transfer systems, computer security, automated personal identification, personal privacy, nuclear energy, aerospace market diversification, country studies; econometric and technological forecasting; corporate planning models

## Representative research assignments at SRI (since 1973)

- . Manager, DATALOG (a monthly publication of the Business Intelligence Program, which provides over 120 research documents annually to clients on a wide range of subjects including global issues, industry analyses, country studies, and technological research)
- . Program Manager, responsible to date for preparation/publication of 20 research documents, participation in five research seminars and three innovation search seminars. Responsible for recommending research projects in air transportation, energy, natural resources, and financial industries
- . Participated in SRI contract research projects in aviation, travel vs. telecommunications, market diversification opportunities, and projects requiring international economic forecasts

## Other professional experience

- . Corporate planning manager, McDonnell Douglas corporate headquarters; managed the corporate planning activities regarding commercial aviation/diversification; participated in the preparation of corporate long range plans, analyses of the future business environment; corporate economist; reported to the senior vice president and other top management executives on a number of special projects, one of which resulted in the creation of a successful \$50 million firm
- . Project leader and nuclear design physicist, University of California Lawrence Livermore Laboratories; responsible for the nuclear physics design of several major missile warhead systems

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presently in the U.S. inventory; AEC physics advisor on atmospheric and underground nuclear explosions

- . Division Officer, U.S. Naval Air Command, Pacific Fleet; aircraft carrier, U.S.S. Hornet (CVA-12), officer of the deck (under way); Lieutenant Commander, USNR
- . Instructor on graduate economics, Golden Gate University/ACE Stanford University

## Academic background

- . B.S. in physics, University of San Francisco; graduate courses in physics, University of California; MBA in business economics, St. Louis University, Ph.D. candidate in international economics and finance, St. Louis University

## Publications

- . "World Commerical Airline Industry," "Travel vs. Telecommunications," "Whither Business Planning Models," "Global Economics Prospects," "Global Inflation," "Telecommunications Services Industry," "Automated Personal Identification," "U.S. Defense Industry"
- . Manager, INTERNATIONAL ECONOMIC INDICATORS, "Nuclear Power Prospects," "Electronics Funds Transfer," " Electric Power-- Cost to Industry," "Preserving Personal Privacy in Business," "Personal Transportation," MEXICO, "Fire Prevention and Control," "Industrial Noise Control," "Capital Availability," "Natural Gas in Western Europe"

## Professional associations

- . National Association of Business Economists; Commonwealth Club; World Affairs Council
- . Participated in SRI contract research projects in aviation, travel vs. telecommunications, market diversification opportunities, and projects requiring international economic forecasts

## Innovations in Engineering Publications

DAVID A. POTTER  
 SENIOR INFORMATION SCIENTIST  
 AUGMENTATION RESEARCH CENTER  
 INFORMATION SCIENCE AND ENGINEERING DIVISION

## Specialized professional competence

- . Planning, implementing, and managing all phases of social science research projects, from proposal writing through data analysis and report writing.

## Representative research assignment at SRI

- . Planned, coordinated, and controlled marketing efforts of the Augmentation Research Center. This involved the simultaneous development of all phases of a marketing plan and strategy for NLS, including the development of a marketing information management system, the cultivation of a group of prospects, direct client and prospect contacts and system demonstrations, and general strategy planning.

## Other professional experience

- . Research Psychologist, Educational Testing Service, Teacher Behavior Research Group, Princeton, New Jersey
- . Supervisor, Organizational and Personnel Consulting, Ernst & Ernst, St. Louis, Missouri
- . Instructor, Summer Session, Department of Psychology, State University of New York, College at Cortland, New York
- . Research Assistant, Department of Psychology, Cornell University, Ithaca, New York
- . Lecturer, Department of Psychology, University of Delaware, Newark, Delaware
- . Teaching Fellow, Department of Psychology, Cornell University, Ithaca, New York

## Academic background

- . B.A. in Psychology, University of Delaware, Newark, Delaware;  
 M.A. in Social Psychology and Industrial Psychology, Cornell University; Ph.D. in Personality and Social Psychology, Cornell University

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## Most recent publications

- . "Honest, Useful, and Unpretentious," Review of W.S. MacDonald and G. Tanabe, Focus on Classroom Behavior: Readings and Research, Contemporary Psychology, 1975, Vol. 20, 51-52
- . Coauthor of "NLS Application Description: Educational Testing Service," Menlo Park, California: Stanford Research Institute (NLS Journal 33201), 1975
- . "Job Analysis of Teaching," Paper presented as part of a symposium at the annual convention of the American Educational Research Association, San Francisco, April 1976
- . "The Automated Researcher: A Total Systems Approach to Knowledge Work," Paper presented at the annual convention of the American Educational Research Association, San Francisco, April 1976
- . "Recommendations for a Teacher Licensing Examination," Paper commissioned by the Commissioner's Task Force on Teacher Certification, New York State, 1976

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JEANNE M. BECK  
RESEARCH ASSOCIATE  
AUGMENTATION RESEARCH CENTER  
INFORMATION SCIENCE AND ENGINEERING DIVISION

Specialized professional competence

- . Technical writing and editing; documentation of computer systems, software, and hardware; development of instructional materials and strategies; problem-solving and training people in the use of computer systems

Representative research assignments at SRI (since 1973)

- . Writing of user and system documentation for the development of an advanced, computer-based interactive text-handling and information retrieval system; participation in online composition and printing of reports and proposals
- . Development, writing, and operation of an interactive computer help system
- . Direct on-site assistance at ARPA (Advanced Research Projects Agency): office systems analysis, consulting, documentation, and training in the use of computer systems
- . Teaching and development of tutorial materials for the online language
- . Training of user and integration of computer-based services into working environments

Academic Background

- . B.A. in Futures Research (with honors, 1974), California State College, Sonoma

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## COMMITMENTS OF PRINCIPAL STAFF

Elizabeth K. Michael, the Principal Investigator, is currently committed to the following contracts:

The Document Production and Control System Design Study (DPCSDS). This project is funded by Rome Air Development Command (RADC) for \$100,000. The contract runs from June 15, 1976 through September 15, 1977. The annual budget is approximately \$80,000.

The EPA Foundry Project. This project is funded by the Environmental Protection Agency for \$15,000. It is a subcontract for processing technical information on foundries. The main contract is an economic impact study of pollution controls. The contract dates are April 1, 1977 through April 1, 1978.

## Proposed contract:

Consulting services for the Air Force Data Systems Design Center. This contract will be funded by Rome Air Development Command for \$14,931 and will run for 15 weeks beginning this fiscal year. The exact number of person-months that Ms. Michael will devote to this project is unknown, but the support will only be occasional.

## Other research personnel to be involved:

Dirk H. van Nouhuys is currently committed to the following two contracts:

The Document Production and Control System Design Study (DPCSDS). This project is funded by Rome Air Development Command (RADC) for \$100,000. The contract runs from June 15, 1976 through September 15, 1977. The annual budget is approximately \$80,000. He has already devoted five person-months to this contract and will devote about two more.

Workshop Utility Service IV--Applications Services. This contract deals with customer support functions for the NLS Utility Workshop. Mr. van Nouhuys is committed only on an as-needed basis, which is less than half time. It is funded by Utility clients for \$598,781 from January 18, 1977 through October 1, 1977. The annual budget is \$798,372.

Richard Harkness is currently committed to the following contract:

A Technology Assessment of Telecommunication Interactions With

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Transportation. Dr. Harkness is the Principal Investigator for this contract, a technical assessment which deals with the possibility for teleconferencing and office automative technology to restructure organizations in a way that will reduce travel demands. This interdisciplinary study is funded by NSF-RANN for \$280,000. The study will be completed upon the submission of the final report in mid-May.

James H. Bair is currently committed to the following contract:

Workshop Utility Service IV--Applications Development. This contract deals with customer support functions for the NLS Utility Workshop. Mr. Bair has committed approximately three fourths of his time to this work through October 1. It is funded by Utility clients for \$598,781 from January 18, 1977 through October 1, 1977. The annual budget is \$798,372.

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## APPENDIX A Job Task Types

The following classification of job task types are similar to those used in an earlier study [7].

Note that the percentage of time spent in task type 8 may be strongly influenced by the experiment. This assessment of time allocation will also be requested during the posttest.

1. Hardware or software work
2. Project engineering, including: contract paperwork (forms memos, etc.), reviewing proposals and reports
3. Writing plans and/or reports
4. Software or hardware operation (including evaluation, debugging of software packages)
5. Briefings and/or demonstrations of systems
6. Managing other personnel
7. Administrative paperwork
8. Study, review of the state-of-the-art, reading, literature search, review of professional news
9. Clerical work (typing, reproduction, errands, etc.)

Additional data will include job title, organizational role (e.g., manager, project engineer), length of employment, years in the profession, experience with computers, skills possessed, number of persons supervised, and amount of funds controlled. This data will permit a discussion of information seeking behavior and how it relates to the experiment device. [2]

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## APPENDIX B Areas to Be Explored in Attitude Questionnaires and Surveys

One goal of the questionnaires and surveys is to extract attitudes toward technology and STI in general, and the service provided in particular. The following lists give the flavor or the information we hope to obtain.

## Attitudes toward technology and STI:

1. automation
2. automated libraries
3. feeling toward computers
4. confidence in computers
5. reliability of computers
6. advantages of computer based information services
7. personal access to a computer
8. personal operation of a terminal
9. online retrieval of STI
10. typing on a computer terminal
11. formulating STI retrieval queries
12. acceptability of terminals for service by colleagues
13. requirements for skill to use a terminal
14. information storage and retrieval systems
15. selective dissemination systems
16. SDI Profiles
17. using keywords to indicate desired items
18. information overload
19. availability of STI
20. usefulness of STI
21. usefulness of current technical library
22. desirability of economic and marketing information

## Attitudes toward the service provided:

1. relevance of items retrieved (relevance metric) by experimental service
2. time from publication to review by subject (timeliness metric)
3. time spent reviewing STI (review-t metric)
4. use of manual library services
5. sources of STI (library, colleague, formal, informal, etc.)
6. percent of time spent reviewing STI
7. number of time system access not possible
8. problems with the terminal or service
9. improvement in effectiveness
10. use of the comment facility
11. training delivered
12. training required

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13. type of terminal used
14. assistance required
15. ease of learning
16. quantity of new information discovered (per item)
17. quantity of training received
18. desired increase in data bases
19. terminal design
20. command language design
21. ease of use
22. overall efficiency/productivity
23. quality of work
24. professional image
25. job performance--information dependent achievements
26. letters to the editor (pretest)
27. usefulness of the data bases