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For more information, contact:

Wayne D. Dominick

Editor
USL/DEMS NASA/RECON Working Paper Series
Computer Science Department
University of Southwestern Louisiana
P. O. Box 44330
Lafayette, Louisiana 70504
(318) 231-6308

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**An Innovative, Multidisciplinary
Educational Program in
Interactive Information
Storage and Retrieval**

**A Thesis
Presented to
The Graduate Faculty of
The University of Southwestern Louisiana
In Partial Fulfillment of the
Requirements for the Degree
Master of Science**

Mary C. Gallagher

January 1985

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1. INTRODUCTION

1.1 Background

The mark of an educated person is not only the breadth and depth of his knowledge but the speed and confidence with which he can increase that knowledge. This capability becomes more significant every day as society progresses further into the Information Age. Scientific literature had expanded from 100 journals at the start of the nineteenth century to 10,000 such publications by 1970 and the increase continues. The counts of books, reports, newsletters, and other printed media are all expanding at comparable rates. Libraries are traditionally the sites at which large numbers of such materials are collected; in fact, a great library has throughout history been considered an indication of a great civilization. In ancient Alexandria, part of the docking fee for any trading ship was a book to be added to the city library; this famous collection formed the heart of a group of educational institutions which influence us to this day; Erastosthenes, Euclid, and Archimedes are among the scholars educated there. How many more such scholars might that great institution have produced if its resources could have been

made available throughout the world? This is the opportunity we have today, by the use of online Information Storage and Retrieval (IS&R) systems, we can present to scholars all over the world the luxury of browsing through the whole of man's published knowledge.

Computerized bibliographic databases were first demonstrated using batch searching in 1954. During the next ten years, research and development (R&D) activities produced several limited services culminating in the Medical Literature Analysis and Retrieval System (MEDLARS) from the National Library of Medicine in 1964. This was the first publicly available, computer-based system; still operating in batch mode, the typical turnaround time for a search request was six weeks [Bou, 80].

The beginning of online systems as we know them may well be traced to a contract which was signed in 1965 between the National Aeronautics and Space Administration (NASA) and Lockheed Information Systems for the development of a bibliographic IS&R system. That system has undergone much expansion and change and is today known as NASA/RECON. Lockheed, building on the knowledge gained from this early endeavor, continued its development efforts. These bore fruit in the DIALOG system which is today the largest and most widespread search service in the world. There are many

such services, ORBIT from the System Development Corporation, BRS from the Bibliographic Retrieval Service, and IRS from the European Space Agency are some of the best known. They represent at least 400 databases and over 55 million entries. Most of these databases support a specific interest or discipline, for example, the Educational Resources Information Center (ERIC), and Chemical Abstracts, both large heavily used products, provide information on education and chemistry respectively. Online IS&R systems may be even more valuable for the very specialized references they provide, for instance, the Philosopher's Index or the Environmental Mutagen Information Center Data Base.

The reasons for the development and phenomenal growth of bibliographic databases and search services are many. First we must consider the technology which supports this activity. When computers were first developed, their perceived value was in the speed and accuracy with which they could perform calculations on large numbers. The advantages of the computer's memory capacity were secondary. However, as the early technical problems were overcome, designers began to spend more time on other computer uses. Electronic data processing capabilities were first proposed for bibliographic control of scientific literature in 1951, during the post World War II era, a time when science was considered a

cure-all for mankind's woes. The size of the bibliographic databases which originated at this time has increased in direct proportion to available computer memory. It is a fact that such memories have increased in size and decreased in cost annually since their inception and, though there are indications that the rate of such changes is slowing, the end to this trend is not in sight. Thus, from a purely hardware viewpoint, online bibliographic systems can be expected to continue increasing in size. At the same time, the scope of such systems has broadened from the original emphasis on science exemplified by BIOSIS and Information Services in Physics, Electrotechnology, Computers and Control (INSPEC). There are today publicly accessible databases which focus on politics, Public Affairs Information Service, and the stock market, Standard & Poor's News. Mention should also be made of non-bibliographic databases such as Smithsonian Science Information Exchange and Producer Price Index which represent areas of future potential growth.

Another impetus for the growth of these systems arises from the publishing industry. Books are no longer produced by typesetters but rather are generated from machine-readable tapes. These tapes concurrently provide a natural input for bibliographic databases. "It is a fundamental economic fact that for the cost of creating a book, one can have both the

book and the database, simply by producing the book via computer tape" [Bag, et al, 83]. Of course, this input must be processed, that is, indexed, abstracted, and formatted into appropriate data structures for the various commercial search services, but the raw material is there. At this time there are few full text databases; although the technology is obviously available, the cost of maintaining text online is high and the search time for full text is impractically long. Nevertheless, we have come too far too fast to discount the possibility of such services in the future. Regardless of whether full texts are stored online, it seems certain that more and more search services will offer not just references but actual texts as part of their service to subscribers, it is estimated that the cost of a book on video disc will soon be somewhere around ten cents [Wil, 78]. This fact alone clearly provides an opportunity for entrepreneurs to enter the information field - along with copyright attorneys and federal regulators.

The communication industry has also contributed to the rise of online systems. Without such services as TYMNET and TELENET most users would be required to pay standard long distance charges and on this basis alone would surely restrict their access to bibliographic databases.

Given the existence of these systems, their

availability, and scope, we come to the problem at hand, namely, the use of such systems. Within academia, access to online public bibliographies is currently the province of librarians; this is in keeping with the function of such institutions as the repositories and sources of knowledge. University research libraries in particular subscribe to such services and provide intermediaries to conduct searches for patrons. To encourage the use of these services, some schools provide a budget for student access, Loyola of New Orleans, for example, will fund the first five dollars of search charges any time a student uses the university facility for such access, a very low allowance, but enough to get a student started [Alb, 84]. The University of Southwestern Louisiana recently provided a press release to the local newspaper to inform the community of the availability of DIALOG and solicit public use through the university library [Dai, 84]. Furthermore, the USL Graduate Student Organization will fund the costs of searches for thesis and dissertation research, a little known fact which could also increase system use appreciably. The willingness of libraries to provide this service is admirable but, in the long run, proves to be a limiting rather than a liberating factor.

When a patron wishes to have a search performed, he must

first fill out a form explaining the subject of his search and the reason for conducting it. He is then interviewed by the staff member who will actually conduct the search to insure proper interpretation of the request. This search intermediary then makes an appointment with the patron so that he can be present when the search is conducted to evaluate the results of queries as they are executed. When the patron arrives for his appointment the intermediary will have drawn up a list of terms and devised a search strategy based on the vocabulary control policy, indexing technique, and file structure of the database to be accessed. Now if all goes well, the librarian has understood the request, and the proper database has been chosen, and the communication lines are operating, and all the hardware and software function properly, the search will be conducted and its results mailed to the patron in two or three days. But in case anything goes wrong, both the patron and the librarian will have wasted their time. In the simplest case another appointment will have to be made. Should the difficulty be a serious communication problem between the patron and the online specialist, a whole new strategy will have to be devised, perhaps involving a different database and a new vocabulary. In this case the patron may lose faith or interest, and the opportunity may be lost.

In the larger world of business, a collateral situation exists, access to online databases is often the function of the information specialist. Even though the equipment is at hand and the service is immediately available, many end users refuse to conduct their own searches. There are many possible explanations: computer anxiety, laziness, the "secretarial" image, to name a few. The same problems arise here as in the academic environment, duplication of effort and the waste of valuable time.

1.2 Thesis Statement

It is a premise of this thesis that the best person to conduct an online bibliographic database search is the person who will finally make use of the results, the patron in the previous example. This person is the expert in the field; no librarian can know as much about an engineer's needs as the engineer himself. According to current practice he should be present when his search is conducted, evaluate the references retrieved and guide the intermediary in the conduct of the search. How much easier and more convenient it would be for an engineer to access a bibliographic database from his own PC-based workstation in his own laboratory or office. Such a system will save time, money, and frustration; the researcher can conduct his search at his convenience. He need not even leave his office. He need not

spend valuable time explaining his goals and problems to an intermediary who simply represents a layer of indirection between the system and the real end user. The purpose of the major scientific databases has always been to provide a service to scientists and engineers performing research for the database producers. By educating these end users in the techniques of online information retrieval we can fulfill this original system objective.

The question remains as to when and how a researcher should be trained in the use of online bibliographic systems. It is the contention of this thesis that the most efficient education of these end users can be accomplished in the last year of undergraduate education. By this time, the student should have achieved some expertise in his chosen field and had extensive experience with manual research techniques which will contribute to his understanding and appreciation of online systems; he will also be concerned with marketable skills since he is about to enter the job market. It will be shown in a subsequent chapter of this thesis that the ability to conduct such searches is a desirable attribute for a new employee. The thrust of this research is the development of a set of courses to fulfill this educational need. It must be transportable to a variety of institutions and, therefore, independent of any specific hardware. It must be flexible in

regard to the structure of the academic year: semester or quarter, and modular in concept to provide useful material for mini-courses and workshops. It must accommodate different systems since each search processor has its own query structure, output generation features, and other idiosyncrasies. As a final challenge, this course must be structured for presentation by instructors who are not expert in either computer science or librarian science but rather the faculty of the subject department.

This thesis is the result of a larger project, the USL NASA/RECON project. The heart of the research reported in this document is detailed in Chapters 2 through 5 while Chapters 6, 7, and 8 contain plans for further stages in the development of the education project. Chapter 9 presents material which was produced by research team members specializing in the use of personal computers as IS&R tools. The last two Chapters report future issues and summarize the foregoing material.

2. REVIEW OF THE LITERATURE

2.1 Definitions

Much has been written about the teaching of online retrieval techniques in general. Before proceeding to an examination of this material it will be helpful to clarify some terms as they relate to this thesis. It is first necessary to make a distinction between education and training. This is not a simple task because education in this area clearly requires certain training components. Borko has made the following distinction between these two ideas,

Education is concerned with the foundations, principles and basic knowledge of information science and other disciplines as these relate to such things as data base structures, data base management systems, file structures, logic, formulation of search strategies in a generic sense, systems analysis and design, vocabulary structures, and user needs. The concerns of training are the contents and structure of specific data bases, design of search strategies as these are implemented within specific on-line or batch systems, and techniques for utilizing specific services offered by individual service centers [Bor, 78].

The preceding quotation is found in a report on teaching retrieval skills to librarians. The fact that librarians are the focus of such comment introduces another problematic

area, the definition of the term "end user." In much of the literature the end user is simply the person sitting at the terminal, generally a search intermediary, often a librarian. In other sources, the end user is the patron for whom the search is being conducted. Of course, if the patron conducts his own search, he is the end user by either standard. Since it is the contention of this thesis that the patron can and should be his own intermediary, and since, regardless of who actually conducts the search, it is this same person who eventually reaps the benefit, the term end user is here restricted to the patron. Consequently, search intermediaries will be specifically identified as such.

Another distinction must be drawn between those organizations which are responsible for the creation of databases, the producers, and those which furnish public access to these files, the processors. Any organization that gathers and stores information in a computer has, de facto, created a database. Most of these private products are of no public interest and are never known outside the site of their creation. Others, like Engineering Index and Psychological Abstracts, are widely available through database processors. Some public, i.e., government sponsored, databases are also well known, such as AGRICOLA from the National Agricultural Library and ERIC. All these products generally originate

from the self interest of the creating agency.

Search processors, on the other hand, deal specifically with the public by providing access to database resources. These organizations, Lockheed Information Systems and System Development Corporation for example, lease databases from their creators. It is not a simple matter of loading tapes and turning a switch. Indeed, much processing must be done before a searcher can access this information. Files must be designed in order to allow searching of specific fields. A conversion program may be needed to change the leased material into a form which is compatible with the search system software. Indices must be built and index terms chosen which will allow efficient access. This entire support system must then be documented and tested. Finally, periodic updates are necessary which entail not just additions to the database itself but restructuring and possible extension of the indices as well. In 1980 it was reported that Lockheed processed over 10 billion characters per month as part of its file maintenance activities [Bou, 80].

Some organizations develop and market their own product; the National Library of Medicine fulfills both functions for its MEDLINE and CATLINE databases. The Department of Energy and NASA perform both roles for DOE/RECON and NASA/RECON

respectively. Many of these databases are also available through commercial search processors.

Two additional terms which require definition are recall and precision; these terms have very specific meanings in the context of bibliographic IS&R systems. These concepts are often encountered in publications which report evaluation of such systems. Recall refers to the number of references found by a search in relation to the number of applicable entries in the database; thus the ratio is:

$$\text{RECALL} = \frac{\text{Relevant retrieved references}}{\text{Relevant records in database}}$$

Precision is the ratio of the number of desirable or correct references located by a search in relation to the total number of references retrieved, thus:

$$\text{PRECISION} = \frac{\text{Relevant references retrieved}}{\text{All records retrieved}}$$

Together these ratios indicate the usefulness and power of a retrieval system as well as the skills of its users. Precision and recall tend to vary inversely. The greater the recall, the lower the precision since more irrelevant records will be retrieved along with the additional relevant records.

On the other hand, the attempt to increase precision will result in the loss of some relevant records along with the irrelevant ones [Bor, 84].

2.2 Survey of Projects

Most of the training available to online searchers has traditionally come from the database processors as part of their marketing strategy. Some producers participate in these activities, usually by conducting special tutorials at processor sponsored workshops, like the Lockheed "Update" and the SDC "Databases on Review" sessions. Wanger points out that users do need database-specific training to focus on content coverage, selection criteria, acquisition policies, and other information which can affect the searcher and his results. These database producers are a rich source of professional information which should be tapped for support of future educational enterprises [Wan, 79].

Education, as opposed to training, in online retrieval has been largely restricted to schools of library science. Thus, most of the material reported in the literature relates to the education of search intermediaries. The British Library Research and Development Department (BLRDD) has taken the lead in developing both courses and teaching aids for this purpose. Beginning in the 1975-76 academic year, the BLRDD began funding proposals from British library schools

for the addition of online bibliographic searching to their curricula. The teaching methods developed under these grants included the traditional lectures and seminars as well as films, tape-slide presentations, and live demonstrations. Even at this early stage, some schools facilitated student participation by the development of recorded searches in which the students could experience some aspects of online searching without the complications of actual communication with a search service. These first research projects involved a total of 500 students at ten library schools [Kee, 82].

Learning about online searching by actually conducting such searches may be the ideal method but several factors operate against this technique. Cost is usually cited first but it is not the only consideration. Equipment and system failures are constant threats along with the potential hazards to system access such as passwords, and overloads. Collateral consideration should be given to the psychology involved, students will learn more easily if they are more relaxed, they can work at their own pace, even repeating some tasks if necessary, if they - and their teacher - are not faced with high system costs [Woo, 84]. Estimates of the time necessary to gain sufficient skill to perform online searches independently differ widely, from two to as many as

forty hours per student per database. This enormous difference may well spring from individual interpretations of the concept of "sufficient skill." Costs also vary but typically run about seventy dollars per hour for database access plus eight dollars for communication charges; this represents the current cost for accessing NASA/RECON via TELENET. Charges for printouts of references generated must be added to these basic figures.

The necessity for extensive online practice has led to a heavy emphasis on various simulations, emulations, and pre-constructed search products as learning aids both in publicly funded education projects and database processor training environments. Wood defines emulations as having "a command language as near as possible to that of the service that is being imitated and a database that can be searched" [Woo, 84], while a simulation mimics the online service that is being imitated by guiding the user through a set search modeled on that particular service. A simulation should be easier to construct but much more restricted in its use than an emulation. Some simulations provide no recognition of error, both right and wrong commands elicit the same response, others include error coding to point out a student's deviation from the expected norm, of course, such a deviation may or may not be a real error but a low level

program cannot differentiate. Such a tool certainly has appropriate applications; it would help to teach the use of the keyboard and provide practice with basic search techniques. What is more the results produced by the "searcher" with this tool will be more like those of a real search than will the results of an emulation. For example, if a real search of ERIC produced 100 citations, a simulation would simply need to copy the 100 records it retrieved, not the whole database, since no real retrieval occurs. The concomitant disadvantage is the lack of flexibility of the simulation, since the commands and results are unalterable.

2.2.1 The Enterprise Milieu

Lockheed's Online Training and Practice (ONTAP) program is a collection of tutorials and emulations modelled on the DIALOG query system. This program originated at the ERIC Clearinghouse on Information Resources at Syracuse University; it was first intended as a practice tool to accompany a printed self-help manual. It provides a complete, if elementary, learning experience entirely online; it is currently online as part of DIALOG itself. ONTAP does not actually access the DIALOG system or any of its large databases, it operates instead on small subsets of selected, frequently searched databases, and these files are not updated by Lockheed. They are made available to all users at

a reduced training rate, currently \$15 per hour. The ONTAP files include sets of presearched queries of increasing complexity for which the user tries to create optimum search strategies. Recall and precision are measured to evaluate each search [Car, 81].

Practice in ordering documents from DIALOG is offered by the use of the .ORDER TRAIN and .ORDERITEM TRAIN commands. After issuing these commands the user can rehearse the procedures for placing orders both for documents identified in DIALOG searches and those identified by other means. These orders will not actually be placed. The combination of the ONTAP programs and the TRAIN commands provide practice for all online DIALOG features except saving searches and printing offline [Car, 81].

DIALOG with PET is the first of a series of programs developed by the Central Information Service of the University of London. The series is intended to teach various aspects of online searching using interactive simulation programs on the Commodore PET microcomputer. This program is intended for novices but should also be helpful for experienced searchers who need to review DIALOG's functions. The second program in the series, also available on a PET cassette teaches basic Boolean logic as it applies to search strategy. It is independent of any specific search

system [Car, 81].

The Congressional Research Service's Subject Control Oriented Retriever for Processing Information On-Line (SCORPIO) training was developed by Control Data Corporation for use exclusively with SCORPIO. The programs were developed using the PLATO software system and must be used with the special-purpose PLATO terminal. The lessons themselves reside in the CDC computers in Minneapolis and are linked to the users in Washington, D.C., via the CDC telecommunications network. The course runs six to seven hours and covers basic search techniques. After its initial offering in 1980 the system was evaluated on the basis of data gathered from 97 participants. 85% of the trainees who completed the course felt satisfied with the results of their practice searches. Similar positive results were produced in terms of content, acceptance, and user persistence.

The necessity of using the PLATO terminals tends to restrict access to this system and thus its usefulness. Learners are unable to take the course in the place where they will be working and on the equipment they will be using which, likewise, reduces its effectiveness. Furthermore, it is not possible to use this program as a reinforcement tool for experienced searchers again because the specialized terminals which must be used require reservation in advance

and, thus, are not readily available. In spite of these shortcomings, the Congressional Research Service has abandoned other types of training and turned exclusively to the SCORPIO online tutorial [Car, 81].

MEDLEARN is intended to teach the basic capabilities of the MEDLINE system to beginning searchers. It was developed jointly by George Washington University Medical Center and the National Library of Medicine (NLM). The programs reside on the NLM computer and are available to subscribers via TELENET, TYMNET or by direct dial-up. MEDLEARN is divided into three instructional levels: basic techniques, advanced methods, and new developments; these must be used in sequence. Each of the levels comprises two different presentations which are intended as alternative rather than sequential offerings. Thus, a trainee who does not understand the first presentation of a skill can get reinforcement without repetition. MEDLEARN is a simulation which allows practice in formulating and executing searches, and includes tests for comprehension and integration of knowledge [Car, 81].

In addition to providing stand-alone training, MEDLEARN is also the first step in the National Library of Medicine's training program for searchers. This is the most elaborate educational offering by either producers or processors

reported in the literature. From 1971 to 1976 this facility provided a three week course for users of the online MEDLINE system; even with this extensive investment of time, the information load proved to be too great a physical and psychological strain for the participants. For this reason, in 1977 the program was replaced with a five stage approach:

1. Preliminary training using MEDLEARN in the trainee's work environment,
2. Five day beginner's course offered by NLM instructors periodically at NLM headquarters, occasionally at other sites,
3. Three to six months of assigned readings and practice searches at the trainee's own location,
4. Five day advanced course at NLM, and
5. Annual updates, specialized workshops, and refresher courses held periodically throughout the year [Wan, 79].

The primary advantage of this type of training is that it is largely conducted in the user's familiar environment and on his equipment (see 1 and 3 above). In addition, the longer time span should allow a more thorough integration of skills at the same time it reduces stress on the trainee.

2.2.2 The Educational Milieu

We begin this section with a survey of reported

activities from Great Britain, where extensive efforts have been made in the area of education for interactive online retrieval.

Standard cassette recording devices can be used to provide online simulations simply by recording search sessions for playback through a terminal. The HP2645A intelligent terminal which has two cartridge units has been a popular host for these tapes. The Manchester University library school has produced a demonstration of searching the MARC database on the British Library Automated Information Service (BLAISE) using this equipment. Table 1 [Ted, 81] shows some of the online recorded searches developed and used by British schools with BLRDD funds.

School	Database(s)	System	Search Topic
Brighton	MARC	BLAISE	Library education in Britain
Wales	ERIC	DIALOG	Bilingual education in Wales
Manchester	MARC	BLAISE	Lead mining in Derbyshire
Sheffield	ERIC	DIALOG	Library education in Britain
	Social Scisearch	DIALOG	Items by M. F. Lynch
Sheffield	MARC	BLAISE	Miscellaneous

Table 1

BLRDD Funded Recorded Searches

It is often desirable to record a commentary to accompany such a recorded search but this entails the problem of synchronization. One solution to this problem is the Mediatron. This device is a specialized audio and digital training mechanism developed in England by Mellordata and the Central Information Service of the University of London under the sponsorship of the BLRDD. It has three separate record and play channels and uses ordinary cassette tapes. One channel records digital data, for example, a search dialogue, the second holds the commentary, and the third automatically controls a slide projector. The device can be used with a standard terminal for individual instruction or practice or hooked to one or more television monitors for group presentations. The three tracks can be recorded separately allowing the construction of the spoken explanation based on the recorded search. This multi-media system is used by British library schools at Loughborough, Ealing, and Brighton, among others; it is also employed by some libraries, for example the Bedfordshire County Library, as a training aid. This device has aroused considerable interest on the European continent where it has been used successfully as part of several training programs for search intermediaries [Ted, 81].

The College of Librarianship Wales (CLW) in Aberstwyth

has been teaching online searching since 1972. Over the years it has produced many teaching aids, the most recent product is a microcomputer-based Computer Aided Learning (CAL) package. The package includes a tutorial module to test knowledge and use of commands and a DIALOG emulation to allow searching of small databases. It was decided to implement this package on a microcomputer because:

1. They are relatively cheap, thus they can be purchased and controlled by a single department,
2. The programs tend to be more portable allowing widespread distribution of the programs and, consequently, lower cost per copy, and
3. Microcomputers are growing more elaborate with larger memories, multiple access capabilities, and other characteristics formerly restricted to large computers.

The tutorial module consists of eight sequential segments which are presented to the students after an introductory lecture on DIALOG commands. These segments are in the form of questionnaires, generally divided into six sections of two questions each. The first question of each section is multiple choice, the student indicates his choice of the available answers by typing the appropriate reference number (See Figure 1).

Type HELP if stuck

MULTICHOICE QUESTION

Which command would you use to enter
the ERIC database?

- 1 START ERIC
- 2 FILE 1
- 3 BEGIN ERIC
- 4 BEGIN 1
- 5 FILE ERIC

(ANSWER 1 OR 2 OR . . . UP to 5)

? 4

CORRECT

It is also possible to abbreviate to B
and/or eliminate the space between
command and file number.

Now press RETURN to continue.

Figure 1

CLW Multichoice Tutorial Sample

After each selection a brief explanation appears, whether the choice was correct or not; the second question is not presented until the first one has been answered properly. Question two refers to the same material as question one but makes the student use the command; abbreviations are accepted and spaces ignored as in the real DIALOG search service. Again a short response is presented with each answer, right or wrong (See Figure 2).

Type HELP if stuck

FREE CHOICE QUESTION

Now command DIALOG to enter the
Agricola database (file ten).

? B10

CORRECT

Abbreviating the command and eliminating
the space saves time.

Now press RETURN to continue.

Figure 2

CLW Free Choice Tutorial Sample

After three wrong answers the tutorial automatically displays HELP information dealing with the command being tested. This information may also be called up by the student at any time during the session.

These questionnaires are specifically intended to familiarize the students with DIALOG commands and the microcomputer keyboard in use. Once the tutorial questionnaires have been successfully completed, the student is ready to begin work on actual searching by using the emulation. The databases are small ERIC subsets on specific subjects, each 110 records long. The ERIC database was

chosen because it is in the public domain and its material is assumed to be of greater interest to the target group, librarians, than other available databases, since it is the database they are most likely to access during their professional lives. The implementation on a microcomputer necessarily limited the space available and forced some restrictions on record formatting so that the objective of exactly copying the ERIC fields had to be sacrificed. For example, only the first author is included and abstracts are limited to 255 characters. Still the product databases and the index files which accompany them enable students to carry out most DIALOG commands. It is possible to search specific fields for author, title, abstract, subject term, corporate source and publication year as well as language and identifier. For reasons of space, the online ERIC thesaurus has been omitted but the emulation does include full-text and proximity searching of the title and abstract, a rare circumstance in micro-based learning aids. The program also includes a simulated logon and logoff procedure to make the experience more realistic and meaningful.

The program can be used on the microcomputer itself, a Research Machines 380Z, or accessed from a separate terminal. This latter method has an additional advantage, the student can use the same terminal for the emulation as for a real

online DIALOG search. Response time is slow but the delay is not considered significant. The main drawback of the system is that the sets retrieved are unrealistically small; however, since there was never any intention to completely replace live searching, this inconsistency is tolerable. The point of this project was to ensure that students' time online be used to its maximum advantage by furnishing the opportunity to become familiar with search strategy and command language before actually accessing a large commercial service. Evaluation of this tool is not complete but the early results appear favorable [Lar, 83].

Another technique used by library schools in the United Kingdom is the creation and use of local databases to practice information retrieval skills. These systems generally reside on the local mainframe computer and are run through the school's computer center. Some of these are purely local packages, in which the record structure, vocabulary control, indexing policies, query language, etc. are unique, such as the Ealing and Newcastle implementations. Others use commercially available packages, for example, 3RIP and FAMULUS. Table 2 presents a survey of these systems [Ted, 81].

School	Search Package	Mode of Use	Database(s)
Aberdeen	IRSINT	online	DINDEX-3000 newspaper clippings on communications OIL-5400 newspaper clippings on North Sea Oil ARPAM-5500 pamphlets on architecture DOFILE-2500 clippings on domestic science INFARM-174 items on computers and pharmacy
Birmingham	FIND-2	online	Records input by students
Brighton	BIRP	batch/online	500 MARC records
Ealing	IR	online	100 items on information and education
Leeds	FAMULUS	batch	Records input by students
Liverpool	FIND-2	batch/online	Records input by students
Loughborough	SIMULATOR	online	40 items on librarianship
Manchester	FIND-2	batch/online	Records input by students
Newcastle	(unnamed)	online	1000 items on social work
Sheffield	FAMULUS	batch	Records input by students

Table 2

Local Databases at UK Library Schools

The final British offering to be examined here is perhaps the most challenging and promising of all. This is

the Schools Information Retrieval (SIR) package and it is designed, not for librarians but for secondary school students. The objective here is to teach basic principles to teenagers; the development was commissioned, as might be expected, by the BLRDD. This is not a simulation, emulation or pre-recorded search but a collection of programs to create databases, or edit existing ones, and an elementary search program to query the databases created.

Each record contains five fields: document number, title, author, bibliographic information, and keywords. The record length is limited to 472 characters, the document number may not exceed eight characters, other fields may be any length. Searching is allowed on the title, author, and keyword fields.

The search program uses an inverted file to access individual records; this file contains single terms only, so the search must be post-coordinated, that is, separate terms of a phrase must be searched individually and the results ANDed. Table 3 [Row, 82] shows the commands of the SIR search program and their meanings.

COMMAND	OPERATION
DISPLAY (term)	Searches the index file for the term. The term is numbered and listed with the number of times it occurs in the database and the field(s) in which it occurs.
FIND (term)	Does the same as DISPLAY but also creates a search set listing all the records containing the term.
FIND (term number)/OPERATION/(term number)	Creates a search set.
FIND (set number)/OPERATION/(set number)	Combines search sets.
SHOW	Displays records from the last search set on the screen.
SHOW Rm-Rn	Displays records m-n on screen.
PRINT	Outputs records to printer.
SHOW SEARCH	Reviews search sets and commands.
STOP	Erases current session, ready for new search.
SAVE - (search name)	Saves a search.
FINDSAVE - (search name)	Reruns a saved search.
END	Exits from the system.
HELP	Gives a summary of commands.

Table 3

Commands of the SIR Search Program

SIR serves a twofold purpose, it teaches skills such as search construction and Boolean manipulation of sets, which can be transferred to other IS&R systems and it increases use of school library resources.

The school libraries subscribe to journals such as New Scientist but find they are underutilized, perhaps this is because it is difficult to find out what each issue of a journal contains. Again, it is a relatively easy task to enter onto a database a record of each item in a journal as it is received. One school has undertaken this task for the journals History Today, Geography and National Geographical (sic) and has found the students' use of the journals has increased [Row, 82].

SIR is being tested in seven trial schools; preliminary reports indicate that it is a useful tool. Students have been able to master its techniques and it has been well received.

The first American product to be examined in this section is perhaps the the most widely reported learning aid for online bibliographic IS&R skills in the world, the TRAINER system. This project was originally developed at the University of Pittsburgh under a grant from the National Science Foundation. It was later extended in conjunction with the relocation and expansion of Pitt's Graduate School of Public and International Affairs (GSPIA). Development work is still in progress at Pitt but as each module is

completed, debugged, and tested, it is placed online at Carnegie-Mellon University. From Carnegie-Mellon, TRAINER is offered to members of the EDUNET network and thus is available for the training of many individuals at institutions of higher learning.

TRAINER offers support for learning both the DIALOG and ORBIT search processor systems. The DIALOG training section consists of eight tutorial modules and an emulator which comprises 500 entries. The emulator is used to practice the skills learned in each of the first seven modules. Practice for the advanced skills presented in module eight should be conducted on the real DIALOG. The TRAINER package is of special interest here both because of its educational orientation and because of the detailed research results reported by its creators. The most recent such information involves an update of the system which was completed in 1982. It was evaluated in May of that year using a group of fourteen graduate students at the GSPIA whose objective was the development of material for class research topics. Only one of the fourteen was unsuccessful, four candidates displayed specific deficiencies while the remaining nine were rated from competent to skilled [Car, et al, 83]. A more extensive evaluation was undertaken in the next academic year at which time two sections of a graduate research methods

course used TRAINER as a class requirement; 61 students were involved. Measurements reported are based on a fifteen minute per student session online to DIALOG, not the TRAINER emulator. Skills were rated from a high of 1 to a low of 6 and correlated with time spent online to TRAINER (See Table 4).

Skill Level	Number of Trainees	Average Hours on TRAINER
1	10	9.3
2	27	7.3
3	13	4.7
4	6	4.7
5	3	3.5
6	2	6.3

Table 4
TRAINER Skills by Online Time

The pattern displayed clearly shows competence as a function of training time for all but the lowest group. No reason has yet been discovered for this anomaly. Other analyses showed relationships for age (Table 5), typing skills (Table 6), and native language (Table 7). Tables 4 through 7 are adapted from [Car, et al, 83].

Age Group	Number of Trainees	Average Skill Level	Average Hours on TRAINER
40-49	9	1.8	10.9
25-39	34	2.6	6.3
18-25	18	2.9	4.4

Table 5
TRAINER Skills by Age Group

While Table 5 shows a positive correlation between trainee age and skill acquisition, it also shows longer hours spent online to reach this skill level.

Typing Skill	Number of Trainees	Average Skill Level	Average Hours on TRAINER
0	15	3.0	8.8
1	26	2.5	5.8
2	17	2.5	5.76
3	3	1.6	5.0

Table 6
TRAINER Skills by Typing Skills

Column one of Table 6 rates the typing skills of trainees from a low of 0, no skill, to a high of three, expert. This

rating correlates positively with the skill achieved by all groups and overrides the significance of online time.

Language Group	Number of Trainees	Average Skill Level	Average Hours on TRAINER
English	42	2.4	7.7
Non-English	19	2.7	8.0

Table 7

TRAINER Skills by Language Group

The differences between the two groups depicted in Table 7 do not indicate a clear relationship between native language and skill development. In fact, the individual who was rated most skilled was a native speaker of Japanese. Prior computer experience was also investigated but found to show no clear influence on skill development although the highest achievement was made by a person with previous training on LEXIS, a full-text legal IS&R system [Car, et al, 83].

The University of Pittsburgh is the site of another training project exclusively for librarians, On-Line Bibliographic and Information Systems: A Training Center for Librarians and Information Specialists, more simply, Online Training Center. Emulators of three search services, DIALOG, ORBIT, and BRS, have been developed at the University and

reside on a minicomputer at the Center. These emulators operate on samples of over sixty databases supplied by the search services. The creators claim a good success rate for their system [Bor, et al, 84].

The State University of New York (SUNY) at Albany is one of many United States schools which offers courses in searching online bibliographic IS&R systems to its library science students. This particular school has several unique solutions to the problems encountered in such offerings. First the faculty problem, SUNY uses adjunct faculty, experienced searchers from the university library, as teachers for these courses. This means that students have access to a proficient specialist who can answer practical questions immediately. The cost problem is ameliorated by providing online system coursework during intersession breaks. The terminal usage during these periods is low and the BRS subscription charge, which must be paid regardless of use, can be incorporated as part of the course overhead. This course does not aim to produce fully trained searchers so extensive online time is not considered essential [Wan, 79].

Some of the goals of the NASA/RECON project appear to be shared by a course offered at the University of California, Santa Barbara (UCSB). This course was designed and taught by

librarians at the Sciences-Engineering Library and focused on students in these disciplines. Participants were introduced to some of the basic ideas of computer searching, such as: vocabulary control, hierarchical thesauri, and index construction, in regular classroom meetings. They were also required to read pertinent sections of user manuals and similar tools from several search services.

Instruction in the search languages of the ORBIT, DIALOG, and BRS database vendors were handled in laboratory sessions separate from the class lectures. This was a labor intensive offering requiring considerable one-to-one work between the student and the teacher who was an experienced search intermediary.

The aim of this program was to introduce the students to online bibliographic searching, not to produce independent end users. In comparison with the current project, only the general subject area and target group are similar. The UCSB course provided no information about file structures, record formats, evaluation techniques, or other basic material found in the NASA/RECON course. The instructors were professional librarians not IS&R neophytes, nor is it possible to use this course at any other school since the only deliverable produced was a bibliography. However, the success of the UCSB offering indicates the great potential benefits to be

derived from teaching interactive online IS&R retrieval skills to end users. The course reinforced the traditional research skills of participating students, raised their collective consciousness of available resources, and even made the instructors aware of some errors in the indexing of the accessed databases. In short, both students and teachers benefited from the experience [Ant, et al, 78].

Caruso, Wanger, and Tedd have all written extensively about available resources and training aids for educating online users [Car, 81], [Wan, 78], [Ted, 81], but there is no report in the literature of a complete coordinated course for educating end users. In fact, the lack of such a package has been remarked by several authors. The NASA/RECON project at the University of Southwestern Louisiana seems to be the first to be targeted at filling this need [Dom, et al, 83].

3. CONCEPTUAL FRAMEWORK AND METHODOLOGY

The need to educate potential users in the techniques of retrieving material from large-scale bibliographic systems has been recognized and some attempts at filling this need have been described in the previous chapter. Schools share this responsibility with the information industry; the field deserves a place in the modern academic curriculum [Mea, 83]. This chapter describes the objectives and methodology of a project which has as its goal the teaching of such skills to large numbers of future scientists and engineers.

In December, 1983, the National Aeronautics and Space Administration (NASA) entered into a contractual agreement (NASA Contract Number NASW-3846) with the University of Southwestern Louisiana (USL) and Southern University (SU) for contracted research and development activities addressing the development, administration, and evaluation of a set of transportable, college-level courses to educate science and engineering students in the effective use of automated scientific and technical information storage and retrieval systems, and, in particular, in the use of the NASA/RECON system.

3.1 Research Objectives

In order to provide an overview of the objectives of the activities performed under NASA sponsorship, this section will highlight the major thrusts of contract activities. These objectives are as follows [Dom, et al, 83]:

1. The development of an educational program comprising a set of courses with varying depth of treatment on the principles and concepts of interactive information storage and retrieval systems and the specifics of effectively utilizing the NASA/RECON system. The course set includes:
 - A. 18 week full semester course,
 - B. 12 week full quarter course,
 - C. 6 week mini-course, and
 - D. 1-2 day intensive workshops.
2. The development of an educational program incorporating extensive hands-on interactive usage of NASA/RECON and other large-scale interactive information storage and retrieval systems.
3. The development of an educational program targeted at scientific and engineering disciplines; assumptions include instructors drawn from science and engineering faculties and students drawn from senior undergraduates in science and engineering.

4. The development of fully transportable course materials available for wide distribution to colleges and universities throughout the United States. The course material development philosophy is predicated on a set of system-independent, discipline-independent core materials, with hooks for incorporating system-specific modules and discipline-specific examples throughout. The course materials currently under development are:

- A. Course syllabi
- B. Lesson plans
- C. Visuals (Overhead transparencies)
- D. Homework assignments with answer keys
- E. Usage assignments with answer keys
- F. Instructor notes
- G. Additional support handouts
- H. Examinations with answer keys
- I. Bibliographies.

Additional course materials under consideration for development include textbook, workbook, and video tapes and films. Incorporation of these entries will depend on the final form of the courses and the evaluations of administering institutions [Gal, et al, 85].

The main focus of this document is the development of the course deliverables listed above. The concepts incorporated, the needs ascertained, and the methods followed are reported in detail. Later chapters describe future

aspects of the development of the educational program and allied research conducted by members of the contract team.

3.2 Critical Considerations

This section will address two critical aspects of the course deliverables, namely, standardization of course material documentation and modularity of the products. With respect to the issue of standardization, a set of standardized course material documentation templates ensured the standardization of all course deliverables. Templates have been developed and used for:

1. Course syllabi
2. Lesson plans
3. Visuals
4. Homework assignments
5. Homework assignment answer keys
6. Usage assignments
7. Usage assignment answer keys
8. Examinations
9. Examination answer keys.

Additional templates will be constructed as needed depending on the inclusion of subsequent entries in the course materials packages.

In light of the critical importance of course material transportability across educational institutions, and course material maintainability and extensibility over time,

modularity of all course materials was a primary consideration of the entire course development process. This modularity was achieved via application of the following basic development principles:

1. The topical area coverage associated with the course of longest duration, the 18 week full semester course, was defined first. The expectation is that successive removal of layers of detail from the most complex course will allow the generation of shorter simplified versions. Thus the six week course may be envisioned as embedded in the 18 week course and so on (See Figure 3).

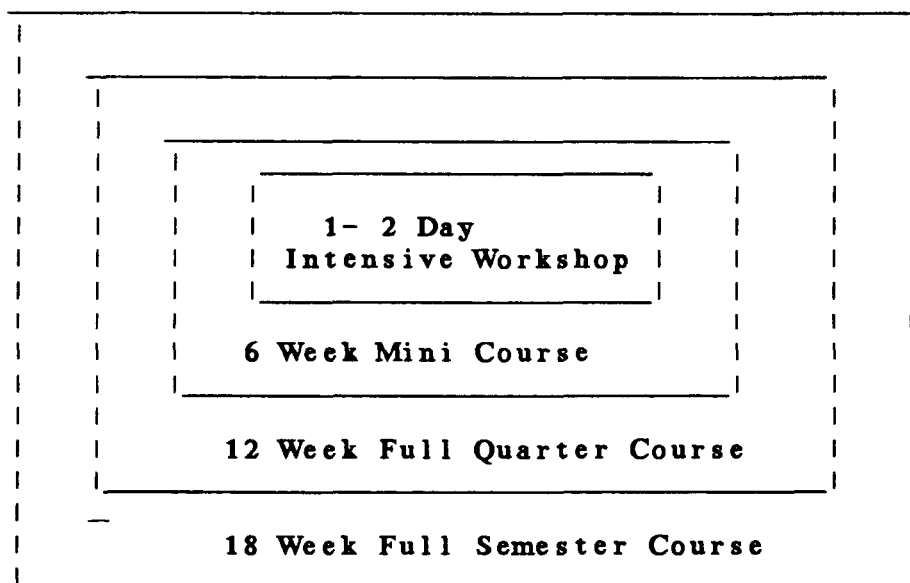


Figure 3

Development Plan for the Set of Four Courses

2. A conceptual, system-independent course syllabus structure was defined before addressing specific,

system-dependent course components. This approach has a number of highly desirable benefits:

- A. It clearly differentiates system-dependent portions of a course from system-independent portions.
- B. It ensures transportability of the system-independent portions of a course without any tailoring.
- C. It greatly facilitates modular development of the system-dependent portions of a course and will aid in the phased production of such materials.
- D. It encourages the development of system-dependent modules according to a consistent, standardized, and parallel set of development guidelines, both in terms of content and format.

These considerations should result in assuring the transportability of the course materials to any institution regardless of which information storage and retrieval system(s) that institution uses. These considerations will also improve the marketability of the final course deliverables.

3.3 Management Phases of the Research

In order to provide a coherent development plan for contract activities and assure proper delegation of responsibility for specific tasks, the entire project has been divided into the following stages:

- A. Needs analysis
- B. Course development
- C. Pilot course administration
- D. Pilot evaluation
- E. Development of distribution plan
- F. Implementation of distribution plan
- G. Conduct of regional seminars
- H. Conduct of on-site seminars
- I. Coordination of request processing and information dissemination
- J. Course state-of-the-art enhancements
- K. Institutional surveys and evaluations
- L. Surveys and evaluations by student participants who have graduated
- M. Periodic statistical summary reporting

Should contract participation be extended to additional systems, appropriate tailoring of this management plan will be performed.

The phases enumerated are not necessarily independent, and some activities may be conducted in parallel. Indeed, in the later phases, the separate activities will overlap both in concept and execution. For example, phases I and J deal with processing information requests and incorporating course enhancements, and it seems logical that some requests will indicate desirable course enhancements to the contract team.

It should be noted that although this list is complete,

it is at best skeletal. Each listed activity involves many smaller steps which will be detailed in later chapters of this thesis dealing with specific course development activities.

Determination of responsibility for deliverables development followed the plan used by the overall NASA/RECON project. The USL Tasks/Status document is the primary project management and control report in use at USL. This document indicates the assignment, monitoring, and management of each project task and sub-task associated with the NASA contract. This report includes a brief description of each task and lists the person(s) responsible for its accomplishment. Each entry also includes a task number, date identified, milestone date, completion date, and status indicator.

4. NEEDS ANALYSIS

The stated purpose of the Needs Analysis survey was to help establish the form and content of the first version of the Course Deliverables by means of input from the institutions which, it was hoped, would eventually use the course in their curricula. The survey was also intended to stimulate the interest of these potential participants and, implicitly, to gain recognition for the project and the universities involved.

4.1 Questionnaire Development

The questionnaire began with suggestions from all original USL participants; this was one of the first of the contract tasks to be undertaken. The suggestions submitted were first consolidated into subject areas and then evaluated to determine their pertinence to the project. Questions chosen were edited to avoid ambiguity and provide a form compatible with computerized analysis.

The questionnaire was divided into four subject areas:

1. General information about the institution,
2. Availability and use of IS&R systems at the school,
3. The need for such a course at the university, and
4. The preferred form of such a course.

A fifth section for comments was included. The full questionnaire is found in Appendix B of this document.

The Needs Analysis phase identified two hundred and thirty-seven target institutions, colleges and universities which offer concentrations in physical science and/or engineering. The list was provided by NASA.

The questionnaire was designed so that the responses would indicate specific information about the institution, its faculty, students, and resources, especially in the area of IS&R systems. More general information was sought in matters of curriculum content, research emphasis, and funding. Some questions required separate answers for the Engineering and Physical Sciences Departments.

A cover letter signed by a NASA representative, John Wilson, NASA contract monitor, as well as the principal investigators, Wayne D. Dominick of USL, and Leroy Roquemore of Southern University, was sent with the questionnaire as was an explanatory preface describing the project and the importance of the responses to the final outcome. The questionnaires were mailed in April, 1984.

4.2 Results Interpretation and Implications

Before the first responses arrived, the contract team began work on a set of programs to automate the process of analyzing the completed forms. First, a file was designed to

accommodate the raw data. A program was written to prompt data input and insert default, that is, null values, when information was omitted. Additional programs read data from the file and translated it into a form compatible with the SPSS statistical library programs which calculated the results of the survey. One hundred and sixty-one completed forms were received; a compilation of the responses to each question is found in Appendix C of this document.

The Needs Analysis survey provided basic information about the diffusion of computer and information resources on university campuses. One hundred and sixteen of the responding institutions reported some access to IS&R systems. The highest number of systems available was fifteen reported by only one school; the lowest, as might be expected, was one, reported by twenty-five schools; the average of the responders reporting any availability was 4.5 systems. The most commonly available system was DIALOG at eighty-eight institutions, next was BRS at fifty-six sites, followed by OCLC at fifty-four schools. Twenty-six schools reported locally developed in-house systems.

In light of the availability of these systems, it is appropriate to consider who is making use of them and to what purpose. 87% of the schools responding reported that systems were available to students for research; somewhat less,

68.7% made the systems available for coursework. Sixty-nine universities, representing 60% of the total responding, reported that these resources were available to the general student body and 35.7% allowed access by the public. Virtually all faculty members, 98.7%, had access to these facilities.

As to who actually conducts the searches, library personnel normally served as intermediaries on 94.8% of the campuses. Some schools (22.4%) allow faculty members to conduct searches; relatively few (8.6%) provide for students to access IS&R systems directly.

Since computing facilities and IS&R systems are widely available, there is no physical impediment to offering such a course. However, it was also necessary to determine the educational philosophies and attitudes of the target institutions. The various departments were queried regarding the importance attached to the research and computer usage skills of the students. The results showed that 86.8% of Engineering Departments considered computer usage Important or Very Important as opposed to 68.2% of Physical Science Departments. Research skills, on the other hand were emphasized by 59.7% of Physical Science Departments as Important or Very Important while 48.8% of Engineering Departments accorded such high ratings in this area.

Most responding institutions (86.4%) testified to an

interest in offering a course such as the one described herein but had several reservations. One hundred and six schools (81.5%) listed funding as an impediment to their participation. 69.2% were willing to consider course administration if they were first allowed to review the material. Other concerns included the provision of adequate training and support for instructors and the additional burden on students.

Responses to a question regarding the types of educational materials to be included in the course package revealed interest in a wide variety of proposed items. Preferences ranged from the high of 73.5% for a syllabus to 38.6% for Examinations. The indication is that a selection of interrelated materials which present, explain, and reinforce a concept would be a desirable means of instruction. Such a structure furnishes the teacher with a fully supported course enabling him to choose, on a day-to-day basis, which materials to use of the many provided. The results of the Needs Analysis survey strongly justify the plan for course construction as well as the research and development activities which will be discussed in a later chapter. On the whole, the schools surveyed indicated a strong interest in providing education for online IS&R system use if the course is properly supported and costs are reasonable.

5. COURSE DEVELOPMENT PHASE

The specific steps involved in developing the course materials are detailed in this Chapter. These include the assignment of precedence to tasks, the determination of development schedules, and the recognition of the relationships among objectives.

5.1 Overall Course Development

This section presents an overview of the educational activities which are part of the NASA contract and the relationships which exist among these activities. Specific details of the development of Course Deliverables are found in the next section.

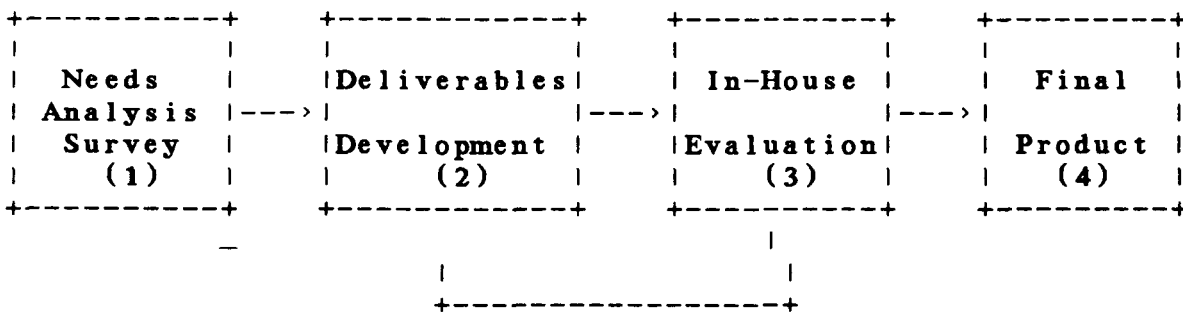


Figure 4
Overall Course Development Diagram

Overall Course Development Diagram Key

1. The Needs Analysis Survey provided indications of the types of institutions and students most likely to participate in the administration of the course. It helped identify needs in IS&R instruction as perceived by the responding university representatives, and therefore dictated the particular topics to be selected for emphasis and the level of material proper for the final product. It also furnished guidance as to the specific materials to be included in the deliverables packages. Finally, it showed which resources are available within the responding institutions. All this data helped the development team in its effort to produce not only a package of high quality, but one which is targeted to specific and diverse student populations.
2. The Deliverables Development block concerns the actual flow of tasks and sub-tasks which produce each version of course materials. It is examined in detail in Section 5.2.
3. In-House Evaluation was conducted on a regular basis at the end of each development period by some members of the team who were not directly involved in producing course materials. These individuals have contributed to

the project by assessing course sections for the following criteria:

- A. Completeness of coverage
- B. Appropriateness of level
- C. Adherence to standards
- D. Smoothness of presentation
- E. Coordination of all entries (Visuals, Lesson Plans, Homework, etc.)
- F. Intelligibility and value.

Continuous evaluation was also performed by the team responsible for the actual design and production of course material. This evaluation proceeded in an iterative fashion throughout each development period and, in addition to the previously cited criteria, assured proper:

- A. Selection of material
- B. Correctness of material
- C. Provision of supporting material

Note that the Deliverables Development block and the In-House Evaluation block form a loop which did not terminate until the deliverables under consideration were deemed acceptable according to all criteria appropriate to the development stage.

4. The Final Product block indicated the termination of the process described above but may not be assumed to mean that the task was complete, only that one development

period had successfully ended. Indeed, the course development process was intended to be continuous. The design of the course facilitates incorporation of state-of-the-art enhancements and additional systems participation, and will accommodate improvements suggested by participating institutions now that the full set of course entries is complete.

5.2 Course Deliverables Development

This section presents details of the development of specific course deliverables. Particular attention is given to the precedence relationships of the various package entries.

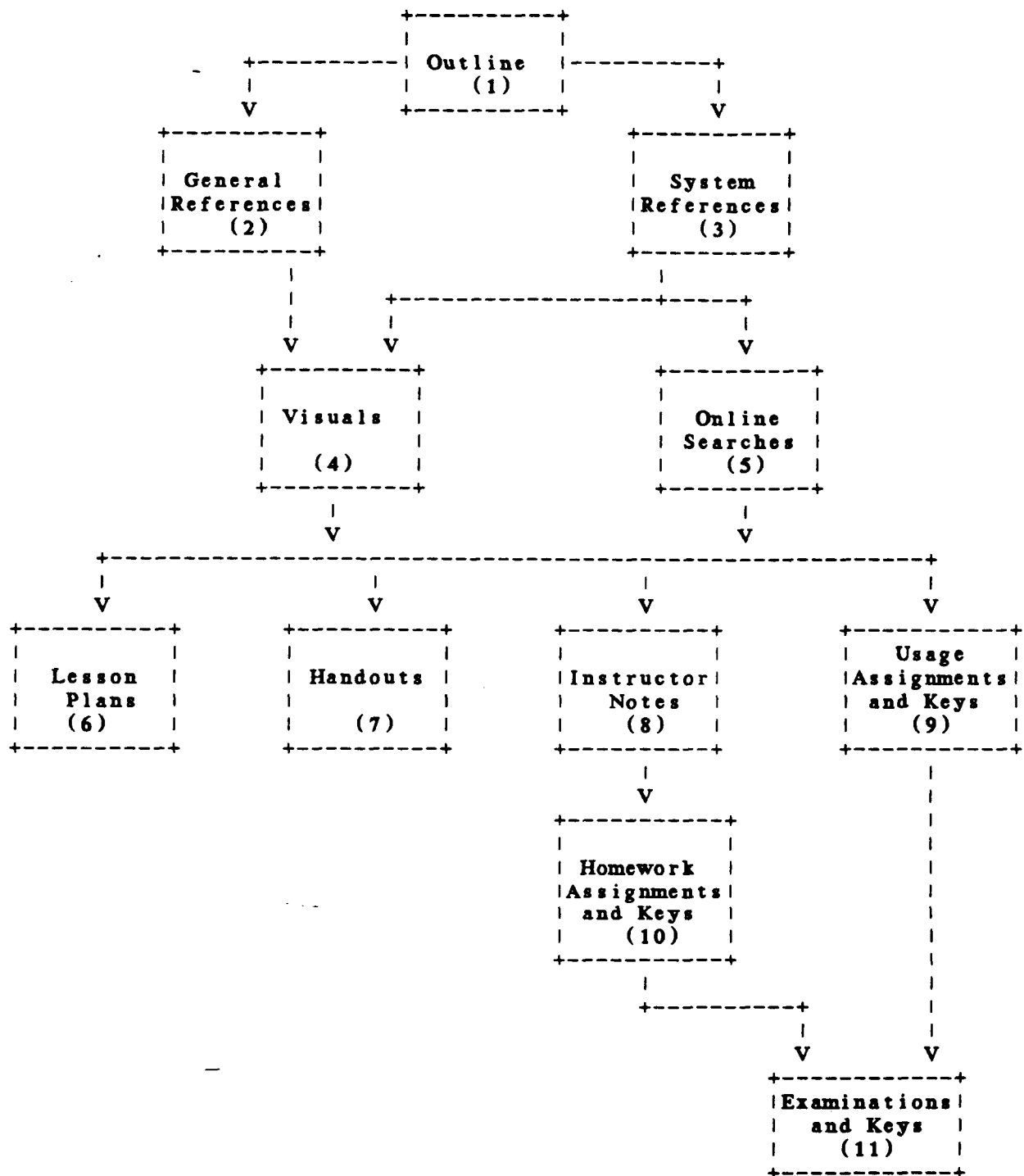


Figure 5

Deliverables Development Diagram

Deliverables Development Diagram Key

1. The Outline provided the starting point for all activity, it was also the basis for the course syllabus.
2. Books, articles, and other documentation on IS&R topics were consulted as a foundation for the universally applicable material in the transparencies and other course deliverables. The references used constitute the bibliography included with the course.
3. NASA/RECON System Manuals and materials were consulted to provide tailored material for presentation within appropriate lessons. These references were also used to formulate and conduct searches on the system involved.
4. The Visuals represent the heart of the material actually presented in the classroom. These are not fully developed as, for example a textbook, but consist of topically organized material, presented in a consistent manner according to clearly stated specifications.
5. Online searches were conducted as a prerequisite to the production of Usage Assignments and Keys, as well as Handouts of sample searches, sample output, etc. to support material presented in the Visuals.
6. The Lesson Plans are intended to indicate the thrust of each lesson, to provide a ready reference of materials needed and activities suggested for each class. Bookkeeping details are also managed as each Lesson Plan

specifies which assignments are to be distributed or collected at a given class period along with a notation of outstanding usage and homework assignments. In addition each Lesson Plan includes a list of suggested reading material which may be used by the teacher himself or passed along to the class.

7. Handouts in general consist of excerpts from NASA/RECON User's Manual, NASA Thesaurus, Vol. 1. Hierarchical Listing, and NASA Thesaurus, Vol. 2. Access Vocabulary as well as samples of searches and output which illustrate the behavior of various languages, systems, and output facilities. Additional handouts include material to support specific lessons.
8. Instructor Notes are Visuals expanded in an interlinear fashion with explanatory material, definitions, references, and so forth. The intention was to provide additional material for the teacher, probably inexperienced in IS&R.
9. Usage Assignments were designed to reinforce material presented in the classroom and to give practice to students in interaction with the NASA/RECON system. There are 5 such assignments and one goal of their development was to provide the broadest possible experience in the shortest possible time. It is recommended that emphasis be placed on proper preparation before these assignments are attempted

online, that is, students should consult the NASA/RECON User's Manual, and both volumes of the NASA Thesaurus to plan their searches. Questions about each assignment are included in order to provide reinforcement of the intended goals.

10. Homework Assignments were designed to stimulate students to thought, discussion, and study. Some questions in each assignment require straightforward repetition of material presented in class but many will necessitate the application of principles learned in the classroom and/or some research for additional information.

11. The Examinations were drawn from the Homework and Usage Assignments. For this reason the timing of the course allows the instructor to present solutions to all assignments before testing of the skills involved. The package is organized in such a way that the instructor has sufficient time to grade and return the material to the students before the examinations [Gal, et al, 85].

Work on developing the actual deliverables began in the Spring Semester of 1984. The Course Outline was the first package entry to be developed. A first version of the Course Visuals and Lesson Plans was also produced at this time.

The individuals responsible for the Lesson Plans developed a form to enable the efficient collection of information regarding each topical area of the Course Visuals. Data gathered included:

1. References used,
2. Estimated number of class periods required,
3. Supporting material required,
4. Possible test questions, etc.

This material was incorporated into the Lesson Plans after decisions were made by the team regarding scheduling of the topics covered.

The next iteration was performed in the Summer of 1984, at which time the Course Outline, Visuals, and Lesson Plans were more tightly coordinated and more fully developed. During this period, work began on other entries in the Course Deliverables package, specifically:

1. Homework assignments and answer keys,
2. Usage assignments and answer keys,
3. Instructor Notes,
4. Handouts, and
5. Examinations and answer keys.

The Instructor Notes are of special interest because they provide the support necessary for the presumably inexperienced teacher. This instrument is an extension of the Course Visuals collection. Each visual is matched with one or more pages of notes, the notes are entered on copies of the Visuals in an interlinear fashion. Instructor Notes comprise material to give additional substance to the Visuals; entries in the notes may be definitions, illustrations, comments, suggestions to stimulate discussion,

in short, anything which might aid the teacher's efforts.

Activity continued in the Fall Semester as entries in the Course Deliverables package neared completion. In particular, the system-specific Visuals for the NASA/RECON system were developed, bibliographic entries in the Lesson Plans were verified and standardized, and Homework and Examinations were completed.

A well-known standard for activities in education, Taxonomy of Educational Objectives edited by B. S. Bloom [Blo, 56], served as a guide for the Homework and Examination development process. According to this source, educational objectives can be divided into three domains:

1. Cognitive, which represents both remembering material learned and solving problems using ideas and methods previously learned,
2. Affective, which emphasizes an emotional reaction; values, interests, and attitudes fall into this category, and
3. Psychomotor, dealing with motor skills such as, handwriting or physical education.

The objectives for this course, as for most formally defined educational projects, are in the cognitive domain.

The cognitive domain contains six major classes:

1. Knowledge - the straightforward recall of appropriate material; this may mean specific data, methods, patterns, processes, or other information.

2. Comprehension - the lowest level of understanding; this implies the ability to use material without necessarily seeing its full implications.
3. Application - the use of abstractions in concrete situations; the abstractions may be general ideas and rules of procedure or technical principles and theories.
4. Analysis - the breakdown of information into its constituent elements; this level involves the clarification of ideas, making explicit the organization, basis, and arrangement of concepts.
5. Synthesis - putting together elements to form a whole; this involves incorporating pieces of information into a pattern or structure not previously present.
6. Evaluation - appraisal of the value of material for a given purpose; this covers both qualitative and quantitative judgements about the satisfaction of specific criteria [Blo, 56].

Each class of the domain must be tested separately in a clear manner; Bloom provides a list of verbs associated with each class to be used for constructing assignments and examinations (See Table 8).

Questions on the three lower levels should constitute 70% of the assigned items; the remaining levels, Analysis, Synthesis, and Evaluation, thus constitute 30% of the

measurement material. Because of the difficulty involved in learning on the higher levels, Bloom suggests that the time spent on this material should be 70% of total time, with the remaining 30% going to the lower level classes, Knowledge, Comprehension, and Application. All homework and examination material for the NASA/RECON Course has been completed according to these guidelines. Thus the course has a solid basis in educational theory.

Class	Objective	Verbs
KNOWLEDGE	Show that you know.	list, tell, define, identify, label, locate, recognize
COMPREHENSION	Show that you understand.	explain, illustrate, describe, summarize, interpret, expand, convert, measure
APPLICATION	Show that you can use what is learned.	demonstrate, apply, use, construct, solve, perform
ANALYSIS	Show that you perceive important points.	differentiate, debate, generalize, conclude, distinguish, determine
SYNTHESIS -	Show that you can combine concepts into an original idea.	create, design, plan, produce, compile, develop
EVALUATION	Show than you can judge ideas.	compare, decide, conclude, appraise, develop criteria

Table 8

Verbs for Objectives in the Cognitive Domain

The Homework and Examination material is ordered by a coding system. Each item has a two part decimal number which refers to the topic area on the Course Syllabus and an alphabetic indicator which shows the cognitive class being tested. The integer part of the number refers to the major section, the decimal part refers to the subheading under each main part. Thus the answer to a question coded 4.6(K) is in topic area 4, subsection 6, and the question tests the Knowledge level. This coding system allows the instructor to vary Examination items by substituting, directly or indirectly, Homework items which have the same code while preserving both the content covered and the domain class tested. To substitute directly the teacher simply replaces one item with another having the identical code. To substitute indirectly the teacher would replace several items with others whose combined codes are equal, for example, test questions 4.6(K), 5.3(AN), and 6.1(S) might be replaced by Homework questions coded 6.1(AN), 4.6(S), and 5.3(K). These substitutions preserve both the content areas (4.6, 5.3, and 6.1) and cognitive domain classes (knowledge, analysis, and synthesis). The only change is in the emphasis of individual items. Since the Homework assignments contain many more questions than the Examinations the flexibility of this system will enable instructors to conveniently generate new tests without sacrificing the foundation in educational theory of the original Examinations [Kne, 85].

6. COURSE DISTRIBUTION PHASE

This and the following two chapters present details of important future plans necessary for the full development and implementation of the NASA/RECON educational program.

Any institution which has a terminal, a modem, and a telephone can provide access to a remote IS&R system. Course materials have been constructed in a modular manner so that system-specific material can be incorporated without affecting the structure of the basic educational material. Thus, no matter which system is accessed by a school, the course package furnishes a complete basic instruction tool. Additionally, every attempt has been made to provide a broad supporting mechanism so that even a relatively naive instructor should be able to effect a full learning experience by exploring the material in the Course Deliverables package. Preparation time should be minimal since all necessary resources are included. Thus one of the prime development objectives, transportability, is achieved. This transportability will allow extensive distribution to many institutions throughout the country. The distribution phase can be divided into two parts: publicity and demonstration.

In the publicity phase the course will be offered to as many universities offering undergraduate degrees in physical science and engineering as possible. The intent of the course as well as the structure required to implement it successfully will be clearly explained to the potential participant universities at regional seminars organized and conducted by the research team.

The demonstration phase begins once the candidate institution has recognized the value and quality of the material, and expressed an interest in offering it. On-site seminars and training sessions will be held. During these meetings, instructors, assumed to be novices in regard to IS&R techniques and resources, will be presented with all the material necessary for the course. The whole package will be reviewed and all questions relevant to the course will be answered. The material presented at this demonstration will be the package to be used at the university concerned. Thus it must be tailored to the appropriate system and discipline(s) as well as the correct course configuration. It is important to the success of the course that these seminars be held on the campus where the course will be offered and, if possible, on the computers or terminals to be used for instruction. In this way the teachers can achieve

more familiarity with the techniques they will be presenting and confidence in their ability to handle the material successfully.

7. COURSE EVALUATION PHASE

Once the course development is complete, a continuous process of review will begin. These studies will govern all future activities associated with the project. There are three separate evaluations listed in the management phases of Chapter 3:

1. Evaluation following the Pilot Administration of the course,
2. Periodic evaluation by institutions offering the course, and
3. Evaluation by students who have completed the course and entered the job market.

These formal evaluations are in addition to the in-house processes already mentioned in Chapter 5 which relate to the development of the various components of the Course Deliverables package. The Pilot Evaluation will be the first and most critical of the three. This stage will involve the first conduct of the course which will be offered at the primary research institutions, USL and Southern University. Before this initial presentation is complete, an informal feedback process should be functioning based on the proximity of course instructors and course developers. This will facilitate any necessary adjustments and allow the rapid incorporation of suggested improvements.

For each of the three formal measurement studies it is necessary to develop an evaluation tool to determine, in the most objective way possible, the benefits and shortcomings of the course. Questionnaires to measure parameters of interest will be constructed. For example, with regard to student participation in the Pilot Administration of the course such parameters might include:

1. Number of students participating,
2. Hours online per student, and
3. Skill level achieved by students.

In addition to these measurements of direct interest, other indicators of effectiveness are out of class application of skills learned and student recommendations. Although students are the ultimate targets of education, the teacher in this case also provides important input to the evaluation process. This is especially true since the course is designed for administration by an instructor who is a novice with respect to IS&R systems. The parameters of interest are more subjective and difficult to determine; they include:

1. Completeness of material,
2. Clarity of material,
3. Appropriateness of discipline-specific examples, and
4. Hours per class preparation time.

Since the number of instructors will be small, the debriefing

associated with this activity may be conducted in an informal but still rigorous manner.

The first draft of a questionnaire measuring student reaction to the course has been drawn up and will be subject to the same process of iterative refinement as was described earlier for the Needs Analysis Questionnaire. The results of this survey and the related input from instructors will be used to determine desirable adjustments in the course content and presentation.

The user satisfaction will be periodically checked by surveys of institutions offering the course. This will enable the research team to follow up on the user's stated needs, facilitating enhancements, changes and updates. The coordination of request processing and information dissemination is a separate activity which requires the formation of a team to receive, analyze, and answer all questions relating to the course. Explanations will be given, changes will be made as needed, and when questions are of general-interest, the answer will be broadcast to all offering universities.

The last planned evaluation will involve the polling of graduated students who have participated in the course offering. These reviews will ascertain the value of the course on the job and furnish suggestions for improvements

from the trenches.

The final step in the management plan provides for periodic statistical reporting to both course sponsors and participating universities. Data will be collected concerning the number of participating institutions and students, frequency of course offerings, course configurations at various institutions, online system usage, grades, effect on employability, and other parameters of interest. This data will be analyzed, summarized, and interpreted and finally reported back to all interested parties as part of the continuing evaluation of the project.

8. EXTENSIONS AND ENHANCEMENTS

The advantages of modular design for such a course are numerous. Individual requirements can be met, while conserving a consistent overall structure. Equally important, such a design allows constant revisions and updates, as well as inclusion of new systems and additional discipline-specific material.

8.1 Additional Systems

This course was originally designed for prospective NASA/RECON users. However, it rapidly became clear that students would benefit from exposure to other commercial and governmental systems. Thus, the participation of other systems, such as DIALOG, DOE/RECON, and EPA/CSIN will be solicited. The course includes multiple "hooks" allowing easy insertion of specific material, as well as extensive examples.

Each system included in a package will offer to the students different searching methods and access to different databases. Time online on every system being studied will be provided to all students attending the course. Figure 6 shows the system specific material to be incorporated into the course.

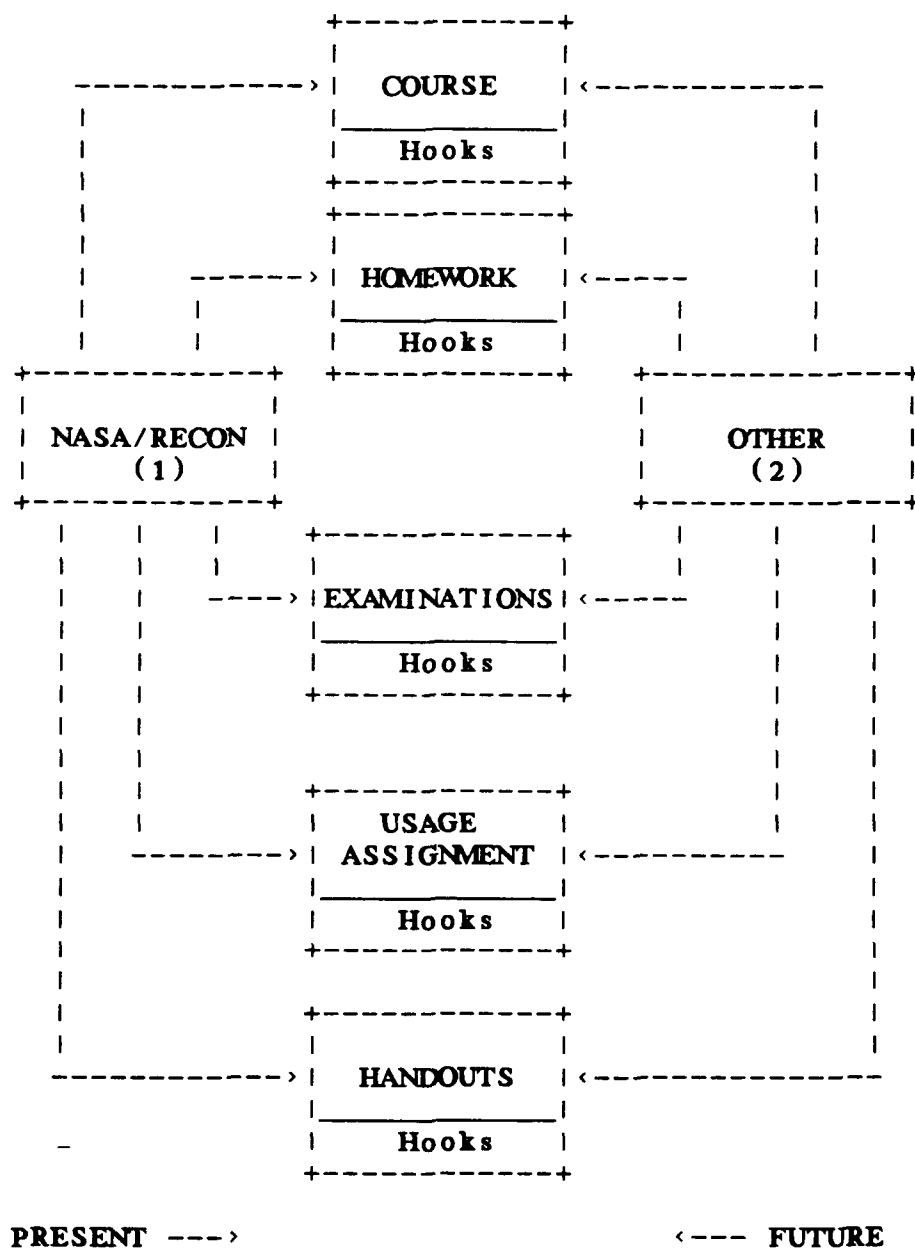


Figure 6
System Incorporation Diagram

System Incorporation Diagram Key

1. NASA/RECON is the source of all the system specific material included in the course at present. This refers to online modules such as sample searches, usage assignments and report generation examples, as well as offline modules such as excerpts from NASA/RECON User's Manual, and NASA Thesaurus. This material has been generated in part from documentation obtained from NASA and also from interactive sessions conducted by team members.
2. Future contract participants' modules will, likewise, be constructed from documentation and printouts of interactive search sessions as shown in the accompanying diagram. Such material is essential to all course deliverables with the exception of the syllabi which have been designed to be completely system independent.

8.2 Additional Disciplines

It may be noted here that discipline specific material, intended to provide motivation for students through the inclusion of examples: thesaurus entries, search subjects, reference documents, etc., will be generated by the research team according to the students' area of interest. It is the intention of the development team at present to develop two

sets of intersubstitutable material, one for engineers and one for physical science majors. The diagram presented for System Incorporation, Figure 6 above, also represents the means of incorporating these discipline specific modules.

Other disciplines provide fertile ground for course presentation, particularly research oriented fields, such as History and English, and those which value current material, for example, Political Science and Journalism. Material aimed at students in these areas can be generated and incorporated simply by the creation of modules for the field in question. The number and location of the necessary modules is indicated by the "hooks" in the original course package. The new modules will contain the same type of examples and demonstrations as those currently in place but with appropriate substitutions of terminology and references.

8.3 Maintenance Activities

Since the main objective of this course is to educate and train students in the art of effective searching, it is very important for the course to offer state-of-the-art information. The design of this course makes such modifications and updates easy operations. For example, the inclusion of new systems, new examples, the revision of usage assignments and changes in questions for examinations will

only be a matter of updating "hooks."

It is also recognized that the needs of universities and the facilities offered by IS&R systems will change in years to come. The course will have to be revised as needed, thus the ease of modification is doubly valuable.

9. PERSONAL COMPUTER R&D CONTRIBUTIONS

The material presented in this chapter was developed as part of the total NASA/RECON contract activity. It is separate from the educational program development which is the main focus of this thesis but intimately related by its goals and sponsorship.

Microcomputers have already been introduced in an earlier chapter of this document as hosts for some of the simulators and emulators which aid in training potential IS&R system users. Personal computers may be considered a subset of this group. For the purpose of this presentation, a personal computer (PC) is simply a single user system. Such a computer is not multiprogrammed but the speed and magnitude of recent increases in the computing power and memory size of machines of this class prevent the assignment of other traditional limitations to the category. The decreasing cost and increasing capability of personal computers have made these machines a potentially effective tool for satisfying the information processing needs of many scientists and engineers. The NASA/PC R&D project was initiated, as an extension of the NASA/RECON project at the University of Southwestern Louisiana, to develop PC-based systems that

support the usage of Information Storage and Retrieval (IS&R) systems in integrated scientific and engineering environments [Dom, 84].

The major goals of this project are to establish a robust PC research and development environment, to develop PC-based support tools for use in the education of scientists and engineers to access online IS&R systems, and to develop PC-based systems to support the interaction of scientists and engineers with local, distributed, and remote information resources.

9.1 The Research and Development Environment

Establishing an effective R&D environment involves the initiation of means to:

1. Identify and evaluate possible R&D tasks. Candidate tasks may be extensions of previous research, explorations of new concepts, or subjects of individual interest. A task is evaluated to determine if it is appropriate to the overall goals of the PC R&D project and to determine its feasibility. A task is feasible if it can be accomplished on available PC hardware, by using available software tools, and by employing available personnel. All such tasks are subject to budget considerations.

2. Facilitate the acquisition of appropriate equipment and software tools. Commercially available PC hardware and software are subject to evaluation for possible incorporation into development efforts. The results of this evaluation mechanism are then catalogued for future reference in feasibility decisions. An evaluation of funding possibilities may be initiated at this time if equipment, software, or additional personnel are needed for a development effort.
3. Establish specifications and procedures for the development of chosen tasks. Specifications are formulated for tasks which are judged to be feasible. These specifications form the primary criteria for evaluating the progress and the results of the task development effort. Development procedures are also defined including programming standards, evaluation methods, and implementation tolerances.
4. Review the progress and results of development efforts. Development tasks are regularly reviewed in terms of progress, result quality, and conformity to the specifications. This is particularly important since many of the tools developed under this project are to be used in a highly integrated workstation

environment.

These activities should be highly objective and as far as possible independent of the actual development efforts. R&D tasks currently being pursued include:

1. Development of a PC-based IS&R emulator for training users in the skills needed to query bibliographic IS&R systems [Tri, 84],
2. Development of a PC-based presentation development system [Mor, 84], and
3. Development of a prototype workstation as a test bed for integrated workstation research, and development of systems to support user access to remote and distributed information resources [Chu, 84].

9.2 Educational Support

As previously discussed, personal computers offer great potential for the development of interactive learning environments. The use of PCs for the implementation of online training aids, simulators and emulators, enhances the learning process and results in a substantial saving in cost and time as compared to more conventional methods. These machines can provide support for education beyond this obvious application, for example, by the use of color graphics to help students visualize complex phenomena [Hir, 81].

These tools will complement the university-level course development effort which is the primary focus of the NASA/RECON contract. Current tasks include the development of a NASA/RECON emulator and an Interactive Presentation Development System (IPDS). The emulator will allow course participants to practice on a local system which is identical to NASA/RECON in all important aspects and will thus result in a substantial cost savings as compared to the alternative of expending high-priced system access time and costly long distance telephone and communications network access charges for this necessary learning activity. The development effort also includes the specification of a generator which will allow the automatic creation of emulators of other systems. IPDS will be utilized to develop easily transportable and extremely flexible visuals for the training courses. This tool has wide application possibilities beyond this single course offering.

9.2.1 The NASA/RECON Emulator

Information system simulation in general provides several advantages during system training. It allows extensive use of the system without the typically high cost overhead of accessing large, remote systems and also can provide a better user interface including more user assistance. This means less cost for the end user and faster

and more efficient training, resulting in increased user productivity.

In the design of the NASA/RECON emulator, the main motive has been the development of an emulator as an educational tool to allow instruction without paying the high cost of long distance telephone charges, TELENET charges, and online host system charges. Computer Aided Instruction (CAI) can easily be embedded in the implementation so that teaching a potential user can be highly automated and thus simplified. This tool has a significant impact on both the host system and the user. The host system itself can be used for information retrieval only, without the overhead associated with training and education of new users. The student, meanwhile, gets training time at his own level, at any time or place, and for extended periods without the cost of host online connect and access time.

In emulating an information system as large and as powerful as the NASA/RECON system, the first priority is to decide on the features which should be included as well as the features to be excluded, if any. This means not only original system features that are duplicated or simulated on the personal computer, but also additional features that the emulator provides in order to enhance its functionality as an educational tool. In cases where a program operating on one

system is to be simulated on another, it is obvious that the techniques applied in the original implementation may not be applicable to implementation of the model. A careful design, that takes into consideration both the facilities available in the host environment and the capabilities of the emulator environment is necessary to ensure the quality and high performance of the final product in the educational process.

The development of the NASA/RECON PC-based emulator is still in the design stage. The functions of the original NASA/RECON system that are to be included have been chosen. The appropriate algorithms and data structures to be used for implementation of the major components have also been defined. The emulator will be implemented in the "C" programming language and a commercially available file management program, Indexed Sequential Access Method (ISAM), will be utilized to perform all database management functions. The design will be implemented on an IBM PC/XT which uses the PC/DOS operating system. It will occupy approximately 365 Kbytes on two double-sided, double-density diskettes. It is the intention of the designers that the system developed be compatible with virtually any personal computer that has the language capabilities mentioned, since a primary consideration of the entire USL NASA/RECON project is the transportability of all materials developed [Tri, 84].

As the future expansion of the project introduces new systems into the contract, individual emulators will be needed, but a separate design of each system would seem inefficient in terms of development time and effort. As a future project objective, an information system emulator generator, retargetable at any IS&R system, is a solution which is being explored. Parameterization of various IS&R systems using an emulator generator can have a large impact on the educational project, since new features of existing systems as well as new systems may be added and presented in the most efficient manner.

9.2.2 Interactive Presentation Development System

The second of the currently active development tasks in the educational PC R&D support area is the Interactive Presentation Development System (IPDS). This system was designed to provide an interactive means of creating, editing, and controlling a video presentation. IPDS can be quickly and effectively employed by users with little or no computer experience. Additionally, the system runs on almost any IBM compatible PC, thus ensuring high transportability of this product. IPDS has been implemented and tested on the IBM PC/XT. The system is currently available to the USL faculty for instructional use in conjunction with video projection systems.

Individual display frames are created on a personal computer using very simple IPDS key sequences. The frames may include text along with a variety of geometric patterns. Background, border and character colors can be changed for emphasis with a single keystroke. Primitives for easily creating boxes and bar graphs are provided, circular figures are also available. Once the display is in final form, it can be saved in a named file. Display file names can be organized into a script sequence using any text editor. A script is a file containing a sequence of display file names to be used in a presentation. Users may step through the sequence forward or backward and may make use of four screen buffers to store displays for quick reference or reinforcement. Displays may be edited or created during the presentation to answer questions, emphasize points, or post assignments. The cursor keys permit flexible positioning of the cursor anywhere on the screen. A selection of cursor pointers is available and the cursor may be moved non-destructively across the screen to draw attention to specific areas of a display.

In contrast to traditional instructional preparation using overhead transparencies, IPDS allows users to easily create, edit, transport, and control video presentations without the difficulty of manually manipulating a stack of

transparencies. The entire process can be carried out at a user's desk or workstation with no delay for additional processing. The advantages of this system are many but for the purpose of the NASA/RECON course, it is sufficient to point out that 490 overhead transparencies can be stored on a single diskette [Mor, 84].

9.3 Workstation Support

The integrated workstation support effort of the PC R&D Project addresses the development of PC-based support for accessing local, distributed, and remote IS&R resources. This involves the specification of such a workstation and development of a prototype workstation as an experimental environment. It will also mean the development of a common user interface to provide transparent access to resources in the workstation environment. The first task in this process is to develop a general statistical analysis package as a testbed for integration of commercial and prototype software. The statistical package will be combined with other components to form a total environment for scientific/engineering processing. Data analysis of information downloaded from remote sources or produced locally is feasible without using mainframe processing time. Numerical processing and applications using statistical/mathematical functions can use the statistical

library, thus reducing development time. Finally the common user interface will supply the necessary functions without complicated programming.

The research effort aimed at design and implementation of a common user interface to all available resources is composed of three distinct development tasks:

1. Interface to local operating system resources,
2. Interface to distributed network resources, and
3. Interface to remote information system resources.

The results of these tasks will be integrated into a common system to provide the user with the capability of accessing all of these resources in a consistent manner.

Local support involves interaction with the local operating system and locally resident software tools. This interaction is composed of the translation of information into a common format for manipulation by the common user interface and the translation of information into representations appropriate for use by local tools. This implies that the common user interface has access to descriptions of information formats appropriate to each of these tools. The interface will therefore possess the ability to incorporate new tools by simply requiring the user to describe the information format of the candidate systems.

Distributed support will give the user transparent

access to resources available from both local and remote facilities. It will provide a robust personal computer workstation environment with a comprehensive set of tools as functional components to serve as a scientist's/engineer's R&D workbench. It will also provide distributed/networked workstation communication and uploading/downloading protocols between workstation and remote mainframes as well as between workstations, thus providing access to a full spectrum of local and remote data management systems.

The remote support environment is the aspect of the workstation most closely associated with the primary project objective, increasing the use of remote, large bibliographic IS&R systems. Most scientists and engineers who access information systems fit into the category of the casual user. These individuals need the information stored in remote information storage and retrieval systems but do not have the time or inclination to learn the query languages necessary to access such systems and satisfy their information needs. This is particularly true when access to multiple systems with different command languages and manipulation procedures is required. Simply gaining access to such systems can be an aggravating impediment to these individuals. One solution, as previously described, has been the utilization of search intermediaries who are familiar with a certain system to

extract the needed information. This solution, however, does not allow the utilization of the end user's considerable knowledge of the subject to dynamically enhance the search process unless the user is present during the actual search.

A more promising alternative is the utilization of a locally implemented interface to facilitate access by infrequent users. Some such interfaces have been implemented on "smart" terminals which have dynamically programmable function keys which can be modified by the system to allow their utilization to perform some access commands. These terminals are, however, limited in their capacity to access multiple systems. Another possibility is the use of a software interface to guide the user in executing a query without the necessity of learning each system-specific language. Such software systems as CONIT and IIDA have tried this approach [Car, 81]. This project proposes to combine and extend these two solutions to provide a truly flexible interface with the capability of incorporating a wide range of systems as well as performing any desired local processing of information. The increasing performance/cost ratio of personal computers and their general availability in scientific and engineering environments has made them an attractive choice for the implementation of such an interface [Hal, 84].

The foundation of support for processing user requests in a remote environment is a communications system which handles access to these environments and transfer of information between environments in a manner which is transparent to the end user. The communications system being designed as part of this task will allow the user to access a number of remote systems and will allow the incorporation of new systems by the input of system access information at the workstation interface level [Chum, et al, 85].

User access to information stored in remote environments will be provided through a multi-level interface which allows the user to progress from a prompting-oriented interaction, such as that provided by IIDA, which guides the user through the steps necessary to retrieve his information, to an independent user mode which will provide maximum flexibility and as little interference as possible. Meadow has pointed out that the intelligent user will make the necessary effort to progress from the ease of use embodied in the early levels of such a system to the more complex but powerful levels because this power facilitates the solution of more difficult problems and the accomplishment of a larger volume of work in an expeditious manner [Mea, 83]. The interface will also provide efficient methods of handling the downloading and uploading of information. A software scheme will be provided

to translate all downloaded information of a similar nature into a common format. Thus local display will have consistency in the representation of information regardless of the source.

The interface will make maximum use of the display capabilities of the personal computer by the incorporation of windowing, color graphics and various interactive devices. These capabilities will be utilized to develop a screen environment which provides the user with a pleasant, functional, and informative representation of the system state.

The provision of facilities for the collection of monitor information for evaluation purposes is also planned. This information is intended to be used for evaluation of the system itself as well as for the evaluation of usage patterns in a production environment for administrative purposes.

The design of this system will be modular in nature to allow the ease of incorporation of additional systems. This will also allow the future incorporation of new PC-based tools into the processing environment as they become available. The application of search enhancement facilities based on knowledge-base techniques is one area which is being carefully considered for implementation when the proper development tools are available.

10. FUTURE ISSUES

10.1 IS&R System Developments

There are two questions to be considered in contemplating the future of IS&R systems, the first is quantitative, the second qualitative. The quantitative question can be handled with dispatch, IS&R systems will continue to grow both in size and number; this is not disputed in any authoritative literature. The decreased cost of online storage, the increased number of publications available in computer-readable form, advances in the generation of indices and abstracts by computerized techniques, improved computer communications, the wide availability of inexpensive hardware, and many other factors we see at work everyday make this growth inevitable. What is more, this quantitative expansion will apply to virtually all types of databases, not just the bibliographic class which is the focus of this paper but also numerical databases for statistical information and representational facilities which store graphical displays [Wil, 78].

The existence of these resources will continue to exert pressure on end users to gain access to this material and will result in two responses. In the short term, projects such as the one described here will educate more people in

online search skills and broaden the clientele of search processors. In the long term, interfaces which are really intelligent assistance programs will be developed to determine what the user wants and compose a proper query for the appropriate search service and database [Mea, 83].

The number of searches conducted, especially by end users will also expand. New indexing practices will be introduced to tailor the information in the databases to the needs of the patron. One of the reasons that online systems are not more widely used now is that indexing is by subject, the name of something. In some technical fields such indexing is inadequate because the user seeking a new solution to his problem may not know the name of the device he needs; what he does know is the function it must fulfill. Thus, indexing by function or attribute will lead an engineer, architect, or other designer to the tool or process which fills his requirements [Bre, 81].

The qualitative changes of the future will be much more far-reaching. The real aim of information retrieval is knowledge, the answer to a question or the solution to a problem. Few researchers are actually interested in reading reference material. In this regard, the bibliographic IS&R systems of today are woefully inadequate. What they retrieve are simply references to publications. The end user must

still:

1. Locate the document referenced,
2. Secure a copy of the document,
3. Study the material in the source document, and
4. Assimilate the pertinent information in the form of knowledge.

Some systems already provide assistance with steps 1 and 2 but little progress has been made to date on the tasks of study and assimilation. At a minimum, the future will see artificial intelligence processes applied to the material retrieved by a database search to produce facts rather than references. Compilation of references is the first step. Abstracts can be scanned for keyword in context listings of sentences or arranged in order of relevance to the query [Wil, 85]. Experiments with this technique have been in progress for some time.

A related area of development is reported by Hampel and his colleagues at Lawrence Livermore National Laboratory (LLNL) [Ham, et al, 85]. Technology Information System (TIS) is an Intelligent Gateway Processor capable of connecting heterogeneous information resources at widely separated locations. It is being developed at LLNL under the joint sponsorship of DOE/OSTI, DOD/DTIC, and NASA/TUA and several other federal agencies. The computers being evaluated at

LLNL are super-mini and super-micro machines connected by a local Ethernet system.

This project provides an interface to remote systems which can be shared in a practical manner. The resources supplied would be too expensive and cumbersome to be cost effective for a single user. The TIS processor places virtually unlimited power at the individual workstation by storing the location and utilization of diverse, scattered resources in the gateway software which is linked to the network.

Besides access to remote IS&R systems, this shared processor provides post-processing tools which can manipulate and reorganize downloaded files to make the information retrieved more intelligible to the user. Table 9 [Ham, et al, 85] shows these TIS routines and their functions.

ROUTINE	FUNCTION
TRANSLATE	Rearranges a citation into a standard format.
MERGE	Forms previously translated files from different sources into one local file.
STAT	Generates a statistical profile of citations.
ANALYZE	Furnishes bibliographic text analysis.
REVIEW	Allows online evaluation of citations.
CONCORD	Creates indices.
PERMUTE	Provides statistical analysis of text in selected fields.
CROSS	Correlates contents of data fields.
PLOT	Graphs number of citations by year.
DISPLAY	Prints contents of file on screen.

Table 9

TIS Bibliographic Post-Processing Routines

Routines are also available for performing mathematical operations on numeric data. These are intended as supplements to standard statistical management packages. The authors report that, "The most significant contribution to

data manipulation on TIS is probably the option given to users to establish their own command language" [Ham, et al, 85]. This facility provides the opportunity for users to build their own tailored post processing programs which can be stored for later use, discarded, or changed as needed. The powerful tools under development at LLNL are precursors of the systems that will deliver knowledge, not references, from IS&R systems in years to come.

10.2 The NASA/RECON Project

This section comprises both short term, i.e. one year or less, and long term goals of the USL NASA/RECON project. The spring semester of 1985 should see several contract phases occur in parallel. The definition of the 12 week full quarter course, the 6 week mini-course, and the intensive workshop configurations will be undertaken as extensions of the course development activities. The entire project has been planned to facilitate this operation.

Pilot course administration should go into effect at the contracting institutions as soon as logistical problems and bureaucratic barriers can be overcome. The design and construction of evaluation tools has begun and will be completed concurrently with the preliminary course offering, so that Pilot Evaluation can be formally conducted as soon as possible after the Pilot Administration of the course.

It is expected that the distribution plan development will also be undertaken shortly. Using the Needs Analysis survey results as a source, a plan will be devised to appeal to potential participants based on their own stated needs and priorities. The results of the Pilot Administration and Evaluation phases will contribute to the refinement of this plan so that it can be ready for implementation as soon as the Pilot phases are complete. Once the course preparation is accomplished and the material has been tried and evaluated by the primary participating institutions, more remote future plans must be established.

The incorporation of search processors other than NASA/RECON as participants in the course development project is a high priority activity for a variety of reasons. Most end users will have access to commercially available, rather than government sponsored, search systems, which would make training with DIALOG or ORBIT more inherently valuable. In addition, each system has unique capabilities, such as the DIALOG SUPERSELECT command and the NASA/RECON user created formatting feature, which must be studied and practiced individually to produce maximum benefits. Likewise each system has specific limitations to be recognized and understood if the searcher is to achieve the best results. One example is the Department of Energy DOE/RECON system

which contrasts with others in that it allows string searching only on previously constructed sets by use of the LOOK command. Various agencies also emphasize specific interests when constructing their databases and search systems, as might easily be seen by scanning a representative list: World Affairs Report, Coffeeline, Historical Abstracts, Exceptional Child Education Resources, and Book Review Index, to name a few.

The best reason for soliciting the participation of additional search processors, however, is the structure of the course itself. It has been built in a modular manner with the intention of allowing additions, deletions, and alterations in a speedy, efficient fashion.

Pursuant to these goals, a proposal has been drafted aimed at additional search processors. This document will be tailored to each potential sponsor indicating the benefits which would accrue to participating agencies. In addition to the obvious advantage of more trained searchers as possible users, these advantages include the creation of system-specific emulators as a by-product of the project and the high visibility of participants on college campuses before the leaders of tomorrow.

The foregoing discussion leads naturally to the idea of incorporating material from other subject areas into the

course. The disciplines emphasized at this time are engineering and physical science because these are the areas of interest to the original sponsoring agency. As other sponsors are added, examples and other supporting material aimed at their target groups will be generated and included in the course. Thus, extending the course to additional disciplines is a joint function and decision of the funding agencies and the USL research team.

A project such as this benefits no one unless it is used; in this case, use means presentation of the materials to appropriate university students. To achieve this end, the course must first be publicized and then sold to potential customer schools. The research team will accomplish this by holding demonstrations to present the material as described previously in Chapter 6.

User's reactions and comments will necessitate some revisions, beginning with the Pilot Administration and continuing for as long as the course material is in use. It is traditional in education for teachers to adapt material from a variety of sources: textbooks, workbooks, film libraries, supplemental readings, and so forth, to their individual needs and styles. One objective of this course is to provide the teacher with a wealth of material, both basic and supplementary to save this time and trouble. A

collateral goal is to maintain contact with instructors and students to learn which materials in the course package are most useful, easy to handle, and beneficial, as well as which entries need work to make them better resources. Thus participants will be periodically given the opportunity to evaluate the course materials so that the research team may strengthen the deliverables. Teachers will also be encouraged to contact the team members responsible for course enhancements and extensions to suggest desirable improvements whenever such suggestions seem appropriate. Such communication may also lead to the development of entirely new entries in the course deliverables package.

11. SUMMARY

This thesis recounts the development of a set of courses designed to present engineering and science students with the concepts of IS&R systems and the skills necessary to use them profitably. The research and development described has been sponsored by NASA with the intention of providing a multidisciplinary program for teaching effective techniques for querying large-scale online bibliographic systems.

An extensive examination of the literature was reported to indicate current educational efforts in this area and to establish the fact that, to date, no complete, coordinated package of educational materials such as the one proposed herein has been developed and implemented.

Simply stated the courses must be adjustable as to length and level of detail, flexible as to IS&R system and content examples incorporated, and completely self-contained as to coverage because of the presumed inexperience of both instructors and students. These goals are achieved by:

1. The modular construction of the courses themselves allowing the addition and deletion of detail blocks and example packages according to the configuration desired and the IS&R system(s) being presented.

2. The exhaustive amount of support material provided including homework, usage assignments, and tests with answer keys, bibliography, numerous handouts, and a very detailed set of instructor's notes.

All of this material is currently under development; much of it is complete and ready for the Pilot Administration phase. Immediate future plans call for the finalization of all course resources and the first presentation of the 18 week full semester course at USL and Southern University. Concurrent work on marketing and distributing the material as well as incorporating additional systems is projected [Gal, et al, 85].

More remote plans involve the continuous evaluation, extension and enhancement of the course materials. Research and development activities are also in progress in the area of PC-based scientific workstations, PC-based emulators, common command languages, PC-based networks, and other topics of interest [Chu, et al, 85].

It is hoped that this educational program will help graduating students become better and more efficient researchers, making them more productive employees once in the job market. The understanding of IS&R systems, and the habits acquired during the students' last year of school should ease the use of online bibliographic information

systems by the graduates during their professional lives and, perhaps stimulate their continued intellectual growth as well.

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APPENDIX A

NASA CONTRACT NASW-3846

TABLE OF CONTENTS
OF
DOCUMENTATION/DELIVERABLES COMPLETED TO DATE
(UPDATED: 12/22/84)

PART I. PROJECT MANAGEMENT AND CONTROL DOCUMENTS

1.1 USL NASA TASKS/STATUS PROJECT MANAGEMENT AND CONTROL
REPORT, 17p.

The primary project management and control report being utilized at USL for project task/status assignment, monitoring, and management. Report identifies tasks and status via task number, task status, responsible party, date identified, date completed, milestone date, and task description.

PART II. NEEDS ANALYSIS PHASE DOCUMENTS

2.1 NEEDS ANALYSIS PHASE: LIST OF TARGETED INSTITUTIONS, 28p.

The list of the institutions that were targeted for surveying via distribution of the first college and university needs analysis questionnaire. Questionnaires were distributed to all entries identified on this list.

2.2 NEEDS ANALYSIS PHASE: QUESTIONNAIRE COVER LETTER TO TARGETED INSTITUTIONS, 2p.

The cover letter distributed to the targeted institutions together with the first college and university needs analysis questionnaire itself in order to overview the intent of the needs analysis phase of the contract and introduce the questionnaire to the surveyed community.

2.3 NEEDS ANALYSIS PHASE: NEEDS ANALYSIS QUESTIONNAIRE, 6p.

The first college and university needs analysis questionnaire distributed to the targeted institutions. The questionnaire addressed information about the universities, information storage and retrieval system usage, information storage and retrieval system educational needs, information storage and retrieval system educational courses, and comments sections.

2.4 NEEDS ANALYSIS PHASE: NEEDS ANALYSIS QUESTIONNAIRE RESULTS, 24p.

The results of the first college and university needs analysis questionnaire. This document contains all descriptive statistics for all questions, basic

correlation analysis, all respondents' comments, and results interpretation sections.

PART III. COURSE DEVELOPMENT PHASE DOCUMENTS AND
COURSE DEVELOPMENT WORKING PAPER SERIES DOCUMENTS

- 3.1 "COURSE DEVELOPMENT PHASE: STANDARDIZED COURSE MATERIAL DOCUMENTATION TEMPLATES," WAYNE D. DOMINICK, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-1, MAY, 1983, 6p.

This Course Development Series entry contains the set of standardized course material documentation templates for each of the following course materials: course syllabi, lesson plans, homework assignments, homework assignment answer keys, usage assignments, usage assignment answer keys, examinations, and examination answer keys.

- 3.2 "COURSE DEVELOPMENT PHASE: COURSE DEVELOPMENT STANDARDS FOR VISUALS OUTLINES," FRANK Y. CHUM, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-2, MARCH 27, 1984, 7p.

This Course Development Series entry contains the set of development and documentation standards for preparing outlines for course visuals.

- 3.3 "COURSE DEVELOPMENT PHASE: COURSE DEVELOPMENT STANDARDS FOR VISUALS," FRANK Y. CHUM AND SUZY GALLAGHER, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-3, MARCH 27, 1984, 12p.

This Course Development Series entry contains the set of development and documentation standards for preparing course visuals.

- 3.4 "COURSE DEVELOPMENT PHASE: SECOND DRAFT OF PROPOSED INTEGRATED OUTLINE OF COURSE VISUALS," WAYNE D. DOMINICK, FRANK Y. CHUM, AND SUZY GALLAGHER, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-4, August 14, 1984, 16p.

This Course Development Series entry contains the second draft of the proposed integrated outline of the system-independent course visuals associated with a full semester course offering.

- 3.5 "COURSE DEVELOPMENT PHASE: FIRST DRAFT OF PROPOSED COURSE VISUALS," SUZY GALLAGHER, MARTIN GRANIER, PHILIP P. HALL, SHERIEF EL-MOUGY, SRINU KAVI, I-HSIUNG LIU, AND KIL-HYUN NAM, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-5, SEPTEMBER 8, 1984, 490p.

This Course Development Series entry contains the first draft of the proposed system-independent course visuals associated with a full semester course offering.

- 3.6 "COURSE DEVELOPMENT PHASE: FIRST DRAFT OF PROPOSED COURSE LESSON PLANS," SUSAN KNELLER, MARTIN GRANIER, AND SUZY GALLAGHER, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-6, AUGUST 22, 1984, 148p.

This Course Development Series entry contains the first draft of the proposed course lesson plans associated with a full semester course offering.

- 3.7 "COURSE DEVELOPMENT PHASE: SECOND DRAFT OF PROPOSED COURSE HOMEWORK ASSIGNMENTS AND ANSWER KEYS," MARTIN GRANIER, SUSAN KNELLER, AND KIL-HYUN NAM, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-7, DECEMBER 14, 1984, 47p.

This Course Development Series entry contains the second draft of the proposed course homework assignments and answer keys associated with a full semester course offering.

- 3.8 "COURSE DEVELOPMENT PHASE: FIRST DRAFT OF PROPOSED COURSE NASA RECON USAGE ASSIGNMENTS," MARTIN GRANIER AND KIL-HYUN NAM, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-8, AUGUST 22, 1984, 33p.

This Course Development Series entry contains the first draft of the proposed course NASA RECON usage assignments associated with a full semester course offering.

- 3.9 "COURSE DEVELOPMENT PHASE: FIRST DRAFT OF PROPOSED COURSE EXAMINATIONS AND ANSWER KEYS," SUSAN KNELLER, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-9, DECEMBER 14, 1984, 13p.

This Course Development Series entry contains the first draft of the proposed course examinations and answer keys associated with a full semester course offering.

- 3.10 "COURSE DEVELOPMENT PHASE: FIRST DRAFT OF PROPOSED COURSE INSTRUCTOR'S MANUAL," SUZY GALLAGHER, MARTIN GRANIER, SHERIEF EL-MOUGY, AND I-HSIUNG LIU, USL/DEMS NASA/COURSES WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/COURSES-10, SEPTEMBER 27, 1984, 562p.

This Course Development Series entry contains the first draft of the proposed course instructor's manual associated with a full semester course offering.

PART IV. WORKING PAPER SERIES DOCUMENTS

- 4.1 USL/DBMS NASA/RECON WORKING PAPER SERIES STANDARDS, REVISED MARCH 29, 1984, 36p.

The full set of standards for the development, formatting, reviewing, and issuance of entries within the USL/DBMS NASA/RECON Working Paper Series.

- 4.2 "OVERVIEW OF THE NASA/RECON EDUCATIONAL, RESEARCH, AND DEVELOPMENT ACTIVITIES OF THE COMPUTER SCIENCE DEPARTMENTS OF THE UNIVERSITY OF SOUTHWESTERN LOUISIANA AND SOUTHERN UNIVERSITY," WAYNE D. DOMINICK, USL/DBMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DBMS.NASA/RECON-1, REVISED MAY 31, 1984, 9p.

An introduction to the USL/DBMS NASA/RECON Working Paper Series which has been established to provide a foundation for a formal information dissemination mechanism concerning activities being performed pursuant to the NASA/RECON contract. This entry also serves as an index into the collection of Working Paper Series reports.

- 4.3 "NASA RECON: COURSE DEVELOPMENT, ADMINISTRATION, AND EVALUATION," WAYNE D. DOMINICK AND LEROY ROQUEMORE, USL/DBMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DBMS.NASA/RECON-2, MAY, 1983, 65p.

Working Paper Series entry representing the scope of the initial contract proposal to NASA.

- 4.4 "TRANSPORTABLE, UNIVERSITY-LEVEL EDUCATIONAL PROGRAMS IN INTERACTIVE INFORMATION STORAGE AND RETRIEVAL SYSTEMS," WAYNE D. DOMINICK AND LEROY ROQUEMORE, USL/DBMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DBMS.NASA/RECON-3, JANUARY 27, 1984, 16p.

Working Paper Series entry representing the abstract and visuals associated with the above named presentation delivered at the 11th Annual Conference of the Mid-South Association for Educational Data Systems. This presentation overviewed the educational aspects of the NASA contract activities.

- 4.5 "THE MAN/MACHINE INTERFACE IN INFORMATION RETRIEVAL: PROVIDING ACCESS TO THE CASUAL USER," MARTIN GRANIER, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-4, MAY 16, 1984, 69p.

Working paper series report surveying the state-of-the-art in high level man/machine interfaces for supporting casual user access to interactive information storage and retrieval systems. Additionally, capabilities and characteristics of selected specific systems are addressed within the report, including LEXIS, CONIT, IIDA, CITE, and CCL.

- 4.6 "KNOWLEDGE-BASED SYSTEMS: A PRELIMINARY SURVEY OF SELECTED ISSUES AND TECHNIQUES," SRINU KAVI, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-5, MAY 31, 1984, 102p.

Working paper series report surveying the state-of-the-art in knowledge-based systems (expert systems), including issues related to knowledge representation, knowledge bases, cognitive engine strategies, user interfaces for knowledge-based systems, and application considerations.

- 4.7 "CONCEPTS AND IMPLEMENATIONS OF NATURAL LANGUAGE QUERY SYSTEMS," I-HSIUNG LIU, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-6, JUNE 1, 1984, 46p.

Working paper series report surveying the state-of-the-art in natural language query systems for information systems, including issues related to

hierarchies of user languages, query language analyzers, dialog controllers, and synthesizers, and implementation considerations for natural language query systems.

- 4.8 "A REPORT ON THE USL NASA/RECON PROJECT: PART I. THE DEVELOPMENT OF A TRANSPORTABLE, UNIVERSITY LEVEL, IS&R EDUCATIONAL PROGRAM," SUZY GALLAGHER AND MARTIN GRANIER, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-7, OCTOBER 4, 1984, 30p.

This Working Paper Series entry describes a project which has as its goal the production of a set of system-independent, discipline-independent transportable college level courses to educate science and engineering students in the use of large-scale information storage and retrieval systems. This project is being conducted with the cooperation and sponsorship of NASA (National Aeronautics and Space Administration) by research and development teams at the University of Southwestern Louisiana and Southern University. Chapter I is an introduction which provides an overview of the project and a listing of the management phases. Chapter II furnishes general information regarding current accomplishments in all areas under development at present. Chapter III deals specifically with the development of the course materials by presenting a series of diagrams and keys to clearly depict the progress and interrelationships of various tasks and sub-tasks. Chapter IV presents plans for activities to be conducted to accomplish the completion of delivery of all course materials. The final chapter constitutes a summary of the project objectives, methods, plans, and accomplishments.

- 4.9 "A REPORT ON THE USL NASA/RECON PROJECT: PART II. PC-BASED R&D IN SUPPORT OF IS&R APPLICATIONS," FRANK Y. CHUM, PHILIP P. HALL, DENNIS R. MOREAU, AND SPIROS TRIANTAFYLLOPOULOS, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-8, OCTOBER 4, 1984, 20p.

This Working Paper Series entry describes the PC R&D development effort initiated as part of the NASA/RECON

Project at the University of Southwestern Louisiana. This effort involves the development of a PC-based environment for the prototyping and evaluation of various tools designed to enhance the interaction between scientists and engineers and remote information systems. The design of PC-based tools for the enhancement of the NASA/RECON university level courses is described as well as the design of a multi-functional PC-based workstation to support access to and processing of information from local, distributed, and remote sources. Course preparation activities are described in a companion report entitled "A Report on the USL NASA/RECON Project: Part I. The Development of a Transportable, University-Level, IS&R Educational Program", by Suzy Gallagher and Martin Granier, USL/DEMS NASA/RECON Working Paper Series report number DEMS.NASA/RECON-7.

- 4.10 "KNOWLEDGE BASED SYSTEMS: A CRITICAL SURVEY OF MAJOR CONCEPTS, ISSUES, AND TECHNIQUES," SRINU KAVI, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-9, DECEMBER 11, 1984, 306p.

This Working Paper Series entry presents a detailed critical survey of knowledge based systems. After being in a relatively dormant state for many years, only recently is artificial intelligence (AI) - that branch of computer science that attempts to have machines emulate intelligent behavior - accomplishing practical results. Most of these results can be attributed to the design and use of Knowledge-Based Systems, KBSs (or expert systems) - problem solving computer programs that can reach a level of performance comparable to that of a human expert in some specialized problem domain. These systems can act as a consultant for various requirements like medical diagnosis, military threat analysis, project risk assessment, etc. These systems possess knowledge to enable them to make intelligent decisions. They are, however, not meant to replace the human specialists in any particular domain. In this thesis, a critical survey of recent work in interactive KBSs is reported, explaining KBS concepts and issues and techniques used to construct KBS. Application considerations to construct KBSs and potential future research areas in KBSs are identified. A case study (MYCIN) of a KBS, a list of existing KBSs, and an

introduction to the Japanese Fifth Generation Computer Project are provided as appendices. Finally, an extensive set of KBS-related references are provided at the end of this report.

- 4.11 "KNOWLEDGE BASED SYSTEMS: A CRITICAL SURVEY OF MAJOR CONCEPTS, ISSUES, AND TECHNIQUES: VISUALS," SRINU KAVI, USL/DEMS NASA/RECON WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/RECON-10, DECEMBER 11, 1984, 64p.

This Working Paper Series entry represents a collection of presentation visuals associated with the companion report entitled "Knowledge Based Systems: A Critical Survey of Major Concepts, Issues, and Techniques", USL/DEMS NASA/RECON Working Paper Series report number DEMS.NASA/RECON-9.

PART V. PC R&D SPECIFICATIONS DOCUMENTS AND
PC R&D WORKING PAPER SERIES DOCUMENTS

- 5.1 "AN OVERVIEW OF THE USL/DEMS NASA/PC R&D PROJECT WORKING PAPER SERIES," WAYNE D. DOMINICK, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-1, REVISED AUGUST 15, 1984, 6p.

An introduction to the USL/DEMS NASA/PC R&D Working Paper Series which has been established to provide a foundation for both a formal and informal information dissemination mechanism concerning PC-based research and development activities being performed pursuant to the NASA contract. This entry also serves as an index into the collection of Working Paper Series reports.

- 5.2 "THE USL NASA PC R&D PROJECT: GENERAL SPECIFICATIONS OF OBJECTIVES," WAYNE D. DOMINICK, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-2, JUNE 6, 1984, 6p.

The general specifications of the objectives of the USL/DEMS NASA PC R&D Project, a Research and Development Project initiated at USL in order to address future R&D issues related to the PC-based processing environments acquired pursuant to the NASA contract work, namely, the IBM PC/XT systems.

- 5.3 "THE USL NASA PC R&D DEVELOPMENT ENVIRONMENT STANDARDS," DENNIS R. MOREAU, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-3, JULY 31, 1984, 8p.

The development environment standards which have been established in order to control usage of the IBM PC/XT development systems and to prevent interference between projects being concurrently developed on the PC's. The standards address the following areas: scheduling PC resources; login/logout procedures; training; file naming conventions; hard disk organization; diskette care; backup procedures; and copying policies.

- 5.4 "GENERAL SPECIFICATIONS FOR THE DEVELOPMENT OF A PC-BASED SIMULATOR OF THE NASA RECON SYSTEM," SPIROS TRIANTAFYLLOPOULOS, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-4, AUGUST 2, 1984, 21p.

The general specifications for the design and implementation of an IBM PC/XT-based simulator of the NASA RECON system, including record designs, file structure designs, command language analysis, program design issues, error recovery considerations, and usage monitoring facilities. Once implemented, such a simulator will be utilized to evaluate the effectiveness of simulated information system access in addition to actual system usage as part of the total educational programs being developed within the NASA contract.

- 5.5 "GENERAL SPECIFICATIONS FOR THE DEVELOPMENT OF A USL NASA PC R&D STATISTICAL ANALYSIS SUPPORT PACKAGE," JINOUS BASSARI AND SPIROS TRIANTAFYLLOPOULOS, USL/DEMS

NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER
DEMS.NASA/PC R&D-5, AUGUST 2, 1984, 14p.

The USL NASA PC R&D statistical analysis support package is designed to be a three level package to allow statistical analysis for a variety of applications within the USL DEMS NASA Contract work. The design addresses usage of the statistical facilities as a library package, as an interactive statistical analysis system, and as a batch processing package.

- 5.6 "GENERAL SPECIFICATIONS FOR THE DEVELOPMENT OF A USL NASA PC R&D DISTRIBUTED WORKSTATION," FRANK Y. CHUM, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-6, AUGUST 15, 1984, 10p.

This document defines the general specifications for the development of a PC-Based distributed workstation (PCDWS) for an information storage and retrieval systems environment. This research proposes the development of a PCDWS prototype as part of the USL/DEMS NASA/PC R&D project in the PC-Based workstation environment.

- 5.7 "THE USL NASA PC R&D INTERACTIVE PRESENTATION DEVELOPMENT SYSTEM," DENNIS R. MOREAU, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-7, AUGUST 2, 1984, 8p.

The Interactive Presentation Development System (IPDS) is a highly interactive system for creating, editing, and displaying video presentation sequences, e.g., for developing and presenting displays of instructional material similar to overhead transparency or slide presentations. However, since this system is PC-based, users (e.g., instructors) can step through sequences forward or backward, focusing attention to areas of the display with special cursor pointers. Additionally, screen displays may be dynamically modified during the presentation to show assignments or to answer questions, much like a traditional blackboard. This system is now implemented at USL for use within the piloting phases of the NASA contract work.

- 5.8 "THE USL NASA PC R&D PROJECT: DETAILED SPECIFICATIONS OF OBJECTIVES," FRANK Y. CHUM, PHILIP P. HALL, DENNIS R. MOREAU, AND SPIROS TRIANTAFYLLOPOULOS, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-8, AUGUST 15, 1984, 21p.

This document represents the specifications for a number of projects which are to be implemented within the USL NASA PC R&D Project. The goals and objectives of the PC development project and the interrelationships of the various components are discussed. Six individual projects are described. They are a NASA/RECON simulator, a user interface to multiple remote information systems, evaluation of various personal computer systems, statistical analysis software development, interactive presentation system development, and the development of a distributed processing environment. The relationships of these projects to each other and to the goals and objectives of the overall project are also discussed.

- 5.9 "DESIGN CRITERIA FOR A PC-BASED COMMON USER INTERFACE TO REMOTE INFORMATION SYSTEMS," PHILIP P. HALL, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-9, AUGUST 13, 1984, 21p.

A set of design criteria are presented which will allow the implementation of an interface to multiple remote information systems on a microcomputer. The focus of the design description is on providing the user with the functionality required to retrieve, store and manipulate data residing in remote information systems through the utilization of a standardized interface system. The intent is to spare the user from learning the details of retrieval from specific systems while retaining the full capabilities of each system. The system design includes multi-level capabilities to enhance usability by a wide range of users and utilizes microcomputer graphics capabilities where applicable. A data collection subsystem for evaluation purposes is also described.

- 5.10 "A PERFORMANCE EVALUATION OF THE IBM 370/XT PERSONAL COMPUTER," SPIROS TRIANTAFYLLOPOULOS, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC

R&D-10, OCTOBER 5, 1984, 47p.

This Working Paper Series entry addresses an evaluation of the IBM 370/XT personal computer. The evaluation focuses primarily on the use of the 370/XT for scientific and technical applications and applications development. A measurement of the capabilities of the 370/XT was performed by means of test programs which are presented in appendices to the report. Also included is a review of the facilities provided by the operating system (VM/PC), along with comments on the IBM 370/XT hardware configuration.

- 5.11 "USL/DEMS NASA/PC R&D PROJECT 'C' PROGRAMMING STANDARDS," DENNIS R. MOREAU, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-11, OCTOBER 5, 1984, 11p.

This Working Paper Series entry establishes a set of programming standards intended to promote reliability, readability, and portability of "C" programs written for PC R&D development projects. These standards must be adhered to except where reasons for deviation are clearly identified and approved by the PC R&D team. Application for approval is made by completing the USL/DEMS NASA/PC R&D Form Number DEMS.NASA/PC FORM-1, "Request for Deviation from C Programming Standards". Any approved deviation from these standards must also be clearly documented in the pertinent source code. Two companion Working Paper Series entries address other system development aspects: (1) "NASA/PC R&D System Design Standards," USL/DEMS NASA/PC R&D Working Paper Series Report Number DEMS.NASA/PC R&D-12, October 12, 1984; and (2) "NASA/PC R&D System Testing Standards," USL/DEMS NASA/RECON Working Paper Series Report Number DEMS.NASA/PC R&D-13, October 12, 1984.

- 5.12 "USL/DEMS NASA/PC R&D PROJECT SYSTEM DESIGN STANDARDS," DENNIS R. MOREAU, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-12, OCTOBER 12, 1984, 5p.

This Working Paper Series entry establishes a set of system design standards intended to assure the completeness and quality of designs developed for PC R&D projects. The standards presented within this document include the areas of problem definition, initial design plan, design specification, and re-evaluation.

- 5.13 "USL/DEMS NASA/PC R&D PROJECT SYSTEM TESTING STANDARDS," SRINU KAVI, DENNIS R. MOREAU, AND LIN YAN, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-13, OCTOBER 12, 1984, 5p.

This Working Paper Series entry establishes a set of system testing standards to be used in the development of all "C" software within the NASA/PC R&D Project. Testing will be considered in two phases, namely, the program testing phase and the system testing phase. The objective of these standards is to provide guidelines for the planning and conduct of program and software system testing.

- 5.14 "IBM PC/IX OPERATING SYSTEM EVALUATION PLAN," MARTIN GRANIER, PHILIP P. HALL, AND SPIROS TRIANTAFYLLOPOULOS, USL/DEMS NASA/PC R&D WORKING PAPER SERIES REPORT NUMBER DEMS.NASA/PC R&D-14, NOVEMBER 28, 1984, 9p.

This Working Paper Series entry contains an evaluation plan for the IBM PC/IX Operating System designed for IBM PC/XT computers. The evaluation plan covers the areas of performance measurement and evaluation, software facilities available, man-machine interface considerations, networking, and suitability of PC/IX as a development environment within the USL NASA PC/R&D project. In order to compare and evaluate the PC/IX system, comparisons with other UNIX*-based systems available are also included. * UNIX is a trademark of AT&T Bell Laboratories.

PART VI. OTHER RESEARCH SUPPORT DOCUMENTS

- 6.1 NASA/RECON SPECIAL TRAINING WORKSHOP AT USL: WORKSHOP AGENDA, LIST OF PARTICIPANTS, AND COMPLETION CERTIFICATES, 4p.

The workshop agenda, list of participants, and a sample copy of the completion certificate associated with the NASA/RECON Special Training Workshop held at USL, January 31, 1984 - February 2, 1984.

- 6.2 NASA/RECON SPECIAL TRAINING WORKSHOP AT USL: PARTICIPANTS EVALUATION FORM SUMMARY RESULTS, 10p.

The summary statistical evaluation results and participants comments associated with the evaluation of the NASA/RECON Special Training Workshop held at USL, January 31, 1984 - February 2, 1984.

- 6.3 USL COMPUTER SCIENCE DEPARTMENT COURSE CMPS669 "ADVANCED TOPICS IN COMPUTER-BASED INFORMATION SYSTEMS (NASA RECON)" COURSE SYLLABUS, SPRING 1984, 7p.

Syllabus for a graduate course offered at USL during the Spring Semester 1984 pursuant to additional student input into, and involvement in the NASA contract educational activities.

6.4 USL CMPS669 STUDENT TASKS/ASSIGNMENTS TASKING
SPECIFICATIONS DOCUMENT: SPRING SEMESTER, 1984, 10p.

Specification of specific tasks being addressed by students enrolled in the aforementioned CMPS669 course offered at USL during the Spring Semester 1984.

6.5 USL CMPS669 STUDENT TASKS/ASSIGNMENTS TASKING
SPECIFICATIONS DOCUMENT: SUMMER SEMESTER, 1984, 11p.

Specifications of specific tasks being addressed by students participating in a second graduate information systems course (CMPS669) at USL during the Summer Semester 1984 pursuant to additional student input into, and involvement in the NASA contract educational activities.

6.6 USL DBMS R&D PROJECT NASA/RECON MULTICS DIRECTORY
STRUCTURE, 28p.

Identification of the automated directory structure which has been established on the USL MULTICS system, under the auspices of the Computer Science Department's DBMS R&D Project, in order to provide automated support for the educational, research and development tasks being addressed within the scope of the NASA/RECON contract.

6.7 USL DBMS NASA/RECON BIBLIOGRAPHIC SUPPORT DATA BASE
STATUS, 33p.

The status of a bibliographic support data base which has been created at USL in order to provide local searchable access to all files being maintained and utilized as part of the NASA/RECON contract activities.

**6.8 USL DEMS IS&R BIBLIOGRAPHIC SUPPORT DATA BASE
STATUS, 139p.**

The status of a bibliographic support data base which has been created at USL in order to provide local searchable access to the primary information storage and retrieval literature (books, journal articles, conference proceedings, technical reports, government reports, and so on) being utilized by the NASA contract team pursuant to the development of all educational materials.

**6.9 USL DEMS PME BIBLIOGRAPHIC SUPPORT DATA BASE
STATUS, 47p.**

The status of a bibliographic support data base which has been created at USL in order to provide local searchable access to the primary information system performance measurement and evaluation literature (books, journal articles, conference proceedings, technical reports, government reports, and so on) being utilized by the NASA contract team pursuant to the development of all educational materials.

**6.10 USL/DEMS NASA/RECON MULTICS WORKBENCH
SPECIFICATIONS, 6p.**

The specifications of an R&D workbench to be implemented on the USL MULTICS system in order to provide centralized control over, and access to all contract work being performed utilizing the MULTICS system as the host processing environment. Versions 1 and 2 of the MULTICS workbench, providing centralized menu control, project management and control report generation, mailing list processors, electronic mail processors, document pre- and post-processors including laser printer format generators, tape backup processors, NASA RECON data base document control processors, and access control have been completely implemented, tested, and are in operational status. Further enhancements to the workbench are currently in design stages.

APPENDIX B

TRANSPORTABLE INFORMATION STORAGE AND RETRIEVAL SYSTEM COURSES NEEDS ANALYSIS QUESTIONNAIRE

Position of Respondent: _____
Institution Name: _____
Address: _____

Note: Throughout the questionnaire, if more than one answer to a
question is applicable, please check all that apply.

PART 1

INFORMATION ABOUT THE UNIVERSITY

1.1 Different universities place emphasis on different educational objectives. The following is a brief list of possible objectives that may or may not be stressed by your university.

For each group, please check the response corresponding to how important an item is for a senior undergraduate student within your university in Physical Sciences and Engineering.

Computer Usage

Physical
Sciences

Engineering

- | | |
|---|--------------------------|
| ☐ Very important (e.g., more than 2 classes required) | ☐ |
| ☐ Important (e.g., 1 to 2 classes required) | ☐ |
| ☐ Desirable (e.g., not required, but highly recommended) | ☐ |
| ☐ Optional (at the student's discretion) | ☐ |
| ☐ Not applicable | ☐ |

Research Skills

- | | |
|--|--------------------------|
| ☐ Very Important (e.g., Baccalaureate Thesis required) | ☐ |
| ☐ Important (e.g., formal training in research techniques required) | ☐ |
| ☐ Desirable (e.g., no formal training, but some skills expected) | ☐ |
| ☐ Optional | ☐ |

1.2 Which of the following describe the access of students in Physical Sciences and Engineering departments to computing facilities?

Physical
Sciences

Engineering

- | | |
|---|--------------------------|
| ☐ Terminals in the department used to access a computer located on the campus | ☐ |
| ☐ Terminals in the department used to access a remote computer not on the campus | ☐ |
| ☐ Terminals located in some other location outside of the department | ☐ |
| ☐ Personal computer workstations located in the department | ☐ |
| ☐ Personal computer workstations available for use but not located in the department | ☐ |

PART 2

INFORMATION STORAGE AND RETRIEVAL SYSTEM USAGE

2.1 Are online information storage and retrieval systems available for use by students at your university?

YES

NO

UNDECIDED

(If "NO", please skip this section and go to PART 3)

2.2 To which departments are these systems available?

- ☐ All Physical Sciences departments
☐ All Engineering departments
☐ Only specific Physical Sciences and/or Engineering departments: Please specify which departments

- ☐ Other departments: Please specify which departments

2.3 Which systems are available?

- | | | |
|---------------------------------------|---------------------------------------|--|
| ☐ BASIS | ☐ DTIC/DROLS | ☐ PERGAMON/INFOLINE |
| ☐ BROWSER | ☐ ENERGY/RECON | ☐ QUESTEL |
| ☐ BRS | ☐ IGS | ☐ SPIRES |
| ☐ CAN/OLE | ☐ ISI | ☐ STAIRS |
| ☐ CAS | ☐ LEADER | ☐ TIS |
| ☐ CGIS | ☐ MEDLINE | ☐ Inhouse system(s) |
| ☐ CSIN | ☐ NASA/RECON | ☐ Other(s): |
| ☐ DATA CENTRAL | ☐ OCLC | Please specify: |
| ☐ DIALOG | ☐ ORBIT | _____ |
| | | _____ |
| | | _____ |

2.4 Are these systems available to:

- ☐ Faculty
- ☐ Staff
- ☐ Students for coursework
- ☐ Students for research
- ☐ The general student body
- ☐ The general public

2.5 How is the availability of database searching advertised?

- ☐ Newsletters
- ☐ Seminars
- ☐ Non-credit courses
- ☐ For-credit courses
- ☐ Other: Please specify: _____

2.6 Select the person(s) responsible for conducting online searches at your university:

- ☐ Librarian
- ☐ Other staff
- ☐ Faculty
- ☐ Students
- ☐ Any trained individual

2.7 What funding source(s) are used to pay for the services?

- ☐ User
- ☐ Department
- ☐ University
- ☐ External Grant(s)/Contract(s)
- ☐ Other: Please specify: _____

PART 3

INFORMATION STORAGE AND RETRIEVAL SYSTEM EDUCATIONAL NEEDS

3.1 Would your university be interested in offering your Physical Sciences and Engineering students an opportunity to learn the principles and concepts of online information storage and retrieval systems, to understand the types of scientific and engineering database services that are available, and to interact with such systems and services?

YES

NO

UNDECIDED

ALREADY OFFERING PRECISELY SUCH COURSES

3.2 What format(s)/duration(s) do you feel such an educational program should take?

☐ 2-3 days workshops☐ Full quarter courses☐ 4-6 week mini-courses☐ Full semester courses

3.3 Do you feel that formal education in these areas, coupled with hands-on experience with one or more major online retrieval systems such as NASA/RECON, would appreciably increase the professional marketability of your graduating scientists and engineers?

YES

NO

UNDECIDED

3.4 If your answer to the preceding question was "YES", did you base your opinion on:

- ☐ Needs expressed by faculty, students and/or alumni?
- ☐ Requirements of potential employers of your graduates?
- ☐ Experience gained through participation in research grants and/or contracts?
- ☐ Knowledge gained through professional literature?
- ☐ Other: Please specify: _____

3.5 What do you foresee as the major obstacles toward teaching and utilizing information storage and retrieval systems more extensively at your university?

☐ Diverse departmental needs☐ Logistical problems☐ Availability of comprehensive course materials☐ Availability of funding☐ Other: Please specify: _____☐ None

PART 4

INFORMATION STORAGE AND RETRIEVAL SYSTEM EDUCATIONAL COURSES

4.1 When transportable information storage and retrieval system courses are available, would your university be interested in incorporating the pre-packaged educational program into your Physical Sciences and/or Engineering curricula?

YES

NO

QUALIFIED: Consideration would be contingent upon:

- ___ The university's opportunity for input into the development phases of the courses
- ___ The possibility of pre-evaluation of all course materials
- ___ The availability of onsite seminars, demonstrations and/or teaching assistance
- ___ The possibility of funding support for system access costs
- ___ Other: Please specify: _____

4.2 Which of the following educational materials would you like to see incorporated within the transportable course packages:

- | | |
|--|----------------------------------|
| ___ Course syllabi | ___ Discussion topics |
| ___ Lesson plans | ___ Workbooks |
| ___ Overhead transparencies | ___ Textbooks |
| ___ Homework assignment
(with answer keys) | ___ Bibliographies |
| ___ Hands-on usage assignments
(with answer keys) | ___ Support handouts |
| ___ Examinations
(with answer keys) | ___ Videotapes and/or films |
| | ___ Other: Please specify: _____ |

PART 5
COMMENTS

Thank you very much for completing this questionnaire.

If you wish to add any comments about any of the specific questions asked, please feel free to do so.

Question
Number

Comments

—	
—	
—	
—	
—	
—	
—	
—	
—	
—	

General Comments:

If you would like to receive a summary of this survey and/or more information about the contract activities, please check the following items:

- Would like to receive a summary of the results of this survey.
- Would like to be placed on our mailing list for dissemination of information related to the contract activities.

APPENDIX C

TRANSPORTABLE INFORMATION STORAGE AND RETRIEVAL SYSTEM COURSES

NEEDS ANALYSIS QUESTIONNAIRE

ANALYSIS RESULTS SUMMARY

POSITION OF RESPONDENT	ABSOLUTE FREQ	RELATIVE FREQ (%)
PRESIDENT, VICE-PRES	32	19.9
DEAN, ASST-DEAN	62	38.5
HEAD OF DEPT	21	13.0
FACULTY MEMBER	16	9.9
OTHER	30	18.6
TOTAL	161	100.0

PART 1 INFORMATION ABOUT THE UNIVERSITY

1.1 Educational Objectives

(Computer Usage)

PHYSICAL SCIENCES	ABSOLUTE FREQ	RELATIVE FREQ (%)
VERY IMPORTANT	38	28.8
IMPORTANT	52	39.4
DESIRABLE	29	21.9
OPTIONAL	2	1.5
NOT APPLICABLE	11	8.5

(SAMPLE SIZE, N = 132)

ENGINEERING	ABSOLUTE FREQ	RELATIVE FREQ (%)
VERY IMPORTANT	81	59.1
IMPORTANT	38	27.7
DESIRABLE	2	1.5
OPTIONAL	1	0.7
NOT APPLICABLE	15	10.9

(N = 137)

1.1 Educational Objectives(Research Skills)

PHYSICAL SCIENCES	ABSOLUTE FREQ	RELATIVE FREQ (%)
VERY IMPORTANT	17	14.3
IMPORTANT	54	45.4
DESIRABLE	43	36.1
OPTIONAL	5	4.2

(N = 119)

ENGINEERING	ABSOLUTE FREQ	RELATIVE FREQ (%)
VERY IMPORTANT	12	10.1
IMPORTANT	46	38.7
DESIRABLE	55	46.2
OPTIONAL	6	5.0

(N = 119)

1.2 Computer Access

PHYSICAL SCIENCES	ABSOLUTE FREQ	RELATIVE FREQ (%)
ON-CAMPUS DEPT TERMINALS	94	79.7
OFF-CAMPUS REMOTE TERMINALS	28	23.7
OUTSIDE OF DEPT TERMINALS	80	67.8
PC IN DEPT	70	59.3
PC OUT OF DEPT	44	40.0

(N = 118)

ENGINEERING	ABSOLUTE FREQ	RELATIVE FREQ (%)
ON-CAMPUS DEPT TERMINALS	104	86.7
OFF-CAMPUS REMOTE TERMINALS	28	23.3
OUTSIDE OF DEPT TERMINALS	78	65.0
PC IN DEPT	80	66.7
PC OUT OF DEPT	42	35.0

(N = 120)

PART 2 IS&R SYSTEM USAGE

2.1 On-Line IS&R

	ABSOLUTE FREQ	RELATIVE FREQ (%)
YES	116	72.0
NO	40	24.8
UNDECIDED	5	3.1

(N = 161)

2.2 Systems Available To Departments

	ABSOLUTE FREQ	RELATIVE FREQ (%)
PHYS SCIENCE DEPTS-ALL	82	76.6
ENGINEERING DEPTS-ALL	73	68.2
ONLY SPECIFIC DEPTS	6	5.6
OTHER DEPTS	51	47.7

(N = 107)

2.3 Available Systems

	ABSOLUTE FREQ	RELATIVE FREQ (%)
BASIS	2	1.7
BROWSER	0	0.0
BRS	56	48.3
CAN/OLE	2	1.7
CAS	24	20.7
CGIS	1	0.9
CSIN	5	4.3
DATA CENTRAL	5	4.3
DIALOG	88	75.9
DTIC/DROLS	1	0.9
ENERGY/RECON	18	15.5
IGS	1	0.9
ISI	22	19.0
LEADER	0	0.0
MEDLINE	40	34.5
NASA/RECON	20	17.2

OCLC	54	46.6
ORBIT	42	36.2
PERGAMON/INFOLINE	9	7.8
QUESTEL	9	7.8
SPIRES	16	13.8
STAIRS	3	2.6
TIS	0	0.0
Inhouse System(s)	26	22.4
Other(s):	32	27.6
ALIS/IDS	2	1.7
ANL	1	0.9
BOEING INFO SYS	1	0.9
CYNET	1	0.9
DATA-TRIEVE (DEC)	1	0.9
D&B	1	0.9
DISCOVER	1	0.9
FAXON	1	0.9
GEOREF	1	0.9
ICTSR	1	0.9
LEXIS	3	2.6
RAMIS	1	0.9
RLIN	5	4.3
RTS	1	0.9
SIR	2	1.7
SYSTEM 1.72	1	0.9
SYSTEM 1032	1	0.9
TECH DATA	1	0.9
VUTEXT/DOW JONES	2	1.7
WESTLAW	2	1.7
NOT SPECIFIED	2	1.7

(N = 116)

2.4 Systems Available To Bodies

	ABSOLUTE FREQ	RELATIVE FREQ (%)
FACULTY	113	98.3
STAFF	104	90.4
STUDENT COURSEWORK	79	68.7
STUDENT RESEARCH	100	87.0
GENERAL STUDENT BODY	69	60.0
GENERAL PUBLIC	41	35.7

(N = 115)

2.5 Data Base Searching Advertised

	ABSOLUTE FREQ	RELATIVE FREQ (%)
NEWSLETTERS	76	69.1
SEMINARS	46	41.8
NON-CREDIT COURSES	17	15.5
FOR-CREDIT COURSES	28	25.5
OTHER:	42	38.2
Brochures	7	6.4
Demos & Lectures by		
Library Staff	9	8.2
Fliers	2	1.8
Internal Memos	3	2.7
Posters	4	3.6
Through Reference Librarian	10	9.1
Word of Mouth	7	6.4

(N = 110)

2.6 Party Responsible for Online Searches

	ABSOLUTE FREQ	RELATIVE FREQ (%)
LIBRARIAN	110	94.8
OTHER STAFF	26	22.4
FACULTY	26	22.4
STUDENTS	10	8.6
ANY TRAINED INDIVIDUAL	21	18.1

(N = 116)

2.7 Funding Source(s)

	ABSOLUTE FREQ	RELATIVE FREQ (%)
USER	82	71.3
DEPARTMENT	74	64.3
UNIVERSITY	61	53.0
GRANT(S)/CONTRACT(S)	71	61.7
OTHER	13	11.3
Agreement With Owner	1	0.8
Cash by Non-affiliated User	2	1.7
Library	7	6.1
Not Specified	3	2.6

(N = 115)

PART 3 IS&R SYSTEM EDUCATIONAL NEEDS**3.1 Course Interest**

	ABSOLUTE FREQ	RELATIVE FREQ (%)
YES	109	67.7
NO	4	2.5
UNDECIDED	35	21.7
PRESENTLY OFFERING	12	7.5

(N = 160)

3.2 Format(s)/Duration(s)

	ABSOLUTE FREQ	RELATIVE FREQ (%)
2-3 DAYS WORKSHOPS	105	76.1
4-6 WEEKS MINI-COURSES	35	25.4
FULL QUARTER COURSE	11	8.0
FULL SEMESTER COURSES	15	10.9

(N = 138)

3.3 Marketability

	ABSOLUTE FREQ	RELATIVE FREQ (%)
YES	76	48.4
NO	36	22.9
UNDECIDED	45	28.7

(N = 157)

3.4 Basis for Opinion

	ABSOLUTE FREQ	RELATIVE FREQ (%)
FAC STDNT ALUMNI NEEDS	36	47.4
POTENTIAL EMPLOYERS	29	38.2
GRANT EXPERIENCE	43	56.6
PROFESSIONAL LITERATURE	37	48.7
OTHER	9	11.8
ACS Meeting	1	1.3
Common Sense	1	1.3
Discussion With Colleagues	1	1.3
Librarian	1	1.3
Personal Experience	4	5.3
Not Specified	1	1.3

(N = 76)

3.5 Major Obstacles

	ABSOLUTE FREQ	RELATIVE FREQ (%)
DIVERSE DEPT NEEDS	54	35.8
LOGISTICAL PROBLEMS	47	31.1
MATERIALS AVAILABILITY	29	19.2
FUNDING AVAILABILITY	124	82.1
OTHER	33	21.9
Availability of Faculty	2	1.3
Availability of Resources	6	4.0
Cost	3	2.0
Crowded Curriculum	7	4.6
Faculty Inertia	3	2.0
Low Priority in Relation to Other Requirements	5	3.3
Unnecessary at Under- graduate Level	3	2.0
Uncertainty About True Generality of IS&R Systems	1	0.7
Not Specified	3	2.0
NONE	3	2.0

(N = 151)

PART 4 IS&R SYSTEM EDUCATIONAL COURSES4.1 Incorporating IS&R Courses

	ABSOLUTE FREQ	RELATIVE FREQ (%)
YES	8	5.0
NO	20	12.4
QUALIFIED	131	81.4

(N = 159)

4.1 (cont'd) Qualification

	ABSOLUTE FREQ	RELATIVE FREQ (%)
UNIVERSITY INPUT	30	23.1
PRE-EVALUATION	90	69.2
ONSITE TRAINING	61	46.9
FUNDING SUPPORT	106	81.5
OTHER	17	13.1
Clear Demonstration of Real Value	1	0.8
Compatability With Present Resources	3	2.3
Consultation With Appropriate Officials	2	1.5
Determination of Student/ Faculty Interest	3	2.3
Non Credit Basis	3	2.3
Relative Importance With Other Courses	3	2.3
Not Specified	2	1.5

(N = 130)

4.2 Educational Materials

	ABSOLUTE FREQ	RELATIVE FREQ (%)
COURSE SYLLABI	97	73.5
LESSON PLANS	71	53.8
OVERHEAD TRANSPARENCIES	73	55.3
HOMEWORK ASSIGNMENTS	65	49.2
HANDS-ON USAGE ASSIGNMENTS	86	65.2
EXAMINATIONS	51	38.6
DISCUSSION TOPICS	52	39.4
WORKBOOKS	80	60.6
TEXTBOOKS	68	51.5
BIBLIOGRAPHIES	57	43.2
SUPPORT HANDOUTS	82	62.1
VIDEOTAPES/FILMS	63	47.7
OTHER	9	6.8
Abstracts	1	0.8
Computer Aided Instruction	4	3.0
Online Tutorials	3	2.3
Not Specified	1	0.8

(N = 132)

PART 5 COMMENTSSpecific Comments

	ABSOLUTE FREQ	RELATIVE (%)	FREQ
NO COMMENTS	136	84.5	
SPECIFIC COMMENTS	25	15.5	

(N = 161)

General Comments

	ABSOLUTE FREQ	RELATIVE (%)	FREQ
NO COMMENTS	137	85.1	
GENERAL COMMENTS	24	14.9	

(N = 161)

Summary Request

	ABSOLUTE FREQ	RELATIVE (%)	FREQ
NO REQUEST	65	40.4	
SUMMARY REQUEST	96	59.6	

(N = 161)

Mailing Request

	ABSOLUTE FREQ	RELATIVE (%)	FREQ
NO REQUEST	86	53.4	
MAILING LIST REQUEST	75	46.6	

(N = 161)

TRANSPORTABLE INFORMATION STORAGE AND RETRIEVAL SYSTEM COURSESNEEDS ANALYSIS QUESTIONNAIRECOMMENTS OF THE RESPONDENTS - SUMMARY

[The numbers in the parentheses are specific question numbers (if specified)]

This college has not given serious thought to this issue. However, as the institution expands its research capability, this activity may well become higher in priority.

All students own powerful personal computer DECPro350. Campus to be networked within 18 months.

Funding both in terms of computer time and staff time is the main impediment to this type of instruction; we have provided a limited introduction to searching to a number of engineering classes over the past 12 years.

As with many other universities information retrieval from data bases such as those mentioned is usually for bibliographic information and is therefore handled by the library. If an undergraduate research methods course were offered then the students could be introduced to online information retrieval and it would not necessarily be limited to bibliographic information. However this course is not currently being considered within the department of Geology.

Determination of student/faculty interest and willingness to participate_probably on a non-credit basis. (4.1)

Transportable instruction should be in the form of written materials, films, tapes, etc. that can be viewed by users when they feel it appropriate. The strongest motivation is need to know.

Departments are using our information retrieval system and many are providing instruction through library - we see instruction (formal & otherwise) as evolving on campus. If NASA supports instructional courseware on information retrieval then I would agree that colleges and universities would have low or no cost to users.

In discussing this questionnaire with my 10 department heads they felt that a very short briefing (2 to 3 hours) was more than ample to demonstrate the system; our faculty and staff have no problem using it with such a briefing.

Physical science: These systems would be useful only for literature search; mainly graduate students and faculty would use them. I believe they would have minimal value for undergraduates.

I would rather see students spend time and effort on fundamentals of DBMS and records management than on specific bibliographic retrieval packages.

It might be more appropriate to incorporate learning these skills within the framework of advanced courses in the major discipline.

Materials should be available as tutorials - online to the most common mainframes eg IBM, CDC. (4.2) Outmoded learning tools for these computer materials. (4.2)

The questionnaire suggests that those planning the system are not familiar with modern use of computer databases. Some help from commercial designers would be advisable.

University has no funding at present to allow for extensive participation.

So far no interest in end-user training has been expressed. (3.5) I would be interested in the design of the course. (4.1)

Clear demonstration of real value. (4.1)

Importance relative to other curriculum requirements. (4.1)

Could you please condense the content of the cover letter to a more clear statement of purpose. It was unclear to me as it is written.

Could this system be used to catalog abstracts from the engineering libraries in the system?

At the point when you decide to proceed you should contact dept. chairs.

We see a great need and usefulness in online searching of the literature. We are however extremely limited by the amount of

available funding to do these searches. Secondary matters such as familiarity with search techniques could easily be overcome.

Most physical science majors are computer literate but only a small portion know how to retrieve information from a central data base.

To modify for own use (4.1). Except for introductory courses computer skills development should be incorporated in general course work (3.2). A model course would be a useful guideline for developing material for incorporation into our own courses. (4.1)

Once students have developed good computer habits in connection with their coursework, it is relatively easy for them to learn the protocol of user friendly software. Then we must make such software available and make students aware of the availability.

Compatibility with present resources. (4.1) Incorporate as part of another course.

CAI w/video disk overlays, such as DEC's IVIS System. (4.2)

At this time the continual state-of-the-art evolution involved in online database searching creates a time investment vs. return (on that time investment) problem for the end user as searcher. More important unless the end user is online 2-5 hrs/mo, there probably will be a problem performing cost effective searches. I realize that database suppliers might see some profit in this problem.

Curricula are full. Something must go if done as a course. (3.5) Computer Assisted Instruction modules would be useful if they could be placed on disks and used in micro-computers. (4.2)

Involvement of our own professionals. (4.2) We will be more actively responding to the Departmental requests as awareness with the implementation of a campus network over the next year or so. (3.1)

Discussions with other professional. (3.4)

Availability of interested faculty. (3.5) Will certainly increase competence. Not clear that increases their marketability. I think you should involve the library profession in your evaluation.

If these are in form for self-learning. (4.1)

Not generally. Some are available through the University Library, but I can not answer specific questions about these services. (2.1)

In a university of our size & diversity, only department heads know the answers to some of your questions.

As with other courses to be introduced, the question is where do we fit them; what do we eliminate?

Inertia. (3.5). Everyone here will have an IBM PC or PC/XT within 5 years. Software Acronyms are far too numerous for faculty to care about.

Faculty and students use the services but are not interested in doing retrievals themselves. (2) There should be a course in chemical literature. Most students and faculty are deficient in elementary skills with Chem. Abst. Training would even make them better clients. (3) I would be interested in the course development. (4)

Not a formal course but an optional seminar. (4.1)

Limited duration (<1 day) overview is envisioned. (4.1) Seminars or short workshops (< 1 day) would be sufficient exposure of overview material. Hands-on usage not necessary on campus. (3.2)

Is there space available in the program? (4.1)

ABSTRACT

There exists a number of large-scale bibliographic Information Storage and Retrieval Systems which contain vast amounts of valuable data of interest in a wide variety of research applications. These systems are not used to capacity because the end users, that is the researchers themselves, have not been trained in the techniques of accessing such systems and their associated data.

This thesis describes the development of a transportable, university-level course in methods of querying online interactive Information Storage and Retrieval systems as a solution to this problem. This course was designed to instruct upper division science and engineering students to enable these end users to directly access such systems. The course is designed to be taught by instructors who are not specialists in either computer science or research skills. It is independent of any particular IS&R system or computer hardware. This project was sponsored by the National Aeronautics and Space Administration and conducted by the University of Southwestern Louisiana and Southern University.

BIOGRAPHICAL SKETCH

Mary C. Gallagher, nee Mary Suzanne [REDACTED], was born in [REDACTED] [REDACTED], [REDACTED] on [REDACTED] [REDACTED] [REDACTED]. She was graduated from Ursuline Academy in 1958 and received a Bachelor of Science degree in Secondary Education from Loyola University of New Orleans in 1962. Mrs. Gallagher was granted certification as a librarian by the state of Louisiana based on work completed at the University of New Orleans in 1975. She enrolled in Graduate School in 1982 and is presently a candidate for the Master of Science degree in Computer Science.

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