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THE DESIGN OF PC/MISI, A PC-BASED COMMON USER INTERFACE TO REMOTE INFORMATION STORAGE AND RETRIEVAL SYSTEMS

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April 24, 1985

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I. PROBLEM DEFINITION

1.1 Introduction

The rapid expansion in the volume of information available through online information storage and retrieval systems and the increasing breadth of this information has created an expectation among many diverse groups of professionals that this information will be readily available to them. A parallel development has been the increasing awareness among these professionals of the advantages of conducting their own searches rather than receiving information extracted through an intermediary [Caruso, 81]. These two factors have created a demand for interactive user interfaces which are easy to use by non-programmers who, in general, will not access the system frequently enough to gain or retain proficiency in its use. The standard interfaces provided by designers of online information systems are simply not adequate. Frequent problems are encountered by users attempting to merely establish initial contact with the system [Penniman, 84; Cooper, 83]. The ability of infrequent users to extract complete information from these systems is

very limited [Fenichel, 81].

1.2 The Casual User

The infrequent (casual) user represents over 70% of the population of users of information systems [Penniman, 84] and it is likely that many more users would like to access these systems directly but are inhibited by the necessity of learning query languages. Training programs designed to teach users the specifics of a query language for a given system are limited in their effectiveness. A user who learns a system language once and then uses that system infrequently is doomed to a cycle of relearning each time he accesses the system. This is a costly process both in wasted user time and in unproductive online system time and is instrumental in discouraging many professionals from conducting their own searches.

Other, more comprehensive, educational programs designed to teach users the fundamentals of searching IS&R systems [Gallagher, 85] are certainly more useful than specific training programs even within the context of a common interface. Even this type of education cannot, however, solve the problems of the truly casual user.

This situation has resulted in the common use of information specialists as intermediaries in the search process [Granier, 84]. These specialists are proficient in the use of a particular system and usually conduct searches

for a number of clients. They will therefore utilize the system frequently enough to acquire and maintain proficiency in its use. Several problems with this approach are immediately apparent. Interposition of an extra person between the user and the information he desires is certain to result in some loss of clarity in the definition of the information to be extracted. Additional loss of effectiveness can be expected as a result of the information specialist's lower level of expertise in the specific area of knowledge which is the subject of the search. The information specialist does not possess the knowledge required to make dynamic decisions during the search process which could refine the queries and result in extraction of a greater volume of relevant material or a smaller volume of more precisely relevant material. These types of dynamic modifications can only be made by the professionals themselves since they possess an intimate, detailed knowledge of the subject matter. The basic situation then, can be described as one in which the skills necessary to extract optimum benefit from online information systems are not generally possessed by a single individual. The full potential of these systems for the dissemination of information is therefore not being realized and will not be realized until a better solution is available.

The effectiveness of online information storage and retrieval systems in supplying an information dissemination service is obviously dependent upon the ability of the interfaces of these systems to interact effectively with the end users of this information. It is important that the design of such an interface be based upon an understanding of the characteristics of the user population. The casual user would be the primary beneficiary of the fulfillment of the promise of the information revolution. These users will generally possess the following characteristics which are relevant to their interaction with information system interfaces:

1) No desire to attempt memorization of large amounts of information concerning command language syntax and utilization.

2) Very limited knowledge of computer programming.

3) Unfamiliarity with specifics of any system command language.

4) Use system infrequently (less than once per week).

5) Unfamiliarity with the structure of any information system.

6) Possess extensive knowledge of a specific subject field.

7) Performance of job function does not require use of the system.

8) Performance of job function could be significantly enhanced by immediate access to information concerning the latest developments in the field.

1.3 Interface Requirements

The class of individuals described above requires a number of characteristics in an information system interface in order to interact effectively with it. They need a system which allows them to move quickly into the process of information extraction without wasting time attempting to recall procedures from memory (and most likely spending expensive system resources with trial and error learning procedures) or reading manuals in order to relearn these procedures. The system must also allow these individuals to move as quickly as possible into a routine which allows them to extract the required information without unnecessary system prompting or other intervention. Finally, the system must ensure that these individuals are allowed to get the maximum advantage from their extensive knowledge of the

subject area.

It is necessary in the design of such an interface to walk a tightrope between the provision of ease of access and interaction and the retention of all system and user capabilities in order to provide efficient interaction between the user and the information contained in the system. The desirability of ease of access will often be in conflict with the desirability of exploiting the full capabilities of each system. Providing ease of access by interposing a layer of software between the user and the system command language interface may prevent the user from becoming proficient in use of the system since the implementation of all system commands in such an interface is not feasible [Caruso, 81]. Conversely, providing the user with full access to system capabilities usually means requiring the user to learn the system command language and dealing with the associated problems.

These problems are compounded when the user requires access to multiple systems. The proliferation of information systems and the increasing breadth of the information contained therein ensures that multiple system access will become increasingly desirable in the future. The provision of a casual user interface by a single information system, no matter how well-designed, becomes an invalid solution as this

situation evolves. It is also unreasonable to expect a wide spectrum of information systems to standardize on one interface any time in the near future. A more likely occurrence would be for the user to be faced with accessing a number of superficially similar interfaces. This may seem to be a minor problem at first glance but, in fact, the utilization of very similar interfaces is more likely to result in errors than the use of totally dissimilar interfaces. This phenomenon is a by-product of the associative nature of human memory and the interference effects which are created in memory when attempting to recall syntactically similar command sequences which perform similar, but not identical, functions [Card, 83]. The lack of standardization in these systems and the difficulties involved in learning multiple systems create seemingly insurmountable problems for the user and it is unlikely that a single user will be able to access multiple systems efficiently utilizing the interfaces provided by the systems themselves. Apparent standardization can be achieved if some capability is available to the user for interpretation of information system interface languages into some common format with which he is familiar. This can be accomplished if the user possesses some sort of local processing capability.

II. THE PERSONAL COMPUTER SOLUTION

2.1 Personalizing the Interface

The optimum position for an interface, then, seems to be as close as possible to the user (i.e., at the user's location). An interface thus situated can provide maximum flexibility for fulfilling the needs of the individual user and provide maximum potential for allowing the user to develop a sufficiently high level of expertise with his system.

Some vendors of information system services have attempted to implement system-specific interface functions at the user location with specialized terminals which allow the user to utilize function keys for frequently-used commands [NASA, 80]. This may be a useful solution for individual system access but is not a reasonable solution for multiple system access since a separate terminal may be required for access to each system. Some of the more sophisticated terminals may be used to access multiple systems whose interfaces will dynamically define the terminal function keys to facilitate user access. This may provide the user of such a terminal with the capability of efficiently accessing several systems, but again standardization becomes a problem and it is unlikely that all systems a user would like to

access will possess the capability of defining the function keys of his particular terminal [Huckle, 84].

The basic requirement for a truly flexible interface is the capability of dynamic adjustment to the terminal/system communications configuration of any system to which the user desires access. It is also desirable for the interface to possess additional capabilities for the processing of information. Some such capabilities are available in the more intelligent terminals, but they are somewhat limited and the addition of new capabilities as required by an individual user is generally not feasible.

2.2 The Personal Computer Advantage

The processing capabilities which would be necessary for the implementation of a personal computer-based multiple information system interface capability are:

1) Pre-Processing of user input into a command string which is recognizable by the host system or communication intermediary.
2) Post-Processing of messages received from the host system or communication intermediary.
3) Storage and manipulation of records retrieved from the host system.

4) Utilization of input devices such as light pens, mice, touch tablets, etc.

5) Modification of screen display characteristics.

While it is certainly true that some of these capabilities are provided by some of the more recent "smart" terminals, these machines do not provide the level of processing capability nor the necessary storage capacity to implement these capabilities.

A personal computer, on the other hand, does. The personal computer also provides the user with the ability to process information when the host system is not available or when the user does not require contact with the host. This allows the user much more flexibility to work at his own pace and on his own time schedule. This capability of providing the user with the ability to control his interaction with the system to the greatest degree possible has been shown to be an important factor in providing a system which will satisfy its users [NRC, 85].

Another possible site for the implementation of the functionality required for this system would be a locally available mini or mainframe or a remote "gateway" system operating on a mini or mainframe computer, and, indeed, systems providing somewhat similar functions have been developed on such systems [Hampel, 85; Marcus, 85]. There

are, however, a number of problems involved with this solution. Many potential users of IS&R systems do not work in an environment which includes mini or mainframe processing capabilities and do not have the resources or the desire to purchase such high-powered machines. The increasing power and capacity of personal computers have made it feasible for many of these smaller organizations to perform all of their information processing activities on a personal computer or on a small network of such machines. It is likely, then, that the machine will already be available in the location where IS&R access is required [Data Decisions, 83]. If the machine is not already available, the funding required to purchase it will be substantially less than the funding required to purchase mini or mainframe configurations.

The use of mini or mainframe computers for this function, even in situations where such facilities are pre-existing, may not be an attractive solution. In many such environments, the available information processing facilities are already over-taxed with previously existing tasks. Indeed, removing the load from these systems is a rationale often used for introducing microcomputers into business and industrial environments [Brown, 83]. The utilization of a microcomputer for this function will avoid adding another burden to the central processing facilities and, at the same

time, provide the user with the flexibility and autonomy which he desires.

This is not, however, intended to imply that this system should be totally isolated from any larger data processing system which may exist at the user's workplace. The system should be designed in a modular manner so that some of the functionality can be transported to a mini or mainframe or microcomputer network system if this becomes desirable. The local processing capability provided by the personal computer is, however, quickly becoming a requirement in any environment in order to provide the user with the capability of efficiently fulfilling his personal information retrieval and processing needs.

2.3 Feasibility of Implementation

The development of a personal computer based common interface to multiple IS&R systems requires:

1) The identification of host system functions which are used by casual users

2) The determination that these functions are provided by the target systems

3) The identification of local processing needs

4) The development of a standard set of commands to be mapped into the required host system functions

5) The mapping of the standard command set into commands recognizable by the host system

6) The identification of hardware requirements for the implementation of the system.

The available information on usage of IS&R system commands [Borgman, 83; NASA, 85; Penniman, 84] indicates that a set of nineteen commands (see Chapter V) represent 99+% of all commands issued to these systems. The remaining <<1% of the commands are more system specific and it is unlikely that the casual user would require their use.

The nineteen identified host system functions represent common commands which are expected to be available in most IS&R systems. The six systems which were examined to verify this (NASA/RECON, DOE/RECON, DIALOG, ORBIT, BRS, and MADAM) indicated only minor variations from this expectation. MADAM, a research system at this University, ORBIT, and BRS do not have the capability of displaying related terms, and DIALOG and ORBIT do not have the capability of displaying the set status of the current session. The lack of these functions will not have a significant impact on the user's ability to extract information from these systems and it is likely that

these systems will eventually add these capabilities.

The identification of local processing needs in a PC-based common interface system cannot be based on existing information since no such information exists. The choice of local processing functions to be incorporated into the system has, therefore, been based on observations of host system usage by individuals involved in the NASA/RECON Project at this university and conversations with these individuals. A certain amount of intuitive reasoning has also guided the selection process. Eight functions have been identified as necessary for local processing activities (see Chapter V).

Although much attention has been paid to the idea of developing a common command language for accessing IS&R systems [Granier, 84], no such language is currently available. The set of commands which will be used in this system (TABLE 1) and the syntax of these commands are a collection of commands which exist on current systems. The selection of specific commands was based on the author's preferences as information does not presently exist to indicate that particular commands are more usable or easier to learn than others. This problem is one which may be clarified by future research efforts using the system described in this document as the primary research vehicle.

The mapping of the interface commands of this system into host system commands is considerably simplified by the reduction of the command to a small subset of all possible commands. Fortunately, there is some uniformity among major systems in the implementation of these commands. The mapping of the interface command language into host system commands is, in most cases, a straightforward substitution of arguments. This is not, however, true of all of the implemented commands. The command to connect to the host system, of course, requires a number of steps, but will be seen by the user as a single command. Other actual search commands may be treated differently by different systems or there may not be a one-to-one translation of interface commands into host system commands (e.g. the Limit command is issued alone in some systems and affects all subsequent searches while in other systems it is ANDed to the current command). The processing required for these translations is identified in the system design plan [Hall, 85: Section 2.2].

The hardware configuration necessary for the development of the proposed system is somewhat dependent upon the amount of information which the user expects to retrieve. The average size of an accession is approximately 5000 bytes [NASA, 85]. The memory requirements of the system itself are expected to be in the neighborhood of 120,000 bytes. It is,

therefore, possible for a user with a dual floppy system and a main memory capacity of 256K to utilize the interface system if he does not expect to download more than 50 accessions or if he is willing to deal with the problems associated with storing his accessions on multiple diskettes. A more desirable configuration would include a hard disk drive to handle the storage of greatly expanded amounts of downloaded information, to maintain archival storage of such information if desired, and to improve the performance of the interface system.

There is also a requirement for a modem which has auto-dialing capability. This is now a standard function on most modems available for personal computer systems which could support the interface system.

The processing needs of the interface system are well within the capabilities of personal computer systems which meet the other hardware configurations as described previously. The cost of acquiring a machine which meets these requirements is also dropping constantly and should be well within the funding available to users of IS&R systems. Section 4.6 provides a complete description of the resource requirements.

III. GOALS AND OBJECTIVES OF SYSTEM DESIGN

3.1 Goals

The general goals of the design of such an interface system may be summarized as follows:

GOAL 1: Design a system which allows ease of access to multiple information systems to both the casual user and the experienced user.

GOAL 2: Utilize the local processing capabilities of the personal computer to enhance the search and retrieval process.

GOAL 3: Design a system which provides the user with sufficient guidance and interactive capability to allow the utilization of his subject knowledge in the development of system search strategies.

GOAL 4: Design a system which utilizes state-of-the-art interface design tools available for personal computers while retaining maximum portability.

GOAL 5: Design a system which may be used for research activities related to the improvement of access

- to IS&R systems and which provides the necessary monitoring and evaluation tools for such research.

GOAL 6: Define future system enhancements.

These goals represent a broad, general description of the concepts which will guide the proposed design of a Personal Computer-based Multiple Information System Interface (PC/MISI).

3.2 Specific Objectives

The actual design of the system will involve the development of specifications and the development of a specific design plan to accomplish the following list of objectives:

OBJECTIVE 1: Provide Ease of Access to Multiple Systems. The system should allow the user to simply choose the information system he wishes to access and PC/MISI should perform all necessary procedures required to establish communications. (Note: This process will also involve security problems which will have to be resolved).

OBJECTIVE 2: Provide for Addition of New Systems.

PC/MISI should have a modular design which will facilitate the addition of new information systems or new processing systems as the need arises.

OBJECTIVE 3: Develop System Documentation

The system user manuals and other documentation should be developed in concert with the system design in order to ensure clarity and relevance.

OBJECTIVE 4: Provide Multilevel Capabilities.

PC/MISI should have interfaces designed for use by users with different levels of expertise and should provide smooth transition from one level to another as the user's level of expertise changes. The user should also be able to choose his own level if he so desires.

OBJECTIVE 5: Maintain User Orientation.

PC/MISI should keep the user informed at all times of his location within the system as well as other pertinent information. The system design should include the definition

of all information which should be available to the user and the methods of providing such information.

OBJECTIVE 6: Utilize User's Knowledge.

PC/MISI should provide users with "advice" on how to develop search strategies to best utilize their specific subject knowledge. This should be an integral part of the highest level user interface and also available on request to the more experienced user.

OBJECTIVE 7: Facilitate Downloading of Information.

PC/MISI should provide simple procedures for allowing users to store information from remote systems in the storage units of their personal computers, edit this information as desired, and print the information on their local printers.

OBJECTIVE 8: Provide Batch Processing Capabilities.

PC/MISI should provide the capability of designing an entire search sequence prior to accessing the remote system and then uploading the entire sequence to the remote

computer and executing it. The user should also have the choice of running this as an interactive process or as an offline batch procedure (assuming remote system support for this procedure).

OBJECTIVE 9: Provide Error Handling Capabilities.

The error messages within PC/MISI should be designed to guide the user to the correct procedure. PC/MISI should provide an interpretation of remote system error messages where necessary and provide the user with additional information and assistance where required.

OBJECTIVE 10: Extract Maximum Benefit from Display Capabilities.

The interface design should make use of graphical and screen management capabilities in order to maintain user interest and assist the user in his search efforts. Care must be taken, however, to ensure maximum portability when using these tools. Concepts of information processing psychology should

also be incorporated into design decisions regarding the utilization of these tools in order to provide naturally usable interface formats and maximize user information processing capabilities.

OBJECTIVE 11: Identify Necessary Data for Evaluation.
The information to be collected for monitoring and evaluation will be defined and the analyses to be conducted on this information will be identified.

OBJECTIVE 12: Design Data Collection Tools.
The data collection system will be described. This will include software monitors as well as user evaluation forms.

OBJECTIVE 13: Identify Uses of Artificial Intelligence for Future Enhancements.
The possible uses of artificial intelligence and knowledge bases as tools for enhancement of user interaction should be identified and necessary system design decisions will be made to allow the future incorporation of these tools.

OBJECTIVE 14: Identify Multi-User Conversion Possibilities.

The original system design will be oriented toward a single user. The possible future incorporation of multi-user capabilities will be discussed as well as factors associated with the incorporation of the system into a distributed workstation environment.

OBJECTIVE 15: Maximize Flexibility.

The system design should provide the capability of easily implementing changes which may be required by modifications to any supported remote system.

3.3 Problem Summary

The casual user of multiple information storage and retrieval systems should not be required to interact with those systems in the varying languages provided by the standard interfaces. The necessity of interacting in that way has proven to be a roadblock preventing the widespread and rapid dissemination of information to the end users of that information [Dillon, 83]. The processing capabilities of microcomputers create the possibility of providing the user

with one familiar and easy to use system which is used to access any machine-readable information that he desires and that he has authorization to access. A carefully designed interface should appear to the user as a single system which contains all of the information and information processing capabilities which he desires. The messy and tedious details involved with the actual access of the information from the source machine should be handled by the user's machine and the user's time can then be allocated to the planning of his search strategy instead of the mechanics of the search operation.

The guidelines presented in the preceding sections provide a framework for the development of a system which will utilize the capabilities of the personal computer to provide such an interface to multiple information storage and retrieval systems. The personal computer promises to become a valuable tool in the effort now in progress by researchers in the information sciences, vendors of information system services, and government organizations [NRC, 85] to establish online information systems as an integral and indispensable part of our society. The fulfillment of that promise requires a careful analysis of all factors involved in the interaction between the user and the system and the incorporation of the results of such an analysis into the design of an interface

system. These guidelines are the initial step in a process which will result in the development of design specifications (See Chapter IV) and a specific design plan (See Chapter V) to be used in the implementation of a system which will meet the goals identified in this chapter.

IV. DESIGN SPECIFICATIONS

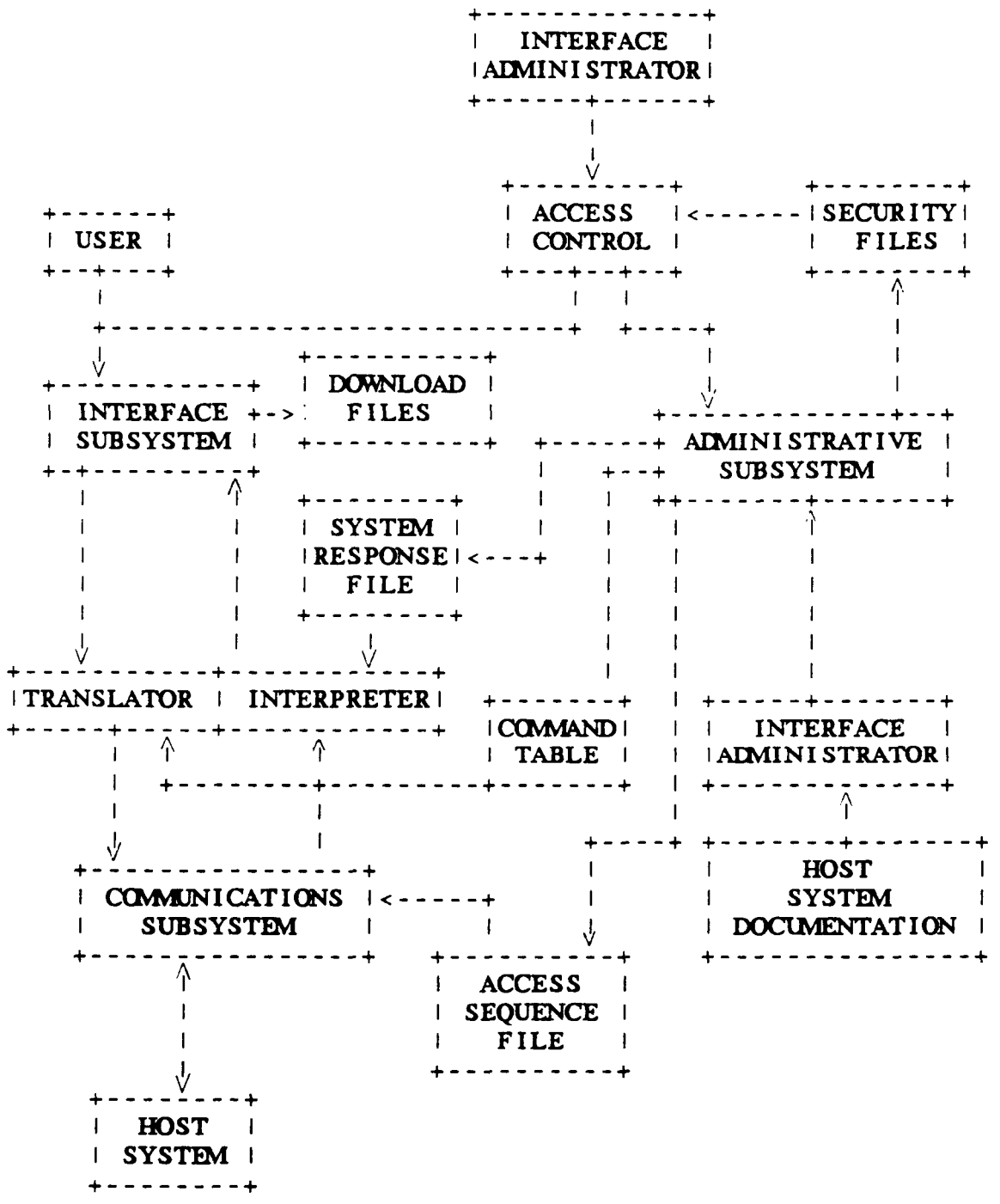
The major technical problems which must be solved in order to implement the PC-Based Multiple Information System Interface (PC/MISI) have been organized into five basic components as follows:

1. Provide necessary communication capabilties
2. Provide capabilities for incorporating new systems and making changes to existing systems
3. Provide mechanisms for translating user commands into host system commands and interpreting responses
4. Provide a multi-level user interface into the system
5. Provide tools for collection and interpretation of evaluation information.

The remainder of this chapter will describe the capabilities which will be required of each of these components. A chart describing the data flow within the system is included as Figure 1. The chart has two boxes labelled "system administrator" simply for the illustration of a point. Both of these boxes represent the same individual.

FIGURE 1

SYSTEM DATA FLOW



4.1. Communications

The functionality which must be provided by the communication interface involves the transmission of commands generated by the translator to either the communication intermediary or the host system and the retrieval and subsequent storage of responses in a file which will be read by the interpreter and used to determine the appropriate next action to be taken. Data flow between the communications subsystem and the other components will be handled by the creation of standard input and output files. The communications interface system must be capable of detecting error conditions which have occurred in establishing the proper communications protocol parameters with a host system and taking steps to rectify these problems to establish proper data communications. If the interface is unable to accomplish this for some reason, it must have the capability of notifying the user of these problems and accepting user-initiated parameters to make the corrections. The system must also have capability of automatic re-dialing when a line into the host system is not available.

4.2. Administrative Subsystem

The addition of new IS&R systems, the modification of existing systems, and the manipulation of access rights will be handled by an administrative subsystem. Access to this subsystem in systems which will be available to multiple users must be restricted to a single user. This user will be referred to, in the remainder of this document, as the interface administrator. This subsystem will provide a step-by-step prompt driven procedure for the addition of new systems. The use of this procedure will result in the creation of three files as follows:

1. Access Sequence - contains the sequence of commands and expected responses which will bring the user to a state where the host system is ready to accept search commands.
2. Command Table - this file will contain a table which will map the commands issued by the user into the appropriate host system syntax.
3. System Response File - this file will be used by the interpreter to identify the response from the host system and perform the appropriate function based on this response.

The access sequence file will be created directly by the interface administrator based on his knowledge of these access procedures. The command table will be generated by prompting the interface administrator with the required system function and allowing the interface administrator to enter the appropriate system command with a standard convention indicating where variable values are to be placed. After creation of these first two files, the interface administrator will be prompted to begin access to the system and the administrative subsystem must be capable of interacting with the communications subsystem through the translator. This will allow testing of the access sequence and correction of any errors which have occurred. The system will then generate the required entries into the system response file by invoking the command which should cause the appropriate response. The system will then ask the interface administrator to verify that the response is the one required and to identify labels or standard indications which identify the response. This procedure will also be used to identify labels of accessions to be downloaded and this information will also be placed into the response file. A unique set of three files will be generated for each host system which is to be incorporated into PC/MISI.

The administrative subsystem must also be able to access

and modify the system security file. This file will be initialized with a personal identifier and password which will be given to the interface administrator of the system. This individual will have primary responsibility for the addition and maintenance of host system files and will be responsible for entering new users into the security file if so desired and setting access to these users for any subset of host systems which are available.

The administrative subsystem must also have the capability of activating the mechanisms which collect and store evaluation data.

4.3. Translator/Interpreter Subsystem

The mapping of user commands to host system commands and the interpretation of the host system responses involve somewhat dissimilar problems, but, in order to solve these problems most efficiently, there is a requirement for the sharing of certain data objects (e.g., the type of request submitted is valuable when attempting to interpret the response). The two functions should, therefore, be implemented as one program with subprocedures to perform the different functions and global variables containing the information to be shared. The translator will accept input from the user interface subsystem and use this information to

identify the correct format for the host system command or commands from the command table, plug in the variable value(s), and send the string(s) thus constructed to the input file to be read by the communications subsystem. The communications interface will then extract the string(s) from the input file, transmit to the host system and await a response.

Each line of the response will be stored in the output file as it is received. When the host transmission is complete, the communication subsystem will return control to the main program which will then call the interpreter. The interpreter will read lines from the output file and utilize information in the system response file to determine any processing required on the response, perform this processing, and then store the transformed lines in the user interface file. If the interpreter is unable to determine the type of the host system transmission, the line(s) of response are simply stored in the user interface file as received.

4.4. User Interface

The user interface accepts input from the user and returns information to the user concerning system activity. There are three levels of interaction which the user may choose:

1. Menu-Driven Interaction
2. Command-Driven Interaction
   (utilizing PC/MISI commands)
3. Direct Interaction with the Host System.

The menu system will list choices which are available to the user at any given point in his interaction with the system and take appropriate action dependent upon the user's response. The user will also be required to enter such items as search variables directly upon prompting from the system. The choices available to the user at level 1 to formulate commands to the host system will basically consist of the full text of the abbreviated commands available to the user at level 2. The abbreviations will be highlighted in order to make the level 1 interaction a tool for learning to deal with the system at level 2. A possible menu might be as follows:

1) FInd Subject term
2) FInd Author
3) COMbine Sets
4) DIsplay Reference

The user at level 1 who wished to extract all references to microcomputers would enter a 1 and would then be prompted for the subject term and would enter "microcomputers". At level 2, the user would accomplish the same action by entering "FIS

microcomputers" when prompted by the system.

At either level, the user will have the option of having each instruction sent to the host system as it is entered or formulating a series of queries offline and connecting to the host system to perform the entire sequence when query formulation is finished. This feature will not require that the host system possess any kind of batch processing capability. The processing of user input will be organized in such a way that the search string sent to the translator will be the same for either Level I or II.

The level III interface is intended for the advanced user of a particular system and allows direct transmission of a command as entered by the user and direct display of the information returned by the system. A user at this level will also have the option of downloading accessions into the standard file format used at the other two levels or saving information into a sequential file exactly as it is transmitted from the host system. The user at this level will use the host system command language for conducting his searches but will also have access to the PC/MISI commands for local processing of his information. The user at level 1 or 2 will also have the capability of sending a single command line directly to the host system if so desired. This capability is necessary in order to maintain flexibility,

recover from unusual error conditions, and to allow users at any level to access unique system functions which are outside the common scope of PC/MISI.

The screen display which the user at any level sees will be divided into three sections. The upper section of the screen will be used by the system to display prompts or menus and receive input from the user. The middle section will be used to display information being returned from the system. The last line of the screen will be used to display user orientation information such as date, time, system being accessed, etc.

4.5. Evaluation

The evaluation subsystem will consist of a collection of imbedded monitor mechanisms (activated by the interface administrator through the administration subsystem) and the data files generated by these mechanisms. There is a necessity for two separate types of evaluation: System Management Evaluation and System Functionality Evaluation. These will be implemented as two separate components.

The System Management files will contain a collection of information concerning the activity of different individuals and the utilization of different host systems. This information will be used to track individual utilization for

possible cost determination when a number of users utilize a system and to determine the cost-effectiveness of individual host systems.

The System Functionality files will be used to determine the learnability and usability of the system and the relative merits of the different interface levels. The information contained in these files will be such entities as number and type of error conditions raised per unit of interaction, number of retrievals generated for each user task and by each individual user query, amount of time spent online to complete a specific task or series of tasks, amount of time spent in the PC/MISI environment prior to accessing the host system, amount of time required to download accessions from the host system and a complete log of all user and system activity. This type of information will be used in controlled and quasi-controlled experiments to determine the relative merits of different interface configurations. The experimenter will have the capability of selecting the specific data which he wishes to collect during a specific time period.

4.6 Resource Requirements

The user interface implementation will require the use of a standard window generation library. The evaluation

subsystem will require an interface with a statistical package. Present plans are to have this statistical package resident on the PC but this function could certainly be distributed to an alternate site. Hardware requirements will include a system with a minimum of 256K memory and a hard disk system for efficient file handling as well as floppy disk capability. The communications system will also require a modem and this implementation will be based on compatibility with a Hayes-1200 Smartmodem. Capabilities will also be provided for the user to change communications configurations to utilize other types of modems. The administration subsystem will be designed so as to include the optional use of a light pen. A color monitor is desirable in order to fully utilize the windowing capabilities to be incorporated into the system.

The programming time required for implementation is difficult to estimate since it is, to a great extent, dependent on the skill of the programmer who will perform the implementation. Rough estimates of implementation time and program size are as follows:

	TIME	SIZE
1. Communication	50-70 Hrs.	20,000 Bytes
2. Administrative Subsystem	60-80 Hrs.	30,000 Bytes
3. Interpreter/Translator	60-80 Hrs.	40,000 Bytes
4. User Interface	40-60 Hrs.	30,000 Bytes

The time to implement the evaluation system is included in the user interface time.

The completion of the Communication Subsystem was delayed due to problems with available communication software tools. The actual time spent in it's implementation was, however, within the range indicated in the preceding table and the size of the module is approximately 13,000 bytes, somewhat smaller than anticipated.

V. SPECIFIC DESIGN PLAN

The specific design plan developed as a blueprint for the implementation of PC/MISI [Hall, 85:] provides a detailed description of the data structures, algorithms and screen displays necessary to the provision of the functionality described in Chapter IV.

The system contains three tables which provide the means for coordinating information exchange between the user and the host system. The PC/MISI Command Table (TABLE 1) is used by the interactive subsystem to interpret user input at Level II (Command Level). The System Command Table (TABLE 2) contains host specific information necessary to transform PC/MISI commands into the commands required to perform the desired functions at the host system location. The Interpreter Table (TABLE 3) contains information necessary to allow the interpreter to identify responses received from the host system and perform the necessary post-processing of the response. The data structure to be used to hold accessions downloaded from the host system (TABLE 4) is also necessary in order to perform this post-processing.

TABLE 1

PC/MISI COMMAND TABLE

1. COS (Connect to system)
2. DIS (Disconnect from system)
3. SED (Select Database)
4. FIS (Find Subject)
5. FIA (Find Author)
6. FIT (Find Title)
7. FIC (Find Corporate Source)
8. LAD (List Adjacent Terms)
9. LIR (List Related Terms)
10. DIA (Display Accession(s))
11. COM (Combine Sets)
12. PRR (Print Remote)
13. SYN (System News)
14. SET (Search Text)
15. FIN (Find Accession Number)
16. LIM (Limit Searches)
17. SES (Display Set Status)
18. REL (Release All Sets)
19. SOR (Sort Set)
20. CHF (Change Download File)
21. SOF (Sort Local File)

22. MEF (Merge Local Files)

23. PRL (Print File on Local Printer)

24. DEF (Delete Download File)

25. DIF (Display Records in Local File)

26. DER (Delete Record from Local File)

Items number 1-19 will be used to form output to the Translator. Items 20-26 are strictly for local processing.

TABLE 2

SYSTEM COMMAND TABLE DESCRIPTION

1. Logoff
2. Combine sets XXX (Boolean Expression)
4. Use Database XXX
4. Create set containing all references to subject XXX
5. Create set containing all references with author XXX
6. Retrieve Accession with title XXX
7. Create set containing all references to corporation XXX
8. Display List of all terms alphabetically adjacent to XXX
9. Display list of all terms related to XXX
10. Display accession located in set SSS, location XXX, in user defined format.
11. Print System News Segment
12. Terminate System News Display
13. Request Print at remote site of set SSS, location XXX
14. Search for term XXX in text of accessions in set SSS
15. Display accession number XXX
16. Limit set number SSS to items dated BEFORE mmddyy<yy>

17. Limit set number SSS to items dated AFTER mmddyy<yy>
18. Month Descriptor (0=alpha; 1=numeric)
19. Limit utilization type
    (0 = command to be ANDed to search expression;
    1 = command to be used alone)
20. Release Limit
21. Display set status
22. Release all sets
23. Sort set SSS on Field FFF
24. Establish user defined format to display only PC/MISI-required fields
25. Display remainder of item which could not fit on one screen
26. Display entire set SSS
27. Display next item in current set
28. Boolean AND
29. Boolean OR
30. Boolean ANDNOT
31. Answer to system query 1
32. Answer to system query 2
33. Answer to system query 3

This table will contain system specific commands to perform the indicated functions with the variables (XXX,SSS,FFF,mm,dd,yy<yy>) in the proper position within the command string. The translator will replace these variables with values passed to it by the Interactive Subsystem.

TABLE 3

INTERPRETER TABLE

1. System Prompt
2. Error Message Standard Label
3. Error Message Indicating That the Specified Search Term is not in the Dictionary
4. Error Message Indicating Invalidly Formed Request
5. Error Message Indicating Invalid User ID
6. Error Message Indicating Invalid Password
7. Message Indicating That System is Down
8. Indicator That There is More of an Accession to be Displayed
9. Response to Set Construction: xxx = set number; yyy = number of retrievals; zzz = retrieval request string
10. Set Status Table Header
11. Accession Number Label
12. Issue Number Label
13. Contract Number Label
14. Publication Name Label
15. Title Label
16. Author Label
17. Corporate Source Label
18. Subject Terms Label
19. Abstract Label

TABLE 4

DOWNLOAD FILE DESCRIPTION

Description	Field Size in Characters
Accession Number	8
Title	50
Author	52
Date	8
Publication Title	50
Corporate Source	10
Contract Number	30
Subject Terms	10 x 42
Abstract	80 x n

All values will be stored as character data except the date which should be stored as an integer representing the number of days since a standard baseline date. The number of lines in an abstract should be flexible and the system should be able to handle any size abstract.

The specific design plan identifies each command available in PC/MISI and its intended functionality is described in detail [Hall, 85:: Section 1.3]. The commands to be implemented were chosen based on available information concerning utilization of host system commands [Borgman, 83; NASA, 85; Penniman, 84]. The final list of commands intended for translation into host system commands includes the following 19 commands which are expected to fulfill all of the processing needs of the casual user:

1) Connect to a system
2) Disconnect from a system
3) Search for a subject
4) Search for an author
5) Search for an accession number
6) Search for a title
7) Search for a corporate source
8) Display an accession on the screen
9) List alphabetically adjacent terms in the index
10) List related terms
11) Boolean operations AND, OR and ANDNOT
12) Change to a new database
13) Print system news
14) Limit search to those accessions before or after a specified date

15) Remote print

16) Search text

17) Set status

18) Release all sets

19) Sort set

More advanced users who wish to utilize more exotic system commands may interact directly with the host system utilizing Level III of PC/MISI. The following additional PC/MISI commands are included which allow the user to perform local-processing activities. The activities supported allow the user to save accessions downloaded from host systems, sort these accessions, merge accessions from different sources, print the accesions, and perform several editing and housekeeping functions. They are:

1) Save accession to local file

2) Sort local file

3) Merge two local files

4) Print on local printer

5) Specify local file name to be used for downloading records.

6) Delete a file

7) Display an accession from a file

8) Delete an accession from a file

Each menu to be used in Level I is completely described and

the Level II commands are identified by inclusion in the Level I menus. All menus are restricted to a maximum of nine selections [Card, 83]. Commands to be used at Level II are all meaningful and are all mnemonic commands to facilitate memorization by the user [Card, 83].

The methodology of accepting command parameters from the user is explicitly identified and the required transformation of this information into an information packet to be provided to the Interpreter Subsystem is also defined [Hall, 85: Sections 1.2 and 2.1]. The presentation of information to the user is also described in detail [Hall, 85: Section 1.3].

The flow of information between PC/MISI modules and the flow of control within the system are explicitly defined [Hall, 85: Sections 1.2, 1.6, 2.1, 3.1 and 4.1] and algorithms are provided which will be required to transform PC/MISI commands into host system commands [Hall, 85: Section 2.2]. The methodology to be used in the identification and handling of host system responses and the transformation of these responses into PC/MISI responses and file structures is clearly defined [Hall, 85: Chapter III, Table 3 & Table 4].

The construction of the System Command Table and the Interpreter Table by the Administrative Subsystem is described by specifying the prompt to be displayed to the user and the specific manner in which the input from the user

is to be stored in the appropriate location [Hall, 85: Chapter V]. Case constructs are used to specify handling of different user responses where required. A methodology for interactive testing of the table entries is provided [Hall, 85: Section 5.1.1] as well as a methodology for utilizing the host system to generate entries into the Interpreter Table where such generation is appropriate [Hall, 85: Section 5.1.2].

Possible sources of errors are identified and the appropriate handling of these errors is also identified. Identification and trapping of specific host system errors where appropriate is provided [Hall, 85: Sections 1.7 and 3.1].

VI. FUTURE CONSIDERATIONS

6.1 Research Potential

> "An obvious and often-noted reason for making information technology a focus of human factors research is the importance of designing information systems that are well-matched to the capabilities of their intended users. This is indeed an important goal of research and one that has increasing economic implications, given the fact that the cost structure of information processing has changed so much in recent years that today the time of a person using an information system is often more costly than that of the system itself. There is an economic incentive therefore to focus on the problem of making efficient use of people's time" [NRC, 85].

This quotation from the Report of the Committee on Human Factors, Commission on Behavioural and Social Sciences and Education of the National Research Council [NRC, 85] identifies an area of research which is of extreme importance in an era of increasing dependence on information retrieved from computing systems. The design of PC/MISI ensures that this system can be utilized for the conduct of such research. The basic system design provides three levels of user/system interaction and the relative merits of the three different methods can be evaluated using the data collection mechanisms to be incorporated into PC/MISI and experimental methodology along the lines of previous studies conducted using mainframe information storage and retrieval systems [Dominick, 78; Maeda, 84; Michelsen, 83]. Some research has been done on

this specific problem [Hauptman, 83], but the results have been inconclusive and much more work is needed in the area [NRC, 85].

The modular design of PC/MISI will also allow research to be conducted on entirely different types of interfaces by replacing the user interface of the system with different modules which still utilize the underlying functionality of the translation, communication, and interpretation modules. Some research topics in this area which may be of interest are the use of various input devices [Goodwin, 75; Whitfield, 83; Pfaff, 82], the use of windowing [Bury, 82; Holcomb, 85], the impact of color displays [Bundesen, 83; Greene, 83], the use of various graphical constructs, and the impact of the user conceptual model on his interaction with the system [Carey, 82; Michelsen, 83].

Another potential area of research for which PC/MISI would be well suited is the application of expert system techniques to the problem of retrieval of information. A data base of knowledge concerning the availability and location of certain types of information could be developed and its efficiency and accuracy in retrieving and assimilating information on a specified topic without user intervention could be evaluated. Such a system could be built using the

basic translation, communication and interpretation tools provided by PC/MISI.

Another possibility for the application of artificial intelligence to the problem of information retrieval is the utilization of an "intelligent" system which retrieves information and then integrates it into a report which summarizes the content of a number of different sources [Wilson, 85]. This is a logical extension of the expert searching described in the preceding paragraph and is admittedly a distant future possibility, but PC/MISI does provide a base level of support for research into the possibility of such a system and, with continuing increases in the power of personal computers, such futuristic capabilities may be possible.

6.2 Enhancements

The modular design of PC/MISI will allow incorporation of enhancements into the system. Enhancements to the user interface of the system based on experimental results of research as described in Section 6.1 can be incorporated by inserting experimental modules or parts of modules into the existing system when the results indicate that specific techniques are more useful than the current implementation. This should be an iterative and constant process so that the

interface-is constantly evolving.

The present design provides an improved access mechanism to bibliographic information storage and retrieval systems. The modular design of the system will also allow the incorporation of a similar common interface to other types of information systems should such an interface be deemed desirable in the future.

VII. THE RESEARCH ENVIRONMENT

The research and development activities described in this document are a small part of a much larger research and development effort in progress at this University. The primary goal of the NASA/RECON Project (NASA Contract NASW-3846) is the identification and development of methods of improving user access to remote information storage and retrieval systems. The Project consists of two major components. These are an educational research and development component and a personal computer research and development component. Each of these components consists of a number of activities. The recently organized NASA/JPL Project (NASA Research Grant NAGW-701) is aimed specifically at the development of mechanisms for automating the process of developing and evaluating pricing options and policies for the NASA Space Station. There is, however, a great deal of overlap between the two projects, particularly in the area of PC research and development.

The PC/MISI project is a part of the PC R&D component of these projects. The PC R&D activities were initiated in an effort to identify and develop PC-based tools to improve the interaction between users and information systems and to develop systems which implement these methods. The major

goals of the PC R&D effort are to establish a robust PC research and development environment, to develop PC-based educational support tools, and to develop tools to directly support the interaction of scientists and engineers with various information sources.

The establishment of an environment in which to conduct these research activities involved:

1) The development of mechanisms to identify and evaluate candidate research activities

2) The development of mechanisms to identify and acquire necessary hardware and software resources for the support of the project

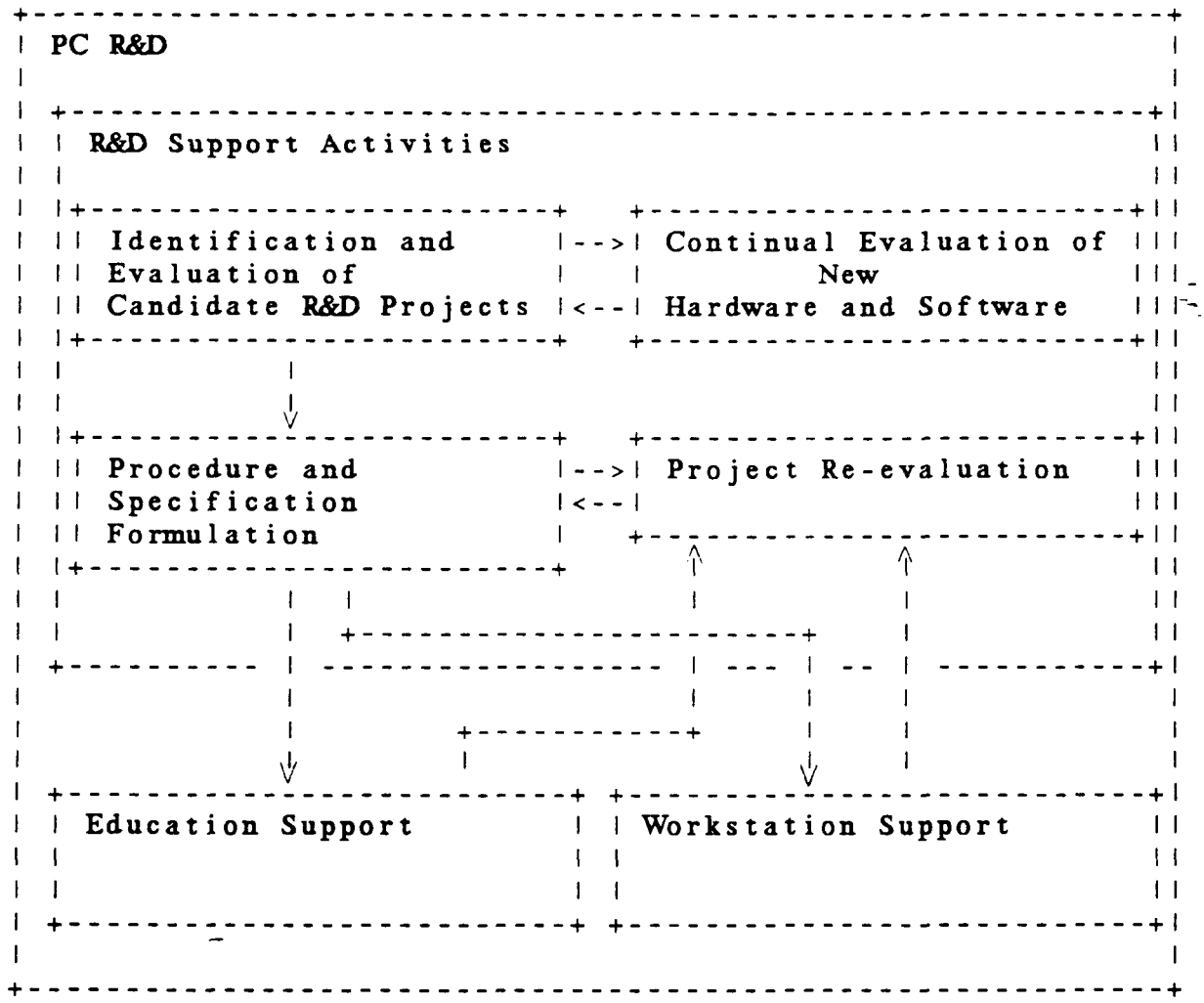
3) The development of procedures and guidelines for the initiation and conduct of research activities

4) The development of procedures for constant re-evaluation of ongoing projects in order to justify the continued committment of resources to these activities (FIGURE 2).

These mechanisms were developed and put into place in the summer of 1984 [Chum, 84a].

FIGURE 2

PC R&D OVERVIEW



The projects initially identified for inclusion in the PC R&D project were an interactive presentation and development system (IPDS) [Moreau, 84], a distributed

engineer's and scientist's workstation [Chum, 84], a statistical analysis support package [Bassari, 84], and a common interface to multiple information storage and retrieval systems [Hall, 84]. Substantial work has been completed on these projects and a number of individuals are presently involved in activities associated with each of them.

The identification of hardware and software resources necessary for the implementation of these projects has been an ongoing process since the initiation of the project. Individuals involved in various aspects of the project are continuously involved in identification of required resources and the evaluation of new products as they become available. The presently available hardware (FIGURE 3) and software (FIGURE 4) resources represent a highly effective environment for development and evaluation of development efforts.

The PC/MISI project is designed to be integrated, along with other systems being developed, into a workstation environment. PC/MISI is also intended to be used as a research vehicle to be used in the evaluation of different display devices and techniques.

FIGURE 3

USL/DBMS NASA/RECON/JPL

PC R&D HARDWARE ENVIRONMENT

2 IBM PC/XTs - Color Monitor
480KB RAM
8087 Math Co-processor
TECMAR Graphics Master
(640x400, 16 Colors)
Joystick, Light Pen, Mouse (1 each)

1 IBM PC - Monochrome Monitor
256KB RAM

1 IBM 3270 PC/G - Hi-Resolution Color Monitor
(720x512, 8 Colors)
576KB RAM
Digitizer Tablet, Mouse

3 3-COM Ethernet Network Interfaces
(10 Million Bits/Second)

2 1200/300 Baud MultiTech Intelligent Modems

2 IBM & TI Dot Matrix Graphics Printers

1 IBM Color Ink Jet Graphics Printer

FIGURE 4

USL/DBMS NASA/RECON/JPL

PC R&D SOFTWARE ENVIRONMENT

Programming Languages

- Computer Innovations C86 C Compiler
- IBM Pascal 2.0 Compiler
- Micro-Prolog Logic Programming System
- XLISP Object-Oriented Programming System
- IBM Basic Compiler

Operating Systems

- IBM PC/DOS 2.1 - 3.0
- IBM PC/IX Microcomputer UNIX System III

File Management Systems

- PHACT ISAM File and Index Manager
- DBASE II Relational Database Manager

Document Processing

- Emerging Technologies EDIX/WORDIX

USL/DBMS NASA/RECON/JPL

PC R&D SOFTWARE ENVIRONMENT (Cont'd)

Network System Software

- 3-COM Ether Series - ETHERLINK
- MIT Ethernet Support System

Communications Packages

- IBM Asynchronous Communications 2.0
- Crosstalk Communications Manager
- Hayes SMARTCOM II Communications Manager
- PC-VT Terminal Emulation System
- Kermit File Transfer System

Graphics Support Software

- Media Cybernetics Halo Graphics System
- IBM Graphics Control Program (GCP)
- IPDS Interactive Presentation Development Development System

VIII. CONCLUSIONS

7.1 Goal Attainment

The design of PC/MISI was intended to accomplish six goals as identified in Chapter III. This section will discuss each of these goals and describe the specific PC/MISI design parameters which were utilized in the pursuit of each of these goals.

GOAL 1: Design a system which allows ease of access to multiple information systems to both the casual user and the experienced user.

The system as currently designed allows the user to access multiple systems armed only with the name of the system, the names of the system databases, and a generalized knowledge of the information contained in the system. The casual user needs no knowledge of the host system command language although the interface administrator is required to be able to extract this knowledge from the host system manuals. The problems of establishing initial contact with the system, which have been identified as a substantial roadblock to information system access have been reduced to a matter of simply selecting the name of the desired host system. The problem of memorizing multiple command languages

has been solved by providing the most casual of users with a set of menus which will fulfill all of their search and retrieval needs and allow these users to progress smoothly to an intermediate level using a single command language to access multiple systems by incorporating these commands into the menu system. The expert user is also provided with the capabilities he desires by allowing him to switch to direct host system access to execute more exotic system commands while at the same time retaining the advantages which are available because of the local processing capability of the personal computer.

GOAL 2: Utilize the local processing capabilities of the personal computer to enhance the search and retrieval process.

The local processing capability of the personal computer has been used by PC/MISI in a number of ways to enhance the search process. The translation of common commands into host system commands and the interpretation of host system responses into a common format is obviously not possible without some local processing power. Similarly the transparency of the communication and connection process is dependent upon and provided by local processing.

Additionally the user is provided with the capability of

directly using local processing capability to manipulate information downloaded from host systems. He will have the capability of merging information from different systems, perusing the information at his convenience, performing sorting and editing of sets of information, and print the information locally at his convenience.

GOAL 3: Design a system which provides the user with sufficient guidance and interactive capability to maximize the utilization of his subject knowledge in the development of system search strategies.

The rationale behind this goal was to wean the user away from the utilization of information specialists for searching information storage and retrieval systems and to provide the user with some level of "advice" in the utilization of the host systems. The first part of this goal was accomplished by reducing the command set to a size which will be easily assimilated by the user and providing him with a structured system which will allow even the most casual user to begin using the system with a minimum of instruction. The provision of "advice" in the current design involves the trapping of certain host system errors and the provision of additional information to the user in order to overcome these errors. The most useful of these provisions in the current design is

that intended to guide the user to appropriate search terms when the one he entered is not found.

GOAL 4: Design a system which utilizes state-of-the-art interface design tools available for personal computers while retaining maximum portability.

The definition of state-of-the-art interface design tools for personal computers is very elusive. The current design of PC/MISI uses windowing techniques and color displays to improve the interaction between the user and the system and also provides the optional use of a light pen for certain functions. The most important consideration here, in light of the rapidly developing nature of this subject, is to provide the flexibility for the incorporation of new tools as their usefulness is proven. The modular design of PC/MISI ensures the efficiency of this operation and this area has also been identified as a possible area of future research in Section 6.1.

GOAL 5: Design a system which may be used for research activities related to the improvement of access to IS&R systems and which provides the necessary monitoring and evaluation tools for such research.

The general evaluation plan is described in Section 4.5 of this document and possible research areas are identified

in Section 6.1. A specific evaluation plan for evaluating the system is currently being developed by one of the individuals involved in the implementation of the system and this plan includes the identification of monitor data and the design of the data collection mechanisms.

GOAL 6: Define future system enhancements.

A number of possible enhancements to PC/MISI have been identified in Section 6.2 and a methodology of evaluating proposed enhancements has been identified in Section 6.1. The potential for enhancement will, of course, increase as the processing power of the personal computer increases and the key once again is the flexibility of the current which will allow these enhancements to be incorporated into the system as they become available.

7.2 Specific Objectives Attainment

The following objectives were identified in Section 3.2 as necessary components of a system design to accomplish the goals of the development effort. An evaluation of the design plan in reference to these objectives will be presented. Section numbers in this section refer to the PC/MISI Design Plan [Hall, 85:].

OBJECTIVE 1: Provide Ease of Access to Multiple Systems.

The system should allow the user to simply choose the information system he wishes to access and PC/MISI should perform all necessary procedures required to establish communications. (Note: This process will also involve security problems which will have to be resolved).

The design plan presents the methodology for providing the capability described [Hall, 85: Sections 4.3 and 5.1]. The user will have no requirement for knowing any of the details of the communication and access processes. The protection of this information within the PC/MISI system will be handled by requiring each user to have a unique PC/MISI password and by encrypting the actual passwords stored in PC/MISI files [Hall, 85: Section 1.1.1].

OBJECTIVE 2: Provide for Addition of New Systems.

PC/MISI should have a modular design which will facilitate the addition of new information systems or new processing systems as the need arises.

The actual addition of new systems to PC/MISI requires that one user (the interface administrator) have a good

understanding of the system to be added or that the system manual be very clear as to the exact methodology and syntax of each function. The process of adding a new system [Hall, 85: Section 5.1], does, however, provide a step-by-step procedure which will assist this individual in accomplishing this and also provides the capability of verifying the entries by directly interacting with the host system and then making any modifications necessary. Once this process is complete and the necessary tables have been created, other users of the PC/MISI system will be able to incorporate these tables into their system easily and modifications to the system as a result of host system modifications are relatively simple requiring only the editing or replacement of table entries.

OBJECTIVE 3: Develop System Documentation

The system user manuals and other documentation should be developed in concert with the system design in order to ensure clarity and relevance.

The rationale behind this objective was to ensure that the programmers who would implement the system were aware of exactly what the users of the system required. As the design of the system progressed, it became obvious that this information could be better utilized if it was incorporated

directly into the design plan which the programmers would use as a blueprint for implementation rather than in a separate document. The design plan therefore incorporates specific definitions of the presentation of information to the user and the required user response. The information contained in the design plan can therefore be modified to reflect the user's view and incorporated into the user manual directly when this document is written.

OBJECTIVE 4: Provide Multilevel Capabilities.

> PC/MISI should have interfaces designed for use by users with different levels of expertise and should provide smooth transition from one level to another as the user's level of expertise changes. The user should also be able to choose his own level if he so desires.

The first-time or infrequent user of PC/MISI is provided with a menu-driven system (Level I) which he can use with very little instruction [Hall, 85: Section 1.3]. This level of interaction provides prompts and menu items which are self-explanatory. The menu system also serves as a training course for users who wish to progress to the Level II command-driven system since the Level II commands are incorporated into the Level I system and highlighted to

enhance memory retention. Via a Level III interface, the more advanced user can interact directly with the host system to utilize more exotic system capabilties yet still retain the PC/MISI common file structure for downloaded accessions if so desired. PC/MISI also provides the capability of easily switching back and forth between levels to provide a greater degree of flexibility.

OBJECTIVE 5: Maintain User Orientation.

> PC/MISI should keep the user informed at all times of his location within the system as well as other pertinent information. The system design should include the definition of all information which should be available to the user and the methods of providing such information.

Knowing where he is in the system is important to a casual user to assist him in conceptualizing the system and becoming more comfortable in using it. Additionally, providing commonly desired information (date and time) is also instrumental in improving the user's opinion of the system [Saja, 85]. PC/MISI provides this information in a reserved user orientation window at the bottom of the screen.

OBJECTIVE-6: Utilize User's Knowledge.

PC/MISI should provide users with "advice" on how to develop search strategies to best utilize their specific subject knowledge. This should be an integral part of the highest level user interface and also available on request to the more experienced user.

The PC/MISI design plan provides feedback to the user allowing him to find related search terms and alphabetically-adjacent terms when the system receives information that a particular search has been unsuccessful [Hall, 85: Section 3.2). This will provide the user with some assistance in his searches, but does not satisfy the objective as originally established. The fulfillment of this objective would require a much more complex interaction between the user and the system and the available time and resources have not allowed the development of a design for this functionality. The incorporation of this function into the system in the future will involve the development of a knowledge base of information concerning possible search strategies and a method of selecting and presenting a subset of these strategies to the user.

OBJECTIVE-7: Facilitate Downloading of Information.

PC/MISI should provide simple procedures for allowing users to store information from remote systems in the storage units of their personal computers, edit this information as desired, and print the information on their local printers.

PC/MISI provides the capability, at all levels, of downloading accessions from multiple host systems into a common file format to be used for local storage of information [Hall, 85: Sections 1.3.5 and 3.3]. These files may then be sorted, merged, examined, or printed by the user at his convenience [Hall, 85: Section 1.3.7].

OBJECTIVE 8: Provide Batch Processing Capabilities.

PC/MISI should provide the capability of designing an entire search sequence prior to accessing the remote system and then uploading the entire sequence to the remote computer and executing it. The user should also have the choice of running this as an interactive process or as an offline batch procedure (assuming remote system support for this procedure).

The user has the capability at all three levels of building a set of commands to be sent to the host system for execution [Hall, 85: Section 1.3.6]. These commands may also be stored for future use.

OBJECTIVE 9: Provide Error Handling Capabilities.

> The error messages within PC/MISI should be designed to guide the user to the correct procedure. PC/MISI should provide an interpretation of remote system error messages where necessary and provide the user with additional information and assistance where required.

The error handling capabilities of PC/MISI are described in the design plan. The capability of identifying specific host system errors and generating additional information concerning these errors which will assist the user in recovering from these errors. Additionally, other host system errors will be identified if the host system uses a standard error format and these errors will be displayed in a specific and consistent location on the user display device [Hall, 85: Section 3.1]. PC/MISI will also identify and trap local errors, assisting the user where possible and, in all cases, preventing abnormal termination [Hall, 85: Section 1.7].

OBJECTIVE 10: Extract Maximum Benefit from Display Capabilities.

The interface design should make use of graphical and screen management capabilities in order to maintain user interest and assist the user in his search efforts. Care must be taken, however, to ensure maximum portability when using these tools. Concepts of information processing psychology should also be incorporated into design decisions regarding the utilization of these tools in order to provide naturally usable interface formats and maximize user information processing capabilities.

The user interface of PC/MISI [Hall, 85: Chapter 1] describes the utilization of windowing and color display capabilities used to enhance the usability of the system. The full potential of the display management capabilities of the personal computer will be explored in future research and development activities utilizing the present modular nature of the system to experiment with different configurations (see Section 6.1 of this document). This particular subject is developing rapidly and the major concern in the present design plan is to maintain maximum flexibility in order to

incorporate and experiment with new tools as they become available.

OBJECTIVE 11: Identify Necessary Data for Evaluation.

The information to be collected for monitoring and evaluation will be defined and the analyses to be conducted on this information will be identified.

This activity is presently in progress by an individual involved in the implementation of the system. The major goals of the evaluation process have been identified in this document (Section 4.5) and these goals are being used as guidleines for the identification of the data to be collected.

OBJECTIVE 12: Design Data Collection Tools.

The data collection system will be described. This will include software monitors as well as user evaluation forms.

These tools are being designed by an individual involved in the implementation of the system. The final product will be a set of data collection tools which will serve as a mechanism for the utilization of PC/MISI as an experimental

vehicle (see Sections 4.5 and 6.1 of this document).

OBJECTIVE 13: Identify Uses of Artificial Intelligence for Future Enhancements.

The possible uses of artificial intelligence and knowledge bases as tools for enhancement of user interaction should be identified and necessary system design decisions will be made to allow the future incorporation of these tools.

The modular design of PC/MISI will allow the incorporation of many different capabilities into the user interface. The possibilities of utilizing artificial intelligence and expert system tools for the enhancement of this interface have been identified in Section 6.1 and Section 6.2 of this document.

OBJECTIVE 14: Identify Multi-User Conversion Possibilities.

The original system design will be oriented toward a single user. The possible future incorporation of multi-user capabilities will be discussed as well as factors associated with the incorporation of the system into a distributed workstation environment.

The utilization of the PC/MISI by multiple users is tied to the possibility of distributing some of the functionality of the system. These possibilities are discussed in Section 6.1 and Section 6.2 of this document.

OBJECTIVE 15: Maximize Flexibility.

> The system design should provide the capability of easily implementing changes which may be required by modifications to any supported remote system.

The administrative subsystem of PC/MISI provides the capability of making changes necessitated by modifications to remote systems. The interface administrator may make these changes by substituting the new command into the System Command Table through the utilization of the administrative subsystem of PC/MISI [Hall, 85: Section 5.2].

7.3 Summary

The results of this design effort have been to demonstrate that the personal computer does have a critical place in the process of information retrieval. The functionality incorporated into the design provides a means of solving a number of problems which have been identified as roadblocks to the efficient utilization of information

storage and retrieval systems. The system design has been "paper-tested" on a number of IS&R systems (NASA/RECON, DOE/RECON, DIALOG, BRS, ORBIT, and MADAM) and has been shown to provide a common means of access to these systems. The system is currently being implemented and the implementation process has progressed sufficiently to allow a determination that the system can be efficiently implemented utilizing currently available personal computer hardware. The addition of enhancements to standard capabilities of IS&R systems through the utilization of local processing has also been shown to be effective in easing access to IS&R systems.

The conclusion of this thesis then is that the personal computer is, indeed, a useful tool in providing a common interface to multiple IS&R systems and that the design of PC/MISI provides the functionality necessary to provide such an interface. This does not, however, imply that the personal computer must function alone in providing this functionality. The distribution of some functionality to larger systems when such systems are available is certainly a possibility whcih should be considered and the modular design of PC/MISI will allow the implementation of such distribution with a minimum of effort. The utilization of local processing power under the control of the user is, however, a necessary ingredient in any effort to provide the casual user with a usable and

efficient- interface to multiple remote information storage and retrieval systems.

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ABSTRACT

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The amount of information contained in the data bases of large-scale information storage and retrieval systems is very large and growing at a rapid rate. The methods currently available for accessing this information have not been successful in making the information easily available to the people who have the greatest need for it.

This thesis describes the design of a personal computer based system which will provide a means for these individuals to retrieve this information through one standardized interface.

The thesis identifies each of the major problems associated with providing access to casual users of information storage and retrieval systems and describes the manner in which these problems are to be solved by the utilization of the local processing power of a personal computer. Additional capabilities, not available with standard access methods, are also provided to improve the user's ability to make use of this information.

The design of PC/MISI is intended to facilitate its use as a research vehicle. Evaluation mechanisms and possible areas of future research are described in this thesis.

The PC/MISI development effort is part of a larger research effort directed at improving access to remote IS&R systems. This research effort, supported in part by the National Aeronautics and Space Administration, is also overviewed in this thesis.

BIOGRAPHICAL SKETCH

Philip P. Hall was born in [redacted] on [redacted]. He was graduated from McNeese State University in 1972 with a Bachelor of Science Degree in Biology. He enrolled in the Graduate Program in Computer Science in January, 1983 and is presently a candidate for the Master of Science degree. He was a research assistant from June, 1984 to December, 1984 on the USL NASA/RECON Project (NASA Contract NASW-3846) and has been a research assistant on the USL NASA/JPL Project since January of 1985. Previous publications include:

"Analyses Directed Toward User/System Interaction", Chapter 13 in Information System Monitoring, Analysis, and Evaluation, W. D. Dominick and W. D. Penniman, book to be published by John Wiley & Sons, Inc., 1985.

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