| N A S A |

USL / DBMS NASA / RECON

WORKING PAPER SERIES

Report Number

DBMS.NASA/RECON-8

The USL/DBMS NASA/RECON Working Paper Series contains a collection of reports representing results of activities being conducted by the Computer Science Department of the University of Southwestern Louisiana pursuant to the specifications of National Aeronautics and Space Administration Contract Number NASW-3846. The work on this contract is being performed jointly by the University of Southwestern Louisiana and Southern University.

For more information, contact:

Wayne D. Dominick

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

(NASA-CR-184516) A REPORT ON THE USL NASA/RECON PROJECT. PART 2: EC-BASED R AND D IN SUPPORT OF IS AND R APPLICATIONS Final Report, 1 Jul. (University of Southwestern Louisiana. Lafayette. Center for Advanced

N89-14956

G3/82 0183554 Unclas

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

Spiros Triantafyllopoulos

The University of Southwestern Louisiana

Lafayette, Louisiana

October 4, 1984

This document represents a preprint of a paper that has been accepted for presentation at the 18th Annual Hawaii International Conference on Systems Sciences (HICSS-18), to be held in Honolulu, Hawaii, January 2-4, 1985, (to be published in the conference proceedings).

ABSTRACT

This paper 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, "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 [5].

ACKNOWLEDGEMENTS

Our primary debt of gratitude is to the National Aeronautics and Space Administration for providing the financial support for equipment acquisition and personnel which has allowed us to pursue this line of research. This support has been provided under NASA Contract NASW-3846. The agency has provided much support in addition to finances in the form af advice and access to their technical expertise. A special measure of thanks must go to John H. Wilson, Jr. , the NASA Contract monitor who has given generously of his time and knowledge and to Jack Kolb, Principal Army Technical Information Officer, Directorate for Technology Planning and Management & our Primary DoD contact person.

We would also like to extend our appreciation to Nancy Van Nortwick and other personnel of International Business Machines Corporation, Baton Rouge, Louisiana, who have given us much support. This support has been not only in the form of providing excellent equipment at very reasonable prices but has also included the donation of software as well and the loan of equipment for evaluation purposes. Their support in the form of technical advice and consultation has also been invaluable.

The Graduate Student Organization of the University of Southwestern Louisiana has also provided much needed financial assistance to individual students conducting thesis research as part of the PC R&D effort. This assistance has benefited not only these individuals, but also, the equipment purchased with these funds will continue to support related research efforts for many years to come.

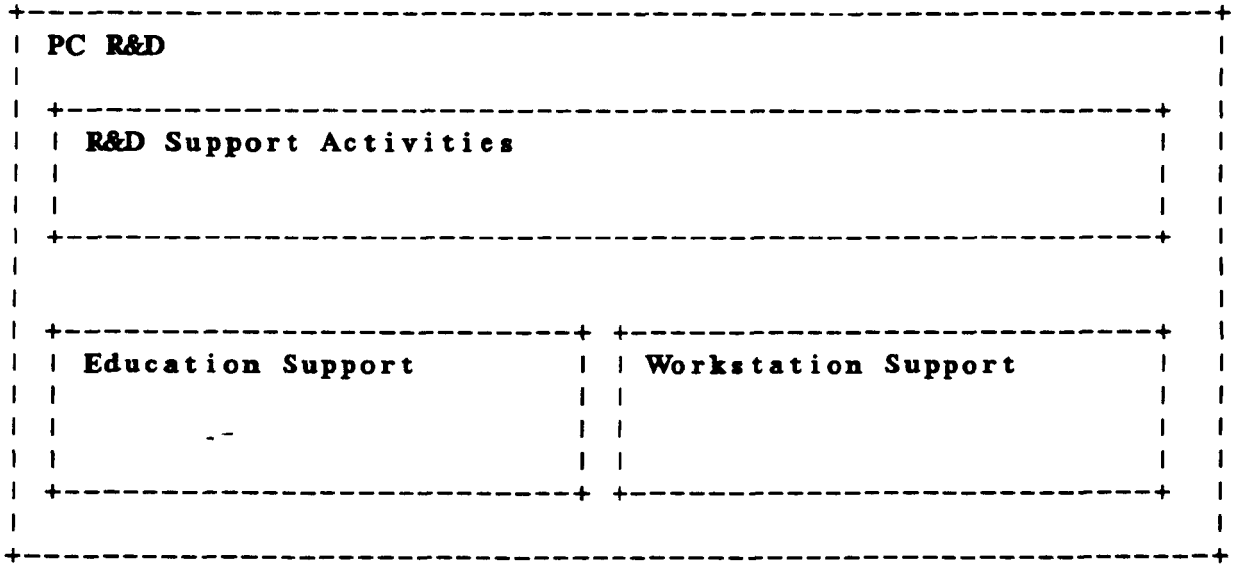
Special recognition must be extended to other members of the NASA contract team, Suzy Gallagher and Martin Granier who, although their primary interest has been in the course development area, have both contributed invaluable guidance and advice to the PC R&D effort.

Finally, it must be noted that there would be no PC R&D Project without the planning and guidance provided by Dr. Wayne D. Dominick. His dedication to the NASA Project and to the PC R&D activity, in particular, has provided a framework within which we can conduct our research activity. The impact of his inspiration, guidance, and expertise can not be adequately described in this space and the debt of gratitude which we owe to him is impossible to express.

1. INTRODUCTION

The decreasing cost and increasing capability of personal computers (PCs) have made these machines a potentially effective tool for satisfying the information processing needs of many scientists and engineers [4]. 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 [2].

The major goals of this project (see Figure 1) are to establish a robust PC research and development environment, to develop PC-based educational support tools for training in the use of IS&R systems, and to develop PC-based systems to support the interaction of scientists and engineers with local, distributed, and remote information resources.



Relationships Between Goals
Figure 1.

2. PC R&D SUPPORT ACTIVITIES

Establishing an effective R&D environment involves the instantiation of mechanisms to identify and evaluate candidate R&D tasks, to facilitate the acquisition of appropriate equipment and software tools, to establish specifications and procedures for the development of initiated tasks, and to review the progress and results of development efforts (see Figure 2). These activities should be highly objective and therefore independent of the actual development efforts.

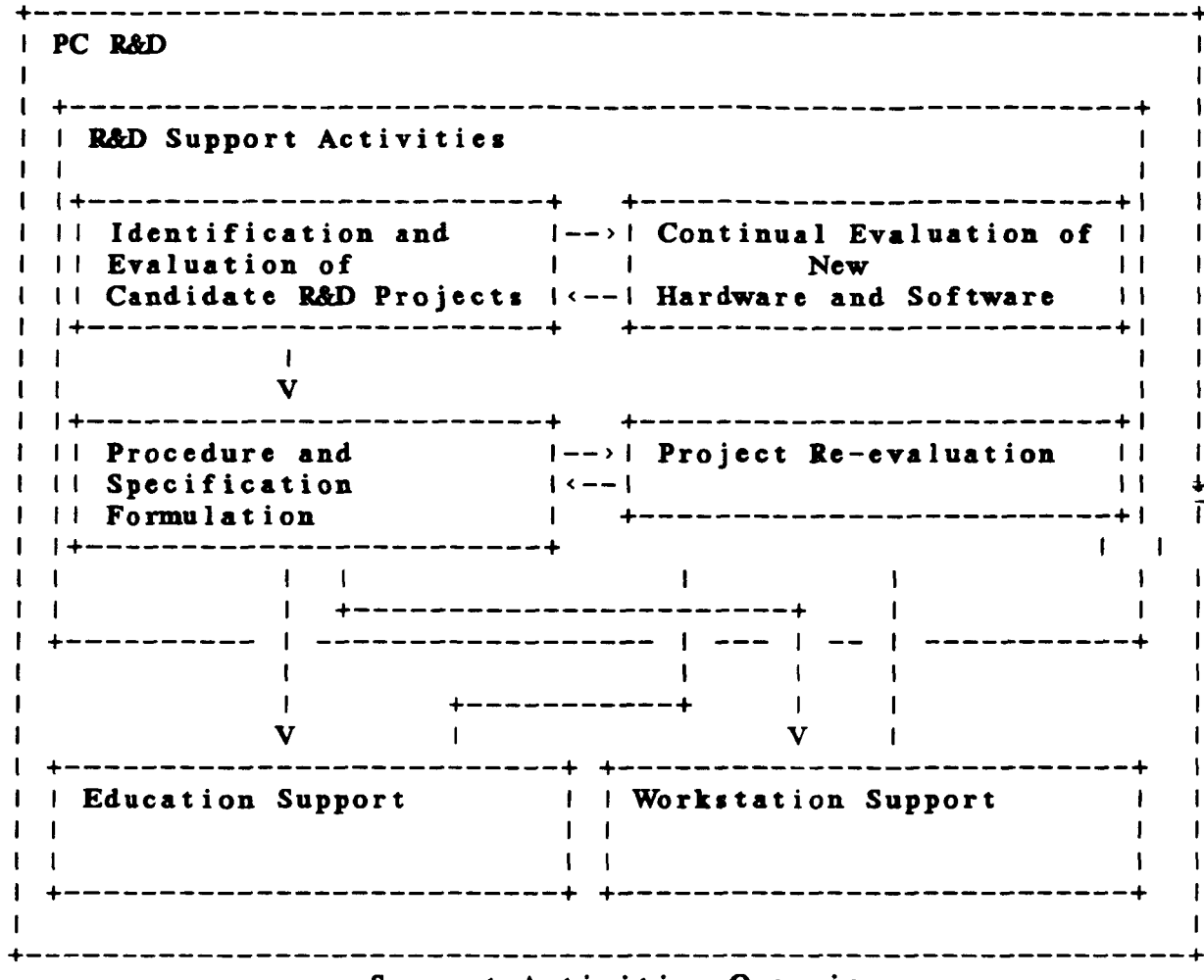
Candidate tasks may be identified as extensions of previous research, exploration of new concepts, or pursuit of individual interests. A candidate task is evaluated to determine if it is appropriate to the overall goals of the PC R&D project and to determine its feasibility. A task is feasible if it can be accomplished on available PC hardware, by using available software tools, and by employing available personnel. This is, of course, subject to ever present cost constraints.

Commercially available PC hardware and software are continually evaluated for 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 in this phase if equipment, software, or additional personnel are needed for a development effort.

Specifications are formulated for tasks which are judged to be feasible. These specifications are the primary criteria for evaluating the progress and the results of the task development effort. Procedures governing the development process are also delineated.

Regularly, development tasks are 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.

Currently active R&D tasks include: development of a PC-based IS&R simulator for training users in the use of IS&R systems, development of a PC-based presentation development system, 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.



Support Activities Overview
Figure 2.

3. EDUCATIONAL SUPPORT

Personal computers have great potential for the development of interactive learning environments. The efficient application of these machines to the enhancement of the learning process can result in a substantial saving in cost and time as compared to more conventional methods.

The educational support effort of the PC R&D Project is aimed at the development of PC-based tools designed to aid the information system user in learning to access the information stored in these systems (see Figure 3). These tools will complement the

university-level course development effort being undertaken by the NASA/RECON contract team [5]. Presently initiated tasks include the development of a NASA/RECON simulator and an Interactive Presentation Development System (IPDS). The simulator will allow course participants to learn and 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 costly system access time and costly long distance telephone and communications network access charges for this necessary learning activity. The simulator development effort also includes the protyping of a simulator generator which will allow the efficient incorporation of simulators of other systems into the project. IPDS will be utilized to develop easily transportable and extremely flexible visuals for the training courses.

3.1 NASA/RECON SIMULATOR

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-scale, 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.

An information system simulator is defined as a program that behaves like a certain (existing or non-existing) information system. The purpose of such a simulation is multiple: prototyping, CAI, reducing online costs, etc. In the NASA/RECON simulator, the main motive has been the development of a simulator as an educational tool to allow instruction without paying the high ($50.00/hour or more) cost of long distance telephone charges, TELENET charges, and online host system charges. Also, CAI can easily be embedded in the implementation so that teaching a potential user can be highly automated and thus simplified. This automation 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, non-computer specialists can be at the student's level, at any time or place, and for extended periods of time without additional costs for host online connect and access time.

In simulating an information system as large and as powerful as the NASA/RECON system, it should be of first priority to decide on the features that should be included as well as the features

to be excluded, if any. This includes not only original system features that are duplicated or simulated on the personal computer, but also additional features that the simulator 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 of the host environment and the available capabilities of the simulator environment is nessecary to ensure the quality and high performance of the final product in the educational/R&D environment.

Until now, the development of the NASA/RECON PC-based simulator has been mainly in the design stage. The functions of the original NASA/RECON system that are to be included have been defined. The appropriate algorithms and data structures to be used for implementation of the major components have also been defined. The simulator implementation language is going to be the "C" language, and a commercially available file management program will be utilized to perform all data base management needs. It is the intention of the design that the system developed be compatible with virtually any computer system that has the language capabilities mentioned.

As the future expansion of the project introduces new systems into the contract scope, the design of individual simulators seems to be inefficient in terms of development time and effort. As a future, but feasible, view of the project, an information system simulator generator, retargetable at any IS&R system is a solution which is being explored presently. Parameterization of various IS&R systems and a simulator generator prototype can have a large impact on education of non-computer science users, since new features of existing systems and/or new systems may be added and presented in the most efficient manner.

3.2 INTERACTIVE PRESENTATION DEVELOPMENT SYSTEM (IPDS)

The second of the currently active development tasks in the educational PC R&D support area is IPDS. This system was designed to provide a very interactive way to create, edit, and control 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.

Individual display frames are created on a personal computer using very simple IPDS key sequences. Background, border and character colors can be changed with a single keystroke. The cursor keys permit flexible positioning of the cursor anywhere on the screen. Primitives for easily creating boxes and bar graphs are provided. 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 referencing. Displays may be edited or created during the presentation to answer questions or to post assignments. 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.

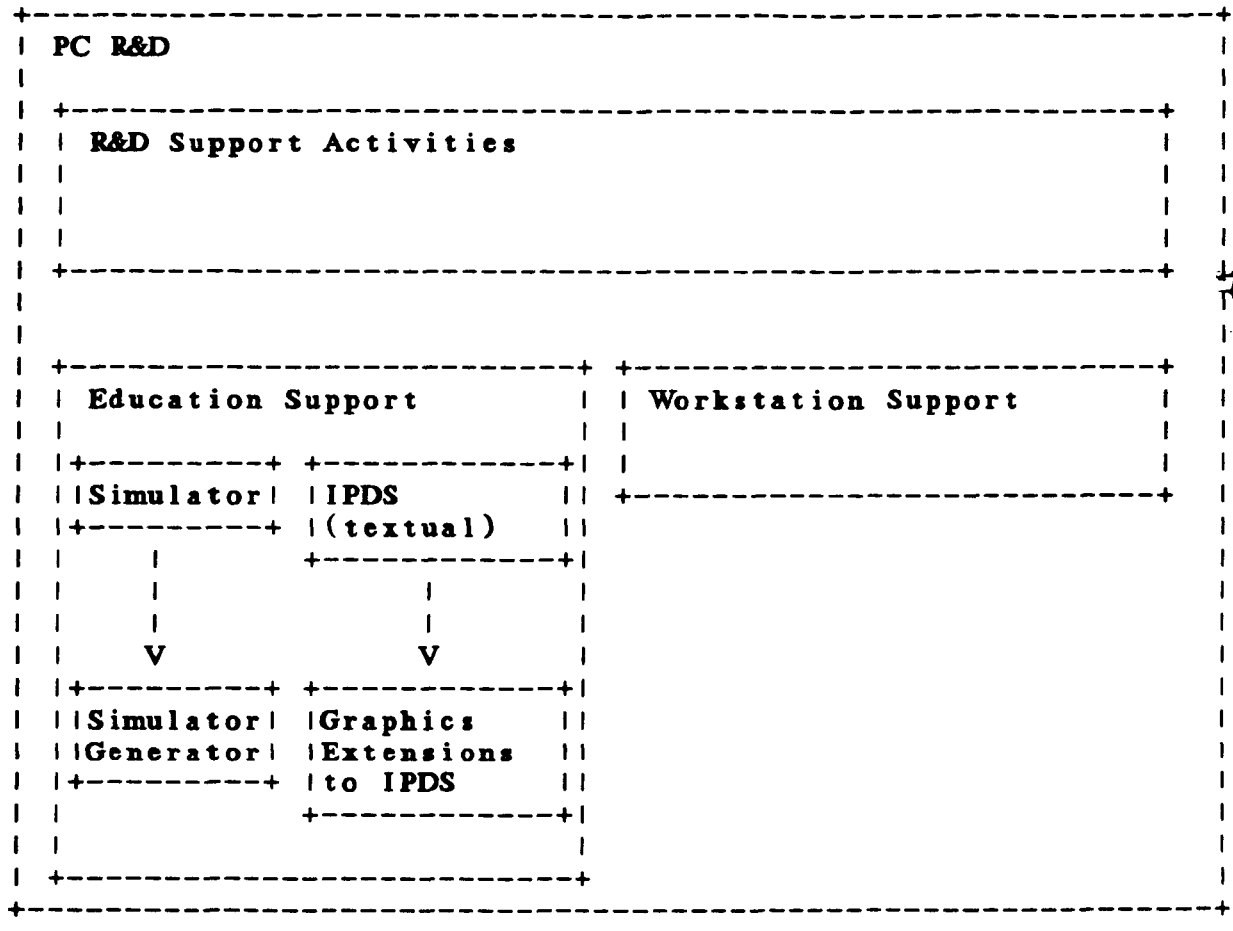
In contrast to traditional instructional preparation using overhead transparencies, IPDS allows users to easily create, edit, transport, and control video presentations without the difficulty of manually handling (or mishandling) a stack of transparencies. The entire process can be carried out at a user's desk or workstation with no delay for additional processing. The system is currently being introduced to the faculty at the University of Southwestern Louisiana for instructional use in conjunction with video projection systems.

3.3 FUTURE CONSIDERATIONS

The educational support projects presently in the implementation phase are primarily intended as complements to the development of comprehensive multi-disciplinary educational courses. The future direction of this effort includes the incorporation of these tools into an expanded and self-contained PC-based instructional system.

The identification of new applications of personal computers to the task of training users to efficiently access information systems is a continuous process. Rapid advances in technology ensure that capabilities of future models of personal computers will be much greater than that of the present generation. All development efforts must therefore produce systems which will be flexible enough to utilize this increased power.

The application of techniques of artificial intelligence and expert systems to educational efforts is one area which is becoming more feasible as the processing capability and memory capacity of personal computers increases. New interactive techniques of human/computer interaction are also being developed rapidly and their incorporation into PC R&D educational projects will be continuously evaluated as they become available.



Education Support Overview
Figure 3.

4. INTEGRATED WORKSTATION SUPPORT

4.1 Introduction

The concept of a personal workstation to satisfy the information processing needs of scientists and engineers has received much attention lately [6, 8, 11]. This attention has focused, however, largely on expensive customized workstations, costing in excess of $20,000 [7, 8].

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 (see Figure 4). In order to achieve this goal, we will identify the functional specification of such a workstation and develop a prototype workstation as an experimental environment. We will then address the development of a common user interface to provide transparent access to resources in the workstation environment. Figure 4 illustrates the components of the integrated workstation support.

The initial task in developing a prototype experimental workstation was to develop a general statistical analysis package as a testbed for integration of commercial and prototype software. The statistical package will integrate with other components to form a total environment for scientific/engineering processing. Data analysis from information downloaded 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, for the non-specialist, the more user-friendly interfaces (interactive and batch languages) supply the neccesary 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
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.

4.2 LOCAL SUPPORT

Access to local resources 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.

4.3 DISTRIBUTED SUPPORT

The proposed PC-based Distributed Workstation (PCDWS) prototype will give the users (scientists and engineers) an integrated PC-based workstation environment for transparent access and sharing of resources available from both local and remote facilities.

The PCDWS 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 intercommunication and uploading/downloading protocols between workstation and remote mainframes as well as between workstations, thus providing access to multiple local and/or remote DBMSs and IS&R systems.

4.4 REMOTE ENVIRONMENT SUPPORT

Most scientists and engineers who access information systems fit into the category of the casual (infrequent) user. These individuals have a great need for information now present 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 via associated multiple command/query languages is required. This category of users exhibit considerable difficulty in simply gaining access to the systems [1, 10] and their ability to extract complete information has been shown to be limited [3]. One solution 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.

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 capability to access multiple systems. A truly flexible interface should provide capabilities 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 increasingly attractive choice for the implementation of such an interface.

Providing ease of access to information stored in remote information storage and retrieval systems is the major goal of this entire project. The aim of this particular development effort is to provide the engineer or scientist with a PC-based system which allows him to access information stored in multiple external systems through one common interface. The personal computer will act as a translator of the user's requests for information and the user will be spared the necessity of learning to interact with many different systems in order to retrieve a broad range of information.

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 [9].

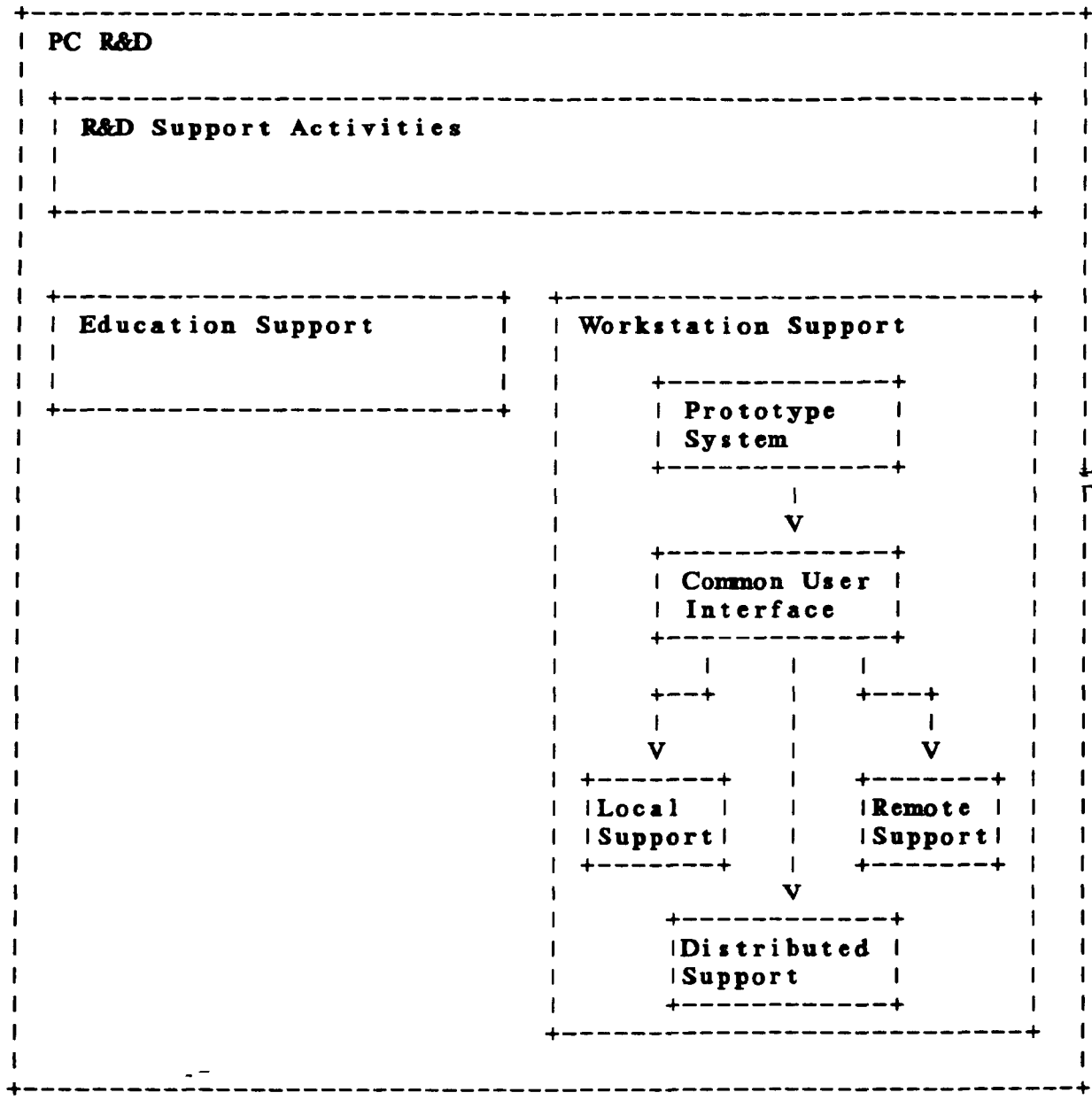
User access to information stored in remote environments will be provided through a multi-level interface which allows the user to progress from a prompting-oriented interaction which guides the user through the steps necessary to retrieve his information, to a user-driven interaction which provides maximum flexibility and as little interference as possible.

The interface will also provide efficient methods of handling the downloading and uploading of information. All downloaded information of a similar nature will be translated into a common format for local display so that the user will have consistency in the representation of information regardless of the source. Batch processing functionality will be provided to allow the user to maximize his online utilization time. The user will also be able to perform other functions during the time required to download information if he so desires.

The interface will make maximum use of the display capabilities of the personal computer by the incorporation of windowing displays, 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 interface will also provide facilities for the collection of monitor information for evaluation purposes. This information is intended to be utilized 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 new 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.



Workstation Support Overview
Figure 4.

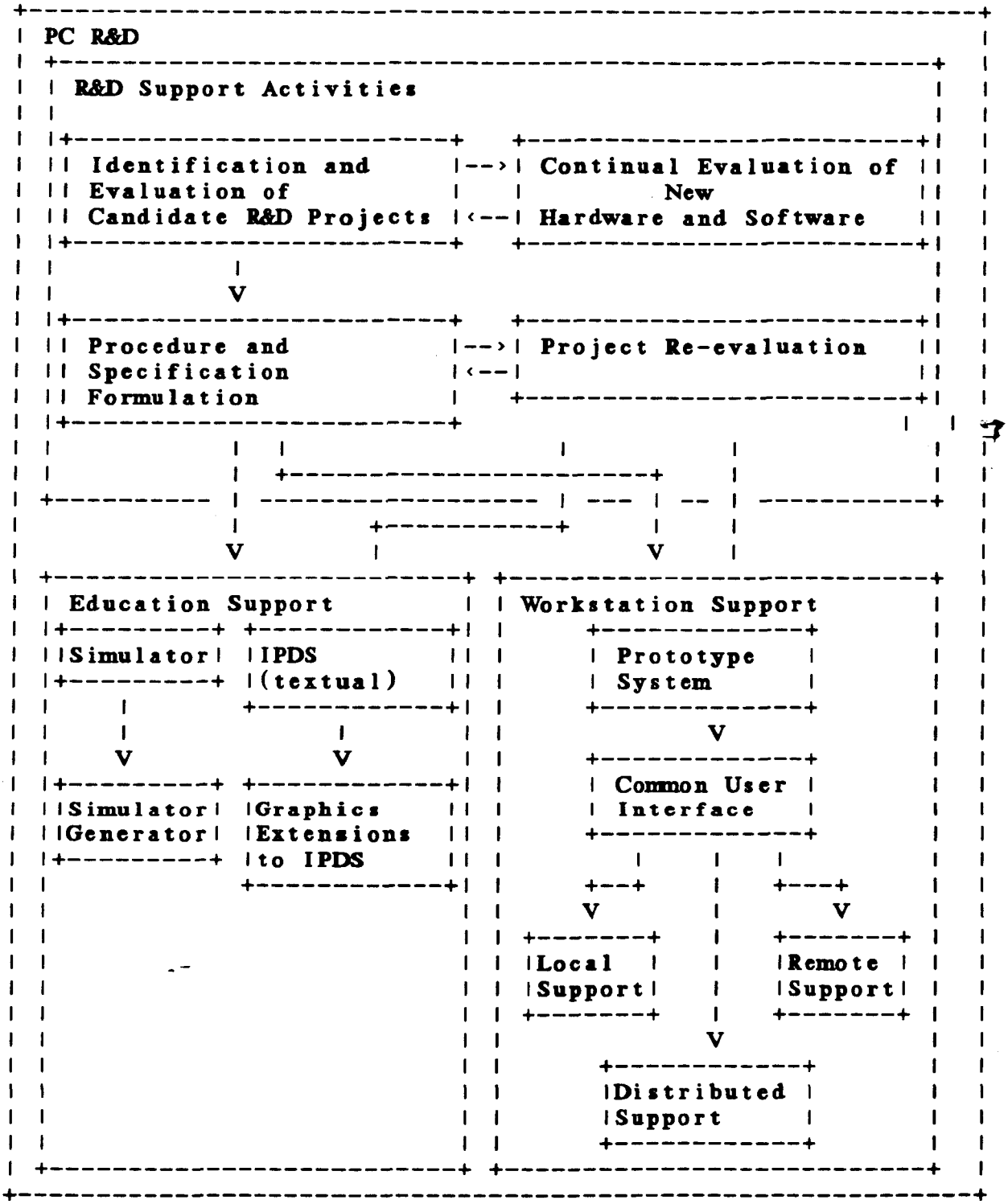

PC R&D
R&D Support Activities
Identification and Evaluation of Candidate R&D Projects
Continual Evaluation of New Hardware and Software
Procedure and Specification Formulation
Project Re-evaluation
Education Support
Simulator
IPDS (textual)
Simulator Generator
Graphics Extensions to IPDS
Workstation Support
Prototype System
Common User Interface
Local Support
Remote Support
Distributed Support

Figure 5.

5. FUTURES

To date, the research and development efforts of the PC R&D project have been concentrated toward establishing a viable base for exploratory efforts in the integrated workstation area. The vast array of low cost enhancements available for personal computers makes possible much of the functionality of more expensive specialized professional workstations. Some of these enhancements are :

- High speed network interfaces
- High speed general and special purpose processors
- Advanced graphics boards and interaction peripherals
- Large capacity personal mass storage
- Highly developed system software
- Very useful software tools.

These and future enhancements are the foundation for extending the capabilities of personal computer systems. Making effective use of this increased capability will require addressing some tough system design issues.

Future projects will deal with generalizing access to all available system resources to simplify user-computer interaction, extension of the user interface to incorporate advanced graphics, knowledge based systems, speech processing, design of natural dialog support, and efficient utilization of distributed resources. Many other projects will be identified and efforts will be initiated for addressing them within the PC R&D project. The extent to which we effectively support and manage these efforts will largely determine their success and integrability into subsequent explorations. It is believed that we have established a technically sound, consistent, and extensible PC environment conducive to this end.

The personal computers of the future will possess much greater processing capabilities and have much larger memories than those available today. These developments will allow the incorporation of knowledge-base applications into the local processing environment. The potential of these applications in providing access to and manipulation of data is enormous. The workstations of the future will allow the user to give instructions to his personal computer in his own voice and in his own words. The system will then carry out his request without requiring the user to have any knowledge of where the information is stored or what procedures are required to perform the requested manipulations of the information. In the long-range future, the system will be

able to gather and consolidate information from sources located anywhere in the world and present this information to the user in any format he wishes.

We are rapidly approaching a state in which practically all of the information known to man will be stored in machine readable form. The retrieval of this information then becomes a matter of establishing communication links. The use of comunication satellites will allow linkages to be established from any one point on the earth (or from space) to any facility where information is stored. New knowledge can then be distributed universally almost as soon as it is created, provided that the end users are provided with an efficient and usable means of access to these facilities. The implications of these developments for the future of our civilization approach the limits of comprehension. The personal computer will certainly be an integral part of this information distribution system and the future research efforts of this project will be directed toward the realization of the potential of these machines.

6. SUMMARY

The PC R&D effort is intended to be a continuously evolving base for research into potential utilizations of personal computers as tools for enhancing access to IS&R systems. Information presented in this paper represents a description of the current state of this development effort. The organizational framework of this project is designed to support a broad range of research areas (see Figure 5). Current tasks in progress under this framework have addressed educational support for training users in accessing IS&R systems and direct support for integrating local, distributed, and remote IS&R systems into an integrated workstation environment. These tasks and others have as their ultimate goal the enancement of the technical user's ability to assimilate information from diverse sources.

BIBLIOGRAPHY

1. M. D. Cooper, "Usage Patterns of an Online Search System," Journal of the American Society for Information Science, vol. 34, no. 5, September, 1983, pp. 343-349.

2. W. D. Dominick, "The USL NASA PC R&D Project: General Specifications of Objectives," USL/DBMS NASA/RECON Working Paper Series Report Number DBMS.NASA/PC R&D-2, June 6, 1984.

3. C. H. Fenichel, "Online Searching: Measures that Discriminate Among Users With Different Types of Experience," Journal of the American Society for Information Science, vol. 32, no. 1, January, 1981, pp. 23-32.

4. J. M. Fisher and J. D. Halford, "The Engineering Workstation: A User's Perspective," IEEE Computer Graphics and Applications, vol. 4, no. 4, August 1984.

5. S. Gallagher and M. Granier, "A Report on the NASA/RECON Project: Part I. The Development of a Transportable University-Level, IS&R Educational Program," accepted for presentation at the 18th Annual Hawaii International Conference on Systems Sciences (HICSS-18), to be held in Honolulu, Hawaii, January 2-4, 1985, (to be published in the conference proceedings).

6. W. N. Joy, "Riding the Learning Curve: The Sun Workstation Architecture," Proceedings of the Seventh Annual Hawaii International Conference on System Sciences, 1984, pp. 480-484.

7. B. Mackinlay, "The SUN-2 Workstation," UNIX/WORLD, vol. 1, no. 5 1984.

8. R. Nickel, "The IRIS Workstation," IEEE Computer Graphics and Applications, vol. 4, no. 8, August 1984.

BIBLIOGRAPHY

9. N. C. Nierenberg, "The ISIS Standard," UNIX/WORLD, vol. 1, no. 3, 1984.

10. W. D. Penniman, "A Methodology for Evaluating Interactive System Usage, " SIGCHI Bulletin, vol. 15, no. 4, April, 1984, pp. 6-11.

11. V. Pratt, "Standards and Performance Issues in the Workstation Market," IEEE Computer Graphics and Applications, vol. 4, April, 1984, pp. 71-76.

4.9

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
IN	183554 ~~147409~~ 221.	

4. Title and Subtitle	5. Report Date
USL/NGT-19-010-900: A REPORT ON THE USL NASA/RECON PROJECT: PART II. PC-BASED R&D IN SUPPORT OF IS&R APPLICATIONS	October 4, 1984 DATE OVERRIDE
	6. Performing Organization Code
7. Author(s) FRANK Y. CHUM, PHILIP P. HALL, DENNIS R. MOREAU, AND SPIROS TRIANTAFYLLOPOULOS	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address University of Southwestern Louisiana The Center for Advanced Computer Studies P.O. Box 44330 Lafayette, LA 70504-4330	11. Contract or Grant No. NGT-19-010-900
	13. Type of Report and Period Covered FINAL; 07/01/85 - 12/31/87
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

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/DBMS NASA/RECON Working Paper Series report number DBMS.NASA/RECON-7.

This report represents one of the 72 attachment reports to the University of Southwestern Louisiana's Final Report on NASA Grant NGT-19-010-900. Accordingly, appropriate care should be taken in using this report out of the context of the full Final Report.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
PC-Based Environments, PC-Based Tools, Information Storage and Retrieval Systems	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	20	

*For sale by the National Technical Information Service, Springfield, Virginia 22161