Preface

This report was completed in the summer of 1990 and represents thousands of hours of work by faculty, staff, and students of Rice University; their efforts reflect the importance that the Rice community places on computing in the future of the university. Created in the fall of 1987, the Computer Planning Board was charged with formulating a set of goals for computing at Rice and proposing a detailed strategy for their implementation; the Board has worked for the past three years with the assistance of a broad segment of the faculty and staff. Three subcommittees, Educational Computing, Research Computing, and Administrative Computing, have focussed on specific areas of computing needs on campus, and the members of these subcommittees worked many hours to produce their reports, which follow the Summary from the Computer Planning Board. The investigative and deliberative efforts of these subcommittees generated the information base and rationale for the recommendations contained in this document. The work of these groups is appreciated greatly.

The first year of the planning process was devoted to formulating goals, the second to implementation strategies, and the third to refining and combining the subcommittees' recommendations. In order to produce an integrated strategy for achieving the delineated goals, the Computer Planning Board reviewed carefully the subcommittees' recommendations for implementation and attempted to bridge the gaps between them. The Board also spent many hours in arriving at a plan which would maximize the effectiveness of the funds expended. Given a common pool of limited resources, it is imperative that expenditures are carefully directed to generate the optimal computing environment within the economic limitations. The thoughtful work of the Computer Planning Board in dealing with this complex, interwoven set of problems and aspirations has been appreciated deeply by the Chair over these past three years.

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Summary

Introduction

The plan outlined in this document delineates the goals for computing capabilities at Rice over the next five years and recommends implementation strategies to achieve these goals. The plan envisions three major initiatives: (1) to build an electronic environment for education of undergraduate and graduate students by implementing an "electronic studio" suited to the needs of each school or division, (2) to enhance faculty and staff productivity by ensuring that every faculty and staff member has access to an appropriate personal computing environment and adequate shared resources for scholarship, research, and administration, and (3) to support the use of computation by developing a strong infrastructure of trained staff members, shared networking and computing resources, electronic classrooms and administrative computing. Finally, the university should put in place a management and planning structure that will ensure the success of these initiatives and the future excellence of the Rice computing environment.

Goals

The Planning Board has identified specific goals that would address the three major initiatives outlined above. These are:

Computer Networking

A campus computer network should connect all faculty, staff, students, and administrative units and provide appropriate access to selected regional, national and international networks. This network would be used for research, education, and administration and would support electronic mail, file transfer and interactive access to remote facilities such as the library, databases, computing resources, and printing services. The network should be managed and maintained through a centralized organization to ensure convenient access, reliable and efficient operations and needed levels of security.

Computer Support Staff

The university should provide expert assistance on all aspects of computation and help manage and maintain computer resources. A central organization should assist departments and administrative units in managing their computer resources. Trained people are also needed within departments or schools. These people would provide support, personal instruction, information, documentation, and one-on-one consultations to help individuals use their computing resources effectively. The central organization should also negotiate group discounts and maintenance agreements (including on-campus maintenance where appropriate) for widely used computer equipment and should assist departments in evaluation of their computing needs and in selecting appropriate equipment. It should also provide educational assistance on topics of broad interest such as personal computing, common programming languages, networking, and access to remote supercomputer centers.

Access to Computing Resources

Access to the computational resources necessary for their work should be available to all faculty, students, and staff. Minimum standards for computing should be set, and every department and administrative unit should be brought at least to the minimum levels. Such standards would include computer access for all faculty and most staff offices, word processing, electronic mail, printing services, and access to databases. In addition, every effort should be made to assist departments with needs not met by these standards. Examples of such needs include access to high-speed supercomputing, modeling, simulation, and design capabilities, graphics and interactive use of local and national databases. The effect should be that for routine tasks computing resources are readily available within faculty and staff offices and student laboratories, with only the expensive, shared resources managed and allocated centrally.

High-Performance Computing

Resources for high-performance computing should be available for current and anticipated research areas that require this capability. High-performance computing is a research tool in many fields of social sciences and humanities (for example, economics and linguistics) and most branches of the natural sciences and engineering. Advances in computational methods and equipment deriving from computational

mathematics, computer science, and computer engineering will be essential for progress in experimental and theoretical research activities across many fields. The relatively small size of Rice University facilitates intellectual exchange that enhances research and interdisciplinary cooperation. Faculty and students working in the many areas of computational science and engineering must have convenient access to high-performance computing to seize rapidly emerging research opportunities and to ensure continuing excellence in education and research.

Computing and the Curriculum

Computing resources should be familiar tools for every student, graduate and undergraduate, and should be systematically integrated into the curriculum where appropriate. Every student should become part of a computational community and should have access to computational resources. An innovative approach to achieving this goal, the electronic studio, will be central to educational computing at Rice. At the simplest level, the electronic studio consists of a computer account and storage system that students can access from any public facility on campus. The studio is an electronic workplace and repository for student software tools, course assignments, papers and personal files. Appropriate computing resources, data bases, and information resources will be selected in each discipline to enhance the curriculum. All educational computing facilities will be integrated into the campus network. Because educational needs differ from school to school, each school needs to develop (and continuously update) plans to meet its needs. All plans should then be coordinated (including those for administrative and research computing, to the maximum extent possible) to ensure a cost-effective, well-integrated system.

Administrative Computing

Modern administrative computing resources should be acquired and must be coordinated to manage information efficiently and increase productivity. A central network should enable different administrative units to share information with other administrators and with faculty, students, and staff. The administrative computing system should ensure that information is gathered efficiently, is made available in a timely fashion, and is provided to appropriate people on

demand. To ensure that minimum standards for administrative computing are met in each department and that departments can interact electronically with administrative offices, departmental facilities must be upgraded or augmented wherever necessary to transmit administrative information.

Information on Computing

Effective and timely communication is central to the overall success of this plan. Individuals on campus must be kept informed about computing possibilities and capabilities, and an attitude that facilitates innovation and productive change should be encouraged.

Strategy

To achieve these goals, we propose an implementation program with three major components:

1. Equip and maintain an appropriate electronic studio for each school in the university.
2. Enhance productivity in educational, research, and administrative activities by provision of adequate personal and shared computing environments.
3. Build an adequate computing infrastructure, including trained staff, networking, shared equipment, and administrative computing, that will ensure the effective use of computational resources in achieving university goals.

Electronic Studios

Laboratories, libraries, and lecture halls have long been the hallmarks of a university's educational strength. Today, computing must be regarded as a fourth major hallmark. Computing capabilities can, in fact, multiply the value of laboratories, libraries, and lecture halls, in the process of making the students and faculty who use them more productive. Rice has a particular vision of integrating computing into the curriculum, a vision based on the innovative concept of an *electronic studio*. By putting the power of the electronic studio into the hands of Rice's enormously gifted students, we project a level of academic achievement unsurpassed in the nation.

By extending human capacities in countless ways, computers are transforming various types of intellectual activity and therefore are reshaping many if not most academic disciplines. This reshaping extends beyond using new technology to teach traditional material: advancements in computing are radically altering *what* is being taught, not merely *how* it is being taught. Moreover, the acceleration of instruction makes it possible for professors to cover the basics far more quickly and so to reach a higher plane of discourse with students. For example, computer developments actually allow a music professor to hear a student's composition, which heretofore would not have been possible without enormous expense and effort. Furthermore, the professor and student can make changes in the composition, hear and record the result, and produce a printed copy of the score all in a single session, a sequence that previously might have taken weeks.

Architecture. The goal of educational computing in Architecture is to incorporate state-of-the-art visualization into existing architectural studios. Both the hardware and software supporting architectural design are advancing rapidly, and therefore efforts must be made to keep Rice students up-to-date. Computers need to be phased into existing architectural studios so that our Architecture students will be at the forefront of computer-assisted design. The electronic studio plan calls for the incorporation of highly specialized computer equipment into the architectural studios. Much of this new equipment will come from external sponsors.

Engineering (Owlnet). The vision for educational computing in Engineering already exists in OWLnet, which has had a dramatic, positive impact on the curriculum. Engineering is far ahead of the other divisions in planning. So far, OWLnet is regarded as an educational success and a strong foundation on which to build. The goal is to ensure access by all students and faculty and the thorough integration of computing into the curriculum. The basic proposal is to double the number of workstations, from 60 to 120, to include color stations among the new additions, and concomitantly to enhance classroom support equipment, such as overhead projection stations.

Humanities. There appear to be a number of important opportunities to incorporate computing into the Humanities curriculum. The basic plan would put writing and research tools, such as automated information retrieval and analysis,

into the hands of both the faculty and students. The electronic studio proposal calls for an electronic classroom that would include 30 personal computers. There is also a need for high-speed networking into each faculty office. Significant sharing of facilities and staff with the division of Social Sciences appears possible.

Jones School. The Jones School is already 75% of the way toward finishing an electronic studio for its graduate students. This studio will give them the necessary computing skills expected by their future employers. These include word-processing, spreadsheets, business graphics, presentation software, and data analysis. At this stage, 90% of all Jones School courses have a computing component that goes beyond basic word-processing. Proposed enhancements include adding more computers and building a network to tie them together within Herring Hall and to the campus backbone.

Music. Computing will have an enormous impact on the curriculum in music. Compared with other areas where computerization mainly accelerates the pace of ongoing activities, computers in music make possible whole new realms of creative activities and interaction between faculty and students (see example above). The Shepherd School's plan calls for involvement of all students in educational computing. Proposed enhancements call for six advanced workstations for the publishing studio and 16 entry-level workstations for the Aural Skills laboratory. These workstations need to be networked with each other and the computers in faculty offices. Because of the highly specialized hardware that goes into computers for music, sharing facilities with other divisions will be limited.

Natural Sciences. Natural Sciences is modelling its electronic studio on OWLnet, and a high degree of compatibility with this studio of the Engineering division is planned, resulting in some cost-savings, especially in terms of technical support staff. The Natural Sciences electronic studio will provide students with essential tools for numerical analysis, color graphics, data analysis, simulation, and word-processing. The plan calls for about 60 mid-level workstations in addition to about 60 entry-level workstations (20 of which would go into a classroom that could be shared with OWLnet).

Social Sciences. Educational computing in the Social

Sciences is based in the Social Science Computing Laboratory (SSCL). This is a modest facility with 12 computers, presently sufficient to give students in the social sciences the basics in computing. In particular, these basics include: statistical analysis (often of large databases such as census or poll data sets) with powerful software packages; simulation; real-time experimental control; graphics; and word-processing. To meet projected student requirements, the SSCL needs to be upgraded to at least 35 workstations of various kinds. These units need to be connected by a local area network, which in turn needs to be connected to the campus backbone in order to provide easy access to the campus mainframe computers.

Funding needs for these electronic studios can be reduced by making maximum use of existing educational computing resources and the experiences gained from the early efforts to develop electronic studios using existing computer laboratories and networks (such as Owlnet, the Mudd Center for Computing, the Center for Scholarship and Information, the Jones School Executive Center for Computing, the Social Sciences Computing Laboratory, and the Rice Advanced Visualization Lab). Studio plans were formulated in Spring 1990 and are continually being updated.

Productivity Enhancement

The initiatives to enhance research and educational computing cannot succeed without active involvement by the faculty. To make the current faculty more productive we must make certain that they have access to a computing environment that will enhance their scholarly and educational activities. At a minimum, this enhancement means that they should have a personal computing environment at least as powerful as the standard electronic studio in their school and access to any specialized facilities needs, such as supercomputers, or graphics workstations, on at least a shared basis. In addition, inadequacy of computing environments should not be a reason why prospective new faculty members turn down offers from Rice. We recommend that the faculty be enabled to achieve the university's objectives through programs that ensure an adequate personal computing environment for each faculty member and access to the specialized computing tools of each discipline. The program we propose has two parts (budgeted separately in Table 1):

Personal Computing Environment. The university should take

measures to ensure that every faculty member will have access to an appropriate personal computing environment. This access will usually mean a personal computer or workstation in one's office. This program can be put into effect by an annual increment to the budget of each school, to be administered by the deans. The funds should be leveraged by the deans to optimize external funding contributions.

Shared Computer Resources. In addition to providing personal computing environments for the faculty, the university should ensure that the faculty has access to adequate specialized computing resources, such as campus mainframe, mid-range computing resources, and time on supercomputers. In addition, state-of-the-art visualization facilities should be available on campus. Finally, research computers must have access to high-speed connections to national networks. Costs of this program can be reduced through equipment support on external grants, partial funding for large programs (such as the Center for Research on Parallel Computing), strategic relationships with vendors, the use of supercomputing facilities elsewhere, and optimizing on-campus sharing of computing resources.

Infrastructure

Staff. The program specified above cannot succeed without adequate staff support. The plan requires two kinds of staff: staff centralized in the Office of Computing Information Services and the Office of Networking and Computing Systems to provide services to the entire university as well as staff distributed to the schools and departments to address the needs of specific disciplines. It is clear from the subcommittee reports and from information received from other universities that adequate staff should be one of the highest priorities. In addition to a full-time professional staff to support each of the electronic studios, the campus network, and the personal and shared computers, we will need to allocate faculty time to ensure that educational and research computing is meeting the needs of individual schools and departments. For example, the subcommittee on educational computing recommends that there should be at least one faculty member per school who serves as a computing liaison person. It further recommends that these responsibilities be taken into account in establishing teaching loads.

Networking. The campus backbone should be extended to include

every academic and administrative building on campus. It should be connected to research and educational subnets that operate at speeds and capacities suited to their individual needs. The university should ensure that the campus backbone connection to national networks remains at the highest possible performance level. In addition, the university should take an active role in setting interface standards for computer networking to ensure that different computer facilities can be connected usefully and conveniently. Finally, the Office of Networking and Computing Systems should have responsibility for the management and operation of the network. Consequently, its staff should be expanded to meet this need.

Administrative Computing

In the near term, Rice should evaluate, select, and install new financial and human-resource software systems, with appropriate hardware. Then, within the five-year planning period, the university should complete the integration and upgrading of all administrative subsystems, including student records, development, alumni, and the library. This will require major purchases of software and hardware. The following strategies can be used to reduce cost.

1. If the hardware can be shared with well-funded research groups, the overall cost of a shared machine might be substantially reduced.
2. Additional savings might be achieved by phasing in the hardware and software over more than one year.

Administrative computing should be integrated into the campus network to facilitate electronic interchange between departments and centralized administrative systems, including the financial system, budget packages, personnel systems, student records, master calendars, classroom scheduling, employee directories, and space-management records. In addition, it may be necessary to purchase or develop integrated budget and endowment-management packages and administrative packages for sponsored research. Departmental systems will need to be upgraded to exchange information with centralized university facilities, and periodic instruction should be provided to staff and faculty in the use of administrative systems. Moreover, the university must address the problem of integrating student records, and alumni and development records. The university should further study the possibility of integrating the library with administrative, educational, and research computing.

Management and Planning

The office of the Vice President for Graduate Studies, Research, and Information Systems should supervise the overall management of the program, with the individual deans responsible for the parts of the program specific to their schools. Planning and evaluating computing for education, research, and administration should be continued with active and ongoing participation by the faculty, students, and staff, including appropriate administrators.

The three Information Systems offices (i.e., Administrative Computing, Computing Information Services, and Networking and Computer Systems) should continue to serve the entire campus. They should provide information and advice on what is available and offer courses on computing to the faculty and staff. The individual schools should also have programs led by the computing liaison faculty member to ensure awareness of new technologies and their use in education.

Budget

Using initial budgetary information from the subcommittees, the Computer Planning Board searched for overlaps between areas and attempted to identify possible forms of cost-cutting to generate a realistic budget. Annual cost comparisons for each component of the computer enhancement budget in FY90 dollars are summarized in the table on the following page.

	Current	Minimum/ Intermediate Enhancement		Full Plan
Electronic Studios	0.4	0.9	1.2	
Personal Computing Environment		0.1	0.5	0.8
Shared Computer Resources		0.6	0.7	1.0
Staff (All Categories)	0.1	1.0	1.5	
Networking	0.3	0.3	0.3	
Administrative Computing		0.3	1.1	1.3
Total	**1.8**	**4.5**	**6.1**	

Table 1. Budget Enhancement in Millions of FY90 Dollars

The first column represents the current expenditures not reflected in the FY90 spending base of about $4.1 million. In a no-growth scenario, we would expect this amount, $1.8 million annually, to be the minimum amount above the base needed to prevent rapid deterioration of existing facilities. This budget would permit none of the initiatives proposed in this plan.

The third column represents the full incremental cost of the plan as we have proposed it. These figures are the product of careful deliberations of every conceivable strategy for economizing. Notice that we show no "up-front" costs. These have been handled by amortizing them over the lifetimes of the items - an approach that permits the university to achieve the goals outlined here either by borrowing from the endowment or phasing in items. We did not consider any cost recovery methods other than grants and contracts.

The middle column represents a more limited program that would still enhance the quality of computing on this campus. To reach these levels, we would substantially cut the budgets for electronic studio and equipment for faculty and staff, reducing the rate at which we could implement the plan and eliminating some of the higher-priced equipment. The largest cut in this budget is to the support staff. A staff at this level would seriously limit the rate at which faculty and students could incorporate computing, although the situation would still be improved over the current one.

Summary of Recommendations

The Computer Planning Board recommends that the university adopt the full plan indicated in Table 1 in order to upgrade the educational and research usage of computer systems, making Rice a leader in educational computer use and competitive in research computing with the best schools. Implementation of these goals can be achieved by phasing in various components over the next five years. While the total budget enhancement is large, the impact on Rice University as a quality institution for teaching, research, and administrative systems would be significant. At the full plan funding level, Rice would become competitive with other national research universities in terms of our total investment in information and computing systems. If this level of funding proves to be impossible, the intermediate plan is the *minimum* necesary to achieve even partially the goals set forth for campus computing.

In summary, we propose an initiative to build electronic studios for all students, an initiative to enhance faculty and staff productivity by providing support for personal and research computing resources, and an initiative to provide adequate infrastructure for education and research staff, for networking, and for administrative computing.