REPORT OF THE SUBCOMMITTEE ON EDUCATIONAL COMPUTING

Goals Report of the Subcommittee on Educational Computing

Summary and Recommendations

This report describes the computing environment that the Subcommittee on Educational Computing believes necessary for Rice University's educational programs in 1993 and proposes policies and general principles essential for achieving that level of capability.

Rice University should give priority to educational computing for three reasons:

* Computing can enhance traditional methods of teaching and make possible new learning experiences. Computing can support learning by improving communication, distribution of materials, and collaborative work.

* Computing and information systems are increasingly important tools for life in a technologically complex world.

* Rice University's ability to attract faculty, students, and funds in the future will depend in part on the quality of its computing environment.

Rice University is dedicated to excellence in undergraduate education and high quality research and advanced study in various selected disciplines and graduate programs. In support of these aims, the subcommittee proposes three educational computing goals:

* All faculty, students, and staff should have access to the computational resources necessary for their work.

* Computing resources should be familiar tools for every student, and computing should be systematically integrated into the curriculum.

* Modern administrative computing must be coordinated to provide efficient information management and productivity for educational functions, such as advising, course registration, and course evaluations.

To achieve these three goals, Rice University needs an implementation plan that includes the following elements: (a) revisions in the curriculum and graduation requirements, (b) a coherent system of instruction in computing to support the use of computing throughout the curriculum, (c) adequate facilities, and (d) ongoing planning and evaluation.

As the primary means for enhancing the educational computing environment for students, the subcommittee recommends a new educational concept, the "electronic studio." The electronic studio provides access via an electronic network to a student's software tools, course assignments, and personal files. It creates an intellectual environment, enabling the student to solve problems and linking him or her to intellectual resources and other members of the university community. The electronic studio differs fundamentally from the computer assisted instruction (CAI) systems of the 1970s, which served as a substitute for faculty and trained the student in a series of tasks.

To integrate computing into the curriculum, the university must expand and improve its network to make it easy for every faculty member, staff member, and student to access educational computing facilities. Standards for both hardware and software must ensure that people can communicate across the network. A knowledgeable professional staff, including a pool of teaching assistants, is needed.

Recommendations

Rice University should

* Develop and implement the network and electronic studio concepts in the seven schools.

* Provide an introduction to computers and basic software that would enable a student to begin working with an electronic studio.

* Offer high quality courses in important new and expanding subdisciplines that use computing as a principal method.

* Provide a system of coherently ordered computing courses that teach those computing techniques needed in subject area courses.

* Ensure through graduation requirements that a degree candidate is competent in computational methods essential

for the disciplines (major and minor) in which the degree is granted. Departments should specify the types (if any) of computation essential to their fields, as they have specified course requirements in the past.

* Enable every undergraduate student to participate in research through traditional methods or through use of computing.

Discussion

Educational Uses of Computing

The computer can dramatically extend human capacities to organize, distill, and disseminate knowledge. Computing reinforces and improves traditional educational methods, as well as supports new ones. The classroom lecture, laboratory experiment, and studio project have long been the primary instructional methods in university education. The computer has a valuable role to play in enhancing each of these methods.

In the classroom, the computer can perform numerical calculations, simulations, and symbolic analyses that are not feasible manually. For example, instructors in the natural sciences, social sciences, or engineering can use the computer to display graphically the dynamic behavior of important mathematical models, giving the students a deeper understanding of the qualitative properties of the models. Similarly, instructors in the humanities can use the computer to analyze the writing style of an author, to find occurrences of particular textual patterns in long documents, and to coordinate visual resources, such as films of native speakers using dialects, dramatic productions, and museum collections available on laser disks.

In the laboratory, the computer can monitor and control experiments, help generate laboratory reports, and model or simulate much more complicated and complete processes than were previously possible. In the art or architecture studio, the computer can provide a wider variety of colors and alternatives for evaluation of designs, and in the music studio it can prompt ear training, analyze existing scores, and process parts and scores. It can help students master grammatical and stylistic conventions in a writing center, and it can facilitate foreign language learning.

While computing can enhance all of these traditional methods of learning, it also can create the possibility of new instructional experiences. In the computer-equipped classroom, instructors and students can explore and manipulate concepts and theories proposed or introduced by the instructor. They can analyze molecular models, test the effects of new definitions of forces or conditions, explore large data sets, and interpret texts. In the laboratory, the computer can simulate experiments that are physically impossible to conduct (for example, the explosion of a star).

Some uses of computing, such as word processing, statistical analysis, and computer-aided design, are already well established and their impact is easy to forecast. Other uses of computing, such as massive simulation, exploratory data analysis (graphics), and textual analysis are promising, but the technology is still in its infancy. While the established applications of computing will produce important and predictable results in education, we believe that many of the most exciting and interesting applications of computing are impossible to predict, because computer technology is advancing rapidly.

In addition, computing has the capacity to support learning by improving communication among teachers and students, providing access to educational materials, and simplifying and facilitating the work of both students and faculty. Collaborative learning processes, such as working with a consultant, can be made easy with a computing network. Now a student who wants to meet with a consultant must telephone the consultant, set up an appointment, walk to the place, and meet with the consultant. With appropriate software and a network, a student working a problem set or writing a paper could call the computer to request help. The computer would connect the student with the first available consultant. Without walking anywhere, the student and consultant could communicate about a problem set or paper, which could be displayed on both their screens.

Professors who now create problem sets, tests, and handouts on a computer and then print and copy these materials for distribution in class could simply transfer these materials electronically to the network, where students could retrieve them and print them out if they desired.

Electronic Studio Concept

The central concept in Rice University's vision of educational computing is the "electronic studio." Ken Kennedy, former Chair of Computer Science, who developed the concept, explains the electronic studio as an analogy to the architect's studio, where a drafting table and storage cabinet serve as a permanent workplace and a repository for tools, design projects, and personal possessions. Philosophically, the electronic studio differs from earlier versions of educational computing, which used the computer as a substitute for the professor by providing a set of instructional sequences that trained the student. In contrast, the electronic studio creates an intellectual tool that the student may use in solving problems and exploring data sets, art collections on laser disk, and many other resources.

An electronic studio consists of a computer account and storage system that the student can access from any public facility on the campus. The studio serves as an electronic workplace and repository for the student's software tools, course assignments, papers, and personal files. A student's space in the electronic studio must be available for the duration of his or her enrollment in the university. Upon graduation, the student is encouraged to take a copy of the accumulated files (excluding proprietary software that is licensed by Rice University rather than the student) so that he or she can recreate this electronic studio on another computer system. The computer network also improves course administration and advising.

A Philosophy of Conservatism and Adventure

The university's planning of computing facilities must cope with continuous and rapid change in computing technology. While many future uses of computing can be predicted quite accurately, a significant fraction of the uses that will be important ten years from now cannot be forecast with certainty. As new equipment and software become available, new possibilities in education will result. In addition, as faculty become more familiar with computing resources, new applications will be discovered or developed.

In order to ensure a fairly high degree of success, we need to plan thoroughly to accommodate the uses [services] we now know are feasible and important. In that sense the objectives proposed here are conservative. But we should be adventurous in pursuing new possibilities, particularly when the incremental costs are low.

Conclusions Underlying the Subcommittee's Recommendations

1. An integrated campus-wide network must link all the computers in a single powerful computing system that supports a common file system and a basic set of utilities (including word processing, electronic mail, editors, window systems, programming tools, browsers for electronic libraries and card catalogs, access to the major international networks, etc.). It is almost impossible to overemphasize the significance of integrated networks. The difference between a collection of isolated computers and an integrated network is comparable to the difference between a set of departmental intercoms and a campus-wide phone system.

2. To build an integrated campus-wide network, we must adopt a limited set of standards governing communication and file access protocols. The situation is roughly analogous to building a nationwide rail system. Without standards governing track gauge, switching protocols, and traffic control, trains could not travel among the track systems belonging to different railroads. Fortunately, widely accepted standards for building campus-wide networks are beginning to emerge.

3. To integrate computing into the curriculum, every faculty member, staff member, and student must be able to access suitable facilities at almost any hour of the day.

4. In selecting computing systems, the university should choose the most general systems consistent with budgetary constraints. General purpose computer systems can accommodate unforeseen applications without major expenditures for new hardware and software.

5. The university should choose equipment and standards in light of the pool of existing and projected software available for each option. The university should emphasize the acquisition and adaptation of existing software rather than the development of new software, which is often extremely expensive and time-consuming.

6. The university should provide a knowledgeable professional support staff, including a large pool of teaching assistants, not just equipment and software, to achieve a high level of faculty participation. Apparently small barriers can be major obstacles in the adoption of new technology. Faculty members will resist using computing in classrooms and laboratories if they find computing intimidating or inconvenient.