MICROS THROUGH MAINFRAMES: A SUCCESSFUL IMPLEMENTATION

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Abstract

Historically universities took their early steps in computing through the acquisition of mainframe computer systems. These early machines were used primarily for academic and research purposes. During the last decade we saw an increased demand for computing services for student applications, research, and administrative purposes. To meet this demand and to bring the systems closer to the users, many of us expanded capacities through the introduction of decentralized facilities. These took the form of mini and supermini computers to be used as dedicated systems, located in academic and administrative departments. While these decentralized systems were most effective, we found that we still could not keep up with the demand for computing facilities. The next natural step was to further decentralize through the introduction of microcomputer systems.

While our growth has been predominately in a decentralized manner, the need for a strong mainframe has been ever present. This has been mainly to support large applications and to be a host on a computing network. Specialized hardware and software need only be supported on a single host system that can be accessed by users via a campus-wide network. This has proven to be cost effective as it has resulted in less duplication of specialized equipment, packages, and support services for decentralized system while still meeting the needs of the users.

Our experiences at Stevens Institute of Technology have followed this pattern of expansion from mainframe to micro with the concept of a campus-wide network as an integral factor. Our recent experiences with the requirement of the acquisition of a specified microcomputer system by our incoming students has been widely publicized. Through this paper I hope to share our experiences including the formulation and evolution of the planning process, its implementation, and some of our future plans based on the success

of the project. Specifically, we now have an Ethernet implementation to support networking of our users with various decentralized systems and mainframes. Also, we have implemented elementary networking functions between various kinds of microcomputers and our DECsystem-10 and VAX-11/780. We are into the next phase of the plan which will allow a massive number of microcomputers onto the Ethernet.

The results of our plan have been most favorable. They include a familiarization of freshman students with computing tools and techniques on a professional basis, the facilitation of computer access for research, an updating of administrative processing, and the communication of the parts in an economical manner. This paper will present a description of our experiences with the intent that they may be used as a model for other institutions looking in the same direction. We believe that Stevens has been the vanguard of colleges that have been successful in arranging a "marriage of convenience" between our micros and mainframes while welcoming our new offspring through the delivery of an Ethernet.

Introduction

We have seen dramatic changes in the capabilities, size and price of computers over the last twenty years. These early machines, particularly mainframes, were large in stature and price, yet relatively small in capabilities compared to those available in today's market. They were centrally located and were used primarily for academic and research purposes to solve complex or time-consuming problems that were impractical to calculate manually. Since those early days we have benefitted from technical innovations that have allowed us to expand the list of applications to include those of a wider, more varied user community. As the number of potential computer users grew, so did the demand for computing power and services. To accommodate the growth, systems were upgraded and expanded. However, due to the limitations of most systems, other means had to be found to support the now varied list of types of users and their applications. This lead to the acquisition of mini and supermini computer systems which could be dedicated to specific applications and physically decentralized to locate the system near the user. Such systems commonly appeared in academic, research, and administrative departments. But even this combination of centralized mainframes and decentralized minis has proven to be inadequate in many instances. The microcomputer is the next logical step toward meeting computing needs beyond those already served by mainframes and minicomputer systems. They require very little physical space or environmental conditioning, are not terribly expensive, and are capable of supporting a variety of applications.

Stevens Institute of Technology

Stevens Institute of Technology is a 4-year college founded in 1870 as a school of mechanical engineering. Its current curricula include Engineering, Science, and Systems Planning and Management. Its undergraduate programs are based around the unified, broad-based, core-oriented approach with concentrations in specific disciplines. Our present enrollment is about 1600 undergraduate students, all of whom are full-time, primarily in the Engineering curriculum. There are about 1400 graduate students

enrolled in Masters, Engineer, and Doctoral degree programs. Our faculty includes approximately 135 full-time members with 100 special faculty and professional research staff members.

Due to our technical orientation, computing at Stevens has followed the traditional path. For many years we have had large central systems for general use. Prior to 1969 we had a variety of IBM, UNIVAC, and DEC equipment. Since 1969 we have had several models of the DECsystem-10 family of mainframes. They have been used for academic and research computing by students, faculty and staff. A separate mainframe has been used to support administrative processing. Currently this machine is a DECsystem-20 that is networked to the DECsystem-10 and shares several disk structures, printers, and graphics devices with the DEC-10. The administrative applications are supported on a separate system to allow for growth of usage for all categories of users. Also, it is easier to maintain a higher degree of security with separate systems even though they are physically located next to each other in the same machine room.

Recent Computing Activities - Pre-Personal Computer Plan

Prior to 1976 all freshmen were taught an introductory level programming course based on FORTRAN. Use of the computer beyond this course was not particularly coordinated or extensive except by students concentrating in Computer Science through either the Mathematics or Electrical Engineering departments. This lack of coordination led to a study and recommendation that a comprehensive plan be implemented for computer-related education. In 1978 two major activities became the framework for the start of the implementation. Stevens received funding from NSF to establish an undergraduate computer graphics facility and for a variety of related curriculum development efforts. The other activity was a study of computers in engineering education. This was funded by the Alfred P. Sloan Foundation. The study included data from over 60 colleges and showed a recurring pattern for computing activities involving use in a freshman course and in senior projects with little else. The major recurring problem was student access. The next steps in our commitment to computing integration were a full review of the Engineering curriculum and the introduction of the Computers in Engineering Education Plan (CEEP). Specifically, CEEP was implemented to ensure that each Stevens engineering graduate is prepared to thrive in an engineering environment in which the computer plays an increasingly pervasive and important role. This preparation implied the following goals:

A propensity and ability to turn to the computer as an aid in engineering education and practice.

Knowledge of the capabilities and limitations of available computational facilities and the ability to choose the appropriate facility for a specific task.

Specific awareness and experience with numerical methods; modelling and simulation; graphics applications; applications packages; and instrumentation and data collection techniques.

Knowledge of a higher-level language and how to develop programs to solve engineering problems.

A comfortable, working knowledge of computing.

The projects include:

- Curriculum development
- Faculty and programmer interaction
- Development of computer-related materials and activities
- Implementation of assessment plans
- Program documentation development
- Seminars for faculty

Similar to other institutions, we have made a major commitment to the integration of computing throughout our undergraduate curricula. The commitment has been visible in the form of a 35% growth rate in computing usage each year for the last five years. It has been very difficult to support such growth on a modest budget. However, a plan was formulated and followed to enhance existing systems and acquire additional ones for both centralized and departmental facilities. We are continuing with this plan and expect to be adding new systems on a regular basis over the next few years. We have approached decentralization in traditional and nontraditional ways. The traditional way includes installing systems and equipment in individual locations near the end users. We have taken a less traditional path with a VAX-11/780 system. It is being used by a small segment of the Stevens community and in fact is a dedicated system much like a decentralized departmental machine. However, it is located in the Computer Center and is accessible via an Ethernet implementation. The Ethernet, a local area network, is currently a limited implementation in that only three academic departments are connected. It will provide the framework by which all buildings can be easily added to the network as the cable route was designed to do.

So far I have described our major systems down to the mini level. Over the last four years we have been acquiring and experimenting with many varieties of microcomputer systems. Their uses have included instrumentation control, data collection, departmental office automation, proposal preparation, software design, courseware authoring, graphics, application implementation, networking, and many more. Some effort was made to standardize on a minimal number of models and vendors to encourage compatibility. This was moderately successful.

Personal Computer Plan

As our academic mainframe began to run out of spare cycles, we knew that we had to make some real decisions about the future direction of computing on campus. We have always felt that we did not want to limit computing access since this would interfere with academic assignments and stifle experimentation. But we could see the time coming that contention for resources would become unreasonable. About that time there was much discussion about the role of personal computers on an individual basis. After much planning with the faculty, the decision was made to introduce a personal computer plan with freshmen in our Science and System Planning curricula. This represented about 20% of our incoming freshman class. A committee was chartered to evaluate and recommend the specific systems within certain guidelines for functionality and price. The group also coordinated the effort to determine which courses would be modified to integrate use of the personal computers

throughout the entire four years. Appropriate faculty members were identified to participate and the project gained momentum. After much planning and preparation, we were operational with the plan in September 1982 as a pioneer of such an effort. Throughout the academic year its progress was monitored and evaluated for possible expansion to include all freshmen this year. As a parallel effort, an extensive evaluation of hardware and software alternatives was undertaken. Our original choice of system for last year was the Atari 800. After considerable discussion and evaluation, it was concluded that the Atari did not include all the functionality required by our Engineering curriculum, although it was a very reasonable system for other environments.

Early in the academic year a list of criteria was formulated, identifying most of the areas of concern, knowing that no machine was likely to meet them all. This list became the framework of an evaluation process that was used from all perspectives - hardware and software availability, reliability, maintainability, applications and utilities, ease of use, graphics capabilities, compatibility with existing campus systems, networking potential, system performance, cost, and numerous others. Tests were conducted on various systems from similar perspectives to determine ease of learning, ease of use, user friendliness, time and effort required to complete tasks, courseware and toolkit development requirements. After several months the field narrowed as systems lacked important functionality. Throughout the process considerable effort went to keeping all segments of the community informed while the faculty was actively participating in the development of the plan. This helped maintain the high level of enthusiasm about the plan and was instrumental in the effort to plan and develop the methodology required for a successful implementation.

During the same time period as the evaluation of the systems, elaborate plans were made for the development of personal computer-related materials for use with introductory-level courses. For many years these courses were taught based on student access to timesharing and batch processing on the DECsystem-10. A new approach had to be developed based on the new hardware and software as well as the change in access. Students would no longer have to compete to gain access to a terminal or system job slot. Also, system response was no longer a variable. With each student having an independent microcomputer, these problems would no longer be relevant. Of course, microcomputers have their own unique set of problems, some of which we probably have yet to discover. Clearly they are not a cure-all for all the headaches related to computing, although they seem to have the potential to meet a substantial number of needs with reasonable solutions. This sounds a bit idealistic, but we feel that we are at the beginning of a new day in computing history. Related to being new is the expectation that we will have to be pioneers in software development. Courseware and tools are not very sophisticated at this time. We are attempting to do such development using the personal computers, but find we still need to use mini and mainframe systems for some major development efforts.

This year we chose the Digital Equipment Corporation Professional 325 as the student system. Its configuration will include 256 KB of memory, dual 400 MB floppy disk drives, and a floating point

accelerator. The software will include the P/OS operating system, BASIC, FORTRAN, and Prose, a text editor/word processor. Faculty members will have access to PC 325 systems as well as PC 350's which also have Winchester disk drives. The entire campus will have access to at least a dozen such microcomputers publicly available in a microcomputer center laboratory. This center will have the basic units along with an array of peripherals and accessories. Also incorporated in this facility will be a number of Atari systems for the convenience of those students and faculty associated with the class of 1986.

Considerations

During an extensive evaluation period the technical considerations of many systems were reviewed and analyzed. As the result of this process, the list of potential systems was reduced to about six. These systems were investigated on a much more detailed level including extensive experimentation with the hardware and software and in depth discussions with the vendors regarding non-technical aspects of the personal computer plan. In the final analysis, there were three major areas of consideration:

- Technical capabilities - including all aspects of the hardware and software.
- Management capabilities - including the ability of the vendor to meet our computing needs effectively and be able to support and nurture a long term institutional partnership.
- Image - including the reputation and stability of the vendor and the expected perception of the personal computer plan by the world.

In general, some of the major, yet specific, considerations pertained to cost, maintenance, services, purchase agreement/contracts, financing, seminars, publicity, software development opportunities, access to advance information on related future products, and partnership possibilities.

System Characteristics

In an effort to evaluate the various systems equally, a list of technical characteristics was compiled to be able to make equitable comparisons. The following were the major elements of this list:

Architecture
Memory size
Storage mode/capacity
Display/graphics
Keyboard
Operating system
Bus structure
Utilities
Expandability/upgradability
I/O interface
Programming languages
Software availability
Portability of hardware
System documentation
Networking capability
Future plans
Support/maintainability

Philosophic and Practical Issues/Questions

During the course of preparation for the personal computer plan a list of questions/issues was generated. They included:

- Should the plan be implemented?
- What should the personal computer system do?
- Could a programmable calculator accomplish the same purpose?

- What are the important/essential features?
- What are the language considerations?
- What would the potential impact be on use of the DECsystem-10?
- How will use of the personal computers relate to our Honor System?
- What should the cost to the students be?
- How will we handle sales, distribution, and maintenance of systems?
- What are the non-academic impacts on students?
- What will be needed in curriculum development and faculty involvement?

We believe that we have addressed these issues sufficiently to feel relatively confident about our efforts.

Institute Commitments

It was recognized that the Institute would have to make some major commitments if the personal computer plan was to be implemented and expected to succeed. Systems had to be acquired and distributed to faculty members involved in courseware development and course modification. Also, significant development time for faculty had to be recognized and funded. Additional systems had to be available to enhance the computing environment. A microcomputer center was planned and established. It includes numerous systems with associated disks, hard copy devices, communications facilities, additional software, etc. This center will be available for general use. We investigated many options for the maintenance of the systems and concluded that an on-campus service program was most feasible. To allow continuous access to the personal computers, units would be provided on loan when units required more complicated repairs than simple board swaps. Other areas being addressed are dormitory renovations to allow for incorporation of the systems, campus networking, financial planning, pre-freshman activities, and constant attention and review of activities by both the Computer Planning and Operational Committees.

Conclusion

We have learned a lot during the last two years. The past year has been a successful learning experience. The class of 1986 will continue to use their systems throughout their four years. We have not forgotten them as we prepare for the class of 1987. Efforts are underway to develop software for advanced courses and continue the integration process. At this point in time we are heavily involved in courseware development to prepare for the fall semester. We have held pre-freshmen orientation sessions to acquaint students with the new systems. Financial considerations have been addressed. Dormitories are being renovated. System utility development is progressing including networking software. At long last we are anxiously awaiting the arrival of our personal computers. We now move into the next phase of the plan beginning with delivery, checkout, storage, distribution of nearly 600 systems. Our enthusiasm is high as we await this delivery and hope that the product of our marriage of convenience will live up to our expectations.

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