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ABSTRACT

Seven papers making up Track I of the 1989 conference of the Professional Association for the Management of Information Technology in Higher Education (known as CAUSE, an acronym of the association's former name) are presented in this document. The focus of Track I is on planning and strategy issues, and the papers include: "Strategic Information Planning in a Higher Educational Institute" (Doug Dunwoody, Sheila Newell, and Terry Smith); "Transformation: Information Technology and the Community College" (Dorothy J. Hopkin and S. Alan McCord); "Implementing a Campus Computing Plan" (Michael D. Richards, Chandler Whitelaw, and Glen Pryor); "A Case of Successful Integration of Technology in a Liberal Arts Environment through an Integrated Voice and Data Network" (Richard A. Detweiler); "The Best Laid Plans...An Implementation Retrospective" (James I. Penrod and Michael G. Dolence); "Planning for Information Resource Management at the University of Pennsylvania: Searching for a New Paradigm" (Karen Miselis and Daniel A Updegrove); and "Academic Departmental Administrative Computing Vison for the 1990s" (John A. Bielec and Sukij Yongpiyakul). Most papers are preceded by an abstract and include references. (DB)

November 28-December 1
SAN DIEGO
CAUSE89

Managing Information Technology: Facing the Issues

Proceedings of the 1989 CAUSE National Conference

TRACK I: Planning and Strategy Issues

November 28 - December 1, 1989
The Sheraton on Harbor Island
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Strategic Information Planning in a Higher Educational Institute

Doug Dunwoody
Shaila Newel
Terry Smith

Southern Alberta Institute of Technology
Calgary
Alberta

The Southern Alberta Institute of Technology has completed the development of a Strategic Information Plan. This plan will enable SAIT to manage its corporate data as a resource by providing a stable foundation of computerized data that supports the ever changing information needs of the Institute. The computer applications developed as a result of this planning effort will address the information needs at all levels of the organization, from the day to day operational needs through the information needs of senior management. This paper will review the methodology and planning process that was utilized in developing the plan.

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Introduction - Why Do a Plan?

Highly sophisticated computer systems are being used to manage information, but their use is often scattered and redundant; they grew out of previous record keeping systems designed for individual departments in an organization. But, rather than addressing the application needs of individual user departments, the focus of information systems should be on corporate data needs shared across the organization. The development and implementation of a strategic information plan will help educational institute administrators make the transition into the information age and meet the challenge facing their organizations: to be distinctively better than the competition.

Few organizations have a more complex structure than educational institutes. Within that complex structure, the number of individuals requiring access to accurate, timely information is growing as more faculty and staff discover the value of computer systems. The number of student clients is also increasing and expanding with the educational trend toward retraining, second or third careers, personal education opportunities through continuing education, and industry emphasis on computer use. The result: the number of requests for accurate information and the number of requests for computer support services received by Information Systems Departments within educational organizations is growing. There may be some additional concern that the objectives and priorities for these requests received by Information Systems may not be the same as objectives and priorities of the Institute. We need to ensure that the objectives of Information Systems Departments are helping the organization meet its objectives.

Some sectors of the institute purchase computer systems independently based on their unique needs -- systems that meet section or department requirements, but do not necessarily satisfy corporate needs. The repercussion is corporate decision making based on data that comes from systems not designed to provide corporate data. Because those long term implications are so important to the health of an organization, executive computer support systems designed for use by upper management have become essential tools for measuring the organization's pulse and keeping the organization moving toward the future. Immediate and effective information management is crucial to educational administrators if they are to accurately forecast student enrollment requirements, project revenue requirements, and assess material and human resources needs. The Southern

Alberta Institute of Technology has developed a Strategic Information Plan that will help them do just that.

SAIT Background

SAIT is a post-secondary institute that offers up-to-date, career related training in a rapidly changing environment. It serves career training needs on campus (in Calgary, Alberta), on company or business premises (local or overseas), on satellite campuses, or by long distance. Instruction can be traditional (in the classroom with or without the aid of computers) or non-traditional (individual telephone tutoring or written correspondence and group instruction by conference call). Instruction is delivered in the daytime, in the evening and on weekends.

SAIT has approximately 646 full time instructors and 760 support staff for a total of 1406 FTE staff members. SAIT also has approximately 300 part time instructors teaching in the Continuing Education program. There are 10,683 students enrolled in SAIT's traditional programs and 41,881 Continuing Education students.

SAIT has several DEC Vax computers, 4 - 785's, 1-8650, 1-8700, 18 - Vax 3100's and 1 - Micro Vax II. We have an Ethernet based campus network linking terminals, MacIntoshes, IBM PC's and workstations to our central resources. We are running VMS, Unix (Ultrix) and Oracle on several platforms in a distributed client/server type configuration.

Strategic Information Plan Objectives

Information Systems provides service to three client groups-- those whose business functions are strategical, tactical, or operational -- who need to have easy access to various types of information to manage

- o the instructional process,
- o financial resources,
- o human resources,
- o student enrollment,
- o material, facilities and space.

The best way to meet strategic, tactical, and operational needs is to implement a Strategic Information Plan that will allow the sharing of corporate data among systems through a network of terminals, workstations and personal computers on and off campus. There must be a clear understanding of corporate data and corporate systems, with consistent definitions throughout the organization.

The Strategic Information Plan that will meet these objectives must provide stable, well defined corporate data, yet be flexible enough to meet clients' needs while not infringing upon their sense of information ownership.

The objectives of the plan are:
- integrated corporate computer applications
- subject databases where data redundancy is reduced
- consistent definitions throughout the organization
- single official source of information
- effective use of end user tools

Some Benefits of Implementing a Strategic Information Plan

The use of computerized information will directly support SAIT's business (people and resource management) and academic (quality of instruction) needs in these ways:

1. Time spent determining and implementing company strategies will be reduced because implementation of a strategic information plan, will allow senior administrators and managers at SAIT to access
   - o institute & personnel performance data,
   - o financial data for forecasting,
   - o information on materials, space and facilities use and availability,
   - o curriculum details to avoid repetition across academic departments and to ensure that learning objectives are consistent.

2. Corporate data will be available to meet the random inquiries for information from outside sources and to support executive decision making.

3. Understanding of SAIT's business functions will be increased because, during the process of designing and building a Strategic Information Plan, the organization's business functions are clearly defined, a process that results in improved understanding of the role, responsibilities, and resources involved in each function and how it contributes to the organization's mission.

4. Analyzing the efficiency and effectiveness of instruction will be possible. Students' progress through the institute and their successes or failures could be tracked in relation to
   - o previous training and experience,
   - o program changes,

- o courses taken,
- o type and style of instruction received,
- o participation in learning.

What managers and instructors discover about student learning could be used to encourage successful patterns in the learning environment and to eliminate unsuccessful patterns.

5. Creating and maintaining records will become much less time consuming. Currently, academic staff spend a good deal of time on clerical and administrative duties. After the implementation of a strategic information plan, time spent on non-instructional tasks can be redirected, increasing the amount of time an instructor can spend preparing or delivering instruction. The more instructional interaction students have with instructors, the greater the opportunity for students to be successful learners and the greater the opportunity for instructors to be successful learning managers.

What approach should be taken?

Few organizational design projects can begin before the organization and its individual departments have clearly defined their mission, goals and objectives. A SAIT-wide strategic planning session and renewal conducted in 1985 ensured that SAIT's mission,

> to be an innovative organization equipping people to compete successfully in a changing world of work by providing relevant, skill-oriented education,

was clear.

Some of the conceptualizing of a workable strategic information plan occurred during Information Systems personnel and SAIT Administration's discussions of business functions. Representatives from each division on campus were questioned about

- o what business functions they perform,
- o what information data they need or would like to access, and
- o what kinds of computer systems they were currently using

Information Systems personnel then drafted a document that seemed well suited to their clients' business function needs. Two key products were the BUSINESS MODELS and the DATA MODELS. These models were validated and revised through a series of interviews and presentations. The next step was to look at the existing computer systems. These existing systems were rated from 1 (low or poor) to 5 (high or excellent) based on 11 criteria.

The technology available when most of SAIT's current computer applications (third generation language tools) were developed did not easily lend itself to integrated applications or data sharing. Currently, SAIT computer business applications are a mixture of custom developed software and purchased software run on a large mainframe system, mini-computers, or on personal computers. Over time, as individual user computer system needs were fulfilled, the amount of duplicate data being created and stored was inadvertently increased.

The resultant problem was inconsistent and redundant corporate data. For example:

- o course data is stored in 6 or more systems,
- o student data, some as simple as student numbers, is stored in as many as 8 systems,
- o employee/instructor data is stored in as many as 13 systems,

and so on. The result is costly. Manpower is wasted, time is lost, and information retrieved is contradictory. For instance, the questions "How many students are registered at SAIT?" or even "How many instructors are employed by SAIT?" could be answered several ways, depending on the person asked, the storage systems used, and the need for the information. In some cases, the answers to questions posed by senior executives are either not obtainable or cumbersome to obtain.

A further problem surfaced with expanded use of personal computers: faculty and staff wanted to use PC based tools to massage and manipulate data that currently resides in the mainframe. This led to more data entry and more data duplication.

After operational information needs, current systems, and system problems were analyzed, the validity of the strategic information plan was assured in the minds of SAIT Information Systems personnel. The design phase outlining the evolution of an integrated computer environment was completed, culminating with the future goal of a system in which

- o all data that needs to be shared would be centralized on the mainframe computers (possibly distributed and client/server based using Vax computers and Oracle Relational DBMS),
- o transfer of information between PC based systems, powerful workstations and VAX mainframe based systems would be possible,
- o new system development would be compatible with existing computer technology,

- summary information would be timely, accurate, and easy to retrieve, and
- ad hoc reporting would be accomplished by end-users creating their own customized reports or on line queries.

Implementing the Strategic Information Plan

It would be a Chief Executive Officer or Information System Director's dream come true to be able to implement the perfect strategic information plan in one fell swoop; needless to say this is not a realistic hope in the educational world of budget restraint and inconsistent use and application of computers across campus. Therefore, a logical accomplishment of the plan had to be devised. The Information Systems team decided that, theoretically, computer applications that create data should be implemented before applications that use data. Consequently, they decided to set these implementation priorities:

1. Financial Resources System
2. Human Resources System
3. Facility Management System
4. Materials Management System
5. Educational Resources (Library) System
6. Student Information System
7. Alumni Donor System

Changes in the recommended order could result in additional costs because temporary interfaces between the old and new applications would have to be developed. As these old applications are replaced by new systems, the temporary interfaces would be thrown out resulting in a waste of time, effort, and money. Naturally, though, should senior management priorities require that the order be changed (for instance, should the creation of an Alumni Donor System lead to increased funds for the institute in general, and for further strategic information plan development, in particular) modifications will be made. Through a Computer Advisory Committee with representatives from several departments, a review of the order of implomentation was done and matched with a "Business Priority Order". This order will vary from institution to institution, but in our case, the Alumni Donor System was moved to the top because of the potential return in investment.

Whenever possible, appropriate software packages compatible with SAIT's management strategy will be purchased. If there are no suitable software packages available for purchase, computer applications will be custom developed.

From inception to completion, implementation of this integrated computer system would vary depending upon availability of

- o financial resources,
- o human resources (end users and systems people), and
- o computer resources.

Any completion deadline Information Systems sets will allow for a phase-in strategy which would increase access to data as each system becomes operational. The data will be implemented in a building block approach with shareable subject databases. It will also incorporate a training schedule that will ensure appropriate use, understanding, and acceptance of an integrated system.

As users learn to access information through a new integrated system, the role of Information System Departments will change from being a central unit responsible for

- o the designing, developing, and maintaining of all systems,
- o the retrieving of information and generating of reports for end users.

to an administrative unit whose role is now to help end users do those tasks themselves more efficiently on an ad hoc basis. Users will have something more important than access to information; they will have access to the right information at the right time.

The Corporate Bottom Line

The estimated cost to SAIT for purchasing software packages, upgrading central computer hardware, and enhancing user workstations to implement the strategic information plan is approximately $3,000,000, excluding manpower and depending on the order of implementation. The expected time frame is 5 to 6 years depending upon funding and staffing resources.

The cost of not implementing the plan is greater: old systems will eventually have to be replaced by new systems for a similar dollar figure, but, for anyone working above the operational level within the organization, frustration with the inability to access timely, consistent, and accurate information for forecasting will <u>not</u> have been eliminated. Information requests critical to business planning will continue to go unanswered while time is spent compiling data from different sources. Operating inefficiencies as a result of duplication will continue and possibly increase when old systems are replaced piecemeal.

Ultimately, implementing a strategic information plan like this one is no more expensive than meeting maintenance and upgrading needs over time, but the bulk of the expense occurs up front. As is often the case, it doesn't really cost any more to do it the right way than it does to implement short term solutions that will not meet long term needs and that will have to be replaced eventually.

The Future -- Implementation Challenges

Major challenges for Information Systems personnel will be

1. to secure and to sustain campus wide commitment to the plan,
2. to overcome the natural resistance to change
3. to implement a long term solution in the form of an information strategic plan while still meeting short term needs, and
4. to obtain the funding to implement long term solutions.

Users would also need to recognize the value of an open approach to corporate data. For instance, in an educational institute those users who determine a student's grade (instructors), could record that grade directly into the system rather than filling out a paper report which is sent to a secretary who photocopies the record and passes it on to the registrar's office where it is changed from the paper report into an on-line record when it is keyed into the system.

The value of an open system will not be recognized until users are convinced that

- o the integrity of data will not be contaminated as a result of direct input,
- o that security of private information will be maintained, and that
- o the way people do their jobs will change, but not their purpose -- providing, either directly or indirectly through support, relevant, skill-oriented education.

For most educational and training organizations, the cost of implementing a strategic information plan is prohibitive, so the challenges relating to funding and finding long term solutions can be met only through an innovative and progressive approach. One that

- o keeps the changes to existing systems to a minimum,
- o appropriately uses interim support systems,
- o establishes optimal user cooperation, and
- o maintains the kind of high standards expressed in

SAIT's Information Systems' mission statement.

The need for innovative and progressive approaches to solving educational funding problems raises interesting questions for administrators: Could inter-institutional cooperation reduce the cost of implementing an advanced and valuable Strategic Information Plan? Are governments prepared to fund systems that will provide better reporting and institutional support systems? Would colleges and post secondary institutes share expenses while exchanging skills and expertise? Is there an international market for successful Strategic Information Plans? Once organizations begin to discuss their common problems and common needs, they will be able to answer these questions and discover new ways to meet funding challenges.

Conclusions

Many attempts have been made to resolve the problem of providing accurate, pertinent, and immediate information to the senior managers of post-secondary institutes. Needs have been analyzed and systems designed in an attempt to meet those needs. Information systems' personnel have attempted to store data in a building block fashion, adding to previously developed discreet systems, adapting them, or creating new systems as each new type of data or request became apparent. But data that is not integrated, data that is stored in different ways, never will be universally reliable.

Senior executive information needs' change from day to day and the only strategy that can meet changing and sometimes undefined executive needs is the establishment of a corporate data base supported by a responsive system that will process that data. The system that will effectively resolve business management problems has to be based on a business model: a Strategic Information Plan like the one described here. Organizations must use sophisticated information gathering systems as part of their corporate decision making or they will be inadequately prepared to meet the future. The challenge that faces far seeing educational administrators who implement a strategic information plan is overcoming resistance to change. The challenge for educational administrators who choose <u>not</u> to implement integrated corporate data systems will be to keep up with those who do.

TRANSFORMATION: INFORMATION TECHNOLOGY AND THE COMMUNITY COLLEGE

PREPARED FOR THE 1989 CAUSE NATIONAL CONFERENCE BY

Dorothy J. Hopkin, Vice President

S. Alan McCord, Director of Computer Services

Information & Telecommunication Systems
Oakland Community College
Bloomfield Hills
Michigan

ABSTRACT

This paper covers the background, planning, implementation and current challenges facing Oakland Community College (OCC) as it transforms its operations through information technology.

The 1986 starting point reflected benign neglect of information technology: low capital spending, obsolete technology, little involvement in college decision-making, no recent systems development, minimal workstation deployment, and no user services function.

New top administration, combined with vision and planning, transformed Information and Telecommunication Systems (ITS) into an integral part of the college environment.

Significant challenges remain. Tight budgets and conflicting priorities have curbed spending. Rapid changes in the college's orientation require that the added value of I/S initiatives be defined. Most importantly, ITS continues to pursue meaningful and predictable involvement in college-wide strategic planning.

Overview of the Oakland Community College District

Oakland Community College is a multi-campus two-year institution of higher education located in Oakland County, Michigan, one of three counties comprising the greater Detroit metropolitan area. The College provides a comprehensive program to meet the diverse and changing needs of the citizens of a district with a population of more than one million. OCC serves 29,000 students at five campus sites and ten extension centers. It is one of the ten largest multi-campus community colleges in the country, and the fifth largest provider of undergraduate education in the State of Michigan.

Oakland County covers an area of approximately 900 square miles; its assessed valuation is over $16 billion. The Oakland Community College District is identical with the Oakland Intermediate School District and generally coterminous with the county boundary.

OCC's five campuses are located throughout the county in Auburn Hills, Farmington Hills, Union Lake, Royal Oak and Southfield. The administrative center is located in Bloomfield Hills, and an additional site is maintained in Pontiac.

The Office of Information and Telecommunication Systems is responsible for administrative computing, academic computing and communications for the College District. Formed in December 1986, this office provides information system services including operating the computer center, supporting business systems, instruction and instructional support, voice, data and video communications, personal computing, and office systems.

The Challenge

Though once enjoying a position of national leadership in the field of information systems, the College had fallen behind in those endeavors. By the mid '70's, the computer center had become a maintenance organization. Essentially it had served two major users, the registrar's office and the data processing instructional program, though payroll, financial aid and some accounting functions were supported as batch operations.

The information technology arena could be characterized as suffering from benign neglect. Organization size remained static and there was little capital investment in technology for nearly ten years. When such investment was made, it was always the "cheapest" (in terms of capital) rather than the best solution. As a result, the College became saddled with inadequate hardware, software and services.

The staff was entrenched in a maintenance posture with few opportunities for professional growth. Furthermore, staffing was inadequate to carry out new initiatives. Reasons for this situation are complex, but probably rest with leadership, interest levels and understanding of technology. The CEO of the institution was a "bottom line" former industry executive; the computer center director wore two hats, as a faculty member in the data processing curriculum and as manager of the computer center.

Strategies, Tactics and Planning

Late in 1985, a new CEO arrived at OCC. Recognizing the state of affairs and committed to the use of technology, Chancellor R. Stephen Nicholson initiated a review of the OCC information systems environment. To accomplish the review he chose the IBM Application Transfer Study (ATS) approach, and called for the convening of an ATS team in October 1986.

The Application Transfer Study process is a free consultative service offered by IBM to its clients. An IBM specialist acts as facilitator for a team of customer participants. Through a system of questionnaires and interviews, the ATS team identified seventeen root problems in the information systems environment. To address these root problems, it made eleven strategic recommendations.* The College has used this study as the blueprint for its information systems strategy.

OCC APPLICATION TRANSFER STUDY RECOMMENDATIONS

1. Develop and Adopt Board Policy
2. Establish User Advisory Council
3. Disseminate Information
4. Provide Tools for Users
5. Acquire Additional Workstations
6. Install Comprehensive Telecom System
7. Upgrade Central Site Computing
8. Upgrade System Software
9. Establish Computer Services Institute
10. Enhance Computer Center Staff and Improve Application Systems
11. Provide Relational Data Bases

Although the team devoted most of its time to discovering problems and developing recommendations, it also suggested a sample implementation schedule. This provided the basis for estimating the cost of the initiative, calculated at approximately $13.9 million over five years. That amount did not, however, include telecommunications.

Coincident with forming the Application Transfer Study team, a new chief information officer was hired in December 1986. Faced with the a forementioned problems, and given the responsibility for computing and communication technologies for the College district, the new vice president began forming plans based on the Application Transfer Study.

The results of the ATS were presented to the Board of Trustees in March, 1987. Although specific funding was not requested at that time, the Board lodged, and subsequently passed, a policy endorsing improved information technology at the College in direct response to the ATS recommendation:

BOARD POLICY

"In order to maximize its resources, Oakland Community College is committed to the development and maintenance of an information and telecommunications system which is at the leading edge of available technology and which serves as a participating partner in all operations of the College.

Such a system will provide accessible data bases and easily available interactive capacities which will effectively expand the capabilities of the staff and significantly enhance educational services and offerings to the community."

* Copies of the OCC ATS report are available from CAUSE.

A new organizational structure for information technology was proposed and approved by the College's top oversight committee, the Chancellor's Council. Known as Information and Telecommunication Systems (ITS), the new organization reflected the ATS recommendations and was comprised as follows:

ITS ORGANIZATION

Vice President--ITS

Director User Services	Director Computer Services	Director Communications

This structure provided for support of end-user computing and recognized the need for strong network planning and management. An advisory Structure for ITS management was devised as well, which featured Information Technology Advisory Groups (ITAGs) at each of the campuses and two college-wide groups — one for Instruction and one for Administration. Composition of the college-wide groups drew from the campus groups as well as including at-large representatives.

Thus, strategies or recommendations, endorsements of improved technology, an organization and an advisory structure were in place. OCC then began to undertake the task of tactical planning based on the guidelines of the ATS.

<u>Hardware, System Software</u>

Many of the ATS findings represented needs in the infrastructure, i.e., the very foundation of information technology. We therefore started our process by addressing hardware and software, which were old, unsupported and lacking sufficient capacity.

The first step in rebuilding the College infrastructure was the replacement of the College's two 4341 processors. By combining processing needs and planning to support our campus-based Computer Integrated Manufacturing lab with T-1 communications lines, and with the benefit of IBM price incentives, we selected IBM's 3090 Model 120-E as our platform. Following Board of Trustees approval in September, the 3090 was installed in November, 1987. OCC was the second community college in the country to install a 3090 processor, and the $1.9 million technology initiative was the largest non-construction proposal passed by an OCC Board.

The system software operating on the 4341 included IBM's OS/VS1, DATACOM/DC telecommunications monitor and ISAM database. Our system software objective was to insure that the College operated with supported IBM software maintained at current levels. We installed CICS and VSAM as part of the 3090 upgrade, managing a major software conversion while planning for the hardware cutover. We chose to first install extensions to the OS/VS1 operating system, and then migrate to MVS following the 3090 installation; MVS became a production operating system in October 1988. The VM environment, the most modern of the system software in place at the start of the initiative, has been continually maintained; we are now testing VM/XA SP2 as part of our future migration activities.

OCC has had a major Computer Integrated Manufacturing (CIM) partnership with IBM, Cross and Trecker, Kennametal, and other corporations since 1985. The OCC project was the model upon which IBM's "CIM in Higher Education" program was based. The

Auburn Hills CIM lab has 12 IBM 5080 3-D graphics terminals connected by T-1 circuits to our central site and a lab of IBM Model 50Z microcomputers. Software includes CADAM, CATIA, MICROCAD, and SLAM/II.

Software costs continue to be a major problem facing higher education. OCC therefore became one of the first participants in IBM's Higher Education Software Consortium, an arrangement that provides access to a wide range of VM software products for a fixed annual fee. As a result of the HESC program, OCC faculty members are now evaluating such VM products as PASCAL, C, SQL/DS and Expert Systems.

Applications

Once the infrastructure was in place, we focused on a small number of application development projects that demonstrated the added value possible with the new system. While most projects were indicated by the ATS study, we selected those that would not be adversely affected by implementation of new integrated administrative software for the College.

Touch*Tone Registration

OCC was a pioneer in online registration systems, implementing its first version in 1967. The registration and records system is our oldest and most robust administrative application, and the registration process itself had not changed substantially for a number of years. We viewed Touch*Tone registration as an opportunity for the College to provide an innovative student service to a changing student community at a relatively low cost.

We began our Touch*Tone research by commissioning a CAUSE survey of large colleges and universities which indentified 50 institutions that had implemented such systems. From the survey we established a field of six vendors who responded to a detailed RFP.* A college-wide task force evaluated the proposals and selected Computer Communications Specialists (CCS) as the hardware and software provider.

The strengths of the CCS offering included an excellent C-based development environment, the ability to locally record and modify text and IBM 3174 emulation. To our host system, the PC-AT based CCS equipment appears as a remote cluster of CICS terminals; no host programs are used to translate Touch*Tone registration requests.

OCC contracted CCS to assist with the development of the initial Touch*Tone registration script. This speeded implementation while providing valuable training for OCC staff. Comprehensive information messages and registration system interfaces were designed by a college-wide team. Students can obtain information on admissions, financial aid and other services; they are able to register for courses, drop, add, search for open course sections and check their fees and schedules.

A randomly selected group of 5,000 students was asked to participate in the system pilot during Fall Term, 1988. The results of the pilot were overwhelmingly positive, with 98% of the students indicating that they would register via Touch*Tone in the future. Touch*Tone registration was offered to the full student community during the 1989 winter term. The service is available from 7 a.m. - 10 p.m., Monday through Friday and

* Copies of the OCC Touch*Tone RFP are available from CAUSE.

8 a.m. - 2 p.m. on Saturday. By the summer term, 50% of the College's early registrants were using Touch*Tone, as opposed to mail-in registration. Mail-in registration has been eliminated for the winter term, 1990.

ITS is presently developing an extension to the Touch*Tone registration system that enables students to pay tuition and fees by credit card. Students will enter credit card numbers and confirming data to store credit card payment information. Credit card transactions are passed to a Visa processor after the close of business and prior to nightly tuition batch processing. Approved credit card payments are then applied to the student's account, and rejected transactions result in a letter to the student.

Touch*Tone registration has been a great success with OCC students (despite a "soft sell" approach), and we anticipate a similar response to credit card payment. Aside from convenience and service for the student, Touch*Tone registration and credit card payment will reduce demands on College staff, diminish dependence on cashiering technology and provide the basis for additional financial services in the future.

Faculty Pay

A second high-visibility/application project addressed enhancements to the faculty pay system of the College. OCC possesses a complicated faculty load system which was managed in the past by turnaround of paper documents. OCC staff designed and implemented online entry screens to input assignments, stipend and department chair information. Online displays enable deans to view teaching schedules and load information on the screen. Load documents are now produced with a number of edits and error checks which alert deans to potential problems. As a result of these enhancements, the percentage of load documents needing manual processing has dropped from approximately 35% to less than 5%.

Electronic Mail

With Touch*Tone registration services provided for students, and improvements to the faculty pay system provided for the faculty and deans, the rest of the College community needed high visibility applications. Electronic mail and a library circulation system were the vehicles for ITS to help connect OCC's multiple campus communities and sites.

A college-wide task force evaluated five electronic mail systems in the spring of 1988. Vendors responded to a comprehensive RFP, made on-site presentations and worked with ITS staff to install all five systems on the College 3090 processor for a true side-by-side evaluation by task force members. In May 1988 the task force recommended IBM's PROFS as OCC's electronic mail system.

Chancellor Nicholson recognized the importance of electronic mail to his leadership team of approximately 45 administrators at seven sites. It was decided that PROFS would be initially implemented among administrators and their principal support staff. Equipment was acquired to insure that each administrator and principal support staff person had a networked workstation on his or her desk.

BITNET

At the same time, OCC became the third community college in the country to become a member of BITNET. We decided to develop a seamless interface between PROFS and BITNET as part of our electronic mail product. We also addressed a number of known shortcomings in the PROFS product, including centralized distribution lists, multiple note log management, disk space warnings, bulletin boards and a staff directory. All OCC enhancements were designed to incorporate the "look and feel" of PROFS. A comprehensive user guide was developed to accompany the product.* PROFS was implemented in November 1988 with 90 users. After one year, there are now over 350 OCC PROFS users.

Building from its initial BITNET link with Wayne State University, OCC has established leased lines with neighboring Macomb Community College and the Oakland Intermediate School District, which provides electronic mail and administrative services to most public school districts in Oakland County. These links provide OCC with the unique opportunity to develop information technology applications with K-12 districts, sister community colleges and four-year institutions in the Southeast Michigan area. OCC is already using an IMS of placement application running on the Oakland Schools mainframe.

Libraries

The OCC libraries, known as Learning Resource Centers (LRC's), fell victim to the same lack of interest and investment that had befallen information system. After a task force reviewed alternatives, OCC decided to join a library consortium, Detroit Area Library Network (DALNET) operated by Wayne State University with NOTIS as the software product. ITS is supporting the technology and networking part of the effort. While most DALNET users have established an independent point-to-point network to support NOTIS, OCC has chosen to connect WSU's and OCC's front-end processors. This enables any terminal on the OCC data network to access DALNET using a full-screen session manager. Users need not know that NOTIS is operating on another institution's mainframe.

Data Network

The first stage of infrastructure building involved the mainframe computing system. The second stage involved replacement of the aging Dimension telephone system with a more modern telecommunication system. Prior to this activity, however, some networking basics had to be addressed.

ITS management decided that it was in the best long-term interest of the College to defer any large expansion of the College data network until after the new telecommunication system cutover. We did, however, decide that any network expansion would consist of VTAM communications and intelligent workstations. We therefore converted the College data network from BTAM to VTAM in several phases, the last of which has only recently been completed. The PROFS initiative provided the opportunity to implement SDLC connectivity over twisted pair media, and the DALNET project enabled us to use interactive applications on remote mainframes.

We also faced the challenge of "buying time" with the communication technologies already in place. Three different technologies were employed, firmware and software were obsolete and inconsistent, wiring was substandard and capacities were exceeded. Furthermore, movement of the data center several years before had left network topologies in disarray. To further complicate matters the obsolete network provided users the opportunity to intervene in network operation and occasionally cause full network failure.

* Copies of the OCC PROFS Guide are available from CAUSE.

The network was upgraded through the purchase of additional equipment, firmware and software upgrades, telephone line conditioning, network reconfiguration, and the VTAM implementation. The last step in the short-term data network activities was adoption of SIM/GCS as the College session manager and 3270 emulation product. Today each workstation in the College now displays the same multi-session menu.

Telecommunications

The problem of the aging and inadequate Dimension voice communication system was addressed in mid-1988. Informal discussions and proposals quickly led to the conclusion that a county-wide Digital Centrex solution provided by our local telco was the most cost effective solution for the College. The savings generated in line costs and, most especially in leased line data circuits, coupled with release of space and a single source vendor interface were the significant reasons for the choice.

In February 1989 the Board approved a proposal for installation of Digital Centrex. The savings generated provided the opportunity to include voice mail, automated attendant, station message detail recording and in-house moves and changes. In addition, our sites are being rewired with shielded twisted pair wiring to accommodate voice and data, as well as jacks for video.

Our data network will migrate to Datapath services, providing significant improvements in speed. Likewise, the price of the Datapath service makes growth possible without inordinate cost increases. The choice of Digital Centrex permits an easy migration to ISDN when feasible. The flash cutover of nearly 1000 stations will take place in February 1990.

Personal Productivity and Laboratory Enhancements

Many of the infrastructure initiatives revolved around central-site hardware and software. Coincident with those activities, we worked to improve the penetration of micro computers at the College. Three separate major proposals amounting to more than $1 million have been approved by the Board. The majority of these initiatives have involved improvements in vocational/technical discipline areas.

Prior to 1987 our only student laboratories were in vocational/technical areas. For this reason we began improvements here. This permitted the College to take advantage of Perkins Act matching funds and to redistribute older technology into support areas where no technology had previously existed. This "trickle-down" approach is employed whenever possible in order to make the greatest penetration.

During this period ITS also established software standards of WordPerfect and Quattro, and installed those packages and a standard menu on nearly 100 machines. For dial-up users, ProComm was selected and installed. Pell-link and SNAP-II software was provided for Financial Aid.

Again in response to ATS recommendations, considerable training in all standard packages and PROFS has been conducted or coordinated using both user computing consultants and faculty. Faculty training in courseware development tools was coordinated with an outside consultant.

Support Services

The ATS called for increased distribution of information and help for users. A newsletter approach was chosen as one vehicle for spreading the word. Named by a faculty member in a college wide competition, TIDBITS (Timely Information Dispensed By Information and Telecommunication Systems) is now published quarterly.

ITS is in the process of releasing its first user guide to information technology at OCC. This publication provides users with a "how to" approach to using our varied technology services. In addition to the user guide, we are developing a document listing all production reports received by each administrator. This document will provide users with an overview of the types of reports available upon request.

Designed to improve responsiveness to information technology problems and questions, a Help Desk, instituted in 1988, currently responds to nearly 800 calls per month. Help Desk calls are screened for urgency and assigned and tracked to completion. A standard request form for services is also tracked by an online application; ITS processes over 1,200 work requests each year.

Selection of a college vendor for microcomputer maintenance and repair also improved service while reducing costs. Users call the Help Desk with a repair request, and the Help Desk then dispatches the service to the site. Billing is coordinated by ITS.

As penetration of personal computers progressed, a campus rotation schedule for user computing consultants was instituted. The scheduled rotation times are published to users who may request "hands on" help by placing a call to the Help Desk.

Personal purchase discounts have been arranged with IBM, Apple and Zenith. Numerous license site agreements have also been arranged for personal computer software.

In 1988, The League for Innovation in the Community College and IBM sponsored a "Competition for Excellence." We encouraged our faculty to submit proposals and helped edit and finalize the forms. As a result, OCC had more entries than any other community college, and two winners.

Where We Are

Until 1988, ITS had relied heavily on the recommendations of the ATS and internal annual tactical planning to build the infrastructure and support services previously mentioned. The ATS had identified the lack of comprehensive information systems planning as one of the key root problems. ITS believed that information systems planning had to be an integral part of college-wide strategic planning. However, since the college-wide activity had not begun, we engaged in an internal planning process that would eventually become incorporated into the college-wide plan.

Early in 1989, the College began its overall strategic planning process. Because of the centrality of the academic mission to the institution, the first phase was preparation of an Academic Master Plan through the goals stage only. Administrative units have just responded to the Academic Master Plan, with ITS being responsible for developing college-wide information technology plans. Early in 1990 the combined academic and administrative plans will be turned into strategies for the College to follow over the next five years.

Our internal planning and the ATS have served us well. We found little conflict with earlier planning efforts once the Academic Master Plan was released. Our earlier activity readily fit into the administrative planning effort and, in fact, made our work easier.

Both our day-to-day involvements and our long-term objectives require considerable expenditures. The College was recently blessed with a one-time lump acquisition of capital, but shrinking state funding will continue to put pressure on operating revenues. Thus human resources and all recurring funding items are left shortchanged.

The College has now been in existence for 25 years. Bricks and mortar are deteriorating; all units of the College have less than adequate support staff; the College Faculty Master Agreement and corresponding pay and overload requirements seem to require all new recurring dollars. Information technology improvements thus compete for scarce resources. To this point we have been fortunate in putting forth adequate plans so that our initiatives have been supported. But the future promises no resources for which to compete, unless alternate sources of funds are identified.

What Have We Learned?

- Progress in the implementation of technology is far easier without the "excess baggage" of the past practice--in other words, if there is less penetration of technology the opportunity for change and transformation are easier. Conversely, the process of educating unsophisticated users is time-consuming and difficult.

- The absence of a sophisticated and integrated institutional planning process has not necessarily hampered our activities. An advocacy plan works, at least for a while. In the case of OCC, the Application Transfer Study served that purpose.

- Some of our initiatives might have been easier if we had known our climate and culture better. From the lay Board of Trustees to the custodian, the College has long held a "small" view of itself. Although the current administration understands the fallacy of that perspective, dealing with the autonomous processes at seven sites in the application of technology was a staggering problem. In our efforts to provide service we often suffer from a misconception on the part of users that we are seeking power.

- Without appropriate leadership in information technology our efforts would have failed. Although hampered by lack of support staff, the overriding vision and experience of the ITS management team is essential. Filling the leadership positions first has proved to be an overwhelmingly successful strategy.

- The combination of in-house and outside experience can make up for lack of staff size and depth. OCC has made judicious use of consultants, but finding the right group is key. Once identified, consultants can provide services in many areas---performing in-house technical training, working side by side with staff, analyzing specific problem areas and conducting mini-needs assessments.

- As noted earlier, ITS established a system of advisory councils. While this process works for ITS-related business, the integration of technology into other college functions required a different approach. Effective this year, ITS administrators now sit on all major college councils: administrative services, student services, academic services and research. Thus ITS is apprised and involved at early stages of activities in other areas that may require technology.

What Do We Face?

- System and network integration, and managing the technology behind this integration, loom as our biggest challenges. "Islands of technology" still exist, though they are not as pervasive as in more mature institutions.

- Given the dispersal of our campus sites, the network must provide the conduits that bring technology to classrooms, desktops, libraries and support service areas. We believe our digital Centrex decision is a sound one. The ability to migrate to Integrated Services Digital Network (ISDN) is particularly appealing since incremental costs will not be as great as if another solution had been chosen.

- Integrated information systems, currently being proposed, will bring technological improvements to the management of the College. These systems will bring to the OCC administration a common base of information to operate the College. These systems may also induce significant and positive organizational change.

- The OCC faculty has been slow to adopt technological approaches in the classroom. Faculty members are even more reticent in the area of courseware development. We have concluded that we must provide some incentives to faculty in order to achieve a greater infusion of technology into the instructional process, e.g., personal computing capability, release time for curricula development, readily available consultation and training on instructional technology issues. We must also guarantee and demonstrate that the needed infrastructure is in place. To address these issues, the college-wide instructional advisory committee membership will be broadened to include more faculty.

- Finally, we must continue to develop advocates for the creative uses of technology and push for the integration of technology planning into the College's strategic planning efforts. These activities promote value-added applications for the end user.

The progress made in applying technology to OCC's goals and mission over the short span of three years has been remarkable, bringing major transformations in the work performed and services delivered throughout the College. The technology infrastructure and direction is in place, and support services are now expected. The foundation has been laid for the future.

IMPLEMENTING A CAMPUS COMPUTING PLAN

Dr. Michael D. Richards, Vice President for College Relations
Dr. Chandler Whitelaw, Director of Computing Service
Mr. Glen Pryor, Director of Administrative Computing
Southern Utah State College
Cedar City
Utah

ABSTRACT

This paper describes a comprehensive computing master plan for academic and administrative computing, including interfacing with existing technology, goals and objectives, networking approaches, organizational impacts, and resource strategies that have been implemented at a mid-size, four-year college. Three years of consensus building and education among various campus constituencies were invested in the plan. Physical design, functional requirements, organizational issues, and policy issues are described. The process of developing and implementing the plan, as well as six months experience with it in place, are reviewed and analyzed. This paper is directed to computing and planning administrators from small-sized and medium-sized institutions.

IMPLEMENTING A CAMPUS COMPUTING PLAN

Background: The Southern Utah State College Environment

The Institution and Computing

Although computing has taken a central role at nearly every institution of higher education, each struggles with the pressure to provide modern computing services with limited resources and with competing priorities. Southern Utah State College is no exception to this common problem. With enrollments growing as high as five percent each year (jumping by 22 percent this year), in a state with severely limited resources for higher education, SUSC has had to respond with a deliberate plan for campus computing. The College is a comprehensive, four-year institution with 3,600 students, 130 faculty, 80 baccalaureate and vocational degree programs, and two master's degree programs. The College is about 200 miles from any similar institution.

Seven years ago, SUSC obtained all administrative computing services via a microwave umbilical to a sister institution 300 miles away. As computing evolved, its fractional development prompted the College to a unified, cohesive approach for all computing. Because of its size and limited resources, the College was unwilling to allow separate planning or completely independent functions. Thus a comprehensive master plan for campus computing was developed and implemented. Under the framework of the plan, administrative computing occurs on the campus VAXcluster, academic computing is decentralized with local area networks, phase 1 of a fiber optic network is in place, and a student-to-microcomputer ratio of 18:1 has been achieved. Equally important, SUSC is organized for computing and for its future in systems integration.

Academic Decentralization

Talking, tension, and consensus building, particularly as the computing master plan was developed, resulted in decentralized academic computing shaped to the needs of academic departments. With the assistance of an ad hoc committee of faculty and staff, and an outside consultant, the administration was persuaded that a student fee, as well as state appropriations, should fund academic computing. On this basis, a request for proposals was issued to install an Ethernet fiber optic network connecting the major academic facilities and to purchase microcomputers and peripheral equipment for three new local area networks (LANs). Figure 1 illustrates the present physical layout of computing under the master plan. In future years, as resources allow, the fiber network will connect all buildings; and all computing will be linked to the network.

Academic computing is distributed through LANs and laboratories. Five LANs are operational, including three in the School of Business (one of which is for computer assisted design), one in the School of Science, and one in the Library. The School of Science also operates an Apple lab and a VAX terminal lab. The School of Arts and Letters and the School of Education provide Apple labs that have not yet been connected to the network. Further, faculty offices in the School of Business and in some of the other departments of the College have microcomputers connected to the network. Departmental and open access hours of use are published.

Decentralization has evolved as campus computing matured. Each department has wanted to shape its own computing destiny, but resources have been limited. What has emerged for the academic departments is centralized computing in a distributed environment. Technical support is centralized in one or two staff; applications support is provided by several faculty members. As a result, users look to the central services of academic computing for training, maintenance, and general support.

Administrative Centralization

In 1984, SUSC acquired the Series Z administrative software from Information Associates (IA). A year later, the State of Utah contracted with IA for statewide licensing of the software for higher education administration. In addition, FOCUS has been added as the fourth generation language and report writer for the campus. All of the major software modules that IA has developed are installed at SUSC and supported by a staff of about 2.5 full time employees (FTE). The college has placed responsibility on the users for the applications of IA software. The Student Information System (SIS) is a responsibility of the registrar's and financial aid offices; Financial Records (FRS) is a responsibility of the controller's office; Human Resources (HRS) is a responsibility of the business and personnel offices; Alumni/Development (ADS) is a responsibility of the development office; and Loan Management (LMS) is a responsibility of the loan collections office.

Campus Computing Network

The fiber optic backbone network connects the major campus buildings. The buildings contain a variety of local area networks connected to building backbone networks. These building networks are connected to the campus fiber optic network through bridges.

The fiber optic network is supplemented in two ways. First, the microwave system of the State of Utah connects SUSC to the University of Utah and from there to the Internet. Faculty, staff, and students can, thereby, access national networks. Interlibrary loan and information exchanges can also be expedited through the microwave system. The link reduces SUSC's geographic isolation and makes possible improved services to the campus.

The second supplement to the fiber network is a terminal network that was initially installed about six years ago. Managed by a DCA 355 communications processor, this network has about 300 terminal lines to residence halls, terminal labs, administrative offices and classrooms. Various applications can be accessed through the terminal network. As the campus grows, additional terminal lines can be added to the terminal network or to the fiber optic network through terminal servers.

Through the campus fiber network, faculty and staff can access on-line course, financial, and other management information. In addition, all users have access to various VAX/VMS tools such as word processing, database management, fourth generation report writers, and statistics packages.

A variety of academic services are also supported through the campus network. The College provides programming languages such as COBOL, FORTRAN, BASIC, Pascal, C and LISP; computer assisted drafting, and a variety of word processing, spreadsheet, graphics, desktop publishing, statistics, and database packages. Electronic mail is available campus-wide, and a variety of specific courseware and public domain applications are also provided.

Functional Organization and Support Resources

Figure 2 illustrates the functional organization of SUSC computing in a stack diagram that begins at its base with hardware and concludes at the top with separate application "arms," one administrative, the other academic courseware. Providing service for hardware platforms, operating systems, network communications, and some utility software has been the responsibility of two FTE staff and many student operators in the Office of Campus Computing Services. Two additional staff are dedicated to the administrative applications, and two are responsible for academic computing.

Ideally, each operating system should have staff support. Network communications and software applications might, likewise, have dedicated, specific staff support. The College is unable to provide levels of support that are demanded by everyone, but much has been done to meet basic levels of operation.

While the diagram illustrates the integration of SUSC's computing functions, it also highlights the complexity of academic computing applications. Courseware is curriculum specific. One or two FTE staff cannot by themselves support, maintain, and integrate all of the courseware appropriate to the curriculum. One or two FTE staff can, however, coordinate courseware technical support and provide needed assistance with network communications to augment academic computing.

The key to the success of integrating computing in the curriculum is the faculty. As faculty members feel comfortable with technology and with the instructional applications of computing, integration begins. Thus, SUSC determined that position announcements for new faculty would include duties regarding computing. Further, a fraction of at least one faculty FTE position in each "computer-active" department would be assigned to courseware implementation and support. Therefore, at least one member in each computer-active department would have a specific duty to support courseware and integrate computing in the department's curriculum.

A dilemma for the College, and perhaps for all small/medium-sized institutions, is how to distribute computing with limited resources and competing priorities. Every department cannot be adequately supported. Technical support for computing trails in priority the need for better faculty salaries, more library books, and modern instructional equipment. Broad-based planning and extensive coordination has been necessary to balance resources and priorities and to recommend a feasible direction.

The Planning Process

Computing Steering Committee

In 1987, the College established a computing steering committee, comprised of faculty and staff, to recommend computing policy and to coordinate computing activity in a planned, cohesive fashion. Two users groups--administrative and academic--were also formed. The Steering Committee developed the computing master plan, assisted by a graduate class in management information systems. The graduate students provided research on specific issues which the Steering Committee suggested. As a class, each student made a presentation to the committee, and many of their recommendations have been included in the master plan.

Computing Survey and Data Collection

With the encouragement of the Steering Committee, the academic users group surveyed each department to determine the extent of computing activity on campus. The survey found that nearly 18% of the curriculum was "computer-active" with faculty requiring or recommending computing in their classes. Other specific findings, included in the plan, formed a database and point of reference for future assessment. Further, the master plan included exhaustive data for two years of VAXcluster utilization. For the first time, the College had data on all its computing services.

Goals and Objectives

The master plan contains the following goals and objectives for the next three years.

1. Extend the fiber optic network to all buildings.
2. Develop all the capabilities of IA software.
3. Complete LANs in three buildings.
4. Implement internal maintenance and repair functions.
5. Compile and analyze student LAN utilization data.
6. Develop through FOCUS a menu-driven decision support system.
7. Assist users with training and reference materials.
8. Continue to improve computing access for faculty and students.
9. Assist faculty in integrating computing into the curriculum.
10. Prepare a budget detail and configuration for processor upgrade.

Problems

The computing master plan encountered three major problems. The first, impacting administrative computing, was one of matching the physical limits of the central processors with user demands in a fiscal environment that will not allow a processor upgrade for 18 months. Usage constraints and other management actions have been taken to "get by," and increased support from the State is being requested.

Academic computing has the difficulty of not clearly understanding all its needs and objectives in terms of workstations and applications. It is further handicapped by a lack of funding to fully operate LANs and provide service in other areas of the campus. The plan recommends increasing student fees for equipment acquisitions and seeking State support for operating funds.

The third problem is the human relations of computing and planning. Individual preferences on issues of philosophy, resource allocation, organization--indeed, nearly every topic, created some discord and distrust. To some people, the plan was a challenge of control. In the end, academic computing decentralized in order to govern itself; yet now, even that decentralization has been "re-centralized" to some degree.

Planning Outcomes

Organizational Implications

The master plan recommended an organizational change to better reflect actual lines of responsibility. The Steering Committee proposed that administrative computing remain under the direction of the Executive Vice President for Financial Affairs, that academic computing be a responsibility of the Provost, and that computing services (computer center and campus network) report to College Relations. Figure 3 illustrates the new organizational structure. The Steering Committee provides a coordination and policy role.

Policy Issues

Implementing the master plan raised several issues of policy which the Steering Committee addressed. The first was how to place usage constraints on the VAXcluster. Without a processor upgrade for 12 to 18 months, action was needed to extend the capacity of the existing processors. The master plan recommended a number of constraints, including limiting IA applications, batch processing and tape back-up to off hours, limiting FRS closings and reports to weekends, and acquiring alternate equipment for Series Z reports.

A unified approach to the standardization of hardware, software, and peripheral equipment was adopted not only to assist with acquisitions of equipment, but also to simplify repairs and servicing under a new, internal maintenance program.

In the past, the College has been unable to accurately identify all expenditures for computing. With the encouragement of the Steering Committee, the Management Information Systems (MIS) class of graduate students researched resource allocation models and procedures and recommended improvements in the structure of the College accounting object codes.

Finally, more responsibility was placed on revitalizing the users groups to determine their objectives and needs. The Provost, for example, actively works with the academic users; and each users group has taken its role more seriously.

Conclusion

With a singular approach to campus-wide computing services, SUSC has implemented a plan within a campus environment of limited resources and competing priorities. The plan is an essential guide for all types of computing and will allow SUSC to remain competitive in the dynamic world of computing technology.

FIGURE 1
PHYSICAL ORGANIZATION

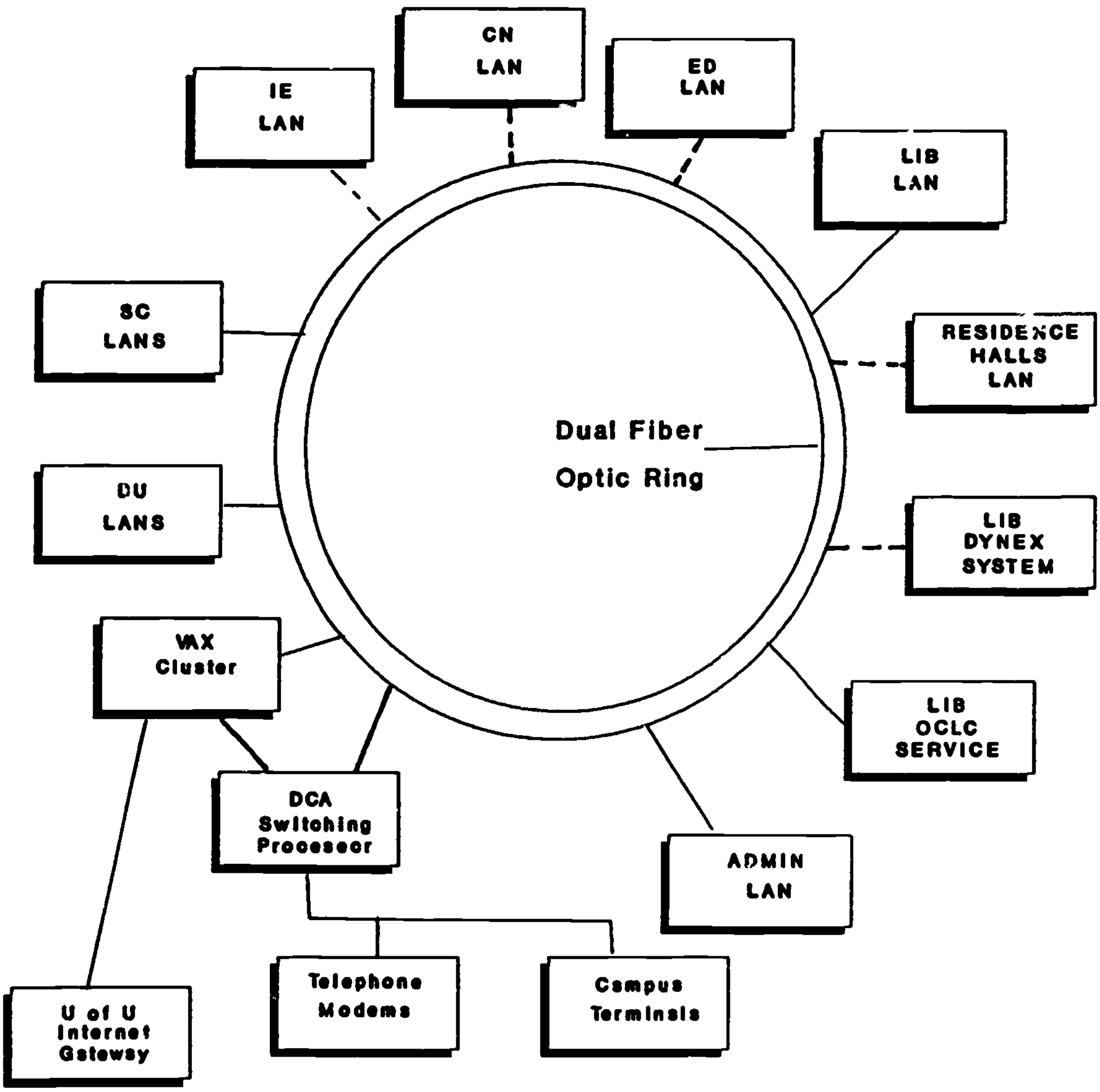


FIGURE 2

FUNCTIONAL ORGANIZATION OF CAMPUS COMPUTING

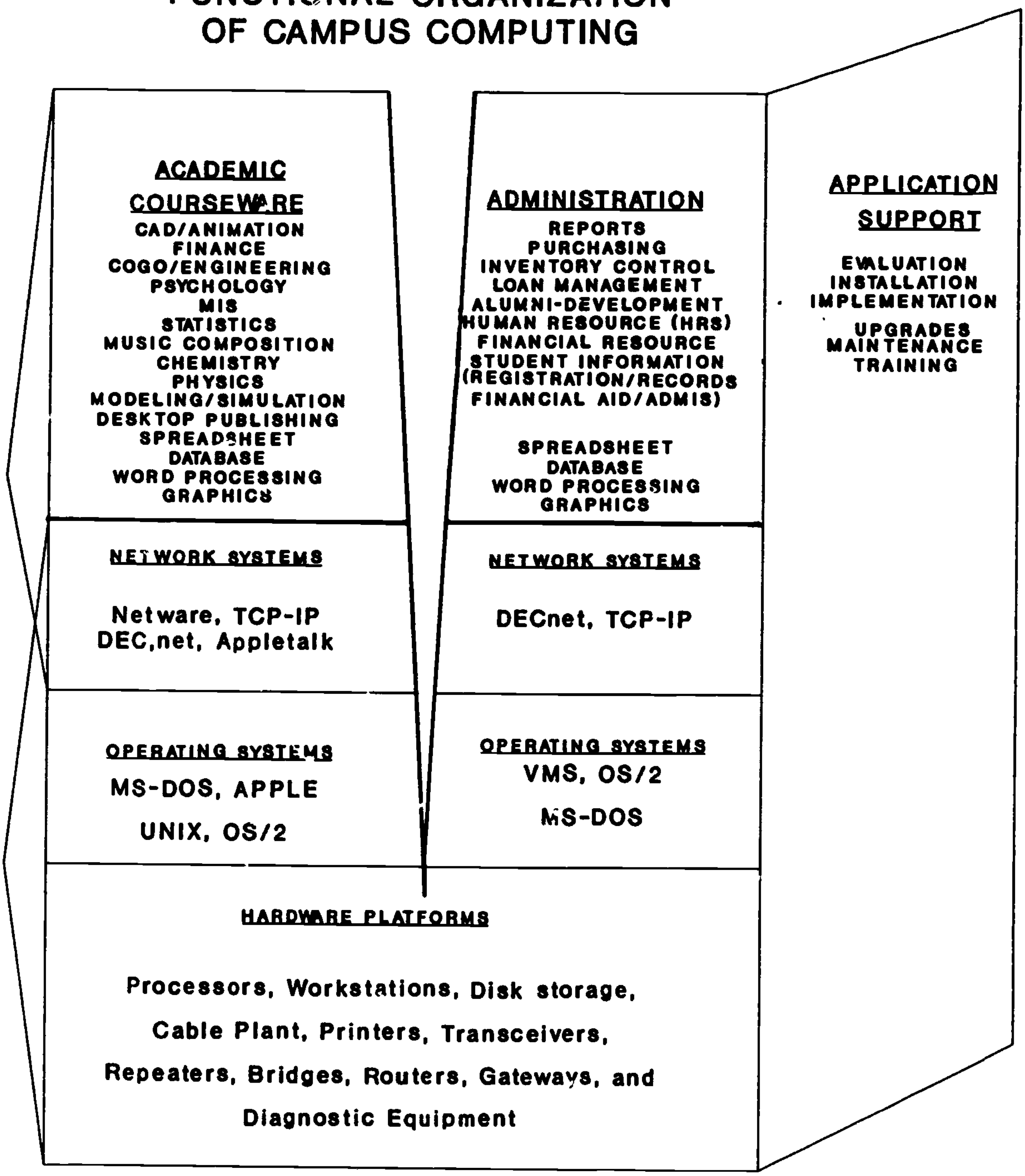
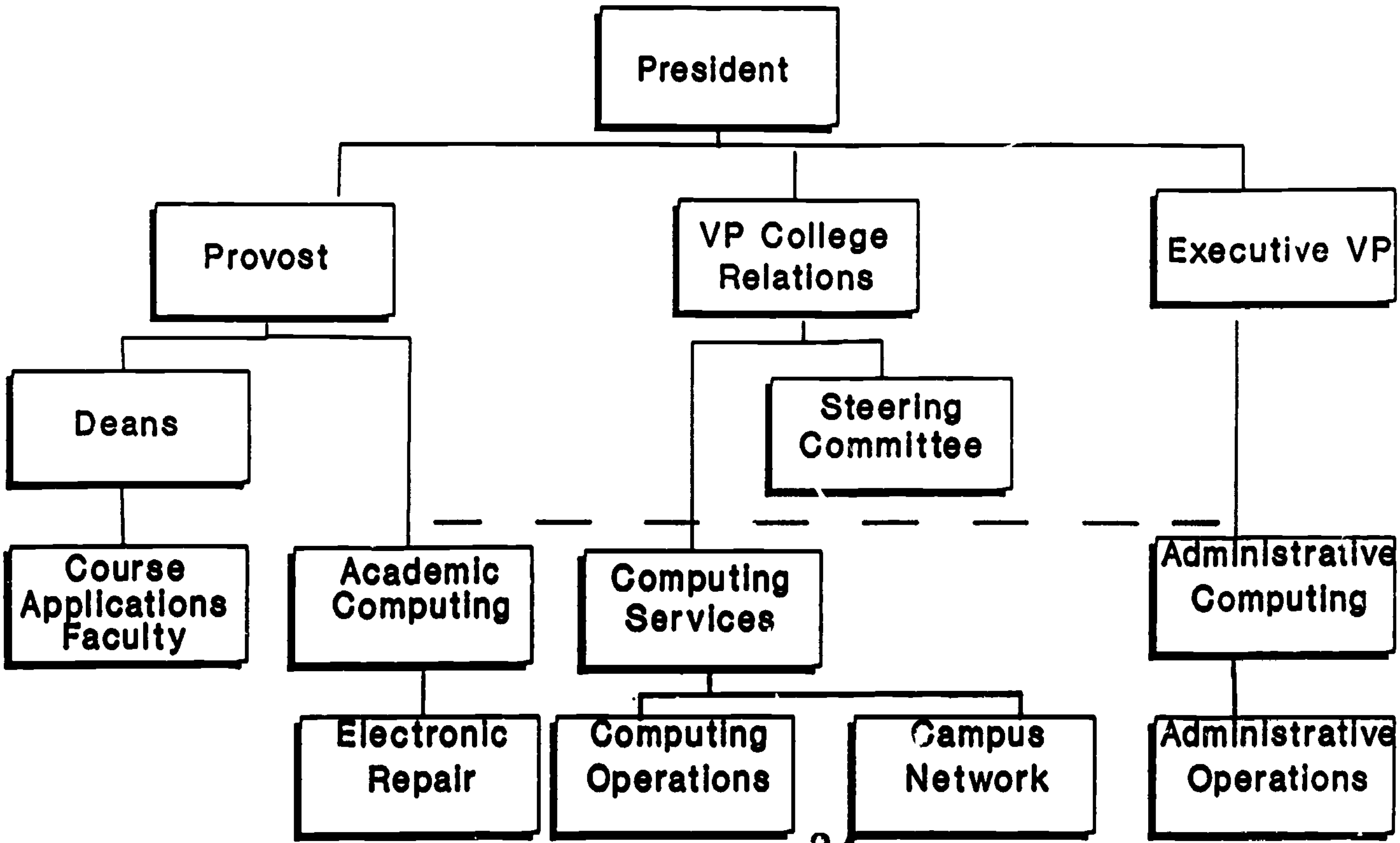


Figure 3
COMPUTING ORGANIZATIONAL PATTERNS



A Case of Successful Integration of Technology in a Liberal Arts Environment through an Integrated Voice and Data Network

Richard A. Detweiler
University Vice President
Drew University
Madison, NJ 07940 USA

Abstract

Drew University is a militantly liberal arts school that has implemented a pervasive technology system that includes computing and a fully integrated voice and data network (all students, faculty, and staff have pc's, voice and data connections, voice and data mail systems, and a range of network services). This system was designed and implemented within the context of general university plans. In addition, all technology operations report to the same person (who is also the chief university planning officer) that results in a more coordinated, powerful, and cost effective decision process than otherwise possible.

In general, when technology is seen as a tool rather than as technology per se, when implementation is seen as a human rather than as a technological endeavor, and when technology can lead demand rather than react to it, the role of technology systems becomes central to institutional strategies.

The Context

The fundamental goal of liberal education is to teach people to think. An educated and thinking person systematically, logically, and creatively assesses available information. With the glut of information (the "information age") education has tended to become specialized and narrow.

The possibility for educational revolution through computer and network related technology is substantial. The nature of this revolution has to do with effective access to broad areas of knowledge, and the ability to communicate efficiently about them. Computer and networking technology is a tool for liberal education. This tool is not the personal computer or the library automation system or software or the academic computing center; rather it is the integrated use of all these components. In addition, if we are to prepare our students to make a contribution to an increasingly technological world, they must make use of technological tools a part of their lifestyle. This does not make our liberal arts students technologists; it does make them more capable, thinking people in their everyday life.

Drew is an independent university of 2200 students, including an undergraduate school, a graduate school, and a theological school. The university is described as "militantly liberal arts," and has exhibited the usual unwillingness to support any undergraduate degree program that smacks of professionalism. Indeed, the decision to allow a major in Computer Science within the mathematics department was made relatively recently and only after much faculty agony.

The seeming anomaly, then, is that in 1983, the college faculty voted, with only one dissenting vote, to implement the "Computer Initiative." This initiative was taken as a result of research and planning efforts that identified the widespread use of personal computer technology as an educationally important and valuable strategic opportunity. The CI, as it is called, provides every entering freshman with a complete computer package: a fully configured pc system, printer, and software. This package, including hardware and software, is the personal property of the student. The CI was followed in 1987 with a decision to implement the Knowledge Initiative: a pervasive implementation of a communications and information processing network system that optimizes every individual's ability to access, process, and communicate information.

Implementing the Knowledge Initiative

While it is typical to think entirely in terms of text-based communications systems (e.g. computers and data networks), this approach overlooks the obvious fact that spoken language is an important, rich, and indeed necessary form of communication. Indeed, since computer technology has now been applied to voice communication, this form of communication may for the first time be integrated in a meaningful way into communication network design. Current generation telephone instruments are in fact computers, digitizing voices before sending any signal over the wires. Feature-buttons (e.g. hold, transfer, conference, forwarding, etc.) are actually digital signaling that send a command over those same wires. Similarly, turning lights on next to buttons is a command signal. Voice processing technology (e.g. voice mail, audiotex, automated attendants) is in reality computer CPU's with disk drives rated in hours (of voice) rather than in megabytes or gigabytes of storage. Thus, not only is the control of voice based information more akin to that which we are used to using effectively with text based systems, but the possibilites for true integration of functionality with data systems very high.

Our general concept is twofold: a) information processing and exchange is the most fundamental activity of an educational institution; and b) one should be free to choose the information exchange method (voice or data, immediate or delayed) which best fits the communication need. Thus, for example, a library search would logically be an interactive data session; the submission of a student paper would be delayed (electronically-mailed) data session; a clarification of a course assignment would be simultaneous voice communication; and a clarification to a class of an assignment by a faculty member would be delayed (voice-mail) voice communication. And of course, the ability to have simultaneous voice and data communications would be a real value in some contexts, such as for a professor and student to be discussing a library automation search reference list on-screen.

We were guided by both the educational and the technological principles as we examined communication network alternatives. The typical choice for data communication is a broad band network of some form. Fiber and Ethernet are among the common university buzz words. Similarly, telephones are telephones and are generally believed to be low-tech twisted-pair creatures. Rather than starting with technology, however, we began with our needs. In our environment, we projected that the typical situation would be a relatively high proportion of our 2100 users active at any one time, but they would be carrying out relatively low volume data transfer tasks (e.g. smaller text files, not multiple screens of high resolution graphics). Our ultimate design need was to allow all 2100 users to simultaneously send several hundred bytes without system response degradation. Packet-based data networks (e.g. Ethernet) are notoriously poor performers in this type of many user/moderate traffic situation; they perform superbly in the reverse situation (relatively few users sending large "chunks" of data). Contrarily, switched networks can handle the many user/moderate traffic scenario easily because moderate transmission rates (e.g. less than 64 kb) handle smaller amounts of information easily. In addition, because current phone systems also use switched network technology we had an opportunity to develop the integration of voice and data services in a way that would not be possible with a separate voice and data network.

Serious planning for this system began with a lengthy national search for telecommunications/networking consultant support. After careful evaluation we selected Telegistics, Inc. as having the best match of capabilities with our needs, and we began using their services in 1987.

The first step was the development of a "request for information" (RFI). Rather than invest heavily in the development of detailed technical specifications applicable to the many switch vendors, we put out an RFI that described what we wanted to accomplish, what our concerns were (e.g. virtually non-blocking switch, digital technology, integration of voice and data, timeline, etc.) and had vendors inform us of what they had to offer, optimal design scenarios, etc. From these responses we examined hardware and software, and put out an RFP to those who appeared to have the technical capability and support apparatus necessary to implement the project. The RFI responses were a binding part of all following RFP responses.

Evaluation of the proposals and selection of the vendor was based on a multitude of factors. In general, three factors were used to screen and rank vendors; for the highest ranked on these two additional factors were applied. The first factor was the user interface. Of primary concern to us was the "humanness" of the system. While there are many aspects to this critical dimension, one example of this is that people are not effective users of "pound/star" commands on telephones (e.g. to pick up a call dial *6). For this reason, we specified that telephone station equipment must have software defined and labeled feature keys (e.g. a separate button on the phone labeled "transfer"). We ultimately concluded that there must be at least 10 such keys available. Similarly, establishing a network data connection had to be not much more complicated than turning on a pc with communications software loaded.

Second was the system performance. In this category fit various aspects of the technology itself: data throughput rate; number of simultaneous users voice and data services; degree to which system balancing or engineering had to be continually done to maintain adequate performance; the ease of use of network management software; etc. Again, we were less interested in specifying the technical attributes of the system than specifying the performance standards of the system.

The third general evaluation factor was future potential. This included two components: the adequacy of the design for the middle-term future (e.g. ease of ability to support ISDN, availability of software development tools on the switch, etc.); and the second was the service and maintenance availability, longevity, and cost. We required evidence of a prior history of satisfied maintenance customers, guarantees of long-term availability of parts for expansion or enhancement and repair, and governors on maintenance cost escalation.

For the top five RFP respondents, a fourth and fifth evaluation factor were applied. The fourth was partnership potential. We knew that we would need an active and on-going relationship with the vendor(s) to develop system enhancements appropriately and keep the system reasonably current for the longer term. We could not afford to be supporting the needed development activities alone but wanted a vendor who would be willing to use our system as a location to cooperatively develop and test software and hardware. We described this as an interest in partnership.

The final factor was price. As with any educational institution, price matters; moreover, we needed a system that optimized the price/performance/humanness trade-off.
We were not willing to make significant concessions on any of these factors.

We evaluated proposals from 14 corporations, including switching and telecommunications hardware from ATT, IBM, Intecom, NEC, and Northern Telecom; and computing hardware from DEC and IBM. Ultimately we chose to forge a partnership with Bell Atlanticom, Intecom, Octel, and Digital, and later with MCI for network services and DRA for library automation. All were committed to creating a one-of-a-kind national showcase demonstrating a fully integrated educational data and voice communications network. While many very visible high technology universities have implemented components of this system, no school has to date implemented a completely pervasive system that provides full functionality to every student, faculty member, and staff office.

The system we installed is a simultaneous voice/data network that is fully non-blocking (that is, all 2100 people can have a simultaneous voice and data connection with no network performance degradation), and that provides a "connection" for every person on campus. The system provides the following four functional components: (1) a data network linking the three computing centers (academic, administrative, and library), all PCs on campus, and external networks (including BITNET); (2) a network server that provides electronic mail, various databases and information services, etc.; (3) a more effective voice system that allows full and timely communication among all members of the campus community through an expansion of current phone service, direct inward dialing, improved forwarding/answering, cost accounting, etc.; and (4) a voice processing facility including voice mail, audiotex (to deliver standard information to internal and external publics), automated call routing, etc. The system includes an Intecom S80 with about 5000 ports (2500 flex-IM ports), an Octel Aspen voice mail system; and a VAX 6330 running All-in-1, DRA library automation software, Alexis call accounting software, and other network services.

In very concrete terms this system is visible to the individual on campus through a "station" that includes a fancy phone with function buttons and the student's personal computer. The phone is in fact digital and uses the same binary communication method that computers use. It gives the student full-featured voice capability (e.g. conference calling, forwarding, etc.) and voice mail, while simultaneously connecting the pc to every other pc on campus, to a data network that includes All-in-1 as the e-mail system, library automation, network connections to other campuses around the world, and a variety of other services including telling you how full the moon is.

The system, including an entirely new cable plant, all new building wiring, building of a new network center, installation of all hardware and software was completed in 10 weeks through heroic efforts of all involved, beginning on about May 25. We began training of faculty and staff on about August 15, and with all students on about September 1. In all cases, voice and voice mail were taught first, followed by network services.

Impact and Implications

There are six outcomes of this system worth special note. First, the system has further blurred the distinction between academic and administrative technology services. While the extremes can still be identified (e.g. the payroll database is clearly administrative and the use of symbolic equation manipulation software is clearly academic), most technology services (networking, pc's, etc.) are used by all faculty, staff, and students. As such, staffing has been largely merged and traditional distinctions among areas largely eliminated.

Second, the system at this time may be thought of as a fairly complete roadway with many vehicles on it; at the same time it is clear that we have hardly begun the process of putting up the roadsigns (appropriate software applications) and building exit ramps (to special purpose processors, e.g. unix or graphic stations). This will develop with time, out of the imaginations of our people.

Third, one should anticipate demand and put in hardware and software before it is universally demanded. This is important for two reasons: a) in the typical case, one or two departments begin experimenting with the use of information systems technology and invest in hardware and software; the general interest grows and the university tries to put in a coherent system, but must fight turf-like battles over which technology is best, and then whether to spend enormous amounts of money trying to link dissimilar systems or throw away the investment by tossing out existing systems; and b) putting in networking systems piecemeal is very expensive on a per unit basis compared with fully designing and implementing a network system designed to optimize needed functionality and minimize compatibility issues. In our case we have acted on personal computers, networking, and telecommunications systems before the demand curve rose. As a result we have established the standard that, though not everybody agrees is the one best one, is certainly in everyone's interest to be compatible with. We have done all this at a cost of perhaps one-third that which would normally be expended for similar functionality in a more typical situation.

Related to the first three is the fourth: never underestimate the potential need for additional staff support. As line distinctions blur, the need for the development of hardware and software integration grows. Similarly, given a versatile network, the opportunities for new applications to make more effective use of the network grows. Both of these are natural and important. One must then balance the new unmet need against the potential cost of development. We, frankly, have tremendous demand for software development that we cannot meet without a number of staff development additions that we cannot now afford. To our way of thinking this is not a crucial problem. This problem would not exist if we had a less capable network. Should we, therefore have put in a less complete network? We could have done that, but at significant longer term cost. Must we immediately meet all need? As long as everyone recognizes that the current system accomplishes much that was never before possible, and that there will be systematic development of software over time, then the answer is no. However, this is a non-trivial credibility and political issue that must be attentively managed.

Fifth the system is complex and expensive to run; on the other hand these expenses are largely anticipated and, because of the inclusion of phone service in the network system, self-amortizing by the application of phone use fees. We would not have been able to afford to put in and maintain a data-only system because fees for its use would not have been appropriate; however, by applying normal residential rates to telephone service sufficient revenues are generated to largely cover system cost over a seven to ten year period.

Finally and most importantly, always remember that the key to the successful integration of technology into an educational environment lies not with technology but with the people. Avoid being unduly excited by technology itself, but do become excited by what technology can do for education and for the preparation of educated people. Pay more attention to preparing people through preparatory information, accessible training, and ready support. Certainly some hardware or software is easier to learn to use than others, but based on current options this is a minor concern. The important factors are not ease of use or quality of graphics display; rather they are how educated people think and approach information. This is not to say that the technology is irrelevant, but that the key to success is to look at all technological endeavors as human endeavors.

CAUSE '89

The Best Laid Plans...
An Implementation Retrospective

James I. Penrod, Vice President for Information Resources Management
California State University, Los Angeles
5151 State University Drive
Los Angeles, CA 90032

Michael G. Dolence, Strategic Planning Administrator
California State University, Los Angeles
5151 State University Drive
Los Angeles, CA 90032

Abstract

Three years ago a paper was presented which discussed the establishment of an IRM organization at Cal State L.A. and initiated a strategic planning process for information technology defining parameters for three major projects (a new digital telecommunications system; OASIS, a new administrative system; and instructional technology). At this point, the University is well into implementation of these multi-year projects.

The University continues to be serious about meaningful strategic planning and in an effort to learn more from our experience, both successes and failures, this paper offers a retrospective view. This analysis is a deep view of what was done, how it was done, what worked, what did not, and what might have been done differently.

The Best Laid Plans . . .
An Implementation Retrospective

Introduction

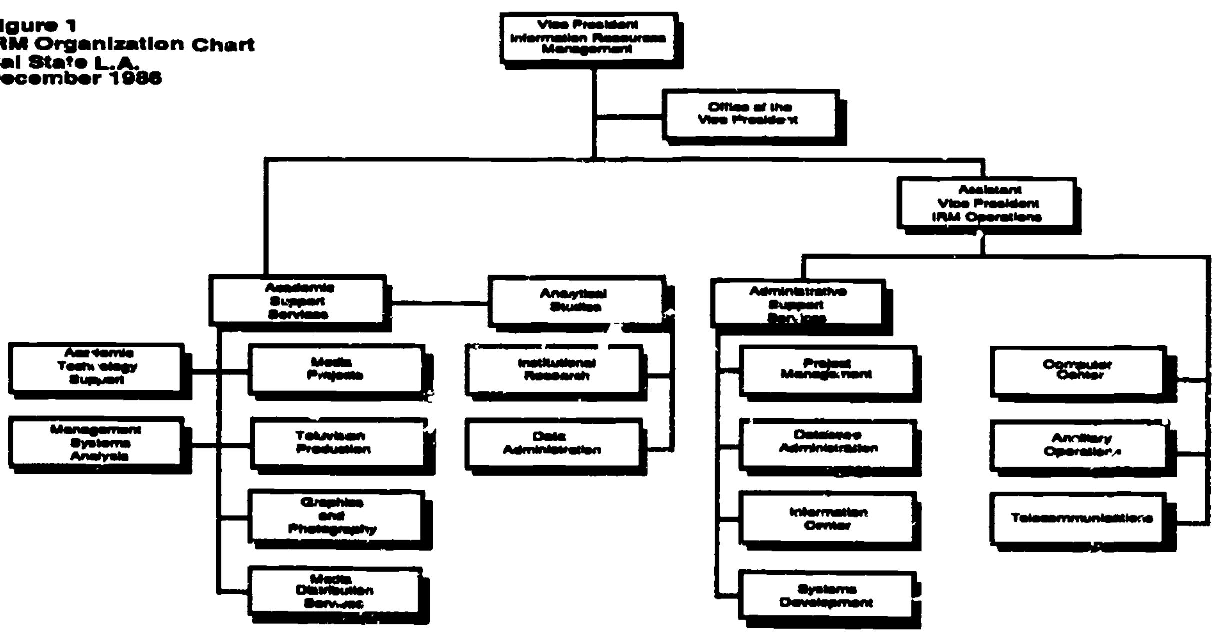
Three years ago, the process of establishing an Information Resources Management (IRM) organization, introducing a participative strategic planning model for information technology (IT), and initiating three major multi-year information technology projects at California State University, Los Angeles (CSLA) was documented.[1] In the ensuing thirty-six months, the IRM organization has matured, the strategic planning process has evolved, and the projects are well on the way to completion. This paper will examine the organizational experiences of the past three years, note how the planning process has changed, and list the major successes and failures from the information technology projects.

Organizational Development

The IRM organization at CSLA was first established in late 1985 by combining several information resource functions previously located in Academic Affairs and Administration into a single unit led by a Vice President for Information Resources Management.

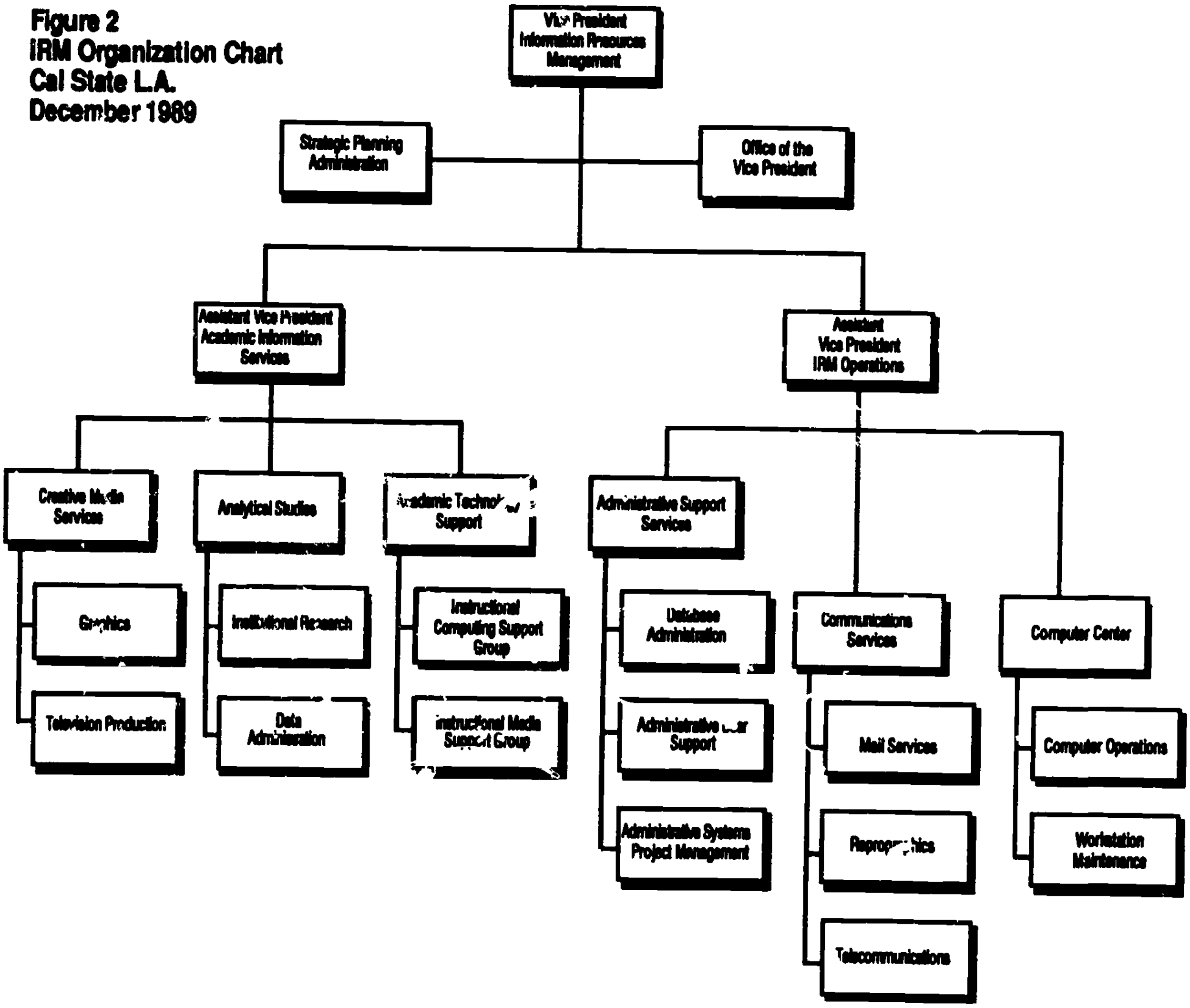
A comparison of the current organization chart to that of Fall 1986 (See Figures 1 and 2) reveals that some "settling in" and regrouping have occurred but that basic functions have changed little. Four significant changes do appear: (1) Telecommunications, Reprographics and Mail Services now form a Communications Services unit; (2) Academic Technology Support now incorporates both instructional computing and instructional media support departments; (3) the Academic Information Services leader has been elevated to an Assistant Vice Presidency; and, (4) strategic planning administration has become a formally defined function within the Office of the Vice President.

Figure 1
IRM Organization Chart
Cal State L.A.
December 1986



The establishment of Communications Services reflects the installation of the telecommunications system and its importance to the campus as a whole. It also indicates the growing impact the campus network has on both Reprographics and Mail Services. The second change, the fusing of media and instructional computing into an academic technology unit, accommodates both the planning and the delivery of instructional support. Media and computing tend to blend as images are created, stored and transmitted. Third, the creation of an Assistant Vice President for IRM, Academic Information Services recognizes the need for a policy level support person to focus upon

Figure 2
IRM Organization Chart
Cal State L.A.
December 1989



information technology issues that are of primary importance in instruction and research. Finally, dedicating a director level position within IRM to strategic planning illustrates the institutional commitment to planning and to closely linking IRM goals and objectives to the institutional mission.

Perhaps the most important changes, however, have occurred in the organizational culture of the IRM unit. The Assistant Vice Presidents (AVPs) and Directors have come to function reasonably well as a team and employ a matrix approach to problem solving and resource allocation with some skill. Personal integrity, a desire to serve clients, forthright communication, and hard work can be legitimately claimed as organizational values. The necessity to find the time to plan and to follow-up activities with meaningful evaluation is recognized as an important part of the fabric of the IRM unit.[2]

The Evolution of Planning Methodology

The first *IRM Strategic Plan* for CSLA utilizing the Shirley planning methodology was produced in early 1986 and predated the adoption of a formal planning model by the institution. After examination and evaluation of various models, the campus chose the Shirley strategic planning methodology in October 1986. The adaptation of the model to campus needs began with the plan to plan which called for the development of ten campuswide tactical plans to provide operational parameters for carrying out the mission and goals of the institution. IRM was one of the designated tactical planning areas.[3]

In Fall 1989, the *CSLA Strategic Plan* was approved and made available to the campus community. The strategic plan sets forth the mission of the University and elaborates upon it through statements of relative emphasis. A long term focus for action is provided through seventeen institutional goals. Drafts of the various tactical plans were also completed and circulated. The IRM plan is carefully aligned to support areas and issues which are emphasized in the CSLA mission statement or specified in formal campus goals.

Unit level plans which collectively encompass all of the goals and objectives in the IRM plan were developed and are now in place. There are seven such documents, e.g., Academic Technology Support (ATS), Administrative Support Services (AdSS), Analytical Studies (AS), Communications Services (CS), Computer Center (CC), Creative Media Services (CMS), and the Office of the Vice President (OVP). Additionally, each manager produces an annual work plan which contains measurable objectives directly linked to the unit plans.

To summarize, in Fall 1986 the *IRM Strategic Plan* contained goals and objectives felt to be supportive of institutional perspectives. Its format was generally determined by guidelines from the systemwide Chancellor's Office which mandated an annual *Campus Information Resources Plan* (CIRP). By Fall 1989, the *IRM Tactical Plan* provided a summary of the *IRM Strategic Plan* (part of the CIRP), conformed to campus guidelines for institutional tactical plans, was directly linked to the *CSLA Strategic Plan*, to the IRM unit plans, and to annual administrator work plans. It was a campus document reflecting policy, priorities, and resources devoted to information technology at CSLA. Goals reflected a three to five year horizon and were accompanied by a projected five year budget. The objectives were written for the current fiscal year and paralleled budgeted expenditures.

Project Review

One of the purposes in creating an IRM unit was to provide leadership in building an integrated information infrastructure which fully supports the instructional, research, communications and administrative needs of the campus. These information technology needs are being addressed through three projects.

The three major multi-year information technology thrusts are summarized in the following goal statements: (1) to plan, coordinate and assist faculty in building an academic computing infrastructure to meet the needs of CSLA through the 1990's; (2) to plan, justify, procure, install and operate a state-of-the-art telecommunications system and campuswide network; and (3) to plan, design, procure, install and operate integrated, relational based administrative applications systems.

Academic Infrastructure

In Fall 1986 the CSLA academic computing environment consisted of about 400 student workstations/terminals in 14 labs or classrooms with 2 LANs, 60 faculty workstations, 14 mini/super minicomputers, a Cyber 730 (shared with administrative computing), 200 ports on a Gandalf PACX system, four full time support staff, and about 20 student assistants.[4] This Fall the academic information technology environment has 630 student workstations in 33 labs or classrooms with 16 LANs, approximately 300 faculty workstations, 28 mini/super minicomputers, an Alliant mini supercomputer, 340 ports on two Gandalfs and an Infotron INX with a bridge to a Proteon Pronet-10, 17 full time support staff (11 are in ATS and six are in Schools/Departments) and 45 student assistants. Additionally, annual academic information technology donations to the campus have tripled to a sum of about one million dollars.

Telecommunications

A Pacific Bell Central Office Centrex providing approximately 2225 telephones which coupled with a Gandalf PACX port selector based data network with about 450 connections made up the communications resources for CSLA in Fall 1986.[5] The campus now has a telecommunications system from Centel Communications Systems consisting of a Northern Telecom Meridian SL-1 PBX with about 2670 telephones, an Infotron INX 4400 medium speed data switch with 250 connections, a Proteon Pronet-10 fiber optic high speed network which supports Ethernet, Token Ring, Starlan 3BNet and Appleshare LANs, a Digital Sound voice server with 555 voice mail boxes, and ComSoft system management software running on a Microvax 3600. Additionally, the Gandalf PACX with approximately 750 connections is linked to the Infotron INX. [6]

Administrative Systems

The administrative computing environment in Fall 1986 consisted of a variety of CSU developed Cobol systems, and an Information Associates integrated business system/financial accounting system (that was significantly modified), operating on the campus Cyber 730. The majority of applications were batch processing, and there was little integration between different modules. There were about 250 administrative connections on the the Gandalf. Today, through project OASIS, a joint development project between IBM, Information Associates (IA), CSLA, California State University Long Beach, and Cal Poly San Luis Obispo, the institution has the alumni development system (ADS), the financial records system (FRS) (with a CSU developed front end), and the student information system (SIS) from Information Associates Series Z applications. A few other Cobol administrative applications have been converted and a property management system has been developed in FOCUS. All applications now run on an IBM 4381 T92E. The Series Z applications are fully integrated and provide on-line access to about 700 administrative users and academic departments.

Prescriptions, Preventatives, and Postmortems

Strategic Planning

The rapid technological change evident in higher education today, as illustrated by the examples just enumerated, almost demands that some form of strategic planning be utilized in implementing information technology initiatives. Such a process must fit the environment of the institution where it is utilized. At CSLA, the Shirley planning methodology provided a guideline that led to the development of a process that has adapted well to campus needs, directions and uniqueness.

The planning model called for an internal and external assessment of the campus, including a values analysis. From this baseline examination and the definition of a vision for the future an extended mission statement, goals and measurable objectives, broadly based operational strategies, and detailed actions plans were developed and put into place. Strong support from the President and Executive Officers, a focus on University-wide priorities, and broadly based participation have been essential elements in the planning resulting in pertinent decision making which has led to the development of meaningful policy and procedures, and most importantly, enhanced services to the University.[7] There is a strong belief at CSLA in strategic planning in general and that strategic planning for IRM works!

Organizational Initiatives

After the establishment of an IRM unit at CSLA in July 1985 and the employment of a Chief Information Officer (CIO), the first order of business was to pull diverse units of the new organization together into a cooperative, cohesive, service oriented group. Through the strategic planning process, immediate emphasis was placed upon an analysis of campuswide information technology needs, client expectations, existing and potential opportunities/constraints, values of the newly formed IRM administrative team, and strengths/weaknesses of both the campus and the IRM unit. This series of exercises resulted in a shared understanding and appreciation of the magnitude of challenge, some ideas for possible early successes, and a commitment to define and infuse a culture into the organization that would be supportive of the CSLA mission and also be meaningful to IRM employees as individuals.[8]

The basic characteristics that the new IRM organizational culture strives to attain are: a recognition that responsibility to one's clientele is inherent; to establish an environment where all individuals are treated with courtesy and respect; fostering a balance between organizational and individual needs; tying rewards to productive performance; maintaining personal integrity at all times; maintaining an atmosphere of professionalism; individuals accepting responsibility for contributing to the solution of problems; an organization providing equitable and consistent service at defined levels; maintenance of security and integrity of campus data bases; and the observance of sound fiscal procedures in all activities.[9]

The approach defined here has proven to have been very successful. Overall, good progress has been made in establishing a culture with similarities to the ideal described above. The morale of IRM staff members is good, the unit is regarded with respect by the University community, and there is broad agreement that positive institutional change has taken place in a relatively short time.

Other factors contributing to organizational initiatives, more fully described elsewhere, are: the usage of carefully selected advisory committees; a broadbased participation in decision making; the employment of a campuswide evaluation structure that involves every IRM unit on a monthly basis; frequent internal evaluation of administrative projects and unit objectives; and providing external and internal feedback on a regular basis.[10]

In hindsight, there are two initiatives which, had they been done, very probably would have enhanced the progress made to date. The first involves the establishment of user liaison positions in AdSS. This was initially planned but put on hold when requested positions were not forthcoming. The role and function of these positions are demanded and are not carried out as well as they might be by project managers and programmer/analysts whose primary focus is elsewhere. Secondly, systems seminars, a set of consciousness-raising, change oriented group exercises for users, were proposed and discussed but not done due to an already extensive primary user training schedule. Had these group exercises been conducted, some unrest and resistance to change deep within client organization could have been lessened as process and procedures were altered.[11]

Academic Infrastructure

When the CSLA IRM unit was formed and three strategic information technology thrusts were set forth, there was a conscious decision by the President to focus first on the academic infrastructure. This was the area of greatest need and visibility, where cooperation between IRM, Academic Affairs, Schools and Departments could most easily be attained (a concept essential to the success of all major projects at CSLA) and where the reallocation of institutional resources was best accepted. The soundness of this action has been shown again and again. Early successes here established an openness to the possibilities the other information technology projects offered. The cooperative efforts worked exceptionally well leading to an expectation of cooperation as the basis for systems implementation. Given the focus on information technology in academic endeavors faculty members have been very receptive to innovation and to incorporating meaningful information technology applications into the curriculum.

Several other decisions were made early in the project that seem to have been useful. These include: (1) a determination to move to a highly distributed, networked, academic environment with the individual workstation as the basic access device; (2) allowing diversity but standardizing application packages whenever general agreement could be attained; (3) providing basic student access through general labs before focusing on broadbased faculty access; (4) developing targets based upon an annually constructed course-by-course matrix showing computing requirements within the curriculum by discipline; and (5) establishing the director ATS as the focal point for planning, funding, implementing and operating the information technology infrastructure.

There are implementation strategies that have also had positive impacts. The cooperative model, referred to earlier, has allowed functionality and defined needs to drive design as opposed to turf issues or politics. Having a plan in place, one central contact, and the ability to leverage funding from various sources has made it far easier to work productively with vendors. The primary mode of faculty training has been to use highly qualified faculty as instructors in formal classes with hardware/software loaned over an extended period (two quarters). These programs have been set up in such a manner, that when the training is finished participating faculty may submit proposals which, if accepted, allow them to keep the workstation and software. Whenever possible, matching funds are provided, usually by central administration, allowing less affluent departments to buy into the distribution of information technology resources.

As mentioned early in this paper, Academic Technology Support now includes both instructional computing and media support personnel. In addition to the advantages already listed, organizational blending has permitted media staff to be cross trained and to augment the small instructional computing staff in support of lab facilities. It has also provided needed networking expertise in this area since media technicians historically provided support for the campuswide video network.

Although a long list of academic infrastructure needs could be completed, they are felt to be more related to meager state funding than to prior decisions that might have been made differently.

Telecommunications

Both of the other major information technology projects could not be successful without an operational network being in place within a specified timeframe. Thus, in a very real way, the telecommunications project is at the center of the information technology strategic thrust at CSLA. Given that the major elements of the campuswide network have been installed close to the implementation schedule and well within the limits needed to support academic and administrative users, that the voice systems provides significantly enhanced functionality over the centrix, that it has been very reliable, and that the voice mail system has been a popular and useful addition, this very complex project has gone well.

There are many reasons that have contributed to the success of this undertaking. Due to a window of state funding, this project was underway before the arrival of the CIO. A draft of a generic request for proposal (RFP) was provided by the State to CSLA. The campus was then asked to modify that document to fit specifications of the institution. A telecommunications consultant with significant experience in higher education, with the CSU and the State of California was retained. The CIO selected by the campus had been involved in two other telecommunications projects at other universities. The AVP for IRM Operations who was recruited by the CIO had led the implementation of a telecom system at another institution. The manager of telecommunications hired by the AVP was a professional in the area with over fifteen years of experience. The basic RFP was modified to include as many mandatory bid options as possible within state guidelines. The RFP review committee consisted of representatives from all areas within the University who were involved in either the procurement or the installation. The client community was briefed well before the project began regarding its complexity, its importance, and potential problems which could arise. Trenching and wiring were done primarily at night and on weekends to avoid, as much as possible, the disruption of classes and administrative work. A train-the-trainer approach was taken so that every academic and administrative department on campus had their own "expert." Beyond this, extensive hands-on training was provided for anyone who would attend (most people did!) just before cutover, and continues on an "as requested" basis. The telecom staff worked with each department to design their own functionality. Once an office configuration was agreed upon, a formal signature by the department head was obtained. As many classrooms (about one in five) and offices were wired for data as the budget would allow. Within guidelines, all new instruments were provided to departments without additional costs to them. Where chargebacks were made, they were set to cover actual expense and were one time charges, i.e., the actual additional cost of an upgraded instrument, $300 for a data connection, $100 for a voice mail box, etc. Finally, ongoing equipment and maintenance costs were covered "off the top" of the state allocation and are not passed on to departments.

Although the overall assessment of the telecommunications implementation was positive, there were a number of things that in retrospect could have been done differently and quite possibly would have made it even better. The generic RFP should have been revised well beyond providing campus specific numbers and adding mandatory options. In some places the layout was confusing to vendors, in others it was vague allowing bidders too much latitude (this was especially true regarding the management system), and the evaluation criteria could have been somewhat more rigorous. The consultant was probably kept on retainer for too long and the new manager of telecommunications was not brought on early enough. The usefulness of the consultant lessened after the vendor was selected and the contract was finalized. The new manager, clearly, should have been involved in the contract negotiation phase. The contract calls for one full time, on site, vendor supplied, technical support position. The needs, at least for the first two years, indicate that a second position should have been specified. The number of secondary vendors involved in the bid probably should have been limited. There are a total of five companies represented in the complete system, and that is too many for a small staff to easily handle. Six weeks were allotted to conduct the station review and to design the department configurations, a minimum of two to three more weeks should have been allowed. The management system was far more critical than initially believed. It should have been in place for three months before cutover and tested with a full compliment of data instead of being available at cutover with limited test data. Finally, the most critical timing issue was related to the voice system; this inadvertently resulted in the other components receiving a somewhat lower level of attention. The same level of intensity was needed until all elements of the total system were in place and completely operable.

Administrative Systems

Project OASIS has enabled CSLA to move away from a 20 year old data processing philosophy for administrative systems into an integrated information systems environment residing on an IBM platform. The second phase of OASIS calls for the installation of a completely integrated DB2 based on-line set of administrative applications. The total project is scheduled for completion in 1992.

This joint development project has progressed very well to date. There were a number of actions that helped account for the success of OASIS. The commitment of the Chancellor's Office and the three CSU campus Presidents set the stage initially and continue to provide a driving influence for the project. The cooperation between the information systems and application area staffs of the campuses have been extraordinary. The support and expertise supplied by IBM and Information Associates have been excellent. An oversight committee structure consisting of a Steering Committee (focusing on policy and contract issues), an Operations Committee (focusing on major implementation issues), and a Technical Committee (focusing on day-to-day technical issues) has worked well.

At the campus level, the implementation has been guided by task forces made up of users and IRM staff. Each major module had an affiliated task force. A policy level task force which included two senior faculty members provided liaison with the Academic Senate. This model provided excellent communication and played a significant role in maintaining an ambitious schedule. A hands-on training room was set up, and extensive training was provided for systems implementers and end users on an on-going basis. Hardware, software and data connections were supplied to every academic and administrative department in the institution allowing almost immediate broadbased access to the database. A voice registration system was installed permitting many students to register via touch-tone lephone creating enough good will to more than overcome any expected "glitches" inherent in a new system. Finally, as this list indicates, the macro level project management was handled with skill.

As anyone who has ever been involved in a major systems implementation realizes, there are always lessons to be learned. Although several senior managers had prior experience in a systems conversion effort, many of the staff did not. Only a few individuals had experience in moving from one hardware vendor to another while doing an applications system conversion. Consequently, the magnitude of the transition from the Cyber to the IBM mainframe and the data conversion efforts were underestimated. In like manner, as mentioned earlier, greater effort was needed to prepare the user community to fully understand issues such as data integrity, coordination and timing that are critical in integrated systems. Due to these difficulties and to the fact that the campus experienced a major earthquake early in the implementation, "catch-up" became an emphasis and project management at the micro level suffered. Although documentation was better than with the replaced systems, more is needed. This is especially true with Computer Center operations and in procedure development in some user areas. The Information Associates Z-writer provided enhanced ad hoc data retrieval capability but was not easily used by a user community without significant experience in doing ad hoc retrieval before. This was one of the areas where user liaison positions were greatly needed. Better coordination between Computer Center operations staff and Facilities Management staff was needed. The new information systems environment required a far more timely response than was true before, and there have been difficulties with environmental systems, i.e., water, power, and air conditioners, that have negatively impacted the implementation effort.

The largest single problem resulted from an over ambitious development schedule for a front end point-of-sale (POS) system for Cashiering. IBM provided hardware, Information Associates mainframe software, Sales-Point (a third party vendor) software for the cash registers, network, and servers, and CSLA did the alpha and beta tests. Due to slippage in delivery of the third party software, the system was put into operation before being thoroughly tested--and predictable difficulties ensued.

Miscellaneous Observations

By any measure, the progress in IRM at CSLA over the three year period from Fall 1986 to Fall 1989 has been reasonably impressive. Eight critical success factors were initially listed as being crucial to the success of the strategic information technology projects. Those factors were: (1) *Top Management Support*: The President and Executive Officers have provided direction, encouragement and resources which offer a very visible context for all to see. (2) *Project Leadership*. Both IS professionals and end users have performed well. Macro project management has been excellent and micro level project management is steadily improving. (3) *Participative Planning*. It is difficult to envision CSLA being where it is today in information technology without the effort that has gone into the planning process and the significant involvement of many people across the campus. (4) *Significant User Involvement*. The task forces have been mentioned and are of great importance. Another aspect of user involvement focuses on the monthly evaluation of IRM units by their clients. All units have been evaluated monthly for two years now and the user response rate remains at over 50%. (5) *Education and Training*. A great effort, with meaningful results, has been devoted to training. This area remains a challenge, and it is clear that further efficiency, effectiveness and innovation are possible if additional resources can be found. (6) *Process, Policy and Procedure Development*. It was anticipated that this would be one of the most difficult challenges. Although much remains to be done, and must be done, adequate progress has been made. Both the task forces and the IRM advisory committee structure are credited with major contributions. (7) *Timely Telecommunications Installation*. All deadlines were met with time to spare. The basic building blocks for the CSLA information technology infrastructure are now in place. The challenge now is to tie as many individuals to the infrastructure as quickly as is possible. (8) *Funding*. To date, through sacrifice, careful planning, good management and extraordinary cooperation, funding has been secured for these projects. The demands are on going, and the campus must look to the State to recognize the importance of information technology in ways beyond what has been historical if the rate of progress is to be sustained over a period of years.[12]

In concluding this section, it must be noted that the comments here have not attempted to address overall needs of any of the information technology projects. Rather, they have been limited to actions basically under fairly direct, short term control by the campus. For example, it would not be recommended that a newly formed organization with a new leader from the "outside" tackle three simultaneous multi-year, multi-million dollar projects. It was done because not doing it would have meant missed opportunities not likely to have been replicated in the foreseeable future.

Conclusion

> The fact that the world is rapidly changing need not mean that we are destined for a future of disorder, disruption, and dysfunction; but higher education administrators must realize that they not only manage finances, curricula, or services -- they also manage change.[13]

This quotation catches the essence of much of what has been reinforced through the IRM projects at CSLA over the first three years. The strategic planning process provided a framework that linked institutional mission and goals, tactical objectives, unit actions, and administrative work plans, thus avoiding disorder, disruption, and dysfunction. It also fostered a process for meaningful analysis of options, strategies and tactics. Indeed, it has been through strategic planning and management that the rapid changes have been controlled and focused upon campus priorities.

The creation of a new IRM unit offered the opportunity to redefine the culture of the information technology organization. The ability to manage an organization's culture as a strategic resource leads to successful change management. Culture -- the beliefs, behaviors, and assumptions of individuals in an organization -- is one of the most powerful forces an administrator confronts.[14] Using culture to drive change rather than to impede it has been key to CSLA.

An IRM approach has played a significant role in what has occurred. One of the added values of IRM is the emphasis on planning. The concept of IRM also includes the vision of capitalizing on existing and new investments in information-related resources, and it includes disciplines required to ensure sound management of these resources.[15] The IRM approach has been far more important than what was reflected in an organization chart since many aspects of technology projects require coordinated involvement across the entire IRM unit.

It is very important to make good early decisions in macro management. If that happens, these decisions often can easily overcome failures at the micro project management level which almost assuredly will occur at some point. Personal experience may be significant at the micro level. For example, developments in the CSLA information technology projects lead the authors to advise administrators to use techniques that have been successful in similar situations in other environments unless strong evidence is presented that "it won't work here" despite advice to the contrary.

Finally, it is prudent to take advantage of major opportunities when the chance occurs even if the organization is not completely prepared if the risk trade off is appropriately weighted. Identifying critical success factors, publicizing them, and working hard to obtain support to meet them goes a long way to overcoming the risks, despite their magnitude.

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Planning for Information Resource Management at the University of Pennsylvania: Searching for a New Paradigm

Karen Miselis
Associate Dean for Administration
School of Arts and Sciences
University of Pennsylvania
116 College Hall
Philadelphia, PA 19104-6377
(215) 898-7320
KMiselis@pennsas.bitnet

Daniel A. Updegrove
Assistant Vice Provost
Data Administration and Information Resource Planning
University of Pennsylvania
3401 Walnut Street, Suite 230A
Philadelphia, PA 19104-6228
(215) 898-2171
Updegrove%a1.relay@upenn.edu

The University of Pennsylvania, like all other major research universities, must harness current and emerging information technology to achieve its missions of teaching, research, patient care, and public service. At Penn planning and management of computing and information systems are especially challenging, because of the autonomy of the twelve school deans. A major strategic planning effort now underway seeks to leverage school investments and initiatives in order to create a University-wide data, systems, and support infrastructure. Key elements of this strategy are a new cooperative planning structure, a new client-centered program management process, and a new data and systems architecture. To succeed, these initiatives will require not only substantial resource commitments, but also a major change in organizational culture.

A year-long effort to define information technology objectives and strategies is underway at the University of Pennsylvania. Although Penn's planning is informed by technology trends and forecasts, the focus of this effort has been on process—how the University should plan, develop, and manage its information resources. Major changes are called for, both within the Office of the Vice Provost for Information Systems and Computing (ISC) and in relationships between the twelve schools and the central administration. This paper represents a snapshot taken near the end of this planning effort.

Vision of the Future

Current planning for information systems and computing at Penn is shaped by a vision of the University in the 1990's. This vision anticipates:

- Enhanced personal productivity, with appropriate information resources and computing tools, on campus and elsewhere, that are easy to use and readily available to faculty, students, researchers, and administrators.

- Increased collaboration, within and across disciplines, between students and faculty, and in administrative areas, for example as the University network, PennNet, is enhanced by new information services, extended to dormitories, and interconnected to a more robust, world-wide academic network.

- Invigorated teaching and learning, with support for development and use of state-of-the-art presentations, demonstrations, simulations, tutorials, and access to semantically-organized knowledge bases.

- Excellence in research, scholarship, student services, patient care, and public service, as Penn's ability to attract the best faculty, students, and staff is supported by our reputation for an outstanding yet cost-effective information infrastructure.

- A cohesive University, as an increasingly diverse population of undergraduates and graduate students, dormitory and off-campus residents, faculty, researchers, clinicians, and staff come to value Penn as more than the sum of its world-class parts. Campus-wide access to new information services and to an integrated administrative data encyclopedia will contribute in important ways to this cohesion.

To understand the relevance of this vision requires background on the institution and its management of computing.

The University of Pennsylvania: A History of Innovation

Two hundred and fifty years ago, a charity school was founded in Philadelphia that was to become the University of Pennsylvania. Benjamin Franklin, who helped found the school, proposed a new kind of institution for students to "learn those things ... most useful and most ornamental, regard being had to the several professions for which they are intended."

Over the years, Penn has carried out Franklin's spirit of innovation in a number of ways: with this country's first liberal arts curriculum, first medical school in 1765, first law courses in 1790, first university-owned teaching hospital in 1874, first collegiate school of business in 1881, first psychological clinic in 1896, and first electronic, general purpose, digital computer, ENIAC, in 1946.

Penn Today

Penn (not to be confused with Penn State, the larger, multi-campus land grant institution) is a private, research university of 22,000 students with a strong commitment to undergraduate education. Its compact, 260-acre campus enhances the unique interdisciplinary focus of the university. For example, faculty members in the School of Veterinary Medicine regularly teach undergraduate neuroscience courses in the School of Arts and Sciences (SAS); the Laboratory for Research in the Structure of Matter includes faculty from Physics, Chemistry and Materials Science; and the new Center for Cognitive Sciences brings together colleagues from Computer and Information Sciences, Linguistics, Psychology, and Philosophy.

Contrasting with the interdisciplinary intellectual tradition is Penn's administrative decentralization, exemplified by "responsibility center budgeting" instituted in 1972. Each of the twelve schools in the university has its own income and expense, and all central expenses are allocated to schools as indirect costs. Responsibility center budgeting has succeeded in maintaining balanced budgets for the university each year since 1972 but has encouraged schools to be more independent and, occasionally, even antagonistic to each other and to the central administration. Fiscal responsibility is very important for Penn, in part because its endowment is modest compared to most peer institutions. A one billion dollar capital campaign was launched in fall 1989 to help address this issue.

Computing at Penn and the Role of the Vice Provost

Computing at Penn is a reflection of the decentralized nature of the university. All instructional and research computing is funded and managed by the schools, with substantial centers in Arts and Sciences (including an IBM 3090-200 with vector processors and an IBM 4381 managed for the University Library's NOTIS system), Engineering (numerous minis and UNIX workstations), Medicine (a small center but many departmental facilities), and the Wharton School (VAX cluster). Some centers have substantial computing facilities, such as the three mini-supercomputers in the Laboratory for Research in the Structure of Matter. Additional research computing is performed at the national supercomputer centers, accessible to the University via JVNCnet and PREPnet, mid-level components of the NSFnet.

Administrative computing is more centralized, with major systems running on an IBM 3090-180. Nevertheless numerous administrative units operate minicomputers to support transaction processing and office automation, and some school facilities support administration as well. Also centralized is installation, maintenance, and management of PennNet, which now connects over 100 buildings via fiber optic backbone. Over 3,000 end nodes can access some 100 host computers via PennNet, which uses the TCP/IP protocol required for NSFnet. PennNet also provides a gateway to BITNET.

Administrative computing and PennNet are the two largest groups reporting to the Vice Provost for Information Systems and Computing, a position established in 1983. The other two units are the Computing Resource Center, which provides campus-wide end user services, and Data Administration and Information Resource Planning. The Vice Provost's budget, roughly $10 million, compares with $10 million for computing at Wharton, $4 million for Arts and Sciences, $3.5 million for Engineering, and $750 thousand (central facility only) for Medicine.

To achieve the vision for the 1990's outlined above will require cooperation and partnerships among the central organization and the schools. The role of Information Systems and Computing (ISC) is to coordinate planning and management from a University-wide perspective and to provide a versatile, powerful, and easy-to-use information and computing infrastructure. As this infrastructure is developed, ISC must see that policies and standards are created and adopted, which requires the many University constituencies to be part of the development and control processes. Accordingly the Office of the Vice Provost has been engaged in a wide-ranging planning process, seeking input from every major constituency of the University.

Objectives

Although the planning process is by no means finished, there is consensus on a set of twelve ISC objectives. The five primary objectives are:

- Enhance access to scholarly information in partnership with University libraries. Provide consistent, easy, fast access from the desktop computer to Penn and other universities' library catalogs and databases.

- Ensure computing capacity for the research community—from resource sharing within the University to participation in regional and national supercomputing centers.

- Support school initiatives in instructional uses of computing.

- Provide students with information, network services, and computing tools. Enable students to become partners in the information environment, using the same tools available to faculty and researchers.

- Provide administrators with the information and systems needed to do their jobs. Design new systems and their underlying data structures from a University-wide perspective to promote integrated management of University resources.

Two organizational objectives are:

- Facilitate, coordinate, and support the computing activities of schools, centers, libraries, and administrative offices.

- Make planning and management of that portion of Penn's information environment under the purview of ISC more widely representative and more responsive to Penn's computing community.

The remaining objectives involve creation of the necessary infrastructure:

- Enhance the University network, PennNet, and connect more faculty, staff, and students, via PennNet, to the world-wide network of colleagues, libraries, academic and administrative information databases, remote supercomputers, and experimental instruments.

- Establish an integrated, campus-wide architecture of selected hardware and software to enable cost-effective system development and data sharing among microcomputers, minicomputers, and mainframes.

- Provide a consistent, intuitive user interface to the selected hardware and software, to encourage easy access and use.

- Establish an accessible, widely-understood base of University data, identified and defined in a University data encyclopedia.

- Enhance user support services, including education, technical assistance, consulting, problem identification and resolution.

Whether these objectives are achieved in five years or ten years depends on the soundness of the strategies proposed to achieve them.

Strategies

Nine strategies have been identified to achieve these objectives:

- Early Follower. Stay close behind the leading (some say "bleeding") edge of information technology in higher education so as to be positioned to integrate components developed elsewhere and build upon Penn's unique strengths as an interdisciplinary institution. Much Penn research will continue to develop and use state-of-the art technology, but University infrastructure will rely on proven technology.

- Funding. Seek increased funding from government, corporations, and foundations, as well as from central University funds and from leveraging initiatives at the School level.

- Representation. Create a widely-representative Information Resource Management Committee (IRMC) with four active subcommittees focused on instruction, research, administration, and infrastructure, to replace the current, disjointed committees and advisory boards.

- Planning. Establish a broad-based planning process that coordinates the information planning of ISC, the schools, centers, and libraries—and that serves as input to the budgeting process.

- Partnerships. Form partnerships internally, with schools, libraries, centers, and administrative offices, and externally, with other universities, industry, and government.

- Organization. Reorganize Information Systems and Computing to ensure leadership and advocacy for the major initiatives required.

- Quality. Taking the needs of end-users into account, establish quality standards and a process for evaluating and improving services.

- Staff Development. Improve each stage of ISC human resource management: recruitment, job assignment, compensation, training, performance evaluation, and career-path planning and development.

- National Recognition. Encourage faculty, staff, and students to seek national recognition for excellence in the use and management of information systems and technology.

Aspects of a New Paradigm

Four aspects of these strategies represent major departures in the way Penn plans and manages its information and technology resources. Although there is growing realization that managing this much change will be a formidable task (to say nothing of the need to keep the network up, get payroll out, *et al.*), there is also genuine excitement expressed by those who foresee substantial benefits from these new directions.

First the Information Resource Management Committee (IRMC, will be charged with reviewing all significant information technology initiatives, whether or not they are to be centrally funded and managed; planning and coordinating development of information systems and services; and serving as a University forum for review of technology-related policy. Subcommittees on research, education, administration, and infrastructure will set objectives and priorities in their areas and, once an initiative is approved, an IRM subcommittee will monitor its progress. Ad hoc subcommittees will be formed as needed when issues such as office automation and information security cross functional boundaries. The IRMC and its subcommittees, drawn from central and school administrators, faculty, and students, will be the first such committee to have institution-wide responsibility for technology.

Second, a Program Management process is being created to oversee individual development projects or "programs." Program team roles and responsibilities are spelled out, along with the steps needed to produce systems on time, on budget, and as users intended. The Program Management process is characterized by end-user authority and responsibility as well as strict documentation of management and design decisions. Each program team is headed by a "Program Manager" usually from the user area. All central initiatives will be managed this way, and the approach will be strongly recommended for decentralized programs as well.

Third, other schools will be encouraged to follow the lead of the School of Arts and Sciences (SAS), which has, since March 1989, been planning for computing with support from the (central) Office of Data Administration and Information Resource Planning. One of the major goals of the SAS planning process is to integrate and enhance the services of its separate academic and administrative computing groups. SAS also plans to integrate the audio visual center. A successful joint school-central planning effort will be an important exemplar for other schools and centers.

Finally, no new major central systems will be developed until a University-wide data and systems architecture is put in place. Current applications, built without benefit of such an architecture, are proving difficult to use and expensive to maintain. Moreover they take little advantage of either the increasing power of desktop workstations or the widespread connectivity of PennNet. The next steps in this key area are to share the "Strategic Directions" document with current and potential corporate partners, and to initiate discussions with other major research universities facing a similar need to integrate a multi-vendor environment.

Conclusion

Many key stakeholders in the Penn community have expressed support for the vision and new approaches, but much remains to be done. Although a portion of the billion-dollar Campaign for Penn is earmarked for computing, these funds are not yet in hand so additional fund-raising strategies must be pursued. Moreover a nationwide search for a new Vice Provost for Information Systems and Computing has not been concluded. Fortunately the interim Vice Provost, Ronald Arenson, has vision, energy, and strong support from senior management. In fact University management is not only supportive of change, they are demanding it. We predict that Penn will be a very interesting place to watch— and work—in the months and years ahead.

Acknowledgements

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ACADEMIC DEPARTMENTAL ADMINISTRATIVE COMPUTING
VISION FOR THE 1990s

John A. Bielec
Assistant Vice President for
Administrative Affairs

Sukij Yongpiyakul
Telecommunications Engineer

USER CHALLENGES

- Need to Access Mutiple Networks with Varying Protocols and Procedures
- Requirement to Utilize Multiple Applications Products and Vendors
- History of Multiple Vendor Standards and Interfaces. Standardization Efforts have generally been unsuccessful
- Growing Diversity as a result of Globalization
- Requirement for a New Operating Vision for the 1990's

GUIDING PRINCIPLES

1) The user's knowledge station should become the center of a network universe consisting of concentric spheres of information access.

2) The network services and resources available should be logical extensions of the already familiar environment of the user's knowledge station.

3) The interface to the network services should be user friendly and should transcend the hardware platform and operating system.

4) The network environment must be as reliable and as promptly responsive as the telephone system.

5) Commercial products should be used whenever possible in order to assure reliability and to reduce support costs.

GUIDING PRINCIPLES (Cont.)

6) Connectivity to intra campus, state, national, and international networks is essential.
7) Security of data must be a primary consideration for any network strategy.
8) Distributed processing services should be available to assure maximum efficiency.
9) The University must limit the hardware and software families which it supports.

GUIDING PRINCIPLES (Cont.)

10) A coupled support strategy combining centralized and decentralized support for networking is essential to guarantee long term success.

11) Defining standards and University endorsed protocols is essential in defining a network strategy.

12) Individual departments must be given options for their local network environments in order to meet their own needs within the parameters which they face.

13) The interface to all network services should have the same "look and feel" for all hardware environments that are supported.

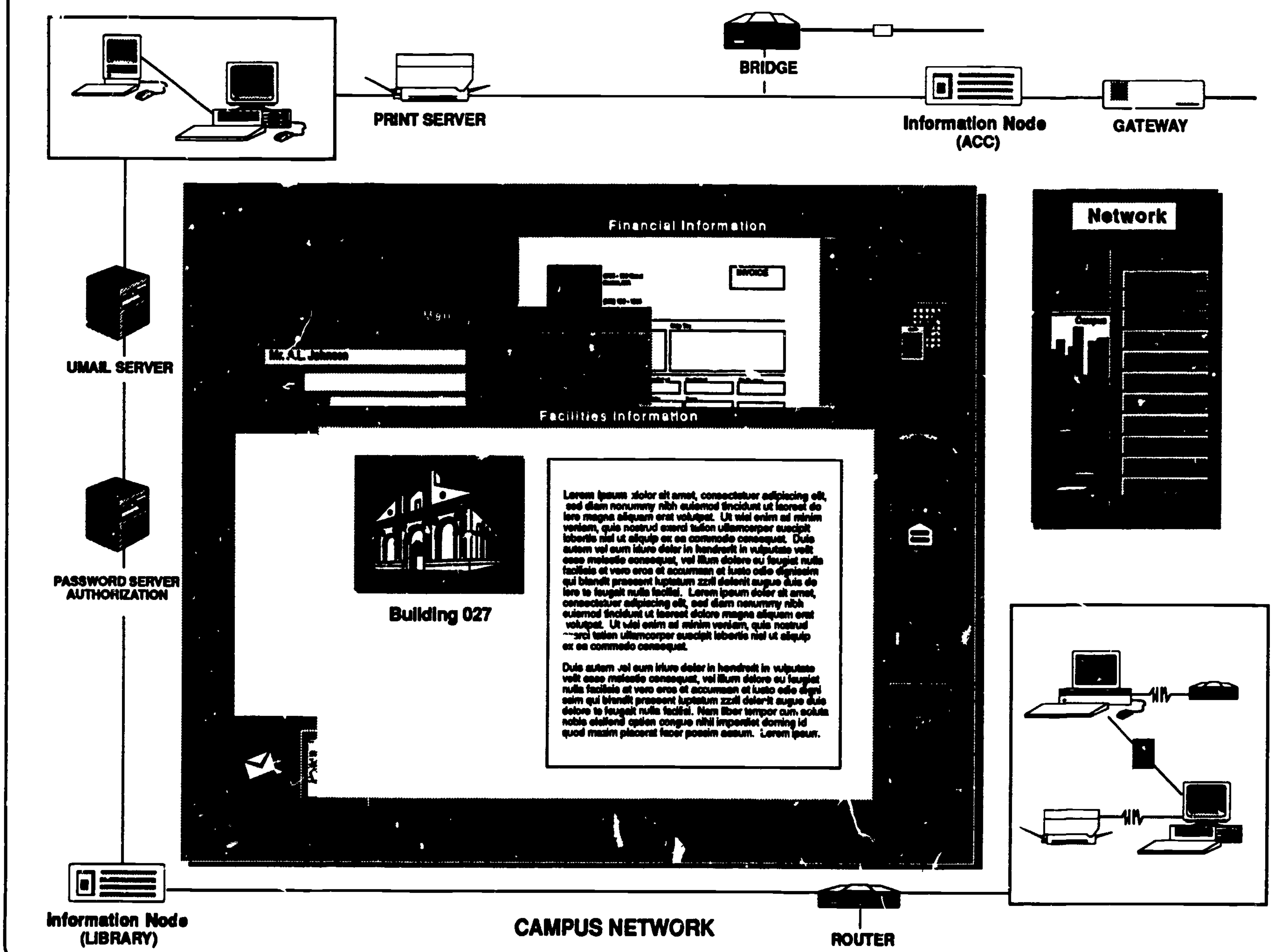
14) The network strategy must be designed to assure maximum flexibility for evolutionary changes in technology.

Liberally Adapted from Brian L. Hawkins, *Academic Computing,* January 1989

REQUIREMENTS

- MULTI PROGRAM "KNOWLEDGE STATION©"
- SINGLE NETWORK IMAGE— HETEROGENEOUS NETWORK ENVIRONMENT
- EASILY NAVIGABLE ACROSS NETWORKS
- SEAMLESS ACCESS ACROSS APPLICATIONS
- INFORMATION SERVERS
- SUPPORTED FAMILY OF HARDWARE AND SOFTWARE STANDARDS

ACADEMIC DEPARTMENTAL ADMINISTRATIVE COMPUTING *VISION FOR THE 1990s*



CAUSE 89

MULTI PROGRAM KNOWLEDGE STATION (PC BASED)

- 5 MIPs Processor Speed
- 10 Megabytes Memory
- Multi-Tasking Operating System
- 40 Megabytes Hard Drive (low access time)
- Mega-Pixel Display
- I/O Processors
- Audio (MIDI) Ports
- Built-in Network Adapter
- CD-ROM
- Scanner

SEAMLESS ACCESS ACROSS APPLICATIONS

- Application Interfaces Based on Supported Family Software Standards via Network Servers
  - ACC, Library, CSC, UMSA, MINC, etc.
- Movement Across Applications Independent of Physical Network Residence
  - Software Driven Direc... ies/Servers
- Intelligent Information Transport
  - Intelligent Information Link across Different Applications
- Paperless On Screen Forms — Document Transfer
- Electronic Signatures
- Security Standards No More Rigid than Standards for Paper Security

RESOURCE REQUIREMENTS

- Adequate Funding for Creation of Knowledge Station Environment, Hardware, Software, and Access
- Establish Resources for Minimum Level of Universal Service
- Trained Personnel
  - Flexible Personnel Classifications
  - Competitive Salaries
  - System of Rewards
- Creation of Maintenance Structure
- User Support for Family Products
- Space
- Security