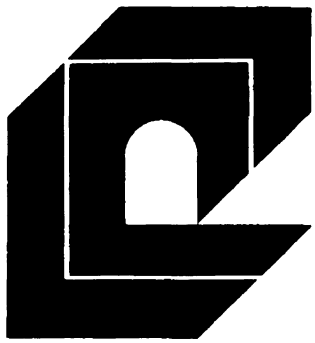


COLLEGE OF ENGINEERING
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

A PROPOSAL TO THE

LOCKHEED CORPORATION

TO SUPPORT THE

COMPUTER-AIDED ENGINEERING NETWORK

MAY 1984

TABLE OF CONTENTS

EXECUTIVE SUMMARY

As this nation seeks to enhance the competitiveness of its industry and its economic security, it has turned increasingly to institutions such as the College of Engineering at The University of Michigan. Industry seeks the assistance of the College in providing the intellectual creativity so fundamental to technological innovation and the talented, broadly-educated engineers and computer scientists capable of understanding and applying this technology.

A key factor in determining the University's capacity to respond to these needs will be the willingness of industry to assist in building the environment necessary for excellence in engineering education.

To this end, the University of Michigan seeks the support of the Lockheed Corporation for the College of Engineering's Computer-Aided Engineering Network. Specifically, the University seeks a sustained support of one of the major CAE computer cluster laboratories in the Network at a level of $100,000 per year for a five-year period. This facility would be designated as the Lockheed Computer-Aided Engineering Laboratory.

The Computer-Aided Engineering Network will be a key component in the College of Engineering's privately-supported North Campus Instructional Complex consisting of: i) a versatile CAE-based instruction center containing classrooms, computer workstation laboratories, and self-paced instructional facilities ($4 million); ii) a technical information center containing the College's Engineering Library along with computer database systems for managing and distributing technical information; and iii) a sophisticated computer communication network (the Computer Aided Engineering Network) integrating the instructional, research, and administrative activities of the College.

The estimated cost of the physical facilities associated with the North Campus Instructional Complex is $12 million. Additional grants and equipment donations are sought at a level of $4 million per year to develop and sustain the Computer Aided Engineering Network.

The instructional and research programs supported by the the Network and Instructional Complex will allow the College to respond directly to urgent national needs for talented engineering graduates and creative research in areas of critical importance to industrial productivity and national security.

1. INTRODUCTION

The College of Engineering at The University of Michigan is a national resource. Its role becomes more crucial day by day as our society becomes ever more dependent upon science and technology and therefore upon the availability of talented, broadly-educated engineers. The degree to which all sectors of our society and unite to support the educational and research activities of premier engineering schools such as the College will in large measure establish the level of economic and military security of this nation. This degree of support will also be a determining factor in the quality of American life.

Today, industry is turning increasingly to institutions such as the College, seeking their assistance in providing the intellectual creativity so fundamental to technological innovation and the engineering graduates who can understand and implement this technology. There is an unprecedented demand on the part of our nation's best high school graduates to pursue engineering careers.

Yet, along with this extraordinary responsibility and opportunity, engineering education in this nation faces perhaps the most serious crisis in its history. A decade of declining public support during a period of rapidly expanding enrollment has left most engineering colleges with overloaded faculties, obsolete laboratories, and deteriorating physical facilities. Beset by such conditions, many of this nation's leading colleges (Michigan among them) are facing the prospect of being forced to drastically reduce engineering enrollments and eliminate programs of critical importance to industry.

Perhaps never before in our history has it been so apparent that those organizations most strongly dependent on an adequate supply of talented engineering graduates and technological innovation must assume a greater responsibility for the support of engineering education. Industry must step forward now to provide the critical resources so desperately needed by this nation's leading engineering colleges if they are to regain the capacity to play the role they must in restoring America's industrial strength.

It is from this perspective, that of attempting to meet serious institutional needs while restoring the capacity to respond to the needs of this nation, that the College of Engineering of The University of Michigan has launched a major new initiative. It seeks the support of industry and private foundations for its North Campus Instructional Complex, an environment designed to achieve and sustain engineering education and research of extraordinary quality in the 1980s and beyond.

The North Campus Instructional Complex will consist of: i) A versatile computer-aided engineering (CAE) based instruction center containing classrooms, computer workstation laboratories, and self-paced instructional facilities ($4 million); ii) a technical information center to contain the College's Engineering Library along with computer database systems for managing and distributing technical information; and iii) a sophisticated computer communication network integrating the instructional, research, and administrative activities of the College.

The North Campus Instructional Complex represents the final facility needed to complete the College's long-awaited move to the North Campus of the University. The Complex will serve as the focus for the development of major new academic and research programs in computer-aided engineering, computer communication networks, and technical information management, areas of critical importance to industrial productivity and national security.

But, most important of all, the North Campus Instructional Complex will allow the College to respond to the intense demand of the outstanding high school graduates seeking admission to its programs while meeting the needs of industry for talented engineers and technological innovation.

2. THE PROJECT

The College of Engineering proposes to develop through its North Campus Instructional Complex the environment necessary to achieve and sustain leadership in engineering education and research in the 1980s and beyond. Engineering education and practice are entering an era of unprecedented change. Both the engineering profession and the economic strength and security of the nation will be profoundly affected by this change.

Developments in computer and communications technology already have had major impact on engineering practice through applications in such fields as computer-aided design (CAD), computer-integrated manufacturing (CIM), and computer and communication networks, fields referred to generically as computer-aided engineering. The disciplines of computer science and engineering are now focused on enhancing the productivity of people rather than simply the productivity of operations. As a result, engineering education faces a twofold challenge: to undertake creative research and development in these fields and to integrate the resulting technologies into academic programs.

The UM College of Engineering intends to respond to this challenge through the development of its College's North Campus Instructional Complex. Through a joint accession of facilities

and equipment based on modern computer/communications technology, the Complex will enable the College to link its instructional programs with a number of technical information centers, research activities, support services, and administrative functions. The Complex itself will consist of three primary components:

- A versatile CAE-based instruction center containing classrooms, computer workstation laboratories, and self-paced instructional facilities ($4 million);

- A major new facilty containing the College's Engineering Library along with computer database systems for managing technical information and distributing it beyond the University community to business and industry ($8 million); and

- A sophisticated computer communication network, the Computer Aided Engineering Network, capable of integrating these instructional and information centers with other activities of the College (research laboratories, student dorms, faculty offices, administrative offices), and with off-campus users as well while providing open access to powerful tools of engineering practice such as CAD/CAM/CIM, scientific computation, database management, and generic services ($4 million per year of sustained support).

The estimated cost of the physical facilities associated with the Complex is $12 million. Additional grants and equipment donations at a level of $4 million per year are sought to develop and sustain the Computer Aided Engineering Network.

3. THE POTENTIAL

The College of Engineering of The University of Michigan has consistently ranked among the leading engineering schools in the nation and the world, whether measured by the quality of its instructional programs, its research accomplishments, or the impact of its graduates. The College's combination of disciplinary breadth and depth of quality across the full spectrum of instruction and research make it unusual among the nation's engineering schools. Most surveys rank each of the College's undergraduate and graduate degree programs high among the leading programs in the nation.

The College is one of the few leading engineering schools imbedded in a great university with strengths across all academic and professional disciplines. This has provided it with a unique opportunity to develop new academic programs and applications

involving those related fields. It has also provided students of the College with an unparalleled breadth of educational opportunities and experiences. Graduates of the College are widely known for their strong background in fundamental science and their ability to apply this knowledge in engineering practice. They move easily and rapidly into positions of leadership in industry, government, and academe.

The primary objective of the College for the decade ahead is to continue and to strengthen its position of leadership in engineering education by achieving excellence in education, research, and the professional activities of faculty, students, and graduates.

Today over 6,000 students are enrolled in the College's 20 degree programs. Each year it graduates more than 1,700 engineers at the BS, MS, and PhD levels. Ranking third among engineering schools in the total number of degrees awarded, it has more than 40,000 alumni spread throughout the world.

In recent years the College has seen an unprecedented interest on the part of the most outstanding high school graduates to enroll in its programs. For example, in 1984 the average entering student ranked in the 97th percentile of his or her high school graduating class. Over 25% of these students had perfect 4.0 grade point averages in high school. The College has seen a similar increase in the demand for admission to its graduate programs (particularly at the PhD level).

The College has long been a leader in the development of new academic programs at the very forefront of technology. It pioneered in the introduction of programs in metallurgical engineering (1854), naval architecture and marine engineering (1881), chemical engineering (1901), aeronautical engineering (1917), nuclear engineering (1953), and computer engineering (1965). This tradition of leadership continues today, as evidenced by the College's thrusts into such new areas as robotics and computer-integrated manufacturing, microelectronics, biotechnology, and thermonuclear fusion.

Recently, an important step has been taken to strengthen the University of Michigan's program in computer science and engineering, electrical sciences, and systems engineering. The merging of the University's Department of Computer and Communication Sciences (CCS) with the College of Engineering's Department of Electrical and Computer Engineering (ECE) into the Department of Electrical Engineering and Computer Science (EECS) will have several important impacts. In recent years the distinction between computer science and computer engineering has

become increasingly blurred. The advantages of merging will be greater intellectual interaction, more efficient use of resources and a stronger national reputation. This in turn will result in much higher visibility for the computer science and engineering activities of the College and the University.

The EECS Department will have two major sections, Computer Science and Engineering (currently 900 students), and Electrical Engineering (900 students). A very wide spectrum of courses and research projects will be offered by both sections. Research in the ECE Section has been concerned with such areas as computer architecture, logic design, computer arithmetic, parallel high-speed computation, software engineering, graphics, distributed systems and languages, database systems, performance evaluation, fault-tolerant computing, artificial intelligence, robotics, and realtime systems. CCS faculty research has been concerned with the theory of computation, principles of software design, programming languages, artificial intelligence, natural systems, and connections with psychology, biology, philosophy, and mathematics.

The merger, accompanied by major efforts to expand the College's computing environment and aggressive recruiting efforts to strengthen key areas, represents a major step toward the College's becoming a national leader in computer science and engineering, electrical sciences, and systems engineering.

The College's decision to undertake the development of a totally new type of environment for engineering education and research is consistent both with its tradition of innovation in engineering education and its present capabilities in the core disciplines necessary for this effort. Critical in the development of the North Campus Instructional Complex will be the faculty and staff of the College's Center for Robotics and Integrated Manufacturing and the Industrial Technology Institute of Michigan. These two organizations will provide the College with access to world-class research institutions concerned with the development, deployment, and implications of industrial technology. Of comparable importance will be the support of faculty and staff from the College's Computer Aided Engineering Network and Computing Research Laboratory.

4. THE COMPONENTS

Over the past year the College has consulted with many leaders of industry, engineering education, and research in the critical areas of computer and communication technology. Based on their guidance and advice, it has identified the following major components of the North Campus Instructional Complex:

The North Campus Instruction Center

The Center will provide a versatile facility for the application of modern tools of computer-aided engineering to education and research. The Center will consist of CAE-based classrooms, computer workstation laboratories, and self-paced instruction facilities constructed in a 40,000 nsf space on the unfinished ground floor of the new Dow Engineering Building.

The Center will enable the College to meet the ever-changing needs of instructional programs over the next several decades. Flexible design plus close integration with its Instructional Television System will enable the College to expand off-campus instructional programs -- both cooperative programs and those in continuing education and professional development. A unique feature of the Center will be its degree of integration into the College's Computer Aided Engineering Network. This will serve a dual purpose, allowing for the introduction into the curriculum of modern methods in computer-aided design, manufacturing, and instruction at the same time that students and faculty are being provided with a high-quality computing environment.

The North Campus Engineering Library

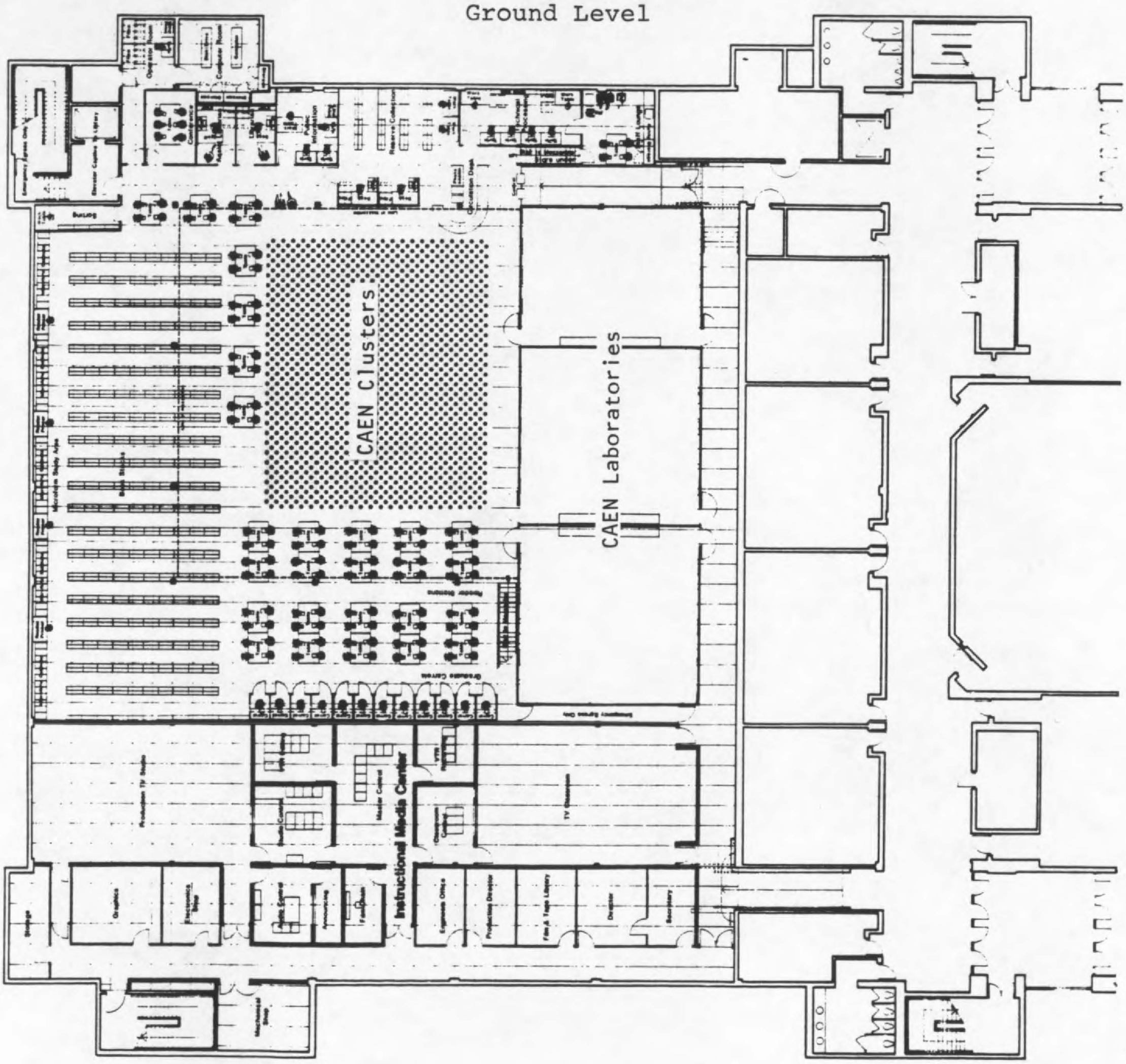
This Library will contain the College's existing technical collections as well as computer database systems for managing and distributing technical information within the University and among external users in industry and government. Responsible for the most complete technical collection in any American university, the College's present library represents a major national resource.

Since the College's move to the North Campus comes at a time of veritable explosion in the amount of technical information and the development of new computer-based methods for handling it, the relocation of this library to the North Campus has motivated a fundamental rethinking of the manner in which such technical information centers should be designed. Although the Library will continue to provide traditional services, it will focus increasingly upon the maintenance of nonproprietary software libraries for all College units, the support of instructional activities in computer-aided engineering, the performance of computer database searches and retrievals, and the development of new methods of information collection, management, and distribution.

The most important single requirement for such a facility will be to provide users with suitable work/study stations,

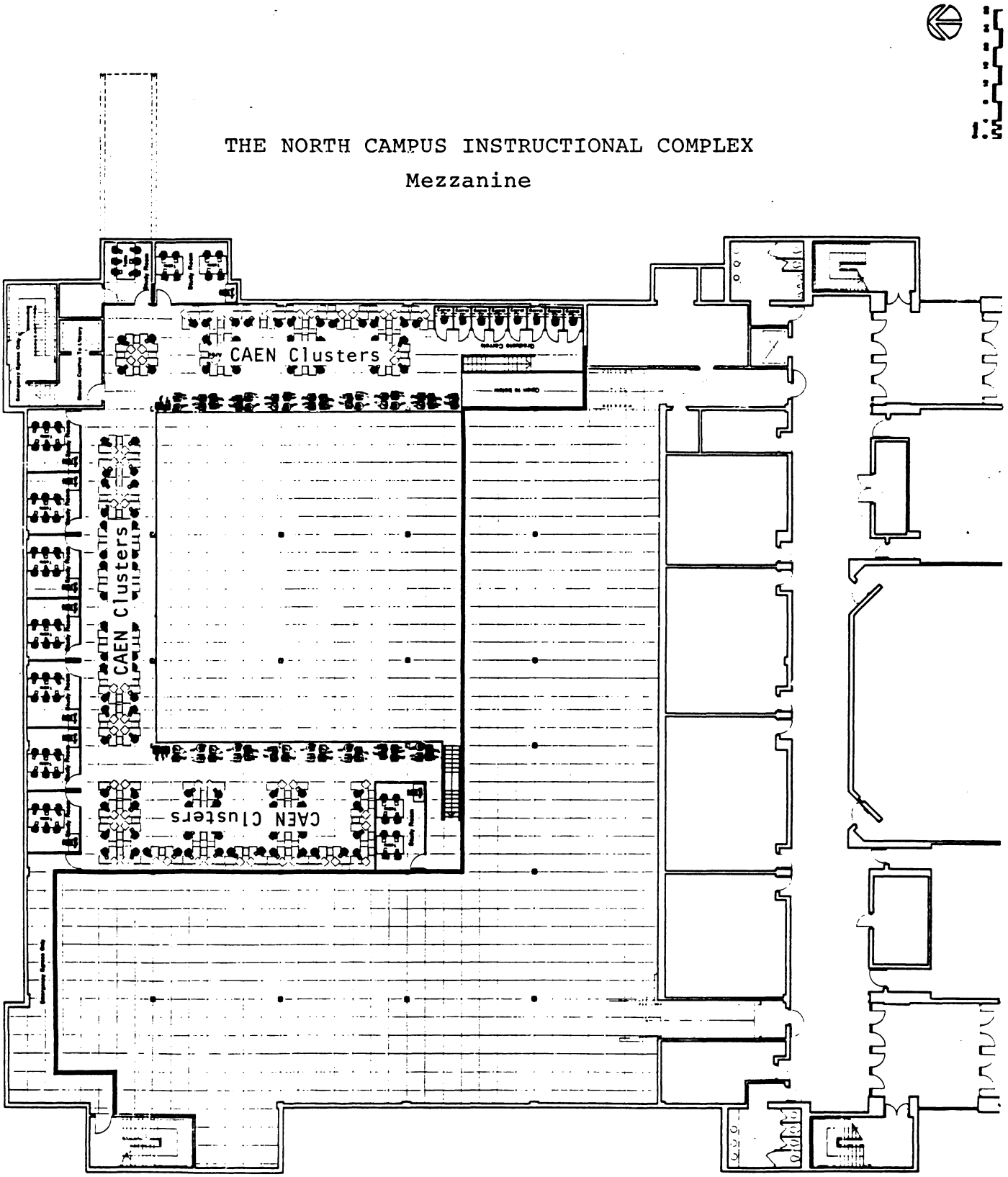
THE NORTH CAMPUS INSTRUCTIONAL COMPLEX

Ground Level



THE NORTH CAMPUS INSTRUCTIONAL COMPLEX

Mezzanine



giving them ready on-line access to such resources as databases remotely located in industrial and government installations, the Library's reference desk and catalog, teleconferencing and electronic mail, and various software products. In order to ensure ease of access, a ready flow of materials, and maximum flexibility in information delivery, the space provided need not be elaborate or costly; but it must be highly flexible and wholly functional.

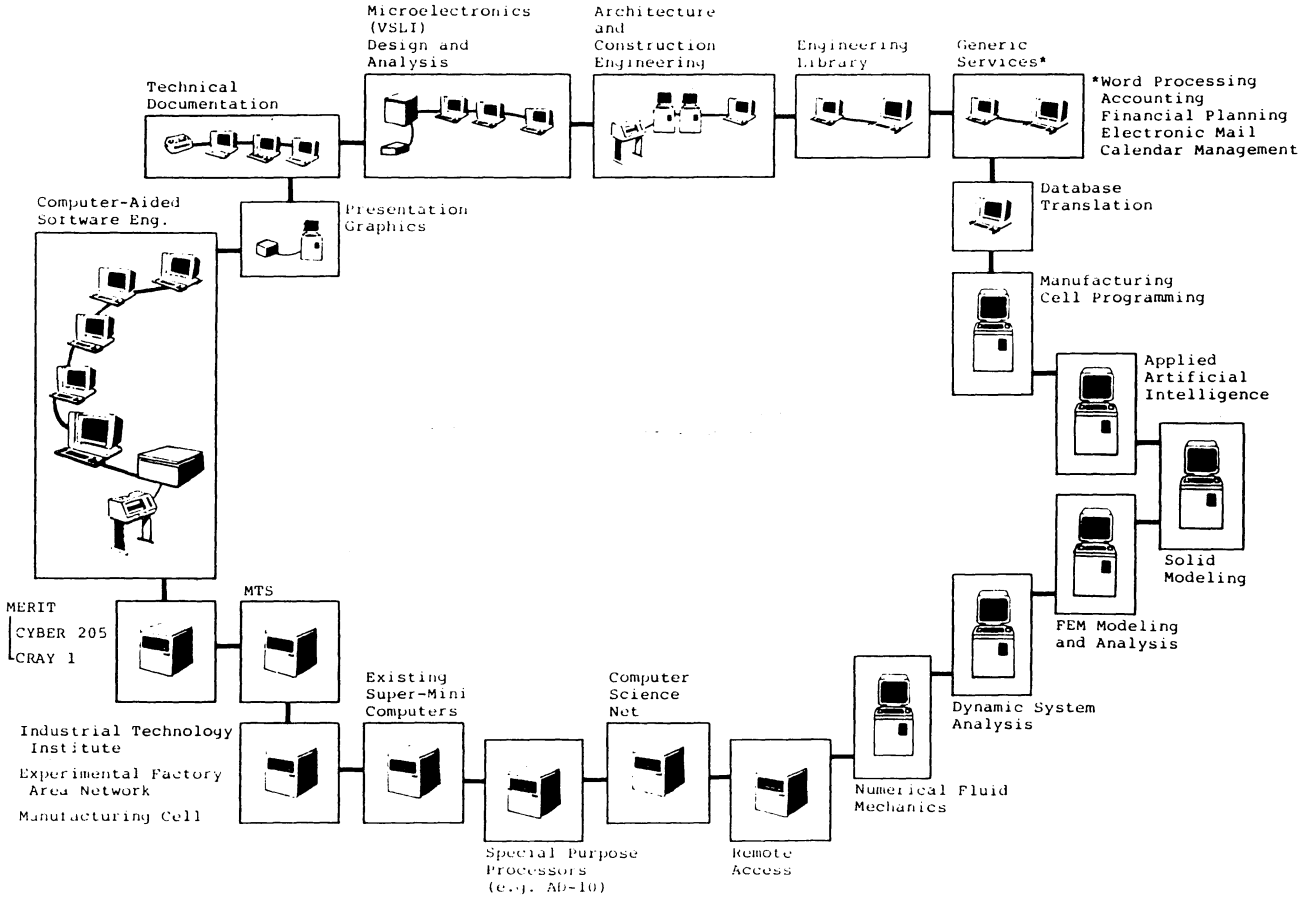
The Computer Aided Engineering Network

The Network will support the College's entire range of instructional and research activities and integrate its laboratories and instructional facilities (including the Instructional Center and the Industrial Technology Institute) with such data sources as the North Campus Engineering Library.

It will service the distributed-intelligence, hierarchical computing system currently being developed by the College to link personal workstations, super-mini computers, mainframe computers, function-specific machines, and gateway machines to supercomputer installations. The network is being designed to support not only general scientific computing, but computer-aided engineering activities, computer-aided instruction, and administrative activities (wordprocessing, electronic mail, database management). It will also provide access to technical and bibliographical databases and will serve as a testbed for research and development in computer and communication engineering.

The North Campus Instructional Complex will meet the urgent needs of the College's instructional and research programs. It will also serve other programs as a model for using state-of-the-art technology in computer databases and communication, computer-aided engineering, and computer-aided instruction.

Key to the development of the Complex will be the concept of integration -- the use of modern technology to link instructional programs with technical information centers, research activities, support services, and administrative functions. By building on strengths already existing in its academic programs while coupling these strengths to its programs in continuing engineering education and instructional television, the College believes that the Complex will become a major resource internally and externally -- for other University units, for other universities, and for organizations of all kinds throughout the nation.



THE COMPUTER AIDED ENGINEERING NETWORK:

AN EXPERIMENT IN COMPUTER-ENHANCED PRODUCTIVITY

5. THE IMPACT

The North Campus Instructional Complex will be a unique facility, given its classrooms, laboratories, libraries, and instructional aids, as well as the computer communications network that will result from an ongoing program in research and development. Although the investment could be justified simply on the basis of its value in improving faculty productivity and student learning, perhaps its most exciting justification will come through pioneering and demonstrating the integration of computer/communication technologies into complex organizations such as an academic institution. The challenge of integrating the various informational functions represented within the Complex is at least as great as it could be in any business or industrial configuration. Indeed, the techniques developed within the Complex will carry the most practical potential not only for other universities but for business, industry, and government as well.

Throughout history the basic mission of engineers has been to apply science and technology to meet the needs of society. But as the needs of society have become more complex, ever more sophisticated and powerful engineering tools have been required to accomplish this mission.

In recent years the development of digital computers and communication techniques has been coupled with major developments in information acquisition, storage, retrieval, and distribution. The result has been an array of powerful new tools that promise to revolutionize engineering practice. We have already witnessed the impact of computer-aided design and manufacturing on industrial productivity (the "factory of the future"). Computer-based communication networks and distributed information processing have had a similar impact on white collar productivity (the "office of the future"). Now a similar revolution can be expected in education through the use of instructional modes in which the computer-aided acquisition, management, and distribution of information are fully exploited ("the classroom and library of the future").

Ultimately, however, these technologies will have their most profound impact not on education but on the professions, since practice is being revolutionized in virtually every aspect. The challenge confronting engineering educators is to integrate these new technologies into academic programs. Specifically, they must improve the quality of instructional and research activity while stimulating faculty productivity, and must introduce students to the use of modern engineering tools while stimulating further research along similar lines.

In seizing this unique opportunity to integrate critical technologies, the College acknowledges the key strengths that make the effort possible and to some degree compelling. These include the combination of technological strength with breadth, its position within a great university, the quality and quantity of students and graduates of the College, and its demonstrated capacity for recruiting outstanding new faculty members.

The entire concept of the Instructional Complex stems from the College's firm commitment to meet the urgent needs of its academic programs by building a world-class center of excellence for the use of modern computer methods in engineering education and practice, and to develop an environment uniquely supportive of research and instruction in related technologies. As a cornerstone of this effort, the Complex and its associated programs will enable the College of Engineering to respond to serious national needs for talented graduates and creative research in these critical areas.

6. THE IMPORTANCE OF INDUSTRIAL SUPPORT

The College of Engineering acknowledges a major responsibility to respond to the needs of American industry. This mission is quite natural for an engineering college. In a very real sense industry represents a major reason for the existence of the College. If one recognizes that engineering is the application of science and technology to meet the needs of society, then it is apparent that industry is the manifestation of this activity. Moreover, the students and research provided by the College can be viewed as the lifeblood of industry and the key to the future of American productivity.

A major thrust of the College in the years ahead will involve a focusing of efforts toward the needs of industry. The College intends to work closely with industry, to learn of its needs and concerns, and to develop academic and research programs to respond to these needs.

However, if this partnership is to succeed, it is important that private industry acknowledge and accept a major responsibility for the support of engineering education. Indeed, without this support industry's supply of engineering manpower stands in serious jeopardy since one by one, the leading engineering schools will be forced to implement major enrollment and program reductions.

Engineering education both throughout this nation and within the College of Engineering has reached a critical point. Industry must now step forward with the support that will provide institutions such as the College of Engineering with the capacity to respond to its needs -- to produce the engineering graduates and technological knowledge essential for national security and economic prosperity.

It is from this perspective that we ask the Lockheed Corporation to consider a major gift to the College of Engineering for the support of its Computer-Aided Engineering Network.

7. THE PROPOSAL

In submitting this proposal for consideration by the Lockheed Corporation, we note several key elements which highlight the special relationship which Michigan and Lockheed have enjoyed.

Lockheed has been a chief employer of Michigan engineering graduates. Through training received at the College of Engineering and the professional experience of Lockheed, both the University and the aerospace industry have mutually benefited from several distinguished individuals who have attained leadership positions within Lockheed. Lockheed continues to recruit talented Michigan engineers who in turn advance their professional development at one of the national leaders in the aerospace industry. Historically, 10-15 graduates of the College of Engineering have accepted positions with Lockheed each year.

This proposal seeks a capital grant of $500,000 over a five-year period. This grant would provide sustained support for one of the major CAE cluster laboratories, to be designated the Lockheed Computer-Aided Engineering Laboratory. Such recognition would assist the University in emphasizing the critical nature of private investment toward engineering excellence. It would also provide a visible example to students, faculty and visitors of the interest of the Lockheed Corporation toward the training of talented engineers to advance the American economy.

APPENDIX

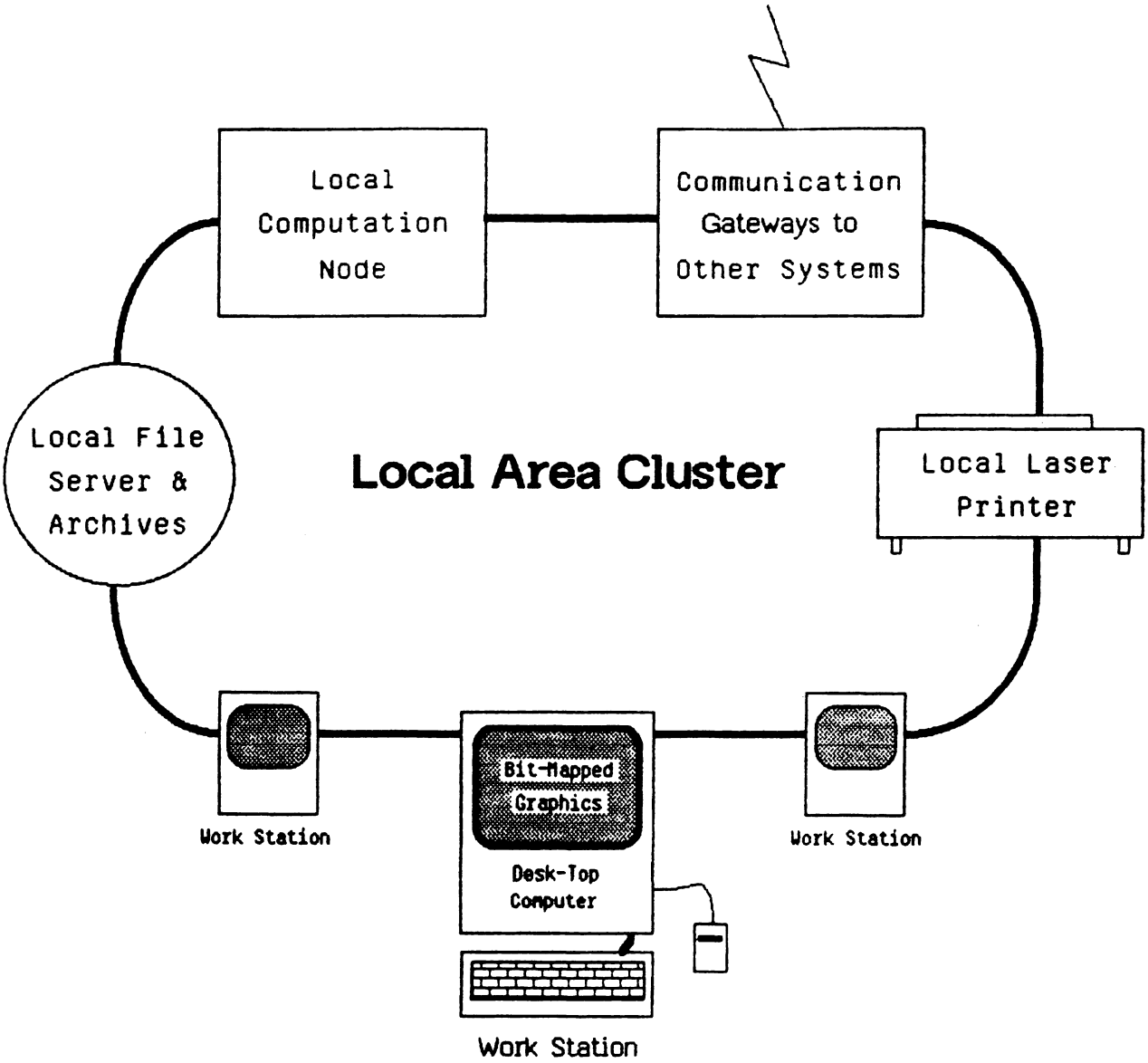
THE COMPUTER AIDED ENGINEERING NETWORK

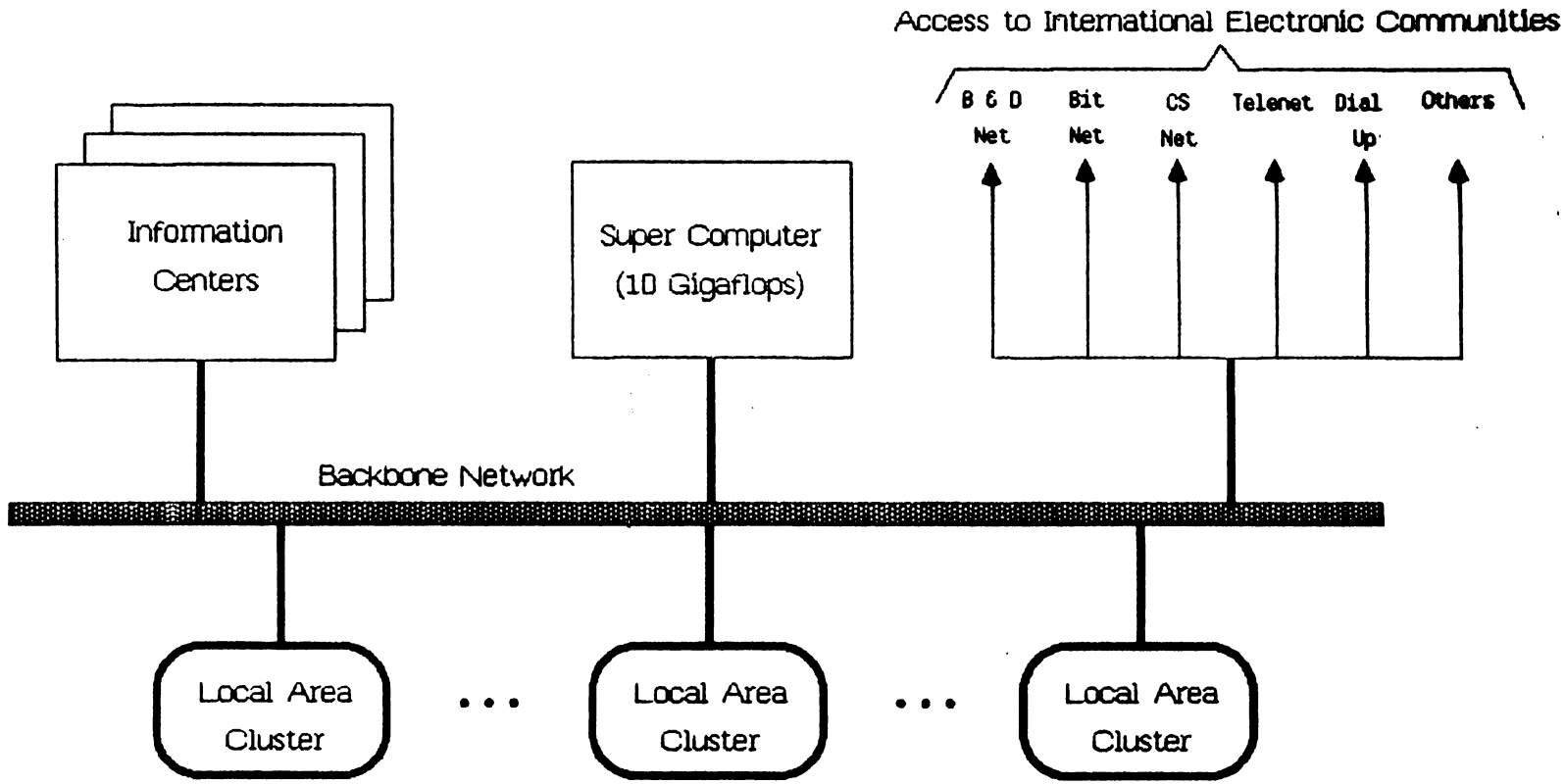
- A STATUS REPORT -

Engineering education and practice are entering an era of unprecedented change. Developments in computer and communications technology already have had a major impact on engineering practice through applications in such fields as computer-aided design (CAD), computer-integrated manufacturing (CIM), and distributed intelligence computer and communication networks. The disciplines of computer science and engineering are now focusing on enhancing the productivity of people rather than simply the productivity of operations. As a result, engineering education faces a twofold challenge: to undertake creative research and development in these fields and to integrate the resulting technologies into academic programs.

To respond to this challenge, an increasing number of universities are requiring all entering students to purchase a personal computer, typically costing $1,000 - $2,000, for use during their studies. However, while this approach may indeed address the need for "computer literacy" among general college students, we do not believe it adequately meets the needs of most engineering students, who require more powerful personal computers (costing in the $5,000 to $20,000 range) capable of supporting sophisticated languages and operating systems (e.g., FORTRAN, Pascal, C, and UNIX), powerful graphics, and communications with mainframe hosts. Furthermore, the rapid evolution of personal computer technology will almost certainly make those machines typically selected for student purchase obsolete during the several years of their studies.

Hence the College of Engineering believes a more effective way to approach the challenge of providing "personal computing" resources to its students is for the educational institution itself to assume the primary responsibility for acquiring, installing, maintaining, and upgrading such computer/communications technology. We are responding to this challenge through the development and implementation of our Computer Aided Engineering Network, a distributed-intelligence, hierarchical computing system linking together personal workstations, superminicomputers, mainframe computers, function-specific machines, and gateway machines to supercomputer installations. The Network is being designed to support not only general scientific computing, but computer-aided engineering activities, computer-aided instruction, and administrative activities (wordprocessing, electronic mail, database management).

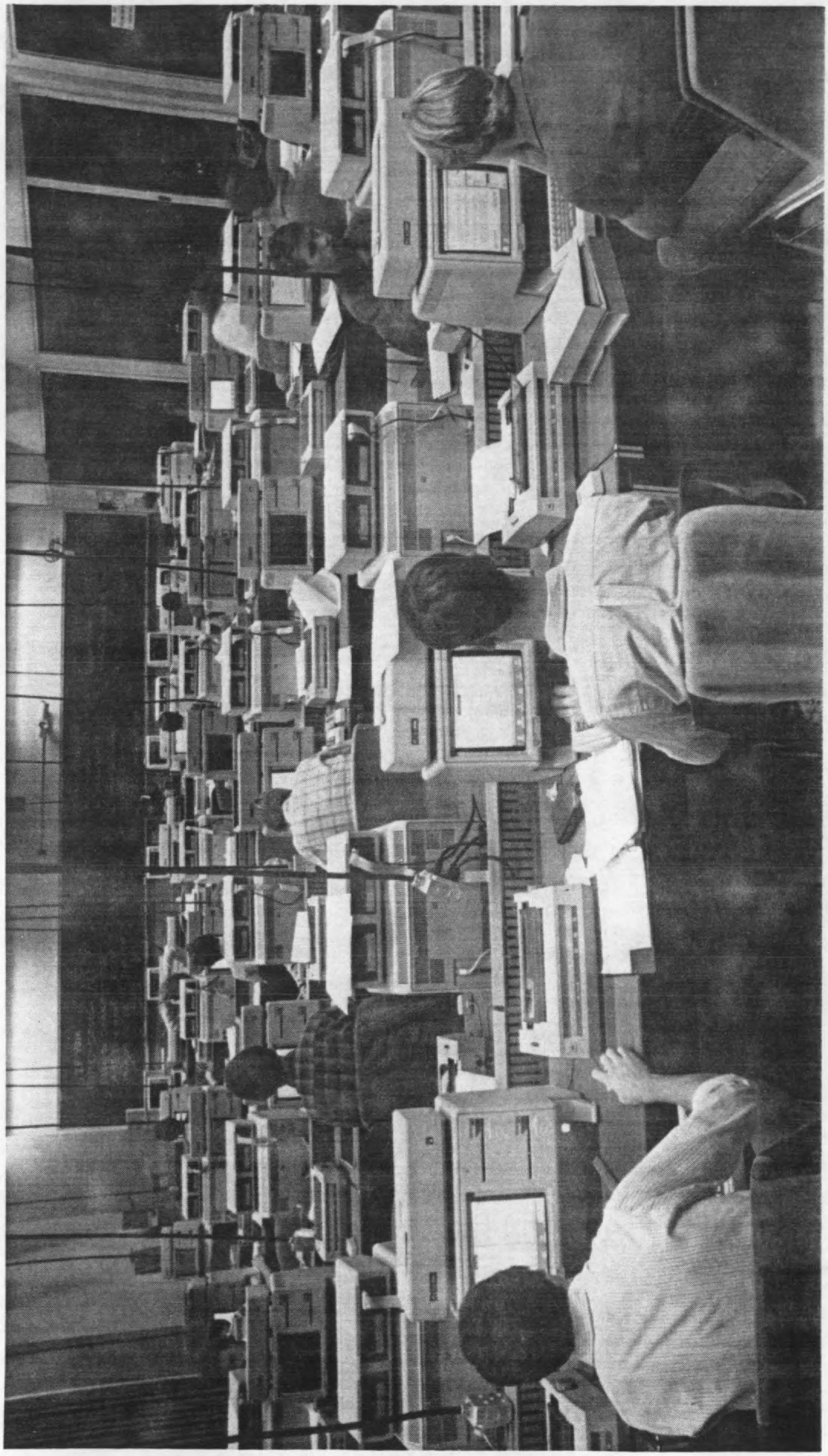

Local
Computation
Node
Communication
Gateways to
Other Systems
Local File
Server &
Archives
Local Area Cluster
Local Laser
Printer
Work Station
Bit-Mapped
Graphics
Desk-Top
Computer
Work Station
Work Station


Access to International Electronic Communities
B & D Net
Bit Net
CS Net
Telenet
Dial Up
Others
Information Centers
Super Computer (10 Gigaflops)
Backbone Network
Local Area Cluster
Local Area Cluster
Local Area Cluster

Both the design and development of the Computer Aided Engineering Network are well underway. Physically the Network is being built from a collection of mainframe and superminicomputer class general purpose machines together with local area networks of the emerging generation of personal workstations. At present we are tracking two classes of personal workstations: advanced personal computers as exemplified by the IBM PC/XT and Apple Lisa; and personal engineering workstations as exemplified by the Apollo Domain, Sun Microsystems, and Masscomp computers with the powerful graphics and floating point processing necessary to support CAD, scientific computation and simulation, and software development.

The evolving capabilities of the personal computer (perhaps best exemplified by the Apple Lisa) and the decreasing cost of engineering workstations (such as the Apollo family) suggest that these two classes of machines may soon converge. Hence our strategy has been to pursue both in an integrated fashion. The personal computer and its derivatives pose interesting new approaches to providing high-access, personal computing to a large number of students and faculty. The availability of an enormous number of third-party hardware and software packages and the economy of scale of the "computer store" product line opens the possibility for the evolution of a powerful and cost-effective computing environment. This environment cannot, however, consist only of isolated personal computers. It must include the capability for sophisticated engineering applications in areas such as CAD, scientific computation and simulation, and software development. The environment must also include provisions for host-to-host communication and the shared access to large databases. This is the intent of the Computer Aided Engineering Network.

The schedule for the installation and evolution of the Computer Aided Engineering Network is ambitious. During the 1983-84 academic year, facilities containing large numbers (400 - 500) of such personal computers and engineering workstations were installed on both the Central and North Campus for the exclusive use of engineering students. Five such student computer clusters have been opened containing 100 Apple Lisas, 120 IBM PC/XT computers, and 30 powerful Apollo engineering workstations. Resident software and peripherals (printers, graphics plotters, file servers) are supporting a variety of activities including instructional work, wordprocessing, database management, and communication with larger host systems. Unlimited use of these facilities is being provided to all enrolled engineering students on an "open computing" basis (e.g., students present an identification card upon entering the cluster and are then allowed complete freedom in the use of the computers and associated networks).



CHRYSLER CENTER COMPUTER CLUSTER

Concurrent with the development of the student computer clusters, the College is also providing each faculty member with a personal workstation. Additional clusters of workstations are also being installed in graduate student work areas to support research activities. Included in these clusters will be more powerful 32-bit computers (so-called "desktop mainframes") capable of supporting sophisticated color graphics and very fast floating-point calculations.

The acquisition and maintenance of the equipment associated with the student component of the Computer Aided Engineering Network is being supported through private gifts and a differential tuition assessment. The faculty component of the Network is supported from research grants and discretionary funds.

Simultaneously with the acquisition and installation of the computer workstations, the College is moving rapidly to link these workstations together in local area networks within given departments or facilities. Each local area network will be tied into the central University Computer Center which will serve as a central electronic mail handling facility for the near term and as an archival data center over the longer term. In addition, various superminicomputers (VAX/Prime/Harris) are accessible through the networked workstations.

Over the next year the University will be installing the first phase of a broadband backbone network, UMnet, in parallel to the College project so that by early 1985, all University buildings (laboratories, classrooms and offices, and residence halls) should be connected by coaxial cables (with the provision for fiber optics to be added later). In addition, the College will be installing a satellite link to major national supercomputer centers within the next year.

During 1984 the College of Engineering will make a decision about expanding the Computer Aided Engineering Network to equip <u>all</u> 6,000+ engineering students with personal computer workstations (which could be kept in offices or residences and tied into the network). This decision will be determined primarily by two factors:

- The availability of a powerful, portable, and relatively inexpensive personal computer with most of the capabilities of the machines installed in the first phase of the Network (e.g., powerful microprocessor, bit-mapped graphics, mouse).

- Progress in developing the appropriate Local Area Networks necessary to link together offices, laboratories, and residence halls.

If we should decide to take this step, it would be our intent to provide such computers to each student on a lease/buy arrangement (at roughly the present differential tuition assessment--$100 per semester). In this way we could relieve the student of the costs of software support and hardware maintenance and upgrading.

The Computer Aided Engineering Network represents the College of Engineering's firm commitment to build a world-class center of excellence for the use of modern computer methods in engineering education and practice and to develop an environment uniquely supportive of instruction and research in related technologies. This computing environment will provide students of the College with a unique opportunity to participate in what is sometimes referred to as "the second computer revolution", to integrate this technology into their activities, and to stay with the cutting edge of this technology throughout their studies at Michigan.