



COLLEGE OF ENGINEERING
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

**UNIVERSITY OF MICHIGAN
FY85-86 STATE
BUDGET REQUEST
COLLEGE OF ENGINEERING**

January 7, 1985

Excerpts from the Narrative Summary of
The University of Michigan - Ann Arbor
Request for Incremental Appropriations
for Fiscal Year 1985-86

The State of Michigan is fortunate to have at The University of Michigan one of the best Engineering Colleges in the nation. Its faculty are commonly ranked with those of the top five schools, and its students are drawn from the top one or two percent in the state and the nation in terms of standard measures of academic ability and achievement. At no time in recent history have the resources of the College been in greater demand by students and by business and industry than now. Because of the high and increasing importance of research and teaching in science and technology-based fields, perhaps at no time in history has the potential value of the College to the State of Michigan been greater than now. Paradoxically, at no time in recent history has support for the College of Engineering been less adequate than it is now. The general fund budget base of \$23.2 million falls far below need. At \$3,900 per student, funding is nearly \$1,500 per student below the norm for peer public engineering colleges, a figure that translates into a funding shortfall of \$8.5 million.

This number represents the amount that is needed to restore the general fund budget base of the College of Engineering to a minimally adequate level, still well below that of the very best institutions such as Berkeley and MIT. It stems principally from shortfalls in two areas of expenditure: A shortfall of at least \$5 million in instructional and support staff to meet enrollment increases that have occurred in recent years; and a shortfall of at least \$3.5 million in the annual instructional equipment allocation for the College to provide an appropriate and competitive per capita base of support for the technology-based instructional environment of the College.

Over the past decade, enrollments in the College of Engineering have risen by about 45%, while the size of instructional staff has declined by about 20%. As a result, instructional loads in the College have risen to an intolerable level, the FYES/FTE being 18.1, or about double the student to teacher ratio that is recommended either by the Owen-Huffman Model or the National Accreditation Board for Engineering and Technology. Not only does this mean that the ability of the College to offer high quality instruction and to meet the growing demands for enrollment have been compromised, but it also means that the capacity of the faculty to sustain an adequate level of research and service and to compete successfully for the external sponsorship that is so essential in this area is severely strained. It is therefore essential that faculty appointments be made in key areas like manufacturing systems, microelectronics, optics, and materials, where both student interest and the College's research programs are burgeoning. An important planning objective for the College at this point in its life cycle

is staff flexibility over the long term in order to ensure that new technological directions can be reflected in the instructional program in a timely fashion. To this end, it is expected that less than one-half of the additional faculty FTEs (\$2,800,000) will be regular, full time, tenure track engineering scholars. The balance of new faculty (\$1,750,000) will be flexibly-assigned teaching staff who will be appointed in accordance with the instructional needs of the College at a given point in time. Bolstering the faculty component of the College as proposed above and augmenting the technical services/support staff (\$450,000) are required to restore the instructional manpower base to the level appropriate for the existing enrollment.

Despite our best efforts to meet these needs of the College of Engineering, which has received more favorable budgetary treatment in our retrenchment and reallocation efforts of the last four years than any other unit in the University, we have been unable to achieve an adequate level of support for the College. Our efforts have been more than offset by rapid enrollment growth and competitive salary increases, and by the relentlessly growing shortfall in expenditures for renewal of the large and essential equipment inventory of the College.

Experience elsewhere in the nation leaves little doubt that a world class college of engineering is an essential ingredient in technology-based industrial development. The ability of the state to strengthen and diversify its industrial base, to compete for new industry, and to support economic growth and new jobs in science and technology, so essential for Michigan's long-range prosperity, will depend in large measure on our ability to adequately support our College of Engineering. Because of the extraordinary quality of the College and its students, and because of the central importance of teaching and research in science- and technology-related fields to the mission of the University, and to the State of Michigan, we are compelled to request special assistance in meeting our needs in this area.

To avoid possible confusion and misunderstanding concerning the total needs of the College, we should underscore that the assistance requested here reflects only what is needed to bring the annual operating budget base of the College up to minimal peer norms. Beyond this, many other needs must be addressed and exciting opportunities grasped in order for the College of Engineering to meet its full potential to support the industrial base of the state. Additional funds will be needed on a one time basis to restore the outdated research equipment and facilities of the College; special assistance will be needed to further stimulate research and provide the incentives that are needed to bring the College to its full potential; opportunities to establish research thrusts that may be of special importance to the state, such as solid state electronics (i.e., equipment for the solid state electronics laboratory), materials research, and applied optics, should be supported, as should special efforts to enhance technology transfer.

-BACKGROUND MATERIAL-
SPECIAL BUDGET REQUEST FOR THE UM COLLEGE OF ENGINEERING

PREMISE:

There is strong evidence to suggest that a primary catalyst and necessary ingredient in technology-based industrial development is the presence of a world-class engineering school. Such institutions provide the technological innovation and entrepreneurs necessary to build new industry, even as they provide the outstanding engineering graduates necessary to sustain and strengthen the competitiveness of existing industry.

The presence in our State of one of the nation's leading engineering schools, the UM College of Engineering, will be of critical importance to our future economic prosperity. Michigan requires a massive infusion of new technology if it is to regain its traditional industrial and economic leadership and become the nation's source of emerging industrial technology, the world leader in complex manufacturing processes. Our State must use technology to revitalize and diversify its present industrial base to protect existing jobs, even as it seeks to spawn and attract new industries over the longer term to create new jobs for Michigan citizens.

The dominant role played by world-class engineering schools in economic development has been identified in study after study. In California and New England, most of the significant technological innovations behind industrial growth originated in key local engineering schools and their associated research laboratories (e.g., MIT, Stanford, UC-Berkeley, and Caltech). These innovations were typically exploited by new firms established by faculty, staff, and graduates of these schools. Companies with origins in these schools subsequently formed the basis of powerful agglomerations of new industries. Furthermore, these schools attracted the massive federal research contracts which played the key role of "risk capital" in building new industries such as electronics and aerospace.

In each case, the key engineering schools involved were top-flight institutions conducting research at the cutting edge of new technology. Furthermore, these schools were oriented to the commercial applications of their innovations, provided the entrepreneurial environment necessary for technology transfer, and were successful in attracting the federal funding necessary to stimulate such industrial development.

It is reasonable to expect that the role of a world-class engineering school will be even more critical in a future increasingly dominated by science and technology. There seems little doubt that Michigan's ability to strengthen and diversify its industrial base, to compete for new industry and economic growth, and to create the new jobs necessary for our State's long-term prosperity will depend on its success in building and sustaining such an institution.

THE OPPORTUNITY:

The UM College of Engineering provides Michigan with both a vehicle and an extraordinary opportunity for investing in the long-term economic health of our State. As one of the leading engineering schools in the nation, the College today is regarded as one of the few institutions in the world capable of achieving the degree of national leadership in science and technology necessary to have a major impact on economic development.

More specifically, the present status of UM College of Engineering can be summarized as follows:

Reputation: 5th in the nation
Capacity: 6,000 students, 320 faculty (3rd in the nation)
Productivity: 1,250 BS/y, 550 MS/y, 100 PhD/y
Research: \$25 million/y (federal and industrial contracts)
Student Quality: 98th percentile (1280 SATs)
Faculty Quality: Outstanding (active and aggressive)
Physical Plant: Rapidly improving
Entrepreneurial Environment: Rapidly improving
Laboratory Equipment: Seriously deficient
Base Funding: Seriously deficient

The College of Engineering has before it a number of unique opportunities to achieve national leadership in areas of major importance to Michigan's future:

- o National Engineering Research Center for Integrated Manufacturing
- o National Center of Excellence in Robotics
- o National Center of Excellence in Microelectronics (with Stanford and North Carolina Research Triangle).
- o National Materials Research Laboratory
- o Center for Applied Optics
- o National Supercomputer Center
- o DOD Software Engineering Institute
- o National Institute for Application of Artificial Intelligence to Manufacturing
- o Strategic Defense Initiative
- o Michigan Research Corporation - Venture Capital Spinoffs
- o Industrial Affiliates and Research Partnership Programs
- o MSE/MBA Program in High-Tech Startups
- o Spinoff Companies from Faculty, Students, and Graduates
- o UM Engineering Television Network for Michigan Industry
- o Co-operative Education Programs

However, if the College is to have the capacity to respond to such opportunities with strong proposals, it will require direct and immediate assistance from the State of Michigan to restore an adequate base level of support for its programs.

THE CHALLENGE:

The importance of world-class engineering programs to economic development has been recognized by state after state. One by one, states such as Illinois, Ohio, Pennsylvania, Minnesota, Indiana, and New York have made massive commitments of public funds to build the MITs, the Berkeleys, and the Stanfords of tomorrow. They have recognized that only engineering schools capable of ranking among the nation's leaders are capable of major impact on economic development, since only such world class programs are capable of attracting the outstanding faculty, the students, and the economic and technological resources necessary to stimulate the growth of new industry.

But, Michigan, unlike most of these other states, already has an institution with a competitive edge, the UM College of Engineering. Ironically, our State also stands apart from others in its failure to act to restore an adequate level of support to its premier engineering school. During a decade in which enrollment in the College grew by over 45% to its present level of 6,000 students, the level of State funding for its programs has dropped dramatically. The College is currently understaffed by at least a factor of two relative to State funding models. This has led to a seriously overloaded faculty and limited opportunities for research and spinoff activities. Furthermore, technical support staff and equipment funds were cannibalized to offset the deterioration in State support, and this has resulted in obsolete and inadequate laboratories and led to an equipment inventory backlog estimated at \$44 million.

Despite its importance to Michigan, the College has been seriously crippled by inadequate State support in its capacity to respond to the needs of Michigan and its citizens. Even more serious is the probable consequence that the College will be forced to cut enrollments by as much as 50% and dismantle programs of critical importance to this State over the next several years if this chronic underfunding cannot be reversed.

To calibrate the magnitude of this crippling degree of underfunding, it should be noted that the UM Engineering College receives an annual instructional budget of roughly \$3,900 per student, compared to levels of \$5,500 in most public peer institutions (Illinois, Purdue, Wisconsin, ...) and an increasing number of emerging institutions (Texas, Arizona, Florida, Maryland,...) In sharp contrast, the leading engineering institutions such as UC-Berkeley, MIT, and Stanford receive roughly \$7,000 per student for their instructional programs -- twice that provided to UM Engineering. It seems evident that unless this serious funding gap is erased, the UM Engineering College will find it increasingly difficult to compete for the faculty and the other resources necessary to achieve the national leadership necessary for maximum economic impact.

THE PLAN:

To achieve maximum economic impact, the UM College of Engineering must be provided with the capacity to achieve national leadership in areas of key importance to this State. To compete with both peer and emerging public institutions, the College will require the following special initiatives by the State of Michigan:

Annual Base Budget Growth Requirements: \$8.5 million

\$5 M faculty and technical support staff
\$3.5 M sustained laboratory equipment support

One-Time Equipment Support Requirements: \$20 million

\$8 M Solid State Electronics Laboratory
\$7 M Materials Research Laboratory
\$3 M Center for Applied Optics
\$2 M UM Engineering Television Network

It should be noted that while such additional support is necessary to bring UM Engineering to the level of peer public institutions, it is still far short of the resources necessary to achieve the level of leading institutions such as MIT, Stanford, and UC-Berkeley. This latter challenge would require roughly twice the additional investment (\$15 million in base budget growth and \$60 million in capital outlay for equipment and facilities).

The UM College of Engineering is unique in this State in its ability to attract the outstanding faculty and students necessary to achieve national leadership. Furthermore, it alone possesses the reputation to leverage this investment of State support several-fold through matching grants and contracts from both the federal government and the private sector. More specifically, the proposed investment by the State would be matched by a growth in College-generated revenues to a sustained level of over \$70 million per year:

\$30 million/y federal and industrial research contracts
\$25 million/y tuition and fees
\$15 million/y private and corporate gifts

Such a partnership between State, federal, and private support is essential in achieving the level of resources necessary to compete with the nation's leading public and private institutions.

THE IMPACT:

There is ample evidence across this nation to demonstrate the impact that world-class engineering schools have on economic development. A major investment by the State of Michigan in the UM College of Engineering at this point in time can be expected to have a similar impact on our State's long-term economic prosperity. Furthermore, since the most talented of Michigan's high school graduates now enroll in the College, such action would also represent an important investment in Michigan's most valuable resource, its youth. These extraordinarily talented students will become the leaders and builders of Michigan industry. Not only will they sustain the competitiveness of existing Michigan companies, but they will found the new companies necessary to diversify Michigan's economic base.

The UM College of Engineering is unique in this State in its ability to attract outstanding faculty and students across all major technologies. Furthermore, it alone possesses the reputation to leverage this investment of State support several-fold through federal and industrial grants and contracts.

The required incremental investment (\$8.5 million in sustained annual funding and \$20 million in capital outlay) is modest compared to the economic impact that would result from the presence of a world-class engineering school in Michigan. Graduates, faculty, and staff of the UM College of Engineering will be key factors in strengthening the competitiveness of existing Michigan industry. But of even more importance, the research activities of the College would spawn and attract new industry to diversify Michigan's economic base.

Roughly 70 years ago, the automotive industry originated in the inspired tinkering of self-educated craftsmen skilled in building engines for boats and machinery. The industry took roots in Michigan and triggered the economic growth which led to the impressive social institutions characterizing our State today. However, recent patterns of economic development such as Silicon Valley and Route 128 suggest that future industrial growth will be stimulated less by physical capital than by intellectual capital -- by technological innovation, the talented engineers capable of understanding and applying this technology, and the entrepreneurs capable of stimulating industrial growth.

Leading engineering schools such as the UM College of Engineering are the key sources of these essential ingredients for technology-based economic development. It is from this perspective that the UM College of Engineering must be viewed as one of the most important investments Michigan can make for its long-term economic prosperity.

SPECIFIC REQUESTS FOR BASE BUDGET ADDITIONS:

Instructional and Support Staff Increases: \$5.0 million

To meet a growing industrial demand for engineers in the State of Michigan, as well as to respond to a dramatic increase in the number of Michigan high school students seeking to enter its engineering programs, the enrollment of the College of Engineering has increased by 45% over the past several years. Yet during this same period, a serious erosion in General Fund support of the College led to a decrease in instructional staff of 54 FTE positions (roughly 20%). It has become apparent that unless this instructional staffing can be restored, the College will be forced to drastically cut enrollments in order to preserve the quality of its academic programs -- despite the critical needs of Michigan industry for talented engineers and the demand on the part of the most outstanding of Michigan's high school graduates to pursue engineering studies in the College.

The proposed additional budget allocation of \$5 million would restore the staff losses of the past several years. This would allow the College to maintain the levels of its present enrollment and research activities, thereby allowing it to provide the intellectual creativity so fundamental to technological innovation in Michigan industry, the talented, broadly-educated engineers who can understand and implement this technology, and the entrepreneurs capable of exploiting these resources to stimulate economic development in Michigan.

Engineering Laboratory Equipment: \$3.5 million

The inadequate state of the College's laboratory equipment inventory must be addressed if it is to have the capacity to respond to this State's needs. A decade of neglect has left the College's laboratories sadly obsolete. This crisis in the state of its laboratories has seriously impeded the College's efforts to provide the intellectual creativity and engineering graduates so much in demand by Michigan industry.

The proposed additional budget allocation of \$3.5 million in base support would restore an adequate level of funding to sustain the laboratory equipment needs of the College. Such a level of base funding for laboratory equipment is consistent with a recommended level of support of \$2,000 per engineering graduate made by the national Accreditation Board for Engineering and Technology (based on the College's production of 1,750 degrees per year). It would also represent an important first step toward meeting the challenge posed by the College's backlog of equipment needs, now estimated by the Michigan Society of Professional Engineers at \$44 million.

STAFFING RESTORATION PLAN

	<u>FTE</u>	<u>Cost</u>
Professorial Staff	50	\$2,800,000
Flexible Instructional Staff	70	1,750,000
Technical Support Staff	15	<u>450,000</u>
Total		\$5,000,000

MAJOR STAFFING AREAS (Faculty)

	<u>FTE</u>
Flexible manufacturing	10
Mechanical Eng - 5	
Industrial Eng - 2	
Electrical Eng - 3	
Computer science and engineering	12
Software engineering - 4	
Artificial intelligence - 4	
Other areas - 4	
Microelectronics	10
Silicon Devices - 3	
Advanced Devices - 3	
Electronic materials - 4	
Applied Optics	8
Optoelectronics - 3	
Nonlinear optics - 2	
Laser diagnostics and machining - 3	
Materials	10
Polymer engineering - 2	
Ceramics - 2	
Metallurgy - 2	
Composites - 2	
Materials characterization - 2	
Total	50

General Fund Dollars per Student

<i>UM Engineering</i>	\$3,900
Public Peers (Illinois, Purdue Wisconsin, ...)	\$5,500
MIT, Stanford, Caltech, UC-Berkeley, UCLA	\$7,000

Challenge: To compete with peer public institutions, UM must increase its base General Fund support through increments in State appropriation and/or tuition by $\$1,500 \times 6,000 =$ **\$9 million.**

NOTE: To complete with leading private and public institutions, UM would have to increase base General Fund support by $\$3,000 \times 6,000 =$ **\$18 million.**

Total Resources per Student

UM Engineering \$10,000

Public Peers \$14,000
(Illinois, Purdue
Wisconsin, ...)

MIT, Stanford, Caltech, \$20,000
UC-Berkeley, UCLA

Challenge: To compete with peer public institutions, UM must increase its total resource base through increments in State appropriation, tuition, contract research, and private support by $\$4,000 \times 6,000 = \underline{\$24 \text{ million}}$.

NOTE: To complete with leading private and public institutions, UM would have to increase base General Fund support by $\$10,000 \times 6,000 = \underline{\$60 \text{ million}}$.

