

UNIVERSITY OF MINNESOTA
Graduate School

Minutes, Graduate School Executive Committee
Meeting of Tuesday, November 21, 1989
2:15 p.m., Room 303 Johnston Hall

Present: Faculty representatives--Professors Timothy J. Ebner, Darrell A. Frohrib, David E. Smith, Nicholas Spadaccini, Michael G. Wade; administrative representatives--Deans Mark Brenner, Robert T. Holt (chair), Walter Weyhmann, Kenneth Zimmerman; Duluth representative--Professor James A. Grant; General Research Advisory Committee representative--Professor Thomas J. Bouchard; Graduate School Fellowship Committee representative--Professor Emi Ito; student representatives--Trudy Dunham, Frank Pucci, Anna Tonkovich, Wayne Hayes; guests: Professors Donald Bell, George O. Johnson, Martin Dworkin, Yechiel Shulman, Carroll P. Vance, and Ms. Rose Gregoire; Civil Service Representative--Tammy Jader; staff--Dean John T. Hatten, Andrew J. Hein, Myrna Smith; secretary--Vicki Field

I. FOR ACTION

A. Approval of the Minutes of the May 23, 1989, Meeting

The minutes were approved as submitted.

B. Proposal for a Ph.D. Degree Program in Biomedical Science

Dean Holt introduced Professor Dworkin, who commented briefly on the proposal and on the structure of the existing M.D./Ph.D. degree program. Professor Dworkin stated that the Ph.D. degree in Biomedical Science is intended for students whose research interests are interdisciplinary and do not fall within the bounds of any one graduate program. The proposed Ph.D. option will permit these students to complete an individualized program of study. Executive Committee members recognized that the program, at some future point, could be formally modified to include others who have the M.D. degree but are not in the combined M.D./Ph.D. program. It was reported that both the Health Sciences, and the Plant and Animal Sciences, Policy and Review Councils had endorsed the proposal.

Executive Committee members approved the proposal on a unanimous vote, with the understanding that the Ph.D. degree in Biomedical Science would be limited, at least initially, to matriculants in the existing, joint M.D./Ph.D. program.

(COPY OF PROPOSAL APPENDED WITH THESE MINUTES)

C. Proposal for an M.S. Degree Program (Plan B) in Management of Technology

Dean Holt introduced Professor Shulman, who commented on key aspects of the program and on supplementary material distributed at the meeting. Intended for employed professionals, the program will have an atypical delivery format that will combine alternate Friday and Saturday classes. Students will be admitted to and advance through the program as a cohort group. The program will be distinctly different from the regular M.B.A. program, which does not

have a strong enough technological component to meet the needs of scientists and engineers who desire leadership skills. It was reported that both the Physical Sciences, and the Social Sciences, Policy and Review Councils had approved the proposal.

(COPY OF PROPOSAL APPENDED WITH THESE MINUTES.)

Executive Committee members engaged in a discussion that focussed on the absence of human factors engineering in the proposed curriculum and on the program's special tuition, structure, and expenses. A motion to approve the proposal passed without dissent.

A brief discussion followed the vote to approve that principally concerned program tuition and the extent of the Committee's responsibility to address policy considerations raised by the proposal's budgetary aspects.

D. Proposal to Change the name of the Graduate Degree Program in Plant Physiology to Plant Biological Sciences and to Simultaneously Discontinue the Graduate Degree Program in Botany

Dean Holt introduced Professor Vance, who commented on recent developments in the plant sciences and on benefits that will accrue from the name change and merger of the Plant Physiology and Botany graduate faculties. Curricular revisions will result in a more flexible program under the new name, "Plant Biological Sciences." In a brief discussion of these related items, attention focussed on the teaching requirement associated with the renamed degree program, and on events leading to the name change, which included a study of the future of the plant sciences at the University of Minnesota and subsequent reorganization of the Department of Botany into the Department of Plant Biology. Professor Smith reported that the Plant and Animal Sciences Policy and Review Council had approved both items.

A motion to approved the name change and program disestablishment passed unanimously.

(COPY OF PROPOSAL APPENDED WITH THESE MINUTES.)

E. Proposal to Change the Name of the Graduate Degree Program in Genetics to Genetics and Molecular Biology

The Executive Committee took no action on this item, because it had been tabled by the Plant and Animal Sciences Policy and Review Council.

F. Request for an Exception to the Graduate School Policy Governing the Double-Counting of Credits Between Master's Degrees: the Master of Business Administration (M.B.A) and the Master of Hospital Administration (M.H.A.) Degrees

Dean Holt introduced Professors Bell and Johnson, who elaborated on the rationale for the request. Mentioned in particular were the natural curricular overlap between the two programs and similar arrangements that have been adopted elsewhere. It was reported that the Social Sciences Policy and Review Council had endorsed the request.

Executive Committee members voted unanimously to approve this item.

(COPY OF PROPOSAL APPENDED WITH THESE MINUTES.)

G. Proposal for an M.S./Ph.D. Degree Program in Toxicology

Dean Holt recalled the history of this proposal, which had first come before the Executive Committee in February, 1989, following approval by the Physical Sciences, and the Plant and Animal Sciences, Policy and Review Councils. The Health Sciences Council had deferred action on the proposal until the proposing faculty had answered questions stemming from the geographic distance between the Duluth and Twin Cities campuses. These questions were subsequently answered, and the Health Sciences group had approved the proposal with the changes stipulated in a recent memorandum from Professor Kendall Wallace to him, Dean Holt said. These changes included providing the core curriculum via compressed two-way audio and video transmission (augmented by symposia and an annual graduate student research colloquium) and, if this format does not prove feasible, delivering the core courses by means of an intensive summer program, sponsored by the Environmental Protection Agency (EPA) Research Laboratory at Duluth. (If electronic transmission of courses is successful, the funds committed by the EPA Research Laboratory would be used to support other aspects of the program, however.) Experience with both of these instructional formats has already been provided, Dean Holt noted: the first, by the UNITE program, and the second, by the intensive summer laboratory offered at Lake Itasca and required of Ph.D. matriculants in Neuroscience. The Health Sciences Council's discussion primarily concerned the technology available to transmit the core curriculum, Professor Ebner said. Professor Grant pointed to the importance of the Toxicology proposal as a "pioneering effort" in the formal establishment graduate degree programs that span the Twin Cities and Duluth campuses. It was noted that students could complete the program on a single campus.

(COPY OF PROPOSAL APPENDED WITH THESE MINUTES.)

Executive Committee members approved the Toxicology proposal without dissent.

H. Repeal of Motion Calling for New Full Member Appointments to the Graduate Faculty to be for Five Years

Dean Holt recalled that the Executive Committee, in fall 1988, had voted with one abstention to require new full member appointments to the graduate faculty to be for five years. This action was consonant with Plan for Focus, which recommended that all members of the graduate faculty reapply for membership every five years. Because of administrative difficulties associated with this policy, Executive Committee members were asked to consider instead an alternative proposal that called for periodic review of graduate faculty membership to take place coincident with the formal program review, or independently at individual programs' discretion prior to the scheduled Graduate School review. At the time of the regular program review (or at another interval at programs' discretion), the program would evaluate the participation of each member of its graduate faculty and request those members who are inactive, according to predetermined criteria, to voluntarily resign their membership in the particular graduate program faculty. It was further

proposed to rescind the motion approved by the Committee in fall 1988 and to implement instead the suggested alternative procedure.

Committee members engaged in a lengthy discussion that principally concerned need to involve the Policy and Review Councils and Graduate School Dean in the review process. Also mentioned was the language of the Graduate School constitution, which suggests that graduate faculty membership for regular University faculty shall be for an indefinite period.

No action was taken. Dean Holt said that a revised procedure would be presented to the Committee for consideration in the winter quarter.

I. Report of the Ad Hoc Committee on Off-Campus Graduate Programs

Dean Holt recalled that the Ad Hoc Committee had been appointed in response to concerns raised by the Physical Sciences Council over the rapid development of the Rochester graduate program. He called attention to the report's five recommendations and reviewed each of these. Professor Frohrib stated that the Physical Sciences group had approved the report in the spring. The report recommends in part that such off-campus programs be inloaded and be the responsibility of the University's regular faculty, Dean Holt noted.

A motion to approve the Ad Hoc Committee's report passed unanimously.

(COPY OF REPORT APPENDED WITH THESE MINUTES.)

II. FOR DISCUSSION

A. Relocation to the Plant and Animal Sciences Policy and Review Council of Programs in the Basic Biological Sciences Previously Represented on the Health Sciences Council

Dean Holt recalled discussions in the Policy and Review Councils of the need to provide a forum in which all graduate programs in the basic biological sciences could meet to discuss common interests and concerns. Historically, these programs have been divided between the Health Sciences and the Plant and Animal Sciences Policy and Review Councils. In view of the support expressed for such a move, basic biology programs previously assigned to the Health Sciences committee this fall joined the Plant and Animal Sciences group, Dean Holt reported. Further adjustments in the Policy and Review Council composition may follow. Dean Holt also observed that at the Graduate School level, programs need not be structured along departmental and collegiate lines.

B. Recruitment and Retention of Minority Graduate Students

Dean Holt stated that the University has set a goal of increasing minority student enrollment to ten percent of the total University enrollment by 1994. Strategies for recruiting graduate students of color vary across the institution; minority graduate student recruitment can therefore be done most

effectively at the program level. Programs must take this issue very seriously, Dean Holt said.

III. FOR INFORMATION

A. Report from the Council of Graduate Students

Ms. Dunham, president of the graduate student organization, presented a report on recent COGS activities. Mentioned in particular were COGS' membership in the National Association of Graduate-Professional Students and participation this fall in the Association's midwest conference; graduate student presentations at a meeting here of the national Council of Graduate Schools; and COGS' "clarification of status" document and related efforts to form a separate graduate and professional student association. Other topics included work to improve health care benefits for graduate students, minority graduate student issues, the University's TA development program, and the number of hours graduate students devote to University governance.

B. Report Entitled "University of Minnesota - Duluth Graduate Education: A New Threshold"

Dean Holt provided a brief historical perspective on the Duluth report. He cited the six recommendations contained in the report and commented briefly on each. (The recommendations called for appointment of a full-time Associate Graduate School Dean at Duluth, expansion of the UMD Graduate Faculty Committee's role, increased interaction between graduate faculty of all campuses, re-examination of funding issues surrounding UMD graduate education, upgrading of library facilities and information access, and examination of the structures of cooperative Ph.D.-level programs.) Professor Grant also commented generally on the report.

C. MSPAN (Minnesota Postsecondary Access and Needs) Project

Dean Holt questioned some of the assumptions reflected in the MSPAN report. Master's degree production here is not congruent with that of other, similar Ph.D.-granting institutions. While the University ranks ninth nationally in the number of Ph.D. degrees awarded, it ranks only twentieth in the number of master's degrees awarded. Dean Holt expressed his own view that the University's funding base must be restored before opportunities for practitioner-oriented master's training can be expanded.

D. Examination of the Role and Nature of the Doctoral Dissertation Undertaken by the Council of Graduate Schools

Dean Holt commented briefly on the CGS study. He will appoint a committee to examine this issue from a University of Minnesota perspective, he said.

E. Dean's Report

Dean Holt called attention to a report on fall quarter 1989 Graduate School enrollments; to information on the Graduate School fellowship, Hill Visiting Professor, and research budgets; and to a draft letter to directors of graduate studies clarifying procedures for readmission to Graduate School programs. He reviewed the content of the letter, noting that it describes current Graduate School policy on readmission and states the Graduate School's intent to actively enforce this policy. Directors of graduate studies consulted in this regard have expressed support for uniform enforcement of the policy, Dean Zimmerman added. Effects of more stringent enforcement on students who register for consecutive quarters in Continuing Education and Extension were briefly considered.

Dean Holt also reported that the Graduate School fellowship budget did not increase this year, despite a ten percent hike in graduate student tuition. Because the Graduate School provides tuition fellowships for graduate assistants and recipients of University-administered fellowships, the tuition increase will result in a deficit of about \$250,000 in this year's Graduate School fellowship budget. Fewer funds will thus be available for departmental block grants, Dean Holt said.

F. Report from the Graduate School Fellowship Committee

Ms. Smith distributed and reviewed information on the results of the first-year Graduate School Fellowship competition for this year. Dean Holt noted that the survey of Fellowship recipients for 1989-90 showed that of the students who declined these awards, 76 percent chose instead from among a group of about fifteen institutions (including Berkeley, Stanford, Harvard, Michigan and UCLA); 50 percent of students who matriculated at Minnesota reported that they also had offers from these same schools. The Graduate School is making a significant effort to recruit top students, Dean Holt said.

G. Report from the General Research Advisory Committee

Dean Holt introduced Deans Brenner and Weyhmann, who this fall replaced former Graduate School Associate Dean Patricia Swan. Professor Bouchard addressed the high quality of applications for Graduate School research funds and the significant shortfall in the Graduate School's research budget. This year, only new faculty received support and only half of the eligible applications were funded. The humanities are the hardest hit by the paucity of Graduate School research funds, Professor Bouchard stated. Discussion followed of the importance of Graduate School research funds to the University and its faculty, and of the need to seek an increase in these funds from the University's central administration.

H. Report of Board of Regents Actions Regarding Degree Program Additions, Deletions, and Name Changes

Dean Zimmerman reported that the Regents this summer approved proposals for an M.S./Ph.D. degree program in Conservation Biology and for a free-standing

graduate minor in Bioethics. These items have not yet been transmitted to HECB, however. Injury to the proposed programs caused by the delay was cited.

I. Old Business

No old business was reported.

J. New Business

Dean Zimmerman noted that President Hasselmo and Senior Vice President Kuhi have met with key committees of the budgetary colleges, and he inquired whether the two should be invited to address the Graduate School Executive Committee. Dean Holt said he would ask both the President and Senior Vice President to the Committee's winter quarter meeting.

K. Date of Next Meeting

The meeting tentatively scheduled for December 4 was cancelled due to lack of business.

The meeting was adjourned at 5:03 p.m.

Respectfully submitted,

Vicki Field, Assistant to the Dean

OCT 17 1989

UNIVERSITY OF MINNESOTA
TWIN CITIES

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October 13, 1989

Dean Kenneth Zimmerman
Graduate School
325 Johnston Hall

Dear Ken:

Enclosed is what I hope is the final version of the proposal for the Biomedical Scientist Graduate Program. Thank you for all your help and guidance in getting it to this stage.

Sincerely,



Martin Dworkin, Ph.D.
Professor of Microbiology

MD:pfw
Enclosure

PROGRAM APPROVAL CERTIFICATION

12/5/89

(Date)

Proposal for (name of program):

Biomedical Science, Ph.D.

Submitted by (department(s) name):

Graduate School

of the (college or campus name):

The Proposal has been reviewed and approved by:

APPROVAL CERTIFICATION

Walter Dworkin 12/5/89

(Department Chair or Equivalent) (Date)

ADDITIONAL APPROVALS (as appropriate)

[Signature] 12/7/89

(Dean, Graduate School) (Date)

[Signature] 12/5/89
for David M. Brown, Dean

(Dean) (Date)

(Vice President, Academic Affairs) (Date)

[Signature]

(Chancellor or Vice Chancellor for Academic Affairs or Administration) (Date)

(Vice President, Health Sciences) (Date)

(Vice President, IANRHE) (Date)

Approved by Board of Regents

(Date)

First Reading by PAC (MHECB):

(Date)

Second reading by PAC (MHECB):

(Date)

Recommendation by MHECB:

(Date)

Confirmation by Board of Regents:

(Date)

UNIFORM PROGRAM INVENTORY
AND PROPOSAL FORM (UPIPF)

SECTION I

(To be completed by the institution(s); see attached instructions)

Name of Institution(s): 1) University of Minnesota (Twin Cities)
2) _____

If more than one institution, indicate if it is:

_____ joint program (two or more institutions grant the degree)

_____ cooperative program (two or more institutions share the curriculum, but only one grants the degree)

1. Program Title (including degree, if applicable):

Ph.D. in Biomedical Science

Program Classification (check one): major minor _____
concentration _____ other _____
(specify)

[If applicant is a private institution, does it have approval to grant the appropriate degree under the Private Institutions Registration program:

Yes _____ No _____ In process _____

2. Program Type: Preservice _____ Occupational
_____ In-service General

3. Proposed Implementation Date: 9 / 90
mo. yr.

4. Program Length: Credit hours 72 Clock hours _____

5. Describe the Program (in 50 words or less):

The proposed program is intended as a supplement to the existing dual degree (M.D./Ph.D.) training program already in place. The present program limits students to existing graduate programs. The proposed program will allow students, in consultation with their faculty advisors, to custom design interdisciplinary programs at the various interfaces of biology, medicine and engineering. It is anticipated that, as the program evolves, interfaces with yet other relevant areas will also evolve.

6. Expected student interest in the program during the first year of operation, and when the program reaches full operating level.

	First Year (19 <u>90</u>)		Full Operation (19 <u>94</u>)	
	Number Expected	Hours Generated	Number Expected	Hours Generated
Program Enrollees	<u>4 - 6</u>	<u> </u>	<u>7 - 12</u>	<u> </u>
Program Graduates	<u>0</u>	<u> </u>	<u>4 - 6</u>	<u> </u>

7. Projected Costs of the Program: ***** (SEE BELOW) *****

	First Year (19 <u> </u>)				Full Operation (19 <u> </u>)			
	New		Reassigned		New		Reassigned	
	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost
a. Faculty	<u> </u>	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>	\$ <u> </u>
b. Civil Service	<u> </u>	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>	\$ <u> </u>
c. Equip, Supplies		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>
d. Space Rental		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>
e. Other		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>
f. Total		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>		\$ <u> </u>

8. Expected Sources of Funds for Program: ***** (SEE BELOW) *****

	First Year (19 <u> </u>)		Full Operation (19 <u> </u>)	
	Dollar Amount	% of Annual Expend.	Dollar Amount	% of Annual Expend.
a. State	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>
b. Tuition	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>
c. Federal	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>
d. Private	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>
e. Other <u> </u> (specify)	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>
f. Total	\$ <u> </u>	<u> </u>	\$ <u> </u>	<u> </u>

******* There are no costs, faculty, civil service personnel, supplies, equipment, travel, space or facility rental costs additional to those already budgeted for the existing M.D./Ph.D. program.

9. Governing Board(s) Preliminary Approval Date(s):

Institution 1 _____

Institution 2 _____

10. System(s) Verification:

_____ Authorized Institution or System Signature	_____ Title	_____ Date
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_____ Authorized Institution or System Signature	_____ Title	_____ Date
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UNIFORM PROGRAM INVENTORY
AND PROPOSAL FORM (UPIPF)

SECTION II

To complete Section II, see attached instructions.

UNIFORM PROGRAM INVENTORY AND PROPOSAL FORM

Section II

1- Mission of the proposed program.

The proposed program is intended as a supplement to the existing dual-degree (MD/PhD) training program already in place. The present program limits students to existing graduate programs. The proposed program will allow students, in consultation with their faculty advisors, to custom design interdisciplinary programs at the various interfaces of biology, medicine and engineering. It is anticipated that, as the program evolves, interfaces with yet other relevant areas will also evolve.

Some details of the program.

A- Trainees.

Trainees will be a subset of students already in the joint degree program who have decided, after their preliminary year or two of training, that an interdisciplinary program is more appropriate for their training. If this is deemed to be reasonable by the Committee on Graduate Studies, they will be admitted to the program.

B- The curriculum.

The curricular program will be formulated in consultation with a subcommittee of the Committee on Graduate Studies, the student, his or her preceptor and a representative of the preceptor's graduate program. It will contain a coherent core of course material as the major emphasis as well as the requisite minor or supporting area.

C- The faculty.

The Graduate faculty of the program will be those who have already been selected as approved preceptors for the joint degree program. Additional faculty may be added using the same parameters of selection.

2- Evidence of institutional readiness.

Any resources or funds required for this program will be drawn from the existing dual-degree program. Accreditation for the program is evidenced by the existing MD/PhD program having been awarded a coveted National Institutes of Health Training Grant.

3- Cost of the Program

Since the proposed program is a supplement to the existing MD/PhD Program any additional costs will be carried by the existing program.

4- Identification of the geographic area served by the program.

While a majority of the students presently in the program are residents of Minnesota and the upper midwest, the program is intended to be a national program and recruits from schools throughout the nation.

5- Justification for Implementation of the Program

A- Thusfar, approximately 10% of the students in the existing program have indicated a desire to participate in the proposed program.

B- There is no equivalent program in Minnesota, or in North or South Dakota. The University of Wisconsin in Milwaukee and the University of Iowa have similar MD/PhD training programs.

C,D,E- Not relevant or already covered.

PROPOSAL FOR A JOINT DEGREE (MD/PhD)

PROGRAM IN BIOMEDICAL SCIENCE

Section III: The Proposal

A. Introduction

There has now been in place for about four years an MD/PhD-joint degree program in the Medical School of the University of Minnesota. The goal of this program has been to train those medical scientists who will be at the interface of medical research and clinical practice. It is the further goal of the program and the hope of its faculty that the graduates of this program will not only be in the vanguard of basic research on human disease and human biology, but will also constitute the core of the future generations of faculty in biomedical departments.

Each student, as part of the training program is required to become enrolled in an existing graduate program and to complete the requirements for the PhD degree in a fashion indistinguishable from his or her single-degree colleagues. Occasionally, however, a student with an interdisciplinary inclination appears for whom the existing graduate programs do not satisfy his or her needs or intentions. This has been encountered most frequently with those students who wish to move into some relatively unexplored aspect of biomedical engineering, but has also arisen with students who wish to work at some interface between two biological programs (see Appendix A).

The immediate goal of the proposed program is to provide a mechanism for custom-designing graduate programs for these students. Despite the interdisciplinary quality of biomedical science, each program will contain a coherent and cohesive core of individualized course material. It is the unqualified intention of this program and its guiding faculty to maintain the high standards of graduate performance that already characterize the young MD/PhD program.

B. Proposed Program

1. Admission requirements

Applicants must have been admitted to the existing, joint-degree, MD/PhD program of the University of Minnesota.

2. Composition of the Committee on Graduate Studies (CGS)

The CGS will consist of seven members plus a Director of Graduate Studies. Three of these members will be selected from graduate faculty holding appointments in basic science departments of the Medical School, three members from the graduate faculty with appointments in departments of clinical science and one member from the graduate faculty in Biomedical Engineering. The Associate Director of the MD/PhD program will act as the Director of Graduate Studies (DGS) until the graduate faculty elects its own DGS, who will automatically become a member of the MD/PhD Advisory Committee.

Initially, the members of the CGS will be appointed by the Advisory Committee of the MD/PhD program. Subsequently they will be elected by the graduate faculty of the Biomedical Sciences program. The terms of the members will be staggered so as to provide an optimal turnover pattern.

3. Admission procedures

Students wishing to gain entrance to the Biomedical Science graduate program of the MD/PhD program will meet with an admissions committee, which will be a subcommittee of the CGS, and will discuss with them the reasons for seeking admission to the program. If the committee feels that this is indeed the most appropriate program for the student, it will recommend admission. The admissions procedure will then follow the usual administrative route.

4. Functions of CGS

- a. Set the faculty of the program
- b. Administer student admissions
- c. Monitor student progress
- d. Set students' preliminary examination and thesis committees
- e. Appoint students' advisory committee for setting up individualized course program
- f. Administer preliminary examinations
- g. Approve thesis topics and advisers
- h. Set program policy

5. Program faculty

There are two routes for appointment to the graduate faculty of the program:

- a. The preceptors approved by the MD/PhD Advisory Council for supervising the thesis research of the joint degree students are automatically appointed to the graduate faculty of the Biomedical Science program (see Appendix B). These faculty have been carefully screened on the basis of the following parameters:
 1. Full or associate member of the graduate faculty in another program.
 2. A productive publication record in peer-reviewed journals.
 3. Grant support from a national, peer-reviewed funding agency.
 4. Emphasis of faculty member's research is fundamental, as contrasted with applied research or clinical studies.
- b. Faculty may apply directly to the CGS for membership. The same parameters as described above will apply.

All appointments to the graduate faculty of the program will be for five-year periods. At the end of that time the faculty member must reapply for membership.

6. Curriculum

There are many possible interfacial areas that will be encountered by the program. It is thus not possible to formulate a fixed core curriculum for all students. However, the following generalizations will be adhered to:

- a. Each student will choose, in consultation with an advisory committee set by the CGS, a coherent core of coursework consisting of a minimum of 18 credit hours. These courses will comprise a bona fide area of emphasis, related to the student's research area and interests.
- b. The student's advisory committee will consist of the following:
 1. The student's preceptor
 2. The Director of Graduate Studies of that preceptor's graduate program. (If the preceptor holds multiple graduate appointments, the DGS will be from that program that is most closely related to the student's thesis area.) In the event that the DGS's area of expertise is not closely related to the intended thesis area of the student, an alternative member of that graduate faculty may be selected.
 3. Three members of the CGS.
- c. This committee will also be responsible for approving the student's minor or supporting program.

7. Quality control

- a. As indicated above ("Program Faculty") the CGS will be responsible for appointing the graduate faculty and for their five-year renewals.
- b. The CGS will receive a yearly report from the student's preceptor indicating the student's course performance and research progress. Students will be expected to maintain at least a 3.0 grade point average.

8. Examination procedures

The student's preliminary examining committee is mandated by the Graduate School to consist of three representatives from the major and two from the minor or supporting program. Insofar as is possible, these will be selected from the student's initial advisory committee by the CGS. If this is not feasible, substitutions will be made. The representatives from the student's major will be drawn from the list of approved MD/PhD preceptors; this need not be the case for the minor representatives.

The written preliminary exam will consist of a written proposition based on the student's thesis proposal (see the Microbiology Graduate Program document "Policies and Practices" for a detailed description of the requirements for the proposition.) This will be examined and approved or rejected by the student's committee. If rejected because it is fundamentally flawed, it will be completely redone and resubmitted. One such resubmission will be permitted. The committee may require that other, less fundamental

flaws be simply corrected before the proposition is approved. The proposition will then be defended before the committee as the oral preliminary. The proposition will serve as the vehicle for any related questions in the major or minor area. This type of exam is intended to determine the student's ability to recognize a significant problem, formulate a hypothesis, devise an appropriate experimental strategy and argue its defense.

9. University resources and cost

At the present time we do not anticipate any additional costs or use of University resources other than additional faculty time for administration of the program. Students will be supported by the existing MD/PhD program and the research grants of their preceptors.

APPENDICES

Appendix A - Sample Programs

- The following are two sample programs. The first is for a hypothetical student whose area of thesis research is in viral genetics.

Year 1

Fall

Micro. 8-110 Structure, Function and Metabolism of Bacteria	3 credits
GCB 8-131 Advanced Genetics I	4 credits
<u>Md.Bc. 5-751 General Biochemistry I</u>	4 credits

Winter

Micro. 8-112 Microbial Genetics	3 credits
GCB 8-132 Advanced Genetics II	4 credits
<u>Md.Bc. 5-752 General Biochemistry II</u>	4 credits

Spring

Micro. 8-421 Virology and Tumor Biology	3 credits
<u>Md.Bc. 5-753 General Biochemistry III</u>	4 credits

Year 2

Fall

<u>Md.Bc. 8-231 Advanced Molecular Biology I</u>	4 credits
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Winter

Micro. 8-217 Frontiers in Immunology II	3 credits
Pathol. 8-122 Basic Science of Cancer	1 credit

Total major courses - 21 credits

Total supporting program courses (underlined) - 16 credits

- The second sample program is for a student whose thesis area is in Biomechanics.

Year 1

Fall

AEM 5-580 Mechanics and Thermodynamics of Solids I	4 credits
AEM 5-438 Intermediate Dynamics	4 credits
<u>Hlnf 5-546 Health Informatics Seminar</u>	1 credit
<u>-----Biomedical Engineering Seminar</u>	1 credit

Winter

AEM 5-581 Mechanics of Solids II	4 credits
AEM 5-200 Kinematics and Dynamics of Fluid Flow	4 credits
<u>Math 5-601 Advanced Calculus 1</u>	4 credits
<u>Hlnf 5-546 Health Informatics Seminar</u>	1 credit
<u>-----Biomedical Engineering Seminar</u>	1 credit

Spring

ME 5-207 Experimental Stress Analysis	4 credits
<u>Math 5-602 Advanced Calculus II</u>	4 credits
<u>Hlnf 5-546 Health Informatics Seminar</u>	1 credit
<u>-----Biomedical Engineering Seminar</u>	1 credit

Year 2

Fall

AEM 8-510 Continuum Mechanics I	4 credits
<u>Hlnf 5-546 Health Informatics Seminar</u>	1 credit
<u>-----Biomedical Engineering Seminar</u>	1 credit

Winter

AEM 8-511 Continuum Mechanics II	4 credits
<u>Hlnf 5-546 Health Informatics Seminar</u>	1 credit
<u>-----Biomedical Engineering Seminar</u>	1 credit

Total major courses - 28 credits
Total supporting courses (underlined) - 18 credits

First Name	Last Name	Department	Graduate Appt
Victor	Bloomfield	Biochemistry	BioC, BioP Sci, BioM Eng, Chem
James	Bodley	Biochemistry	BioC
Bianca	Conti-Tronconi	Biochemistry	BioC, BioP Sci, C&D Bio, Pharm
Mary	Dempsey	Biochemistry	BioC, Nutrition
Nelson	Goldberg	Biochemistry	BioC, Path, Pharm
H. P.	Hogenkamp	Biochemistry	BioC
James	Howard	Biochemistry	BioC
James	Koerner	Biochemistry	BioC, NeuroS
David	LaPorte	Biochemistry	BioC, Genetics
John	Lipscomb	Biochemistry	BioC
Gary	Nelstuen	Biochemistry	BioC
David	Thomas	Biochemistry	BioC, BioP Sci
Howard	Towle	Biochemistry	BioC, C&D Bio, Genetics
Gary	Gray	Biochemistry/Chemistry	BioC, Chem
Robert	Elde	Cell Biology/Neuroanatomy	Anat, C&D Bio, NeuroSci, Pharm
Stanley	Erlandsen	Cell Biology/Neuroanatomy	Anat, C&D Bio, CLS
Glenn	Giesler	Cell Biology/Neuroanatomy	Anat
David	Hamilton	Cell Biology/Neuroanatomy	Anat, C&D Bio
Paul	Letourneau	Cell Biology/Neuroanatomy	Anat, C&D Bio
Richard	Linck	Cell Biology/Neuroanatomy	Anat, C&D Bio
Steven	McLoon	Cell Biology/Neuroanatomy	Anat, C&D Bio
Virginia	Seybold	Cell Biology/Neuroanatomy	Anat, C&D Bio, Pharm
Dwight	Anderson	Dentistry	Micro, Genetics, Dentistry
Stephen	Riederer	Diagnostic Radiology	BioM Eng
David	Fan	Genetics & Cell Biology	C&D Bio, Genetics, Micro, Micro Eng
Perry	Hackett	Genetics & Cell Biology	C&D Bio, Genetics
Robert	Herman	Genetics & Cell Biology	C&D Bio, Genetics, Micro Eng
Victoria	Iwanij	Genetics & Cell Biology	C&D Bio, Genetics
Ross	Johnson	Genetics & Cell Biology	C&D Bio, Genetics
Irwin	Rubenstein	Genetics & Cell Biology	C&D Bio, Micro Eng
Kamil	Ugurbil	Gray Fresh Water Inst.	BioC
Anthony	Faras	Institute of Human Genetics	Genetics, Micro, Micro Eng
Brian	Van Ness	Institute of Human Genetics	BioC, Genetics, Path
Fritz	Bach	Lab Medicine & Pathology	Path, Genetics
Aristidis	Charonis	Lab Medicine & Pathology	Path
John	Eaton	Lab Medicine & Pathology	Path, BioM Eng, CLS, Genetics, Micro
Leo T.	Furcht	Lab Medicine & Pathology	Path
John	Kersey	Lab Medicine & Pathology	Path, CLS, Ther Rad
Tucker	LeBien	Lab Medicine & Pathology	Path, CLS, Micro
James B.	McCarthy	Lab Medicine & Pathology	Path, C&D Bio
R. Scott	McIvor	Lab Medicine & Pathology	Path, CLS, Genetics, Micro
James	O'Leary	Lab Medicine & Pathology	Path, BioP Sci
Harry	Orr	Lab Medicine & Pathology	Path, CLS, Genetics, Micro
Andreas	Rosenberg	Lab Medicine & Pathology	Path, BioC, BioP
Effie	Tsilibary	Lab Medicine & Pathology	Path

First Name	Last Name	Department	Graduate Appt
Daniel	Vallera	Lab Medicine & Pathology	Path, CLS
James	White	Lab Medicine & Pathology	Path, C&D Bio, Peds
Robert	Bache	Medicine	BioM Eng
Jordan L.	Holtzman	Medicine	Pharm
Thomas	Hostetter	Medicine	
Harry	Jacob	Medicine	Path
Colin	Jordan	Medicine	Micro
Neil	Kay	Medicine	Path
Jack	Oppenheimer	Medicine	Physiol
Paul	Robertson	Medicine	C&D Bio
Paul	Cleary	Microbiology	Micro
Martin	Dworkin	Microbiology	Micro, C&D Bio, Micro Eng
Ashley	Haase	Microbiology	Micro, Vet Micro
Ronald	Jemmerson	Microbiology	Micro
Marc	Jenkins	Microbiology	Micro
Peter	Plagemann	Microbiology	Micro, C&D Bio
Palmer	Rogers	Microbiology	BioC, C&D Bio, Micro, Micro Eng
Stewart	Scherer	Microbiology	Micro
Patrick	Schleivert	Microbiology	Micro
Peter	Southern	Microbiology	Micro
Tim	Ebner	Neurosurgery	NeuroSci, NeuroSurg, Physiol
Margaret	Hostetter	Pediatrics	Micro
Alfred	Michael	Pediatrics	Path, Peds
Robert	O'Dea	Pediatrics	Pharm
Nancy	Lee	Pharmacology	Pharm, NeuroSci
Horace	Loh	Pharmacology	Pharm, NeuroSci
Norman E.	Sladek	Pharmacology	Pharm
Sheldon	Sparber	Pharmacology	Pharm
Akira	Takemori	Pharmacology	Pharm
Hon Cheung	Lee	Physiology	Physiol, C&D Bio
Chang W.	Song	Therapeutic Radiology	BioP Sci, Ther Rad

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Biochemistry
Medical School
4-225 Millard Hall
435 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 625-6100

October 10, 1989

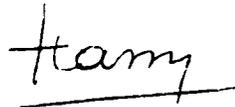
Dr. Martin Dworkin
Associate Director
Combined MD/PhD Program
Department of Microbiology
Box 196 UMHC

Dear Marty:

On behalf of the Department of Biochemistry, I endorse the proposed MD/PhD graduate program in Biomedical Science.

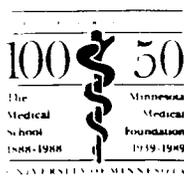
It is my understanding that this new program will provide graduate education opportunities for MD/PhD students for whom the traditional programs are not suitable.

Sincerely,



H.P.C. Hogenkamp
Professor and Head

/nzb





UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Radiology
Medical School
Box 292 UMHC
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

October 6, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PhD Program
Box 609 UMHC

Re: Endorsement of New MD/PhD Graduate Program in Biomedical
Science

Dear Dr. Dworkin:

It has come to my attention that the MD/PhD Graduate Program Committee has developed a proposal for a joint degree (MD/PhD) program in Biomedical Science. This is an excellent idea as it will provide a broader MD/PhD program, particularly, in the area of Biomedical and Biophysical sciences. By allowing individuals to pursue this type of MD/PhD program, we will be investing in a training program for those physicians-scientists who will be our faculty for future generations. As Chairman of Radiology, I am particularly interested in developing MD/PhD programs which would allow one to pursue a career in applied medical science and particularly in medical physics programs. This seems to be a good step in that direction. If you would like me to comment further or add anymore specific information, I would be delighted to do so.

Sincerely yours,

William M. Thompson, M.D.
Professor and Chairman

WMT/jt

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Family Practice and Community Health
Medical School
6-240 Phillips-Wangensteen Building
516 Delaware Street S.E., Box 381 UMHC
Minneapolis, Minnesota 55455
(612) 624-2622

October 6, 1989

Martin Dworkin, Ph.D.
Associate Director
Combined MD/PhD Program
Department of Microbiology
Medical School
Box 196 UMHC
Main Campus

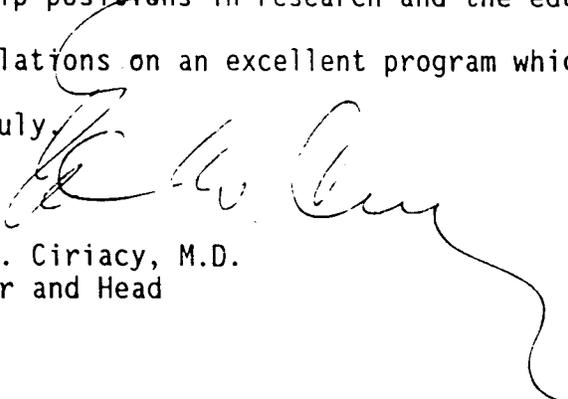
Dear Martin:

I am responding to your October 4, 1989 letter relative to the proposal for a joint degree (MD/PhD) program in Bio-Medical Science.

I would like to take this opportunity to congratulate you and your committee on the development of an excellent program. Our MD/PhD programs have made very significant contributions to the biomedical research enterprise. This proposal will not only carry out that tradition, but enhance its potential effectiveness. I would anticipate that the proposed program would prepare very talented, well grounded physician/scientists who will assume faculty leadership positions in research and the education of future scientists.

Congratulations on an excellent program which I most heartily endorse!

Yours truly,


Edward W. Ciriacy, M.D.
Professor and Head

EWC:cm



UNIVERSITY OF MINNESOTA

Department of Obstetrics and Gynecology
UMHC Box 395
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

Bruce A Work Jr., MD
Professor and Head

(612) 626-6065

6 October 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PhD Program
Department of Microbiology
Box 196 UMHC

Dear Martin:

Thank you for your letter of October 4, 1989, addressing the new MD/PhD graduate program in Biomedical Science.

I certainly do enthusiastically support this proposal as presented. I see this as a logical development in the academic spectrum of graduate programs. Such programs are clearly critical to increasing the number of individuals with capabilities and interests in becoming the physician-scientists, already in short supply, of the near future.

Please use this letter in supporting the proposal.

Sincerely,

Bruce A. Work Jr., M.D.
Professor and Head

BAW/smm



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Ophthalmology
9-240 Phillips-Wangensteen Building
UMHC Box 493
516 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 625-4400 (office, clinic and laboratories)
1-800-937-4393

October 6, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PhD Program
Box 609 UMHC

Dear Dr. Dworkin:

It is my pleasure to support the proposed new MD/PhD Program in Biomedical Science.

The MD/PhD Program is one of the outstanding programs in our University. It clearly recognizes the need for training physician-scientists who will be our faculty for the next generation. The quality of the students in this Program, their enthusiasm, and the national recognition that is received, is a testimony to the quality of this program, and it should be supported in whatever way possible by members of the University community.

Sincerely yours,

Donald J. Doughman, M.D.
Professor and Chairman
Department of Ophthalmology

DJD/blp



UNIVERSITY OF MINNESOTA
TWIN CITIES

Regents' Professor
Department of Surgery
Medical School
Phillips-Wangensteen Building
516 Delaware Street S.E., Box 195
Minneapolis, Minnesota 55455-0321

(612) 625-8444
(612) 625-3604
Fax (612) 625-8496

October 5, 1989

Martin Dworkin, Ph.D.
Associate Director
Combined M.D./Ph.D. Program
Box 609 UMHC

RE: Combined M.D./Ph.D. Program

Dear Martin:

The Department of Surgery is very pleased to strongly support the proposal for the new M.D./Ph.D. graduate program in Biomedical Science. I think it is very important that we continue to train physician scientists, who will eventually assume academic status for our own medical school, as well as for other medical schools.

We, in the Department of Surgery, have had a continuing interest in developing academic surgeons, and in our postgraduate program in Surgery, have included a compulsory three year laboratory research experience for all of our residents. Thus, most of our residents graduate with either a Ph.D. or a Master's degree and 80% of our graduates end up in academic positions.

I feel that the M.D./Ph.D. program that has been proposed for medical students will help stimulate more individuals to follow academic careers and improve the teaching of medicine in the future.

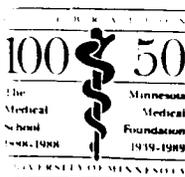
Wishing you well in the pursuit of this important new program,

Sincerely yours,

John S. Najarian, M.D.
Regents' Professor
Jay Phillips Chair in Surgery

JSN:slk

cc: Leo Furcht, M.D.
Mary Jane Towle





UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Microbiology
Medical School
1460 Mayo Memorial Building
Box 196 UMHC
420 Delaware Street S.E.
Minneapolis, Minnesota 55455-0312

Telephone: (612) 624-6190
Telefax: (612) 626-0623

October 9, 1989

Dr. Martin Dworkin
Department of Microbiology
Box 196 UMHC

Dear Marty:

I am writing to commend you and your committee for developing the thoughtful and contemporary M.D./Ph.D. program in Biomedical Sciences. As a "senior" physician-scientist myself, I am enthused about these kind of tailored and flexible curriculum that will provide the rigorous and basic training for this generation of medical scientists from which we will draw many of our faculty in the future. I enthusiastically endorse your efforts and wish you success in the implementation.

Sincerely,

A handwritten signature in cursive script, appearing to read 'Ashley T. Haase'.

Ashley T. Haase, M.D.
Professor and Head

ATH/dc



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Pharmacology
Medical School
3-249 Millard Hall
435 Delaware Street S.E.
Minneapolis, Minnesota 55455 U.S.A.
(612) 625-9997

October 6, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PhD Program
Department of Microbiology
Box 196 UMHC

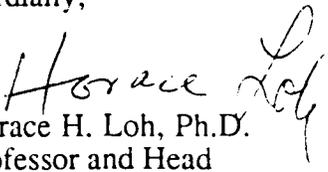
Dear Martin:

I am very pleased to support your Committee's Proposal for a Joint Degree (MD/PhD) Program in Biomedical Science. There is an every-increasing need for medical school faculty members who are physicians and who have research training in the biomedical sciences. I believe the proposed joint-degree program will help meet these needs in the years ahead. The proposal is well-conceived and meets the high standards expected for a quality degree program.

Pharmacology faculty members have long supported the goals of the MD/PhD program. Our graduates with combined degrees have taken on important academic roles that utilize both their clinical and research skills. Currently, two students in the joint-degree program are completing their rotations in our department.

We very much look forward to participating fully in the medical scientists program.

Cordially,


Horace H. Loh, Ph.D.
Professor and Head

HHL:kd



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Medicine
Phillips-Wangensteen Building
516 Delaware Street S.E.
Minneapolis, Minnesota 55455

October 5, 1989

Martin Dworkin, PhD
Associate Director, Combined MD/PhD Program
Medical School
Box 609 UMHC

Dear Marty,

I strongly support the new MD/PhD graduate program in Biomedical Science which will be added to the present set of choices available to the MD/PhD students. As you know the Department of Medicine strongly endorses this program since it is from this cadre of students the next generation of our faculty will spring. The Department presently supports one student in the MD/PhD program and has several faculty involved in the guidance and research activities of these superb individuals. The program has the most enthusiastic support of me and the entire Department.

Yours truly,

A handwritten signature in cursive script, appearing to read 'Tom'.

Thomas F. Ferris, M.D.
Nesbitt Professor and Chairman

TFF/lc



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Laboratory Medicine and Pathology
Medical School
Box 198, 420 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 625-9171

October 5, 1989

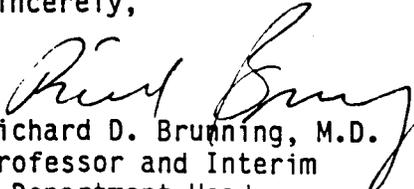
Martin Dworkin, Ph.D.
Associate Director
Combined M.D./Ph.D. Program
Department of Microbiology
Box 196 UMHC

Dear Dr. Dworkin:

I would like to express my enthusiastic approval for the proposed new M.D./Ph.D. graduate program in Biomedical Sciences for this institution. I think it very important that this we make a strong commitment to a program of this type which is vital to the future of medical education. We have entered a new era in biomedical science in which highly sophisticated technologies are making it possible to study disease at the most basic cellular level. It is critical that we have training programs such as the proposed combined M.D./Ph.D. curriculum to nurture physician/scientists who will be our future faculty.

I strongly endorse this proposal and urge its quick adoption by the University Administration.

Sincerely,


Richard D. Brunning, M.D.
Professor and Interim
Department Head

RDB:crb



UNIVERSITY OF MINNESOTA
TWIN CITIES

Office of the Dean
Medical School
Box 293 UMHC
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

Office at 3-120 Owre Hall
(612) 626-4949
FAX (612) 626-5657

October 6, 1989

Martin Dworkin, Ph.D.
Associate Director
Combined MD/PhD Program
Box 609 UMHC

Dear Marty:

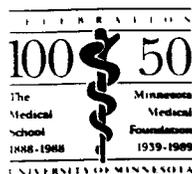
I enthusiastically endorse the reconstructed proposal for a joint MD/PhD program in biomedical science. This degree status would reflect in a very constructive manner the scientific and educational directions which are appropriate and necessary for the candidates to receive this degree. It represents the rather broad and sometimes eclectic programmatic approach which is appropriate for those individuals. It would enhance their ability to pursue fundamental research, frequently in clinical departments. They would then serve as the major foundation of research programs in those departments for the future.

Best of luck and thank you for your very productive efforts on behalf of this program.

Sincerely,

David M. Brown, M.D.
Dean
Professor, Laboratory Medicine
and Pathology and Pediatrics

DMB:pat
cc: Dr. Leo Furcht





UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Neurosurgery
Medical School
Box 96 UMHC
B590 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 624-6666

October 6, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined M.D./Ph.D. Program
Department of Microbiology
Box 196 UMHC
Hospital Mail

Dear Dr. Dworkin:

With this letter I would like to register my strong support to the new M.D./Ph.D. Graduate Program in Biomedical Science. I firmly believe that this program is a necessity if our Medical School is going to remain as a pace setter in this age of astonishingly rapid technical and scientific advances in the biomedical field. I am sure that it will be from within programs such as this that physicians-scientists-teachers of our faculty during the next generation will come.

In brief, I cannot support this program in stronger terms.

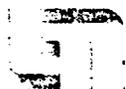
Sincerely,

Roberto C. Heros, M.D.
Lyle A. French Professor
and Department Head

RCH/kr

cc David M. Brown, M.D., Professor and Dean, Medical School
Leo T. Furcht, Director, Combined M.D./Ph.D. Program

OCT 20 1989



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Dermatology
Box 98 UMHC/4-240 PWB
420 Delaware Street S.E.
Minneapolis, Minnesota 55455-0392
(612) 625-8625

October 10, 1989

Martin Eworkin, Ph.D.
Associate Director
Combined M.D./Ph.D. Program
Box 809 UMHC

Dear Marty:

I am pleased to respond to your notification of October 4, 1989 regarding the establishment of a new M.D./Ph.D. program in biomedical science. I view this as a very valuable addition to the choices already available to the M.D./Ph.D. students. Certainly, I view this as the single most important thing that can be done by the Medical School to help assure the nation of an adequate number of able, well-trained faculty members for the years to come. Nobody needs to be reminded that science has become increasingly complex and that some of the traditional routes to faculty positions, through clinical medicine, simply will not do for the future. Training at the Ph.D. level will be almost a strict requirement for future faculty members and, obviously, those with the M.D./Ph.D. degree will have first preference because of their ability to bridge the gap between clinical medicine and basic investigation.

I am proud to be a faculty member at a school such as Minnesota which realizes the value of the M.D./Ph.D. program. You have my complete support in every way.

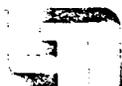
Sincerely,

A handwritten signature in cursive script that reads "Peter J. Lynch".

Peter J. Lynch, M.D.
Professor and Head
Department of Dermatology

PJL:af

OCT 20 1989



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Anesthesiology
Medical School
B515 Mayo Memorial Building, Box 294
420 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 624-9990

October 10, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PhD Program
UMHC Box #609

Re: MD/PhD Program in Biomedical Science

Dear Doctor Dworkin:

I am pleased to support, enthusiastically, the new graduate program. A custom program designed for the biomedical scientist has tremendous potential to train the physician-scientist we will be seeking as our faculty in the near and distant future.

I would be pleased to provide more support for this program in some way should it be necessary.

Sincerely yours,

Richard J. Palahniuk, M.D.
Professor and Head

RJP:cln



OCT 20 1989

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Psychiatry
Medical School
Box 393 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

October 17, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PHD Program
Department of Microbiology
Box 196 UMHC
University of Minnesota
Minneapolis, MN 55455

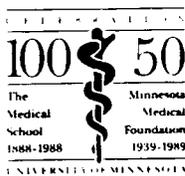
Dear Dr. Dworkin:

I write to heartily support the new MD/PHD graduate program in Biomedical Science. I think it is an important addition to the present set of choices available to the MD/PHD students. The training of more academic MDs is crucial for the future of medicine.

Sincerely,


Paula J. Clayton, M.D.
Professor and Head

PJC:bdm



OCT 26 1989

Office of the Department Chairman



UNIVERSITY OF MINNESOTA
TWIN CITIES

Variety Club Children's Hospital
Department of Pediatrics
Box 391 UMHC
13-107 Phillips-Wangensteen Building
516 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 624-4477

October 20, 1989

Martin Dworkin, Ph.D.
Associate Director, Combined MD/PhD Program
Department of Microbiology
Box 196 UMHC

Dear Marty,

I write to provide endorsement for the Proposal for a Joint Degree (MD/PhD) Program in Biomedical Science. In my judgment, this is an exceedingly important endeavor which bears directly on the vitality of the Medical School as well as its research/educational mission. In particular, the education of physician-scientists is essential to provide future faculty for clinical and basic science programs in the present and especially in the future.

Sincerely yours,

A handwritten signature in cursive script, appearing to read 'Alfred'.

Alfred F. Michael, M.D.
Regents' Professor of Pediatrics,
Laboratory Medicine and Pathology
Chairman, Department of Pediatrics

AFM:mj





UNIVERSITY OF MINNESOTA
TWIN CITIES

Graduate School
Johnston Hall
101 Pleasant Street S.E.
Minneapolis, Minnesota 55455-0421

18 December 1989

Professor Martin Dworkin
Department of Microbiology
Box 196 UMHC
East Bank Campus

Dear Professor Dworkin:

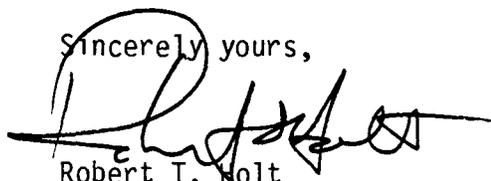
As you know, the Graduate School Executive Committee, at its meeting on 21 November, voted unanimously to approve the proposal for a Ph.D. degree in Biomedical Science. This action followed recommendation by the Health Sciences, and the Plant and Animal Sciences, Policy and Review Councils on 17 and 20 November, respectively.

In accordance with clarifications provided at the Council and Executive Committee meetings, the following Graduate School requirements will pertain with respect to the new Ph.D. degree when it is finally approved: 1) eighteen course credits will be required in a minor or supporting field, in addition to the eighteen credits required in a coherent core related to the student's research interests; 2) for students who elect a traditional minor, the director of graduate studies in the field of the minor must also approve this aspect of the official degree program; and 3) students will be expected to register for thirty-six thesis credits.

Only students admitted to the existing, joint-M.D./Ph.D. program will be eligible for the optional Biomedical Science Ph.D. degree, as stated in the proposal. You will recall, however, the Executive Committee's acknowledgment that a future amendment to the proposal might expand eligibility to others with the M.D. degree. Some enthusiasm was demonstrated for this notion, particularly among members of the Health Sciences Council. I think it is an idea worth exploring.

I have forwarded the proposal to the Board of Regents with a request for their initial consideration of the document in January 1990.

Sincerely yours,



Robert T. Wolt
Dean

RTH/vf

cc: Dean David M. Brown
Dean H. Mead Cavert
Professor Leo T. Furcht
Professor Lael Gatewood
Professor David E. Smith
Dean Kenneth Zimmerman



UNIVERSITY OF MINNESOTA
TWIN CITIES

Center for the Development of Technological Leadership
107 Lind Hall
207 Church Street S.E.
Minneapolis, Minnesota 55455
(612) 624-5747

October 26, 1989

To: Robert T. Holt
Dean, Graduate School

From: Yechiel Shulman 
W.R. Sweatt Chair
and Acting Director, CDTL

Subject: Proposal for a Master of Science in Management of Technology program

Enclosed herewith please find the proposal for a Master of Science in Management of Technology program.

This program was developed under the guidance of the Curriculum Advisory Committee for Management of Technology. The committee was composed of eight faculty members from CLA, Carlson School of Management, HHH Institute and the Institute of Technology, and of a retired Honeywell technical executive, acting in a consultative capacity.

The proposed program represents the considered judgment of the committee. As a novel program, however, we expect it to evolve and develop as academic and industrial environments change. For this reason we see a continued need for the active involvement of interested faculty in overseeing the academic excellence and relevance of this program.

I respectfully urge your support of this program and thank you and Dean Zimmerman for your continued interest and encouragement.

YS/dd
enclosure



UNIVERSITY OF MINNESOTA
TWIN CITIES

Institute of Technology
105 Walter Library
117 Pleasant Street S.E.
Minneapolis, Minnesota 55455
(612) 624-2006

October 23, 1989

To: Dean Robert Holt

From: E. F. Infante
Dean

E. F. Infante / by *Arden S. Beavers*

Subject: Program proposal for a Master of Science in Management of Technology.

This proposal is being submitted to the Graduate School, as its first step toward its implementation. It is a thoughtful proposal that deserves careful consideration.

As you are well aware, this proposal is most responsive to three very important issues of academic, national competitiveness, and local nature:

- o The establishment of this program addresses repeated and loudly voiced criticisms of undergraduate education in science and engineering being overly narrow and of not providing an appropriate academic background in non-technical, industrially-oriented topics for those students who will find themselves in industrial organizations.
- o A serious shortcoming in the lack of managerial expertise on the part of our industrial technologists, and of lack of technical experience by managers in industrial organizations, with profound effects on our industrial effectiveness and competitiveness.
- o The paucity of "practitioner oriented" master's degrees in technical and technological areas in Minnesota, especially in the Metropolitan area.

Because this proposal addresses in a most positive, thoughtful, and imaginative manner all of these issues, I endorse it with enthusiasm.

The only concern I have about this proposal is that its budgetary presentation might be on the one hand misconstrued, on the other have

Memo to Dean Robert Holt
October 23, 1989

Page 2

undesirable repercussions. Please note that the budgetary presentation is perfectly correct but:

- o At the level of Full Operation the direct cost of this program is correctly stated at \$510,000 (for 55 students and 25 graduates per year. But these are direct costs only; I estimate the "indirect" cost at 50%, yielding a real cost of \$765,000 per year (or \$30,600 per M.S.). Although this is an in-service program, its cost should not be considered as marginal costs (i.e., let us not continue to sin, as we have in the past).
- o This program is most fortunate in enjoying the luxury of an endowment. However, this endowment does not cover the cost. Moreover, the program is inloaded. This brings up the question of tuition policy. The policy proposed is quite clear and explicit. Needless to say, I have some concerns on how it will be interpreted (i.e., why should not the 1/3, 2/3 apply? or, why shouldn't the usual graduate school tuition rate apply?) or about its implications elsewhere (i.e., in Rochester and in other programs).

I understand full well that some of these questions raise major policy issues. However, I feel very strongly that the implementation of this program should not be held captive to the resolution of them; whatever policy decisions in the large are made will be appropriately accommodated by this program as it evolves and matures.

Thank you.

EFI:mls

cc: Associate Dean Gordon S. Beavers
Professor Jack Shulman

Attachment



University of Minnesota

Carlson School of Management
Office of the Dean

TO: Dean Robert Holt

FROM: Tim Nantell *T Nantell*
Acting Dean

SUBJECT: Program Proposal for a Master of Science in Management of Technology

DATE: November 6, 1989

This proposed program represents a joint program, requiring the participation of IT, the Carlson School and other units as well. Such efforts can be difficult, but they present the university with many benefits. Problems and programs rarely fit into neat departments. We are happy to be able to participate in this imaginative approach to addressing the management of technology.

We spent a good deal of time over the last year visiting with technology firms regarding the desirability of exactly this kind of program. Although we have some concerns relative to how it competes with existing Carlson programs, CDTL and IT have shown genuine interest in designing the program so that it adds to the university offerings, as opposed to cannibalizing existing programs.

We expect to be a significant contributor of faculty. We think we have the expertise required and existing faculty are very interested in influencing the content of the program. In addition, as we understand it, the finances of the program are such that the faculty resources displaced by this program can be replaced at full cost.

I want to reinforce Dean Infante's comments regarding tuition, matching state support, and costs. The level of faculty talent, program support and facilities required to make this type a program a success are substantial. We know -- we have been offering an Executive MBA program to an audience and in a format similar to those proposed for this program. The program meets a demand and it addresses one of the major issues discussed in MSPAN. For these reasons, I will join with Dean Infante in raising the fundamental policy questions regarding how the university should be determining its support of this program.

c: Jim Infante
Gordon Beavers
Fred Beier
Carl Adams
Jack Shulman

PROGRAM APPROVAL CERTIFICATION

November 28, 1989

(Date)

Proposal for (name of program): Master of Science in Management of Technology

Submitted by (department(s) name): Center for the Development of Technological Leadership

of the (college or campus name): Institute of Technology

The Proposal has been reviewed and approved by:

APPROVAL CERTIFICATION

[Signature] 11/28/89
(Department Chair or Equivalent) (Date)

[Signature]
(Dean, Institute of Technology) (Date)

[Signature] 11/28/89
(Dean, Carlson School of Management) (Date)

ADDITIONAL APPROVALS (as appropriate)

[Signature] 11/27/89
(Dean, Graduate School) (Date)

(Chancellor or Vice Chancellor for Academic Affairs or Administration) (Date)

(Vice President, Academic Affairs) (Date)

Approved by Board of Regents: _____
(Date)

First Reading by PAC (MHECB): _____
(Date)

Second Reading by PAC (MHECB): _____
(Date)

Recommendation by MHECB: _____
(Date)

Confirmation by Board of Regents: _____
(Date)

SECTION I

UNIFORM PROGRAM INVENTORY AND PROPOSAL FORM (UPIPF)

(To be completed by the institution(s); see attached instructions)

Name of Institution(s): UNIVERSITY OF MINNESOTA - TWIN CITIES

1. Program Title: MASTER OF SCIENCE IN MANAGEMENT OF TECHNOLOGY
(PLAN B)

Program Classification: MAJOR

2. Program Type: Preservice Occupational
 In-Service General

3. Proposed Implementation Date: September 1990

4. Program Length: Credit Hours 52 Clock Hours --

5. Program Description:

The Master of Science in Management of Technology is a two-year advanced study program, interdisciplinary in scope, providing graduate training in technology management. It follows a cohort group, part-time format, and is designed for and targeted at persons with a technological educational background and a minimum of five years of professional work experience with demonstrated leadership potential at their respective organizations.

6. Expected student interest in the program during the first year of operation and when the program reaches full operating level:

	<u>First Year - 1990-91</u>		<u>Full Operation - 1992-93</u>	
	Number	Hours	Number	Hours
	Expected	Generated	Expected	Generated
Program Enrollees	25		55	
Program Graduates	0		25	

7. Projected Costs of the Program:

	<u>First Year - 1990-91</u>				<u>Full Operation - 1992-93</u>			
	New		Reassigned		New		Reassigned	
	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost
a. Faculty	<u>1</u>	<u>\$ 100,000</u>	<u>1</u>	<u>\$ 100,000</u>	<u>2</u>	<u>\$ 200,000</u>	<u>2</u>	<u>\$200,000</u>
b. Acad. Profess.	<u>1</u>	<u>\$ 35,000</u>	<u> </u>	<u>\$ 0</u>	<u>1</u>	<u>\$ 40,000</u>	<u> </u>	<u>\$ 0</u>
c. Civil Service	<u>1/2</u>	<u>\$ 13,250</u>	<u>1</u>	<u>\$ 30,000</u>	<u>1</u>	<u>\$ 21,150</u>	<u>1 1/2</u>	<u>\$ 45,000</u>
d. Equip., Supplies		<u>\$ 25,000</u>		<u>\$ 0</u>		<u>\$ 55,000</u>		<u>\$ 0</u>
e. Space Rental		<u>\$ 0</u>		<u>\$ 0</u>		<u>\$ 0</u>		<u>\$ 0</u>
f. One-time Costs		<u>\$ 20,000</u>		<u>\$ 0</u>		<u>\$ 0</u>		<u>\$ 0</u>
g. Other		<u>\$ 48,000</u>		<u>\$ 0</u>		<u>\$ 105,600</u>		<u>\$ 0</u>
h. Total		<u>\$ 241,250</u>		<u>\$ 130,000</u>		<u>\$ 421,750</u>		<u>\$ 245,000</u>

8. Expected Sources of Funds for Program:

	<u>First Year - 1990-91</u>		<u>Full Operation - 1992-93</u>	
	Dollar Amount	% of Annual Expend.	Dollar Amount	% of Annual Expend.
a. State	\$ <u>0</u>	<u> </u>	\$ <u>0</u>	<u> </u>
b. Tuition	\$ <u>123,750</u>	<u>33 %</u>	\$ <u>272,250</u>	<u>41 %</u>
c. Federal	\$ <u>0</u>	<u> </u>	\$ <u>0</u>	<u> </u>
d. Endowment Income	\$ <u>125,000</u>	<u>34 %</u>	\$ <u>125,000</u>	<u>19 %</u>
e. Other	\$ <u>122,500</u>	<u>33 %</u>	\$ <u>269,500</u>	<u>40 %</u>
f. Total	\$ <u>371,250</u>	<u>100 %</u>	\$ <u>666,750</u>	<u>100 %</u>

9. Governing Board Preliminary Approval Date:

10. System Verification:

 Authorized Institution or System Signature Title Date

SECTION II

PROPOSED PROGRAM'S COMPLIANCE WITH MHECB GUIDELINES

1. Mission of the Proposing Institution

The introduction of an M.S. in Management of Technology program at the University of Minnesota is consonant with the University's overall mission to be on the forefront of undergraduate and graduate education and research and to be of service to the community. The program directly addresses the need outlined in the MSPAN report for more practitioner-oriented educational offerings.¹ The M.S. in Management of Technology program is targeted at practicing engineers and scientists from area industries. Its objective is to train these professionals for technological management positions and to prepare them and their organizations to compete effectively in an ever-intensifying international competitive environment.

2. Evidence of Institutional Readiness

The graduate program in Management of Technology will be based primarily on existing faculty. Since it is interdisciplinary in scope, it will be able to build on the strength of faculty from diverse disciplines at the Institute of Technology, the Carlson School of Management, the College of Liberal Arts, the Hubert H. Humphrey Institute and the Department of Agricultural and Applied Economics. In addition, the Sweatt/Honeywell endowed chairs in Technological Leadership will augment existing faculty and provide additional strength and resources, as well as leadership and direction, to the program. No additional physical facilities, except for the use of existing lecture rooms, are needed. Access to computational facilities and to existing library resources will be required.

Accreditation is not required since the M.S. in Management of Technology is a graduate program.

¹Higher Education Coordinating Board, Minnesota Post-Secondary Access and Needs Project, Phase I, February, 1989.

3. Cost of the Program

This program will not require the use of public tax funds or any other public resources. It will be financed entirely by endowment income, tuition and fees.

The program cost breakdown, as summarized in Section I.7 above, is as follows (note that the following figures include fringe benefits but do not include any overhead rate; an asterisk (*) denotes New):

I. <u>Implementation (1990-91)</u>	
a. Faculty:	
H.W. Sweatt Chair in Technological Leadership(*)	\$100,000
1 FTE reassigned faculty	100,000
b. Academic Professional:	
1 Program Coordinator(*)	35,000
c. Civil Service: 1 FTE reassigned secretary	
	30,000
1/2 FTE new secretary(*)	13,250
d. Equipment and Supplies etc. (*)	
	25,000
e. One-time costs: Office eqpt, promotional material(*)	
	20,000
f. Other: books, accommodations, meals etc.	
	<u>48,000</u>
g. Total program costs:	
	\$371,250
II. <u>Full Operation (1992-93)</u>	
a. Faculty:	
H.W. Sweatt Chair in Technological Leadership(*)	\$100,000
W.R. Sweatt Land Grant Chair in Tech. Leadership(*)	100,000
2 FTE reassigned faculty	200,000
b. Academic Professional:	
1 Program Coordinator(*)	40,000
c. Civil Service:	
1 1/2 FTE reassigned secretary	45,000
1 FTE new secretary(*)	21,150
d. Equipment and Supplies etc. (*)	
	55,000
e. Other: books, accommodations, meals etc.	
	<u>105,600</u>
e. Total Program costs:	
	\$666,750

Remark on program cost: These figures reflect a portion of the total cost of the operation of the Center for the Development of Technological Leadership allocated to this program.

4. Geographic Area Served by the Program

No other institution in Minnesota or in the upper Midwest offers a master's degree program in Management of Technology. The proposed program would be accessible to students within approximately a 200 mile radius of the Twin Cities. This area, in addition to the state of Minnesota, would include northern Iowa, western Wisconsin, and eastern North and South Dakota. Although the program is expected to serve this large area, the bulk of the student population would come from the St. Cloud to Rochester corridor.

5. Justification for Implementation of the Program

A. Need

A.1. Student Demand A compelling reason to initiate a graduate program in Management of Technology is to address the demand in Minnesota and across the nation for professionals who can more effectively capture the benefits of technological innovation. Industry reports an ever increasing need for technical personnel who have the ability to perform in a managerial capacity. Data collected from 46 Divisional Directors, Technical Directors, General Managers and Technology Managers at 19 Twin Cities corporations confirmed the need to strengthen the management of high technology. Those interviewed believe their managers need to improve their technology risk assessment and risk management, and that technologists need to improve their business comprehension and communication skills. Approximately 25-50% of the employees in divisions managed by those interviewed have a B.S. or above. Respondents indicated that the M.S. in Management of Technology would be recommended to about 10-20% of those degreed employees. Overall, this currently represents 550-700 potential students from twelve respondents and their companies.²

A.2. Employment Opportunities Employment opportunities for engineers and scientists with the ability to manage technical activities are impressive. In a study conducted by Dr. William LeBold of Purdue, data collected from 3350 engineers revealed that the actual work done by engineers over their careers included much more than design and production and requires more than technical expertise. Their actual work includes a great deal of managing and communicating - functions and

²Martha G. Russell & William T. Sackett, Report of Interviews with Executives of Technology-Based Companies, presented to the Board of Advisors, Center for the Development of Technological Leadership, University of Minnesota, 1988, Unpublished.

skills for which few engineers have training and which fall outside the concerns of most accreditation reviews. The data also reveal that the engineers, across all ages and stages of professional development, spend an average of 61% of their time in supervision, communications and management-related functions. The need for training in Management of Technology is clearly growing and will continue to grow in response to industry growth and demands. The ability to make productive technical contributions depends, at least in part, on an understanding of the business environment and on an ability to manage and lead others.³

B. Program Duplication

There are currently no identical or similar programs being offered in Minnesota. The Master of Science in Management of Technology will be a novel educational program in the area.

C. Existing Programs

As stated, there are no existing programs at the University of Minnesota or elsewhere in the state.

D. Placement Data

Due to the novelty of existing graduate programs in Management of Technology throughout the United States, there are no statistics available on placement. Nevertheless, It should be noted that this program will serve students who are employed full-time in their professions.

E. Current need

Graduate education in Management of Technology is a growing field that has been developed to address the United States' limitations in this area. The Twin Cities provide an important center for the development of technology and therefore, have a great need for a program that will provide technical professionals with expertise in this area. The need for training in this field has not been

³Martha G. Russell & William LeBold, Educating Engineers for Technology Business, University of Minnesota, 1989, Unpublished.

adequately met by the traditional graduate programs in science, engineering or management. It has become apparent in recent years that a program which is interdisciplinary in scope is the one most suitable to address the special needs of the potential student population. Because of its diversity, and the availability and support of eminently qualified faculty at its various collegiate units, the University of Minnesota is uniquely positioned to play a leading role in this effort.

SECTION III

THE PROPOSAL

A. Introduction

This document proposes the establishment of a Master of Science degree in Management of Technology at the University of Minnesota, Twin Cities. Management of technology has been targeted as a top national priority. In their joint report on engineering practice in the United States, the Committee on the Education and Utilization of the Engineer, the Commission on Engineering and Technical Systems, and the National Research Council recommend actions to be taken in this area.⁴ The Master of Science in Management of Technology, an interdisciplinary program, will directly address this priority by providing engineers and scientists with technological leadership capabilities. The program was developed because of the pressing need to provide such a development opportunity for technical professionals in the area.

The leadership of engineers and scientists requires unique skills. Industrial leaders have been expressing the opinion that the education and training of people who eventually become engineering supervisors and higher level technology leaders are not providing them with the appropriate skills for contemporary and future technological leadership. There is a strong sentiment that a severe shortage of persons with technological leadership skills is now facing United States industry.⁵ In addition to an inadequate background in economics and the fundamentals of management science, major deficiencies include poor communication skills; an insensitivity to the needs and motivations of highly trained and creative individuals, whose energies must often be harnessed in team efforts; an inability to place specific tasks and projects within a larger context, be it a corporate strategy or an international market; lack of a basic awareness of the historical and cultural influences that have shaped and now threaten many of the country's leading industries; and a fundamental lack of knowledge and understanding of the foreign cultures with which American industry does business and against which it competes.

⁴Committee on the Education and Utilization of the Engineer, Commission on Engineering and Technical Systems, and National Research Council, Engineering Education and Practice in the United States: Foundations of Our Techno-Economic Future, (Washington DC: National Academy Press) 1985.

⁵William F. Miller, Crafting and Coaching Intellectual Organizations, Monograph, Center for the Development of Technological Leadership, University of Minnesota, 1989.

The education of engineers and scientists -- those professionals who are expected to assume positions of leadership in technology-intensive industries -- has become increasingly specialized and narrow in its technical focus. This is in direct response to the growing complexity of modern science and engineering. As a result, those who are asked to assume positions of leadership are often poorly prepared for their new roles. The rather rigid requirements of their undergraduate programs have left little room for the broad educational experience that would foster and enhance leadership capabilities.

This is not a new problem. In the past few years, however, two factors have combined to heighten the consequences of our reluctance to address it. The first is the speed of technological change. The second is the intense international competition that has developed from countries such as Japan and Germany. These competitors have already demonstrated their superiority in deploying available technology in products and manufacturing processes. Effectiveness, creativity, and vision in the management of technology have never been more important for the United States.

The University of Minnesota has a broad and strong foundation upon which to develop the Master of Science in Management of Technology program. It is located in a major metropolitan region, with close ties to, and with enthusiastic and generous support from the local industrial community, which in many respects is a good microcosm of the national industrial community. The area also provides a significant number of professionals who could benefit from such a program. In addition, the program would have available to it a wealth of faculty and other resources from which to draw valuable expertise.

The M.S. in Management of Technology program will include courses appropriate to technical rather than general management. It includes such areas as finance and accounting, project management, and interpersonal communication, but it also emphasizes technical competency, while developing a sense of the strategic technologies that are changing research, design, and manufacturing environments. The program, because of its interdisciplinary nature, will require expertise from diverse disciplines at the Institute of Technology, the Curtis L. Carlson School of Management, the College of Liberal Arts, the Hubert H. Humphrey Institute and the Department of Agricultural and Applied Economics.

Planning activities for the M.S. in Management of Technology have involved individuals from various disciplines and from both the University faculty and industry. Similar programs around the country have been investigated and have provided much useful data in the planning process

(Appendix I). Planning has also been facilitated by research activities conducted in this area. An advisory committee was established to develop program curriculum requirements, and to obtain faculty assignments. Interviews with industry leaders and focus sessions were conducted to establish industry needs and how graduate education in this area could meet these needs.

The Master of Science in Management of Technology responds directly to the growing demand of industry and government for managers who can effectively manage new technological advances. The program will have a positive impact on Minnesota's economy as it strongly underpins the state's effort to maintain its position in the high-tech industry. In addition, as outlined in the MSPAN report, there is a current need for practitioner-oriented graduate programs in the Twin Cities area.⁶ The M.S. in Management of Technology will meet this need by providing a program that, through its contents and its delivery mode, will directly enhance one's professional performance. The program proposal has received enthusiastic support from both education and industry and promises to provide a much needed component in the career development of engineers and scientists.

⁶Higher Education Coordinating Board, Minnesota Post-Secondary Access and Needs Project, Phase I, February, 1989.

B. The Proposed Program

1. Program Objectives

The rationale behind the proposed program is the recognition within industry and academic circles that the traditional engineering curriculum falls short in preparing students for management roles in their professional career. Similarly, traditional MBA programs are general in scope and do not address the specific management development needs of those who have training and professional experience in technology and science.

This program aims, therefore, to train future leaders in technology management by:

- a. Designing a curriculum which addresses this specific need and is tailored to this specific audience.
- b. Careful selection of students who have demonstrated a potential to benefit from this program.
- c. Delivering the program in a mode designed to attract practicing technology professionals, while concurrently appealing to their employers and requiring their own continued commitment to participation in the program.
- d. Using the Honeywell endowed chairs to augment existing faculty in support of this program.

The Master of Science in Management of Technology will be interdisciplinary in scope in order to provide technical professionals with the desired development opportunities. Drawing on the expertise of various disciplines will ensure the delivery of the most suitable program to this specific student population. It is expected that graduates of this program would be equipped with the tools, the knowledge and the viewpoint to assume leadership roles in technology management positions.

2. Admission Requirements

The formal admission requirements are as follows:

- a. A bachelor's degree in engineering or physical science from an accredited program .
- b. A minimum of five years' professional experience in the student's technical field. In exceptional circumstances, promising candidates with less experience may be considered.
- c. Other stipulated general admissions requirements to the Graduate School of the University of Minnesota.
- d. Recommendations from the applicant's supervisors.

3. Delivery Mode

The Master of Science degree in Management of Technology program is aimed at practicing engineers or scientists who, through their talents and experience have achieved springboard positions in their organizations which will permit advancement into technology management positions with the proper additional training. It is unlikely that such individuals could be expected to leave their jobs for one or two years and attend a graduate program on a full-time basis. Although this has been successfully done to some degree at the Sloan School of Management at the Massachusetts Institute of Technology, it is not a model suitable for the University of Minnesota's environment.

Another delivery mode is based on the late-afternoon or evening program model. Although this has proven successful in a number of disciplines, it is believed that the aims of this program and the interests of the students in this program would be better served if the group of students in the program would advance as a cohort group. This would provide the students an opportunity to learn from each other's experience, to establish networks and to work as teams on course projects.

All the students would enter the program together and advance as a group, attending the same courses for a period of two years. During the six academic quarters, class meetings alternate between Friday one week and Saturday the following week, with one class given in the morning hours and the other in the afternoon. In addition, there are two 4-5 day residency periods during which additional courses or seminars are offered. These are held prior to the fall Quarter in each of the two years. Using this format, students would be away from their jobs for one day every other week, thus minimizing their absence from their regular duties. In addition, students would be committing every other Saturday of their own time to the program, thus further ensuring their continued interest and commitment to the program. This model has been followed with great success for many years in the Executive Program at the University of Chicago Graduate School of Business.

4. Curriculum

The Master of Science degree in Management of Technology is a two-year program of advanced study for students with undergraduate engineering or science education. It is intended for professionals with a minimum of five years of technical experience, who are currently employed in their respective technical fields, most likely in some first- or second-level management capacity,

and who are unable to take a leave from their duties in order to pursue a full-time program of study.

The objectives and rationale for this program have been discussed elsewhere in this document. It should be stressed however, that this program differs from the two-year MBA program in scope and emphasis, in background of students and in duration. It follows the so-called executive education format - all students proceed as a cohort group and take the same sequence of courses throughout the duration of the program. The course of study begins in the fall Quarter and extends over six successive academic quarters. Two 3 or 4 credit courses are given each quarter. In addition, one 3 or 4 credit course or seminar is being offered during each residency period. The courses offered according to this schedule would be attended exclusively by students in this program. All classes will be held in the same lecture room, which has been secured for this program. It is equipped with the necessary audio-visual equipment expected to be utilized in many of the classes.

During its initial implementation period, the curriculum will consist of a uniform set of courses which all students will be required to attend. It is expected, however, that as the program gains in size, three or four of the required courses may be replaced by a selection from an approved set of electives. This set may include subjects such as: Ethical & Legal Issues in Management; International Operations Management; Problems in Interpersonal Communications; Management of Information Systems etc. This will enable students to customize the program according to their own needs and interests. Since this program is planned as a cohort group, this will become feasible only if the number of students in the program will warrant the offering of courses with relatively low attendance.

All courses taught under this program are expected to be part of the regular teaching workload (in-load) of the teaching faculty, and not as an over-load. Proper arrangements will be made with the faculty's home departments.

In addition to the formal courses and seminars, each student is expected to complete a project. These projects could be related to the student's work responsibilities, or could be otherwise selected. Examples of project topics might be: examination of new product feasibility; issues in managing professional staff; strategy for developing new hi-tech industrial products; strategic management of new technological ventures in specific markets etc. Each such project will be under the supervision of a project advisory committee, composed of participating faculty and possibly some industry people. It will be pursued during the last two quarters of the program. Successful

completion of such a project and a formal presentation (oral examination) will constitute the satisfaction of the Plan B project requirement.

A. Degree Requirements

Total required credit hours: 52

6 credits are represented by the required Project.

46 credits are represented by the following required courses:

1. Communication in Human Organizations, 4 cr (Speech 5441)

This course is designed to increase students' understanding of organizations as political, rhetorical systems, constructed by and using communication at all levels. Organizations are addressed as open systems, as cultures, and as politicized environments, with attention to the identification and management of problems developing from the integration of organization and communication.

2. Managerial Accounting, 4 cr (IEOR 5020)

Basic accounting concepts; financial statements; analysis and control of current assets such as cash, receivables and inventory; cost analysis, standard costs for product costing; time value of money; qualification of risk and uncertainty; cost of capital and capital structure; capital budgeting under capital rationing; management and investment decisions.

3. Human Resources Management , 4 cr (MBA 8015)

Systematic approach to major phases of human resource management in organizations, including knowledge bases and theories, problems, constraints, opportunities, program control, evaluations and costs, and results of effective and efficient human resource management.

4. Technology and Development, 3 cr (Econ 5312)

Technical change and economic growth, sources of productivity change, economics of research and development, science and technology policy.

5. Financial Management, 4 cr (MBA 8040)

Analytical introduction to the theory and practice of finance. Application of basic financial concepts of risk, return and valuation to decisions that must be made about sources and uses of funds during conditions of changing financial markets.

6. Marketing of Technology-based Products, 4 cr (new course, Mktg 8xxx)

Understanding the environmental and competitive forces that affect the success of Technology-based products and services and the needs and wants of prospective buyers and users; collecting and analyzing information to develop a cohesive marketing program that considers the product, price, promotion and distribution elements to satisfy prospective buyers and users.

7. Strategic Technology Management, 4 cr (new course, Mgmt 8xxx)

Strategic planning and decision-making in technology management. General concepts, analytical tools, decision support systems, implementation. Liberal use of case studies.

8. Recent Advances in Technology, 3 cr (new course, IT 8xxx)

Review of current development trends in technology and their commercialization potential.

9. Project Management, 4 cr (IEOR 5703)

A broad practical understanding of project management team building; communicating with/motivating/managing team members; project requirements and planning; scheduling; budgeting; staffing; task and cost control; and microcomputer applications using "Timeline" and "MacProject" software.

10. Seminar in Technology Management, 4 cr (new course, IT 8xxx)

Interaction with senior executives from organizations in which technology plays a major role. Discussion and analysis of practices and case histories in Technology Management.

11. Manufacturing for Competitive Advantage, 4 cr (OMS 5700)

An examination of the competitive bases for manufacturing. Different aspects of manufacturing strategy, including capacity, facilities and technology are discussed using both lecture and case materials. Issues in international competitiveness are explored.

12. Quality Management and Reliability, 4 cr (IEOR 5030)

Philosophies, methodologies, and techniques associated with quality management and related improvement activities. Topics include quality strategy, economic models, quality management programs, quality and design, statistical process control, and reliability studies.

B. Course Schedule

Year 1

Residency Period 1

1. Communication in Human Organizations

Quarter 1 (fall)

1. Managerial Accounting
2. Human Resources Management

Quarter 2 (winter)

1. Technology and Development
2. Financial Management

Quarter 3 (spring)

1. Marketing of Technology-based Products
2. Quality Management and Reliability

Year 2

Residency Period 2

1. Recent Advances in Technology

Quarter 4 (fall)

1. Project Management
2. Seminar in Technology Management

Quarter 5 (winter)

1. Manufacturing for Competitive Advantages
2. Project

Quarter 6 (spring)

1. Strategic Technology Management
2. Project

C. Planning

Since during the implementation period all students will follow the same course schedule, faculty assignments, course scheduling and class sizes will be quite predictable, allowing for efficient planning. As enrollment in the program rises, elective courses will be offered on the same schedule

as the required courses. Since this will effectively lower the average class size, very careful pre-planning will have to be done.

5. Graduation Requirements

Graduation Requirements for a Master of Science in Management of Technology will follow those of the Graduate School of the University of Minnesota. Students pursuing a Master of Science in Management of Technology will follow Plan B, Master's Degree without thesis, of the Graduate School requirements. Students will be expected to complete Plan B Project(s) in addition to successfully completing all required courses. Students must demonstrate familiarity with the tools of research or scholarship in their field, the ability to work independently, and the ability to present the results of their investigation effectively, by completing at least one Plan B Project. Successful completion of the required courses will satisfy the matriculation requirements of the Graduate School .

The Plan B Project(s) should involve approximately 120 hours of work. The graduate faculty in the program specifies both the nature and extent of the options available to satisfy this requirement.

C. Educational and Social Need for the Program

1. Student Interest and Employment Prospects

Employment opportunities for engineers and scientists with the ability to manage technical activities are impressive. Industry reports an ever increasing need for technical personnel who have the ability to perform in a managerial capacity. Most technical personnel can anticipate facing some form of management responsibilities during their careers. Many companies have a dual career ladder after the 3rd or 4th level. Up to this branching point, technical skills and ability to communicate tend to be the most important factors in promotion to technical supervision. Beyond this point, producing results with teams, effective delegation and judgment are critical. Consequently, the demand for graduate programs that provide a special managerial perspective is growing as individuals find they are unable to progress professionally without this necessary expertise.

Other institutions offering graduate programs in Management of Technology confirm the market readiness for this type of experience. For example, the Management of Technology Program at the Massachusetts Institute of Technology, initiated in 1981, has enjoyed a growing reputation and a very high demand, despite its high price tag (tuition is \$28,200). Enrollment has grown considerably since the program was initiated - 20 students per year to currently 40 students per year. The program is sponsored and actively supported by a wide variety of national and international organizations. Corporate sponsorship of employees in the program has steadily increased as organizations have realized the benefits of the program. This fall, the National Technological University has started a Master's program in Management of Technology with a tuition cost of \$25,000. An enrollment of 31 was realized with the first class. Other universities, such as Pepperdine and Polytechnic have also announced the introduction of similar programs (Appendix I).

Data collected from 46 Divisional Directors, Technical Directors, General Managers and Technology Managers at 19 Twin Cities corporations confirmed the need corporations have to strengthen their management of high technology.⁷ Those interviewed believe their managers need to improve their technology risk assessment and risk management, and that technologists need to improve their business comprehension and communication skills. Approximately 25-50% of the

⁷Martha G. Russell & William T. Sackett, Report of Interviews with Executives of Technology-Based Companies, presented to the Board of Advisors, Center for the Development of Technological Leadership, University of Minnesota, 1988, Unpublished.

employees in divisions managed by those interviewed have a B.S. or above. Respondents indicated that the M.S. in Management of Technology would be recommended to about 10-20% of those degreed employees. Overall, this represents 550-700 potential students from 12 respondents and their companies.

The proposed program is designed to admit 25 students the first year, and 30 students in subsequent years. This number is constrained by optimal class size considerations. If demand warrants, class size will approximately double by the addition of a second group.

2. Educational, Research, Cultural, and Social Benefits

Objectives of engineering education have, for the most part, been based on the need to inculcate technical fundamentals - basic concepts for problem solving in design and production. The selection, endorsement and enforcement of these technical fundamentals have been standardized by the accreditation process. However, the actual work done by engineers over their careers includes much more than design and production and requires more than technical expertise. Their actual work includes a great deal of managing and communicating - functions and skills for which few engineers have training and which fall outside the concerns of most accreditation reviews.

In a study conducted by Dr. William LeBold of Purdue, an examination of cross-sectional surveys of engineers shows definite patterns in their functions and responsibilities across their careers. Surveys were returned from 3350 engineers drawn in 1985 from a national sample of engineers selected from professional society rosters and from over 50 technology-intensive companies. Responses indicated that engineers, across all ages and stages of professional development, spend an average of 61% of their time in supervision, communications and management-related functions. Furthermore, the percentage of time which engineers spend in non-technical activities tends to increase throughout their careers. The greatest increment in these added managerial responsibilities occurs in the first ten years. After ten years' experience over one third of all engineers reported spending at least 50% of their time performing management-related functions.

Engineers participating in the LeBold study were asked about their needs for continuing education and professional development. Approximately one half of these engineers perceive available on-the-job training and non-credit courses to be insufficient for their educational needs and over one third feel a need for graduate education. Those who reported a need for graduate education felt that the most pressing educational needs across all age groups were in the areas of business and management. Since the need for engineers will continue to grow over the next decades, high

demand for graduate education in Management of Technology should be expected to continue. The ability to make productive technical contributions depends, at least in part, on an understanding of the business environment and on an ability to manage and lead others.

Engineering education purports to prepare men and women for careers in engineering - very likely, careers in technology-based industries. The success of these new engineers will reside in their contributions to the productivity and profits of the companies which employ them. In other words, their engineering skills must be exercised so that their efforts enhance the business of those companies. This is especially difficult for engineers who lack an understanding of the realities of the business environment. Yet, many engineering curricula fail to acknowledge the critical importance of business fundamentals for the success of their graduates.⁸

A master's degree program in Management of Technology would directly address the needs of both the educational and corporate communities by providing those with technical backgrounds the ability to understand the business and management components of a business. In essence, much of the utilization and productivity of engineering professionals depends on skills in management, communications and interpersonal relations of other engineers. For the most part, these skills have been acquired through continuing education and professional development programs which have been offered on a rather ad hoc basis.

Research and development that is generated from a program in Management of Technology can be of critical importance to the Minnesota corporate community which, in turn, impacts national as well as international transactions. The University of Minnesota has built a strong relationship with area industries through its ability to provide them with supporting research and development opportunities. This relationship would only be enhanced by providing quality development for technical professionals.

Higher education has an important role to play in leading the educational innovations which will make new options available. A market clearly exists for practitioner-oriented graduate programs that provide students with the necessary tools for professional development.⁹ Academic leaders have an opportunity to respond through modifications in degree-oriented curricula, and through the design of new delivery structures for continuing and professional education programs.

⁸Martha G. Russell & William LeBold, Educating Engineers for Technology Business, University of Minnesota, 1989, Unpublished.

⁹Higher Education Coordinating Board, Minnesota Post-Secondary Access and Needs Project, Phase I, February, 1989.

D. Comparison with Similar Programs

There are no similar programs being offered at the University of Minnesota or at any other educational institution in Minnesota. Master's programs in Management of Technology are relatively new in American universities, and only a handful are currently being offered. Some of these have been mentioned elsewhere in this proposal and are documented in Appendix I.

There are a number of universities, such as Stanford, Northwestern, Michigan Technological University and University of Missouri at Rolla, for example, who offer Master's programs in Engineering Management. Depending on the particular case, the objectives, contents and/or delivery mode may bear some similarity to the proposed program at the University of Minnesota. However, the curriculum, admission requirements and the delivery mode of this program are targeted at the specific student audience defined for this program's market area.

E. Quality Control

1. Faculty Qualifications

The following are faculty members who have been active in program curriculum planning activities or who expressed strong interest in participating in program activities, either as instructors of program courses, members of the curriculum advisory and review committee or participants in project advisory committees. Additional faculty members from a number of departments have expressed their interest in participating in this program. At this writing, however, no definite commitments have yet been made with respect to the latter group. It should be noted that in order to maintain relevance and close contact with the students' organizations, it is intended that certain select number of people from industry, with proper credentials and qualifications, may serve on project advisory committees.

Carl R. Adams, Ph.D.

Professor and Chair, Department of Information and Decision Sciences, Curtis L. Carlson School of Management.

Research Interests: Problem-solving methodology; characteristics of cognitive processing in managerial problem solving; decision support processes; and clinical methods in management education.

Kevin J. Dooley, Ph.D.

Assistant Professor, Department of Mechanical Engineering, Industrial Engineering Division, Institute of Technology.

Research Interests: Quality management and control; applied statistics; fault diagnosis; expert systems; simulation of manufacturing systems; cellular manufacturing; scheduling.

Tarald O. Kvalseth, Ph.D.

Professor, Department of Mechanical Engineering; Head, Industrial Engineering Division, Institute of Technology.

Research Interests: Human factors engineering.

Dennis L. Polla, Ph.D.

Associate Professor, Department of Electrical Engineering, Institute of Technology.

Research Interests: Microsensors and microactuators with silicon VLSI technologies; CMOS integrated circuit processing technologies and planning of a new microelectronics fabrication facility; silicon-based integrated sensors and fabrication of solid-state microstructures; optical spectroscopy of semiconductors and new contactless semiconductor materials evaluation techniques; electrical and optical characterization and modeling of deep impurity levels and associate electronic processes.

James W. Ramsey, Ph.D.

Professor and Associate Head, Department of Mechanical Engineering, Institute of Technology.

Research Interests: Energy and the indoor environment; simulation of moisture movement and storage in buildings; performance of clean rooms; combined heat and mass transfer with phase change in porous media; air quality and moisture in buildings; variable speed drives for heat pump capacity; reciprocating compressor heat transfer; energy conservation by subsurface construction; solar heating and cooling.

William Rudelius, Ph.D.

Professor, Department of Marketing and Business Law, Curtis L. Carlson School of Management.

Research Interests: New product development; market segmentation; high-technology startups; innovation management; judgmental sales forecasting.

Vernon W. Ruttan, Ph.D.

Regents' Professor, Department of Agricultural and Applied Economics; Department of Economics, Hubert H. Humphrey Institute.

Research Interests: Economic development; technical change; research and development.

Gary D. Scudder, Ph.D.

Associate Professor, Department of Operations and Management Sciences; Director, Center for Research in Operations Management, Curtis L. Carlson School of Management.

Research Interests: Manufacturing scheduling; management of technology and innovation; scheduling, using net present value objectives; scheduling in cellular manufacturing; operations innovation; batch sizing for repair operations.

George L. Shapiro, Ph.D.

Professor, Department of Speech Communication, College of Liberal Arts.

Research Interests: Ethical leadership; leadership and followership; power and politics in organizations.

Yechiel Shulman, Sc.D.

William R. Sweatt Visiting Land Grant Chair in Technological Leadership; Visiting Professor, Department of Mechanical Engineering; Acting Director, Center for the Development of Technological Leadership.

Research Interests: Shell dynamics; pollution control; technology management.

2. Educational Development Activity

A Curriculum Advisory Committee, consisting of eight faculty members from the Institute of Technology, Carlson School of Management, College of Liberal Arts and Department of Agricultural and Applied Economics, plus two industry advisers, was appointed to recommend an appropriate curriculum for the Master's program in Management of Technology. The committee met numerous times and considered various approaches and proposals to satisfy the unique requirements of this program. The result of these deliberations is the curriculum presented in this proposal. It is recognized that as a new and evolving program, this curriculum will undergo modifications and changes. For this reason, it is proposed that a Program Curriculum Advisory & Review Committee be maintained as part of this proposed program. The makeup of this committee should be similar to the committee mentioned above.

3. Program Governance

The program will be governed according to the usual procedures for a graduate program in the Graduate School. Because of the interdisciplinary nature of this program, any curriculum changes will be voted on and approved by the program's graduate faculty prior to approvals by the Graduate School. The program will be offered under the auspices of the Center for Development of Technological Leadership and it is expected that the program faculty will be members in good standing of the Center.

4. External Accrediting and Certification Agencies

Since this is a graduate program, no external accreditation is required.

5. Systematic Review and Evaluation

Due to its novel nature, this program will be monitored, reviewed and evaluated on a continuing basis by the Program Advisory & Review Committee mentioned above. Similar to other Graduate programs, it will, of course, be subject to the standard review procedures of the Graduate School of the University of Minnesota.

F. Implementation

1. Time Schedule

Subject to approval by the University of Minnesota Board of Regents and the Minnesota Higher Education Coordinating Board, it is planned for the first group of students to attend the program starting in the fall Quarter, 1990. By fall 1992, the program is expected to be in full operation.

2. University Resources Required

This program will not require the use of additional tax funds or any other public resources. No state subsidy funding is expected, at least initially. However, all tuition income is considered as marginal revenue and will be retained by the University and accrue to the program. The program will be financed entirely by endowment income (\$2.5 million over five years endowed by the Honeywell Foundation, matched by PUF funds) and by tuition & fees. No additional physical facilities, except for the use of an existing lecture room for one full day per week, are needed. Access to computational facilities and existing library resources will be required.

(Note that the following figures include fringe benefits but do not include any overhead rate; costs are designated as new (*) or as reassigned costs.)

I. <u>Implementation (1990-91)</u>		
a. Faculty:		
H.W. Sweatt Chair in Technological Leadership(*)		\$100,000
1 FTE reassigned faculty		100,000
b. Academic Professional:		
1 Program Coordinator(*)		35,000
c. Civil Service: 1 FTE reassigned secretary		
1/2 FTE new secretary(*)		13,250
d. Equipment and Supplies etc. (*)		25,000
e. One-time costs: Office eqpt, promotional material(*)		20,000
f. Other: books, accommodations, meals etc.		<u>48,000</u>
g. Total program costs:		\$371,250

II. Full Operation (1992-93)

a. Faculty:	
H.W. Sweatt Chair in Technological Leadership(*)	\$100,000
W.R. Sweatt Land Grant Chair in Tech. Leadership(*)	100,000
2 FTE reassigned faculty	200,000
b. Academic Professional:	
1 Program Coordinator(*)	40,000
c. Civil Service:	
1 1/2 FTE reassigned secretary	45,000
1 FTE new secretary(*)	21,150
d. Equipment and Supplies etc.(*)	55,000
e. Other: books, accommodations, meals etc.	<u>105,600</u>
e. Total Program costs:	\$666,750

Remark on program cost: Part of these figures reflect that portion of the total cost of the operation of the Center for the Development of Technological Leadership allocated to this program.

3. Extra-University Resources

It is anticipated that a select number of people from industry, with proper credentials and qualifications, may serve on project advisory committees in the program.

APPENDIX I

Management of Technology Programs:

Massachusetts Institute of Technology

National Technological University

Pepperdine University

Polytechnic University

**The MIT
Management
of Technology
Program**

**Massachusetts
Institute
of Technology
1989 - 90**

**The School
of Management**

**The School
of Engineering**



Peter P. Gil

Director
MIT Management
of Technology Program

Massachusetts Institute of Technology
Department of Management
Science Center
77 Massachusetts Avenue
Cambridge, Massachusetts
02139



**The MIT
Management
of Technology
Program**

**June 12, 1989 to
June 4, 1990**

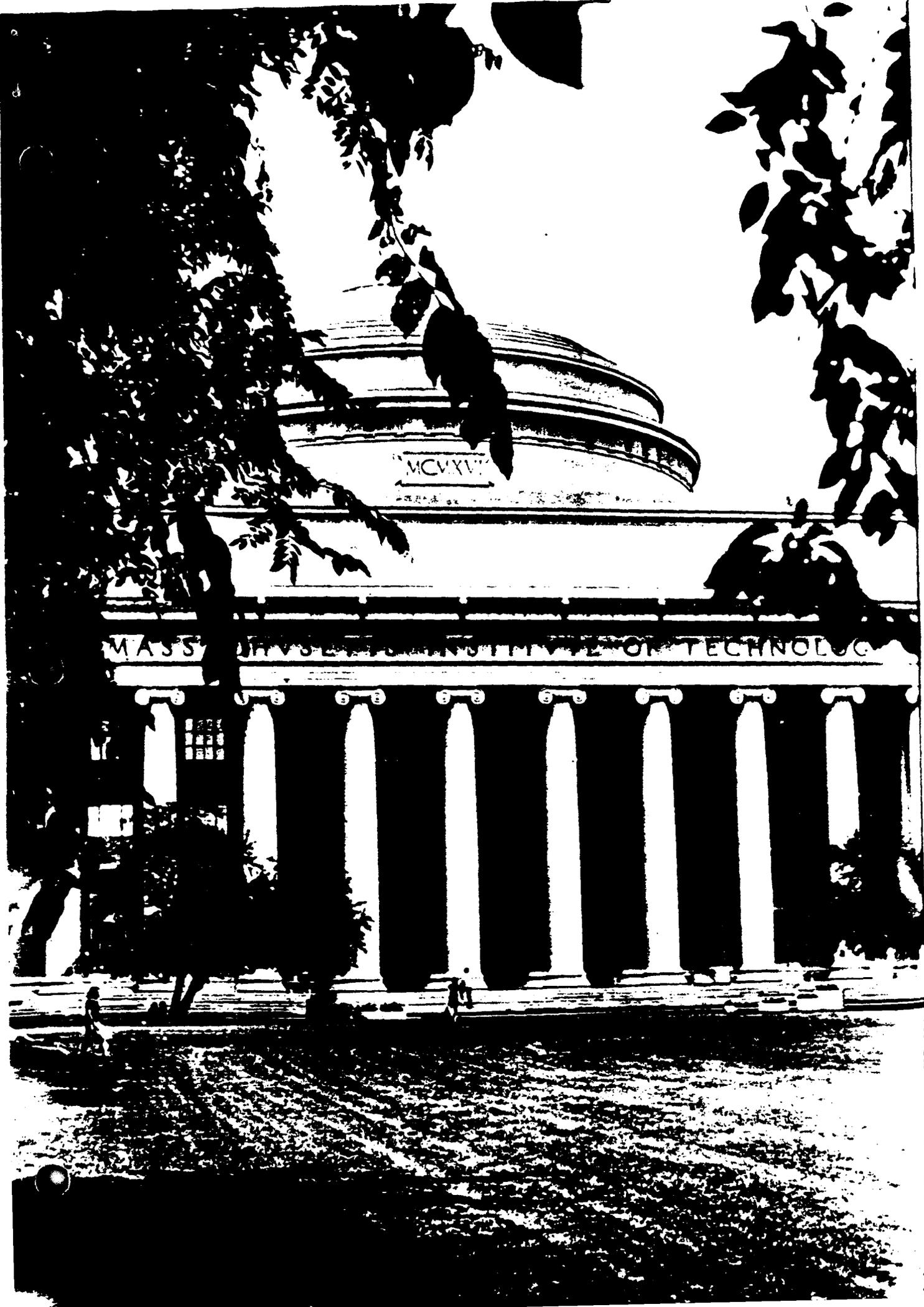
**The School
of Management**

**The School
of Engineering**

A twelve-month executive education program leading to the degree of Master of Science in the Management of Technology, aimed at meeting the growing, worldwide demand for managers who can help bring advances in technology to the marketplace in the form of new products and manufacturing processes.

Designed for men and women with engineering or science backgrounds – and five to ten years of technical work experience – who wish to learn to understand, develop and manage both the new and the established technological resources of public and private organizations in a global economy of rapid change.

Offered jointly by the MIT Schools of Engineering and Management, this is the nation's first advanced degree program focusing directly on the management of technology.



MCMXXV

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The MIT Management of Technology Program



Background

Increasingly competitive international markets have turned the world's attention to technology as a source of new products and improved manufacturing productivity. Questions of managing technological innovation, capturing its benefits, and incorporating technological change into company strategy have taken on increased importance in both the firm and the economy. Faculty at MIT have been researching the area of the management of engineering, of R&D and of technological innovation for 25 years in active, ongoing research programs. For example, current research projects include analysis of R&D project structure and performance, the study of product-line strategies of small high-technology firms, work on international technology transfer, research on micro-innovation, the examination of communication patterns among software engineers, and assessment of lead users in the innovation process and how innovators capture the economic benefits of their efforts.

Precisely this need for a unique combination of technical and management abilities led to the creation of the Management of Technology Program at MIT. The curriculum was developed from the significant body of research available through MIT faculty and was designed expressly for scientists and engineers who have been in the field for at least five to ten years, anticipating increasing managerial responsibilities on the technical side of the organization.

Purpose

The Management of Technology Program is an executive education program responding directly to the growing, worldwide demand of industry and government for managers who can help bring advances in technology to the marketplace in the form of new products and manufacturing processes. In order to cope successfully with the accelerating pace of technological change, today's leaders of technical functions and organizations increasingly require a special managerial perspective, one that was not being addressed comprehensively by educational institutions. To manage effectively, these individuals need more than an in-depth scientific or engineering education and on-the-job experience. They also must possess substantial managerial knowledge in planning and controlling technical and scientific projects, directing engineering design and product quality, inspiring and developing professional technical employees, and integrating with the marketing and manufacturing functions of the organization. They require a different education than the general-management, MBA-type of program can offer.

MIT's Management of Technology Program is the nation's first advanced degree program focusing directly on the management of technology. Initiated in 1981, it is conducted jointly by the School of Management and the School of Engineering. The Program leads to a Master of Science degree in the Management of Technology after 12 months of full-time study.

Structure

Beginning in June of each year, Management of Technology Program students undertake a rigorous curriculum developed and taught by faculty from both the School of Management and the School of Engineering.

The Program is designed around three major, integrated elements:

Core, background subjects in analytical methods drawn from the disciplines of engineering, statistics, mathematics, economics and the behavioral sciences.

Analysis of the theories, concepts and practice of managing technology-based programs and projects; technology-based organizations; and technical professionals.

An original thesis, under faculty consultation, in the area of technology management.

All three elements are offered within the academic framework of formal studies of the continuously changing economic, technical and social environment, in a highly competitive global market.

Sponsoring Organizations

The following organizations have sponsored participants to the Management of Technology Program:

Advanced Energy Technology
Argentine Navy
AT&T
Bell Communications Research
Bell Northern Research
BellSouth Corporation
Boeing Aerospace Company
British Petroleum Company
Carpenter Technology Corporation
Center for Measurement Standards, Taiwan
Charles Stark Draper Laboratory
China Steel Corp.
Civil Aviation Administration, Spain
Dainippon Ink & Chemicals
Data General Corporation
Det Norske Veritas, Norway
Digital Equipment Corporation
Eastman Kodak Company
Electric Power Research Institute
Eli Lilly, Physio Control Corporation
Ellemtel Utvecklings AB, Sweden
Fuji-Xerox Co. Ltd.
GEC Hirst Research Limited, U.K.
General Motors Corporation
Hazama-Gumi, Ltd.
Hewlett-Packard Corp.
Hitachi, Ltd., Japan
IBM Corporation
Ingersoll Milling Machine Company
Instrumentos Cientificos CG, Brazil
Johnson & Johnson Products, Inc.
Nippon Zeon Co., Ltd., Japan
People's Republic of China
Pilkington Brothers Limited, U.K.
RCA Corporation
Rhone Poulenc, France
Richard O. Custer S.A.
Sanders Associates, Inc.
Schlumberger, Netherlands
Schlumberger Well Services
Shimizu Construction Company, Limited, Japan
Singapore Institute of Standards & Industrial Research
Telecom Authority of Singapore
Temple, Barker, & Sloane, Inc.
The Mitsubishi Bank, Ltd., Japan
Toyo Engineering Corp.
United States Air Force
United States Army
United States Information Agency – Voice of America
United States Navy
Vitro Capital Goods
Weyerhaeuser Company
Yoshitomi Pharmaceuticals, Japan





The MIT School of Management



Lester C. Thurow
Dean, School of Management



Alan F. White
Associate Dean for Executive Education

The School of Management, founded at MIT in 1952 as the School of Industrial Management, is the outgrowth of a pioneering curriculum combining management and engineering education that was first organized at the Institute in 1914. The gift of Alfred P. Sloan, Jr. in 1952 led to the establishment of a new level and a new scope in management education at MIT.

There are three Executive Education Programs at the School of Management: the MIT Sloan Fellows Program, a twelve-month master's degree program designed to broaden typically specialized mid-career executives for more general management responsibilities; the MIT Program for Senior Executives, a two-month program for senior members of management; and the MIT Management of Technology Program, which is jointly offered with the School of Engineering and leads to the degree of Master of Science in the Management of Technology. The latter program is intended for experienced scientists and engineers who are advancing within the technical side of their organizations into increasing but primarily functional management responsibilities. In addition, the School has developed an extensive program of special one- and two-week summer courses designed primarily to meet the needs of its alumni and alumnae and other practicing professionals.

The School of Management offers an undergraduate course leading to the degree of Bachelor of Science in Management; a master's program leading to the degree of Master of Science in Management; and a doctoral program leading to the degree of Doctor of Philosophy.

In all its efforts the School is committed to educating men and women who have the will to manage and to risk, who can deal with complex systems, who have insight into themselves as well as others, who are interested in the total environment in which they live, and who continue to learn. The School seeks to provide students with a solid grounding in the academic disciplines relevant to management—economics, mathematics, and the behavioral sciences—and to develop their awareness of the multiple facets that characterize important management problems, from technical data to human and environmental factors. In the conduct of research to produce new understanding and better solutions to management problems, and to communicate research findings to an increasingly broad audience, the School complements its educational programs. Our research and educational goals are mutually reinforcing, and we are confident of their continued impact on the fields of management and management education.

The School of Management is under the leadership of Dean Lester C. Thurow.

The Executive Education Programs are part of the School's regular teaching program and are under the direction of Alan F. White, Associate Dean for Executive Education.

In all its academic programs the resources of the School of Management are supplemented by those of the Departments of Economics and Political Science in the School of Humanities and Social Science.



The MIT School of Engineering



Gerald L. Wilson
Dean, School of Engineering



The MIT School of Engineering is organized into eight broad academic departments: Aeronautics and Astronautics, Chemical Engineering, Civil Engineering, Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Ocean Engineering. Each department has its own Department Head, reporting directly to the Dean of the Engineering School, Gerald L. Wilson.

The primary objectives of the School are to educate men and women so they can become leaders in industry, government, and educational institutions; to advance the knowledge base of the engineering professions; and to influence the future directions of engineering education and practice. The educational programs in the School emphasize understanding of fundamental principles; facility with experimental, computational, and analytical methods; development of skill in the creative processes of engineering such as design; and the development of a self-confidence and a versatility of mind which prepare the individual for a lifetime of learning and professional growth.

The academic departments in the School provide the primary homes for faculty, students, and degree programs and provide continuity and stability for the basic engineering disciplines.

However, the departments increasingly share common interests in the broad areas of application to which their individual disciplines and technologies apply. The approximately 35 interdepartmental centers, laboratories, and programs in which the School is involved provide the mechanisms and facilities for faculty and students to undertake collaborative research and engage in educational programs dealing with major interdisciplinary applications of importance to society.

The School of Engineering offers formal graduate degree programs in both the departmental areas and a number of interdepartmental areas including: Biomedical Engineering, Environmental Studies, Instrumentation, Operations Research, Materials, Mineral Resources Engineering, and Management of Technology. In addition, numerous other interdepartmental opportunities exist at both the undergraduate and graduate levels. Undergraduate degrees are awarded by the departments of the School but can embrace several interdepartmental fields as well.

In addition, the School also offers an extensive program in continuing education through the Center for Advanced Engineering Study. Its goal is to improve the technical capabilities and effectiveness of practicing engineers. Priority is given to advancing the arts and sciences of applications, rather than to remedial instruction.



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Student Profile and Career Focus

Student Profile, Class of 1988

Age:	Median	34
Years of Experience:	Median	9
Education:	Bachelor	26
	Master	10
	Ph D	2
	Diplome	2
	M.D.	1
Total Students:		29
International Students:	Canada, France, Israel, Japan, Mexico, Peoples Repub. of China, Peru, Repub of China (Taiwan), Switzerland	
Examples of Positions Held Prior to Entering Program:	Chief Flight Systems Engineer; Project Manager, R&D; Manager - Electronic Design; Division Manager - Engineering; Head of Development; Engineering Systems Analyst; Superintendent, Aluminum Foil Mill Division; Vice-President of Technology and Development; Planner & Designer of Electrical Installations; Technical Asst. to the Laboratory Director; Senior Software Engineer; Assistant Manager, Civil Engineering Department; Director, Office Systems Applications; Senior Scientist	
University Background:	Applied Chemistry; Architecture and Civil Engineering; Chemistry; Computer Science; Control Engineering; Economics; Engineering (Electronic, Electrical, Industrial, Mechanical, Metallurgical); Medicine M.D.; Material Science; Management Science; Physics; Operations Research; Zoology.	

The Management of Technology Program is intended for experienced engineers and scientists on a career path requiring increasing responsibility for managing technical and scientific activities in technology-based organizations. Its purpose is to provide these individuals with essential management skills and understanding as they progress further into the creation, planning, and control of technical projects and organizations.

Accordingly, the Program's most direct benefits are for individuals who plan for the near future to remain on the technical side of the organization, rather than moving immediately into general management positions. It is expressly structured to prepare them for more senior roles in functional management, where they will be able to both generate and manage technology-based endeavors.

The Program requires that all applicants must have at least five years of full-time work experience prior to enrollment. There is a natural progression in a technical professional's career development that may lead to his or her advancement into a management role. Yet, that progression takes time. The technologically based organization wants to see an individual's significant progress as a technical performer before granting him or her increasing management responsibility. The individual scientist or engineer, as well, requires significant work experience to fully appreciate the career options available and make the informed decision that he or she prefers to follow the management route.

Consequently, the Program is designed for the individual who can draw upon that wealth of experience in the classroom, share issues and concerns with his or her colleagues, and bring to the table a knowledge that only on-the-job experience can provide. Not surprisingly, though Program admission requires a minimum of five years' experience, many attendees have ten or more years of technology-related work and have gained substantial management responsibility prior to enrolling. For example, sponsoring companies have sent individuals with titles such as Technical Director, General Manager for the R&D Center, and Manager of Program Operations, as well as providing younger candidates such as Group Leader, Project Engineer, and Senior Physicist.

The Program welcomes applications from company- and governmentally sponsored persons as well as self-sponsored candidates. Perhaps understandably, the student body has become increasingly a sponsored one as additional companies and government agencies each year realize the benefits of the Management of Technology Program as a key development tool. Students have come from a wide variety of industries, including electronics, chemical, aerospace, automotives, biomedical, energy, plus the military and other government organizations. An international institute, MIT also attracts students from around the world.



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The Curriculum

Because it focuses on the fundamentals of technology management decision-making, the Program provides an academic as well as an applied state-of-the art orientation. The Program curriculum consists of a carefully balanced mixture of formal course work by engineering and management faculty plus formal and informal seminars with senior practitioners responsible for the technical resources and technology strategy of their organizations. The year is divided into three seasonal terms, Summer, Fall, and Spring.

Summer

The Summer Term is an extremely intensive term devoted primarily to the core of subjects in basic underlying disciplines that provide a background in general management principles and analytic methods, similar in content to those core courses usually offered in the first year of any MBA-type of program. However, the orientation of the faculty and the background experience and goals of the Management of Technology Program students combine to make the Summer experience a critical underpinning of the entire year.

Applied Micro- and Macroeconomics

Intermediate level in micro- and macroeconomics, with emphasis on applications to managerial decision-making. Microeconomics portion focuses on cost and demand analysis, market structure and industrial performance, design of pricing strategies and effects of government regulation. Macroeconomics portion focuses on the measurement, forecasting, and interpretation of aggregate economic variables, how those variables are affected by government policies, and the implications for management. S. Maital.

Decision Support Systems II

Introduction to probability and statistical data analysis with emphasis on applications in management. Topics: basic probability, sampling and data collection, exploratory data analysis, inference and diagnostics for linear regression models, statistical computing and simulation. A. Drake.

Financial and Management Accounting

Basic concepts that underlie the collection, processing, and reporting of financial information in business. Emphasis on the understanding and use of corporate financial statements and internal financial data as a basis for decision-making. R. Olive.

Engineering Systems Analysis

Synthesis of analytic procedures for identification and selection of optimal systems. Review of economic framework for analysis. Systematic survey of theory and application of mathematical optimization to engineering problems. Evaluation procedures for single and multi-attribute problems covering utility theory and decision analysis in addition to standard procedures. Application of this material to real problems in planning and design stressed throughout term. R. de Neufville, J.P. Clark.

Managing Professionals

Examines human side of management through application of behavioral science research findings. Topics: supervising/motivating professional employees; career orientations; effective conflict management; group creativity/decision making; managing product teams; group aging; critical roles for innovation; organizational structure/communication. Emphasizes professional individuals and groups. R. Katz.

Seminar and Workshop in Computer Systems

A seminar and workshop concentrating on the following topics: overview of information systems for management; introduction to spreadsheet modeling and to data base management; PC workshop. MIT Faculty.

Seminar in Communication for Managers

Focuses on effective writing & speaking skills in a management environment. Reviews important communication concepts, analyzes a variety of communication situations, and helps students develop communications strategies and techniques. J. Yates.

Fall

The R&D Process: Communication and Problem Solving

Introduces sociology of science and technology, emphasizing similarities and differences between the two activities. Basic problem-solving processes in R&D. Presents research finding of intra- and inter-organizational technology flows. Role of interpersonal, organization, and architectural factors in affecting communication of technical information. T. Allen.

Market/Technology Interface

Market inputs to product research, design and development. Market research techniques for new product development in both consumer and industrial areas. User role as source of innovation in industrial goods. Marketing of advanced technology products and systems. E. von Hippel.

Marketing Management

The object of this course is to build an understanding of the marketing function and how it relates to the management of technology. We study the strategic implications of marketing and show how they relate to the benefits that products and the "marketing mix" deliver. We study how to obtain the voice of the customer and to use that voice in product design. Advertising, promotion, salesforce, pricing, and distribution assure that the customer knows about our products and services, understands them, and can obtain them. J.R. Hauser.

Strategic Management

Examines the entire field of strategic management including the general management tradition, the use of various analytical and conceptual tools for strategic planning and the employment of internal structure and support systems for the implementation of strategic decisions. This course uses case studies, books, articles and outside speakers. M. Horwitch.

Business Implications of Advanced Technologies

To establish a dialogue between managers and scientists about advanced technological development, in order to familiarize students with: Leading-edge research conducted in a wide variety of fields at MIT; how current research will impact the commercialization of new products and processes in the not-too-distant future; how firms active in advanced technology development can benefit from university interaction; the unique managerial challenges in commercializing advanced technologies; the study of international differences in developing and commercializing advanced technologies. T.H. Lee and M.A. Rappa and Guest Speakers.

Seminar in Management of Technology

Complements classroom work and provides opportunities to discuss current practices in the Management of Technology. Weekly sessions include about two hours of informal discussion with senior executives from organizations where technology is of paramount importance. This is followed by a dinner where discussion continues. The following executives from industry and government participated in this seminar: P. Gil

Eric E. Abell

Director of Engineering – Advanced Tactical Fighter
Aeronautical Systems Division, USAF

Michael J. Cronin

President and CEO, Automatrix, Inc.

Kenneth G. Ingram

Director of Network Architecture and Technology Planning, AT&T

Thomas J. Lindem

Vice President of Technology
The Ingersoll Milling Machine Company

Paul R. Low

President, General Products Division
IBM Corporation

Marty Matsuo

General Manager, Technology and Projects
Nippon Zeon of America, Inc.

John F. Pilat

Staff Consultant, Data General Corp.

Richard K. Snelling

Executive Vice President – Network
Southern Bell Telephone and Telegraph Co.

Daniel M. Viccione

Technology Programs Manager
Naval Underwater Systems Center,
US Navy

The January Field Trip

An important required and integral part of the curriculum is the opportunity offered to correlate classroom work with field work and observation throughout the entire year. Almost all contacts with industry, government, and other senior executive officers are off-the-record informal question and answer sessions.

No trips, visits, or meetings are scheduled without carefully preparing the general lines of inquiry to be pursued and the relevant issues and major areas to be covered. All trips, visits, and meetings are reviewed in debriefing sessions after the event.

The January Field Trip will take place in Washington, DC from January 30, 1989 to February 3, 1989. Students will meet with senior members of all three branches of the Federal Government for off-the-record discussions about the national and international impact on science and technology by current and proposed government action. Meetings will range from broad background briefings (*An Overview of the Scientific Community and Decision-Making in the Federal Government*) to more specific topics, e.g.: *Science, Technology, and International Telecommunications*. Meetings with Frank Press, President of the National Academy of Sciences, will include *Developing an International Framework for Science and Technology Policy: Issues, Elements, Strategies*. Meetings have been arranged for the Management of Technology Program with and by The Brookings Institution.

While in Washington the group will also meet with senior executives of the Martin Marietta Corporation in nearby Bethesda, Maryland, to discuss the management of technological innovation and manufacturing systems in practice, as part of meetings with senior managers of technology throughout the fall and spring.

Electives

In addition to the required courses, Program students enroll in at least three elective courses during the year. Students have combined considerations of their own special interests with the tight Program schedule in choosing electives from some field of advanced managerial or technical study. Electives in the areas of political science and humanities have also been chosen on occasion. Popular elective choices over the years have included some of the following courses: Japanese Technology Management; International Business Management; Development Process for Products and Manufacturing; Financial Management; International Technology Transfer; Principles of Management Information Systems; Management Information Technology; The American Legal System; Power & Negotiation; System Dynamics for Business Policy; New Enterprises; Planning & Control Systems; The Operating Manager; Seminar in Operations Management; Strategic Management; Advanced Topics in Mechanical Engineering.



JoAnne Yates, Ph.D., Senior Lecturer
Coordinator, Sloan Communication Program



George R. Heaton, Jr., J.D.

Spring

Manufacturing/ Technology Interface

Focus on the management of process innovations. Economic and other influences on manufacturing process change. Interactions between research, development, and engineering activities and manufacturing operations. Transfer of new product developments into manufacturing. J. Utterback.

Corporate Strategies for Managing Research, Development and Engineering

Strategic issues in managing research, development, and engineering. Seminar focus changes each year; previous topics have included management of corporate research laboratories, new venture organizations, and integration of RD&E into corporate strategy. Lecture sessions by faculty and by invited speakers from government and industry. Independent study, and preparation of reports by individual students or teams of students. E. Roberts.

Government and the Management of Technology

The role of government in shaping the management of technology in the civilian sector of the economy. Rationales, processes, and mechanisms of government involvement; promotion and regulation of technological development, and industrial policy in the U.S. and other countries. Case studies are used to illustrate these themes. D. Nyhart, G. Heaton.

Cases and Issues in Engineering Management

Engineering and business management case studies illustrate product strategy, R&D planning, technology assessment and transfer, and project management. Current issues in advanced technologies: dynamics of technology life cycle; total quality control systems; computer integrated manufacturing; and joint venture issues between East and West. T. Lee.

Cross-Registration with Harvard University

MIT and Harvard students enjoy cross-registration privileges in any field provided prerequisites, faculty approval and schedules permit.

The Thesis

All Master's degree candidates at MIT are required to submit a thesis as part of the requirements for the degree. Program participants are encouraged to integrate these studies with ongoing MIT research in the management of technology. Organizations that are sponsoring students in the Program find the thesis a golden opportunity to have their participants study in depth and detail some ongoing question or concern of prime importance to the organization, and sponsored students are encouraged to coordinate their thesis research with organizational projects.

Thesis research is completed and the thesis written during the Spring semester, to be handed in before the end of the Spring term. However, Program students must choose their thesis topic and faculty supervisor in the Fall semester, organizing their thesis research and submitting a formal Thesis Proposal, signed by their supervisor, prior to the end of the Fall term. The bulk of the thesis research must necessarily be completed by the end of January, MIT's Independent Activities Period. (There are no formal classes scheduled in January.) The Program faculty and staff provide guidance concerning topics and potential supervisors; however, the thesis provides an opportunity for the individual to study in significant depth some topic or concern of particular interest to the student. Topics have been chosen by past Program attendees in a wide variety of areas. For example, a list of thesis titles from the 1987-88 class includes:

"The Strategic Management of Telecommunications Technology in Developing Countries."

"Successful New Product Strategy for Instrumentation Companies."

"An Evaluation of Technology Transfer in the Electric Utility Industry."

"An Empirical Study of Some Factors Related to the Performance of Professionals in a Technological Environment."

"An Option Pricing Model for R&D Projects."

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"Usage and Motivations of a Large Electronic Bulletin Board System."

"Technology Strategy Formulation Within the U.S. Defense Industry."

"Technology Strategy of the Color Hard-Copy Industry."

"Development of a Business Plan for a Recombinant DNA Technology Based Pharmaceutical Company."

"Attitudes of Telecommunications Executives About Information Technology."

"Technology and Strategy in the Development of the Office Automation Industry."

"The Business of Technology Intelligence: An Investigation of the Formation and Management of External Technology-Based Linkages."

"Business Development Plan for Varian Associates' Direction Finding Receiver Product Line."

"Biotechnology: Engineering the Strategic Alliance."

"Corporate Renewal and Growth in Major Technology-Based Companies: The Role of New Business Development."

"The Management of Long Term Research and Development Efforts: Display Holography at Polaroid Corporation."

"Changes in the Japanese Model for Government Subsidized Collaborative R&D in the Semiconductor Industry."

"Strategic Positioning for a Revitalized Vaccine Industry."

"Assessment of the Commercial Opportunity of a New Therapeutic Approach to Replacement of Damaged Human Tissues."

"The Application of a Job Longevity Model to Technical Professional Groups."

"Project Performance as a Function of Subsystem Interdependence for Multi-Site Projects."

"A Comparison of the Corporate Strategies of U.S. and Japanese Engineering and Construction Companies."

"Technical Competitive Advantage: A Study in the Engineering Services Industry."

"The Negotiations Process Within a Matrix Management Structure: A Case Study of a Department of Defense Engineering Organization."

"Technological Discontinuities: The Emergence of Fiber Optics."

"A Technology Strategy Model for Telecommunications: A Case Study of International Business Machines Corporation."





Eligibility, Admissions, and Application Procedure



The MIT Management of Technology Program term begins in June of each year only. Candidates for admission to the Program should meet the following requirements: an undergraduate technical degree; a minimum of five to ten years' experience in industry or government in areas related to technology; completion of a year's work in calculus and in economics. (If these subjects have not been completed in an undergraduate program, they should be covered by formal courses prior to enrollment.)

Students are selected for admission by a Faculty Program Admissions Committee based on its evaluation of an applicant's previous work experience, academic record, and overall qualifications, including employer recommendations. Applicants are sought who show strong motivation and promise of future career advancement in technology management. The Program Office seeks registration for each enrollee through the School of Management. All enrollees follow the same curriculum and earn the same degree, an M.S. in the Management of Technology.

All applicants must submit scores from the Graduate Management Admissions Test (GMAT) with their application and should plan to take the October or January test to meet our application deadline. The GMAT is given several times a year at centers throughout the world, and one must register at least a month in advance. For information on this test, contact the Management of Technology Program Office or write to the Educational Testing Service, Princeton, New Jersey 08540, USA (609-921-9000).

Applicants from non-English-speaking nations must demonstrate proficiency in both oral and written English by taking the Test of English as a Foreign Language (TOEFL). For information about the TOEFL, contact: TOEFL, Educational Testing Service, Princeton, New Jersey 08540 (609-921-9000). A minimum score of 575 is required for visa certification by MIT.

Applications for admission must be submitted to the Program Office by February 19 of each year for admission in June of that year. Applications received after this date will be considered on a space-available basis only. The application form, available only through the Management of Technology Program Office, requires an essay by the applicant describing why the Program is particularly appropriate at this point in his or her career. The application also requires the applicant to submit at least three letters of recommendation, preferably from the applicant's supervisors at his or her place of employment. All transcripts from previous college work must also be included.

For further information, please contact:

Dr. Peter P. Gil, Director (Acting)
Management of Technology Program
Room E52-125
Massachusetts Institute of Technology
50 Memorial Drive
Cambridge, Massachusetts 02139
(617-253-3733)

Jennifer A. Mapes
Coordinator, Management of
Technology Program
(617) 253-3733



Tuition and Costs



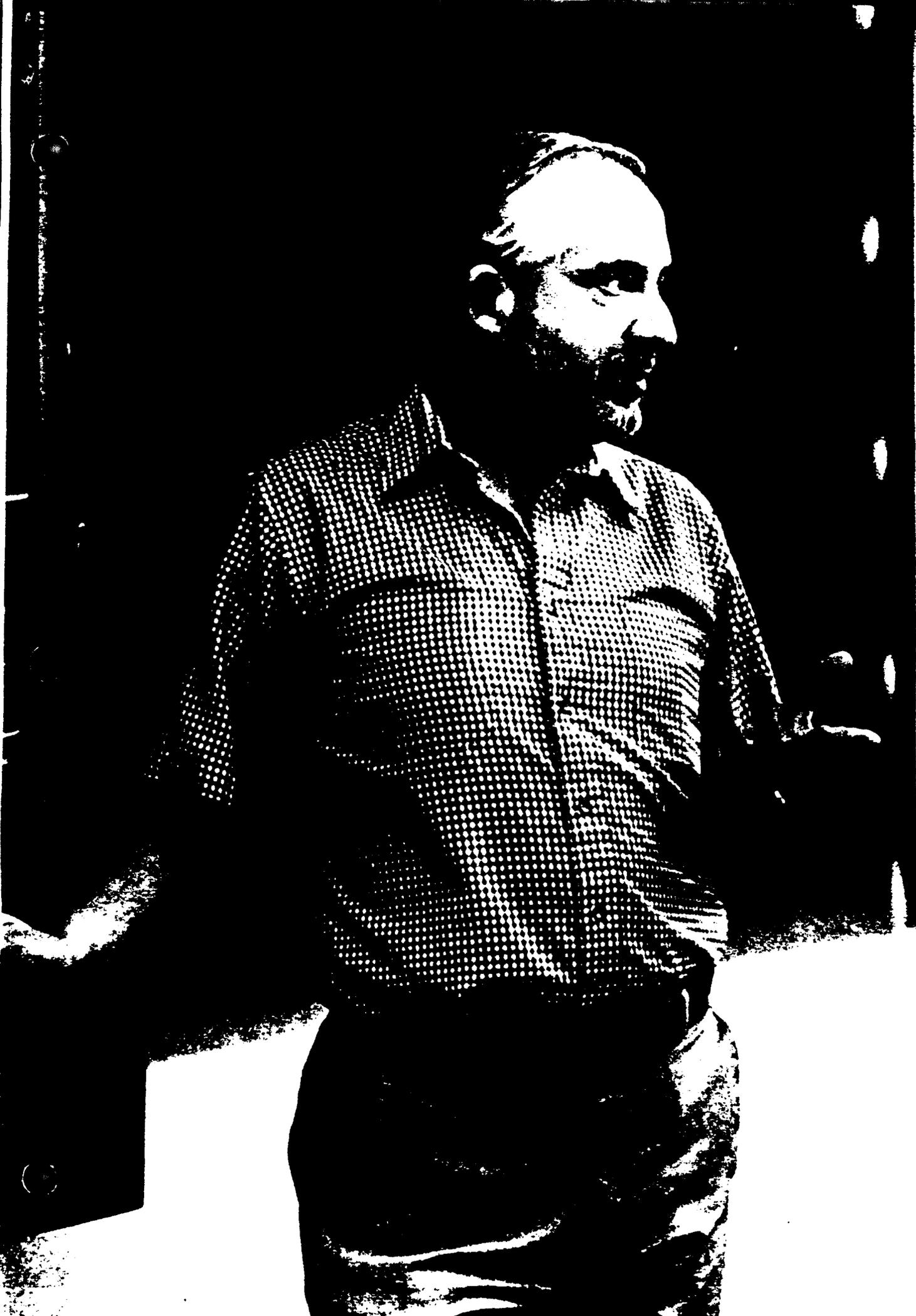
Tuition for 1989-90 is \$28,200. The cost of books and personal items should be estimated individually. Accommodations and transportation expenses for field trips are not included.

Living expenses for one year in the Boston area depend heavily on the needs, lifestyle, and the family size of each individual student. As a figure to work from, a single adult may be able to live for as low as \$20,000 per year. A few students find living on campus is both convenient and cost-effective. MIT's Student Housing Office (617-253-5148) can provide information on campus housing for single or married graduate students. Most students prefer living off-campus in apartments or houses in the Boston/Cambridge area or in the suburbs. Rental prices and quality of housing vary widely from community to community, so one should contact a real estate agent to help with the search. If a visit to MIT is being planned, schedule a stop at MIT's Off-Campus Housing Office, in Building E18, Room 301, for information on available housing for prospective students.



Many of the apartments and houses being lived in by current Program students become available for members of the incoming class. The Program Office will send out a list and description of these to all admitted candidates in April, and prospective students are welcome to contact the current class directly. However, there is nothing that can substitute for a trip to Boston a month or two prior to June enrollment, and we recommend every incoming student make arrangements to take a couple of days in Boston to look for housing. There is no time for house hunting once the Summer term begins.

The MIT Program has no fellowship funds available, nor does it offer any teaching or research assistantships. However, students who are U.S. citizens or permanent residents are eligible for Federal Guaranteed Student Loans (GSLs), generally available through banks. Questions concerning the GSL should be directed to: MIT Student Financial Aid Office, Room 5-119, MIT, Cambridge, MA 02139 (617-253-4971).



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Principal Teaching Faculty

Alvin W. Drake, Sc.D. (left)

Applied probability; operations research applications in the public sector; decision and risk-benefit analysis; probability and risk assessment; donor motivation and system organization for blood, organ, and tissue banking.



Edward B. Roberts, Ph.D.

Faculty Chairman

Management of Technology Program

RD&E management and technological innovation; corporate and social systems dynamics; new enterprises and venture management; health care management and biomedical innovation.



Thomas J. Allen, Jr., Ph.D.

Management of research and development, specifically those aspects dealing with the flow of scientific and technical information; organizational communications; international transfer of technology, and the problem-solving process in research.



Thomas H. Lee, Ph.D.

Energy technology and policy; electric power systems engineering; physical electronics; technology assessment and planning.

Michael A. Cusumano, Ph.D.

Technology strategy and management in Japan; software engineering management; international industry and competitive analysis; production and operations management; comparative business history



Mei Horwitch, D.B.A.

Corporate strategy especially in advanced technological industries; managing large-scale complex enterprises and project management; energy policy; institutional history.



J. Daniel Nyhart, J.D.

Law; analysis and design of negotiation and other dispute resolution alternatives to the adversary process; analysis of regulatory processes, particularly involving science and technology; international law; law of the sea; regulation of multinational corporations.



Richard L. de Neufville, Ph.D.

Systems analysis applied to strategic planning and design of engineering projects; decision analysis and optimization; definition of policy issues in technology



Ralph Katz, Ph.D.

Management of RD&E professionals and project groups encompassing the general problem of how to maintain group and individual effectiveness over long periods of time; management of organizational careers for RD&E professionals; alternative organizational structures and their effects on project performance; the effectiveness of managerial styles and the management of conflict



John R. Hauser, Sc.D.

Emphasis is on emerging theory and practice that draw on market research, competitive analysis, and marketing science. We use lectures, cases, PC simulations, readings, an integrating exercise, and a course project to provide a mix of theory and hands-on experience so that the concepts of marketing management become useful to the management of technology.

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Russell W. Olive, D.B.A.

Entrepreneurship; management of new ventures; accounting and control; business and manufacturing strategies; management of product quality; operations and human resource management; technology transfer; productivity.



James M. Utterback, Ph.D.

Technological innovation in industry; factors which influence innovation including corporate behavior, strategy, and government policy.



Joel P. Clark, Sc.D.

Applied engineering systems analysis; economic modeling of minerals and materials markets; strategic planning in natural resource industries; substitution among materials; cost of production models of resource industries



Michael A. Rappa, Ph.D.

Nature of technological revolutions; government and industrial laboratories; international comparisons of technological development; technological forecasting and its strategic implications.



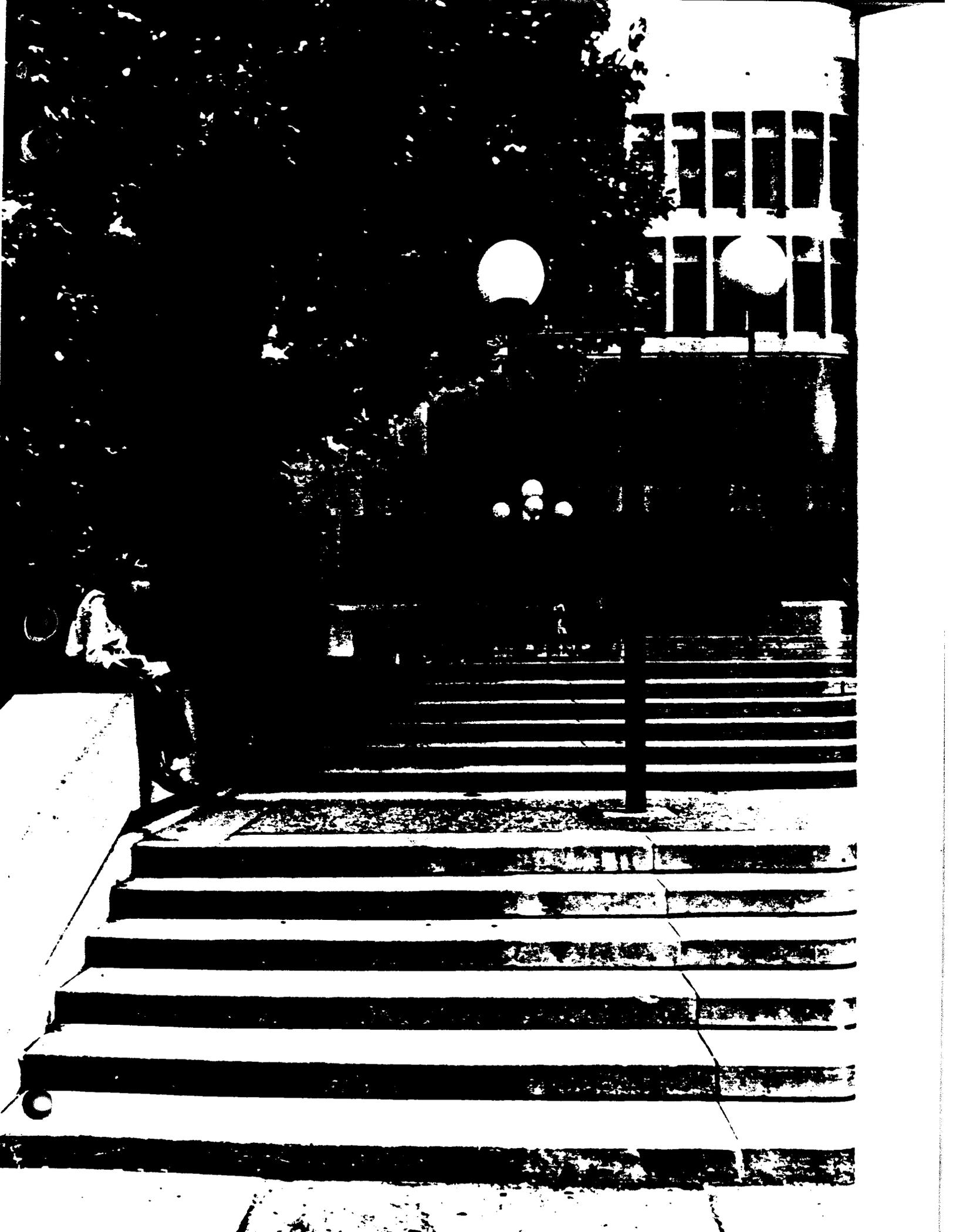
Eric von Hippel, Ph.D.

Management of the product innovation process; primarily those early stages in which a "user need" is perceived and a responsive innovation task is specified and undertaken; examination of the ways in which innovators are able to capture benefit from their innovations.



Shlomo Maital, Ph.D.

Focus: Microeconomics on cost and demand analysis, market structure and industrial performance, design of pricing strategies and effects of government regulation. Macroeconomics on measurement, forecasting and interpretation of aggregate economic variables, how those variables are affected by government policies, and the implications for management.



Program Staff



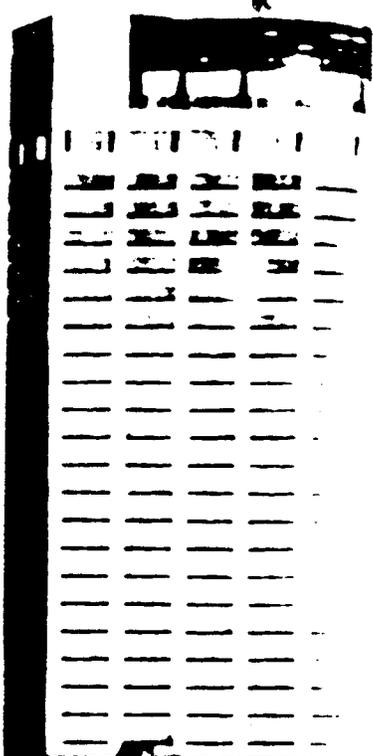
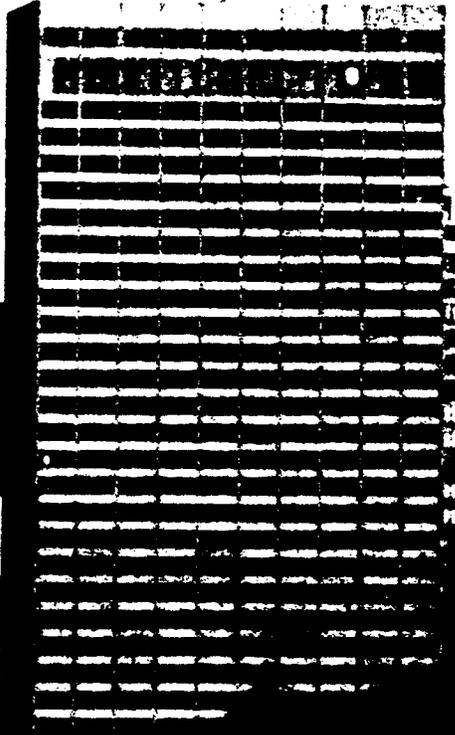
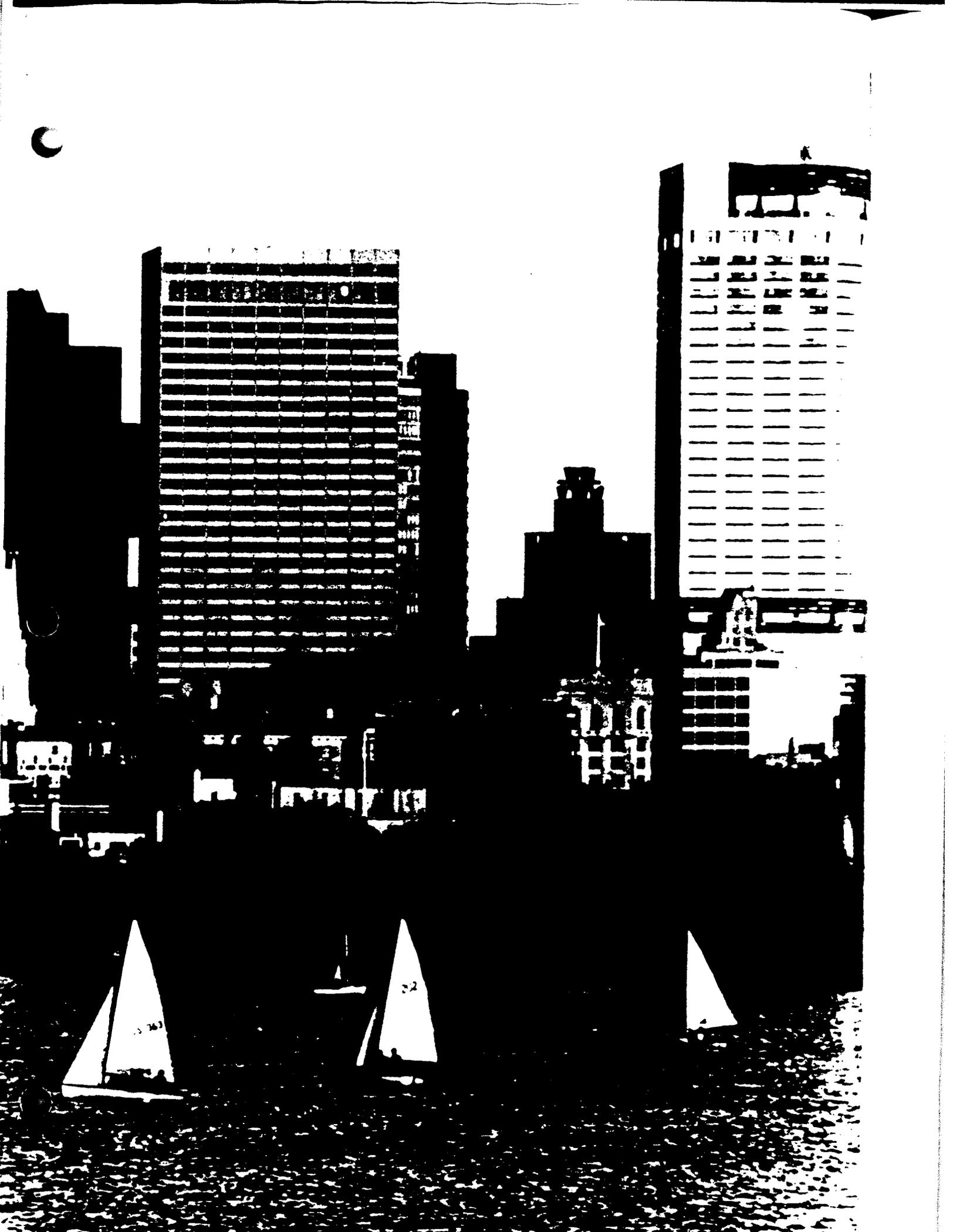
Peter P. Gil
Director (Acting)
Management of Technology
Program



Jennifer A. Mapes
Coordinator, Management of
Technology Program



Cheryl A. Kelliher
Administrative Assistant



Living in the Boston Area

MIT is in Cambridge, Massachusetts, on the north bank of the Charles River, facing the city of Boston. The city of Cambridge, best known as the residence of MIT and Harvard, is home to many students and young professionals, especially near the two campuses. The city also has a strong ethnic character with tightly knit Portuguese, Italian, and Irish neighborhoods.

An hour or two away from MIT by car are the mountains of Vermont and New Hampshire, the ocean beaches of Cape Cod, the lakes and rivers of Maine, the small clusters of fishing towns along the New England coast, and many historical places of interest – Salem, Sturbridge, Lexington, Concord, and Plymouth in Massachusetts alone. The four distinct seasons of New England combined with the varied landscape offer unlimited possibilities for recreation – skiing, mountain climbing, hiking, sailing, canoeing, kayaking, swimming, and camping.

Within a two-mile radius of the Institute are the Museums of Science and Fine Arts, the Gardner Museum, the New England Conservatory of Music, Symphony Hall, the New England Aquarium, and the Boston Public Library. Students can travel easily to the theater district where pre-Broadway plays are often previewed and local productions are staged.

Among the numerous cultural organizations in the area are the Boston Symphony Orchestra, the Boston Pops, the Boston Ballet Company, the Opera Company of Boston, the Boston Center for the Arts, the Loeb Drama Center, and the American Repertory Theatre.

MIT is one of more than 50 schools located within the Boston area. Others include Harvard University, Radcliffe College, Boston University, Northeastern University, Boston College, Brandeis University, Tufts University, Simmons College, Wellesley College, and many specialized professional art and music schools. The concentration of academic, cultural, and intellectual activities in the Boston area is one of the largest in the country and there is an extraordinary variety of people from all over the country and the world.

Academic Calendar 1989-1990

1989

June 12	Orientation and registration
June 13	Reception
June 14	First day of Summer classes
September 11	Registration Day for Fall Semester
September 12	First day of Fall classes
October 9-10	Columbus Day vacation
November 10	Veterans Day holiday
November 23-24	Thanksgiving vacation
December 14	Last Day of Fall classes
December 19-22	Final exam period
December 23-January 7	Christmas vacation

1990

January 8-31	Independent Activities Period (Thesis Research)
January 29-February 2	Field Trip
February 5	Registration Day for Spring Semester
February 6	First day of Spring classes
February 19-20	Washington's Birthday vacation
March 26-30	Spring vacation
April 16-17	Patriot's Day vacation
May 12	Thesis due
May 17	Last day of Spring classes
May 21-23	Final exam period
June 4	Commencement (graduation exercises)

The Massachusetts Institute of Technology admits students of any race, color, sex, religion, or national or ethnic origin to all rights, privileges, programs, and activities generally accorded or made available to students at the Institute. It does not discriminate against individuals on the basis of race, color, sex, sexual orientation, religion, handicap, age, or national or ethnic origin in administration of its educational policies, admissions policies, employment policies, scholarship and loan programs, and other Institute administered programs and activities, but may favor US citizens or residents in admissions and financial aid.

The Institute has adopted an affirmative action plan expressing its continuing commitment to the principle of equal opportunity in education.

Inquiries concerning the Institute's policies and compliance with applicable laws, statutes, and regulations (such as Title IX and Section 504) may be directed to Dr. Clarence G. Williams, Special Assistant to the President and Assistant Equal Opportunity Officer, Room 3-221, (617) 253-5446. Inquiries about the laws and about compliance may also be directed to the Assistant Secretary for Civil Rights, US Department of Education.

The Institute reserves the right to make changes in the regulations and courses announced in this brochure.

Photography by Bradford Herzog, Calvin Campbell, Margaret Foote, and Kevin Galvin. Photographs also supplied by the MIT Office of Communications.

Design by Celia Metcalf
MIT Design Services

Printing by Arlington Lithograph

The Management of Technology Program was made feasible by generous grants from Pilkington Brothers Limited and the Gillette Company, which supported the initial curriculum development. Additional corporate donations from Computer Services Corporation (Japan), Corning Glass Works, and Rogers Corporation have underwritten the continuing evolution and growth of the Program.

Massachusetts Institute of Technology,
Management of Technology Program
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Cambridge, Massachusetts 02139

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Telex: 797961 MIT SLOAN UD
FAX: 617 258 6002



National Technological University
P.O. Box 700, 601 S. Howes St.
Fort Collins, CO 80522
303-484-0668 (FAX)
303-484-6050

NTU Announces Degree in Management of Technology

We are pleased to announce a new graduate program which could have a great and positive impact on your company. Students nominated for and completing this program may be your company's leaders in the future. We urge you to choose high potential outstanding candidates.

The ability for companies to effectively manage technology has been identified as one of industry's top priorities. In 1987, The Manufacturing Studies Board of the National Research Council published the conclusions of their study. They observed that because management of technology was a new discipline and interdisciplinary in nature, the traditional university would have great difficulty in bringing together the required educational programs, but they urged that a curriculum be developed.

NTU recognized an opportunity to utilize its unique abilities and has developed a model management of technology curriculum. NTU is unusually well suited to bring together an ideal interdisciplinary program which crosses departmental lines. It brings to the program the best resources in the country. Now, after more than two years of planning and development, NTU is proud to announce its new Masters Degree in Management of Technology.

This new program will be unique both to NTU and to the nation. Participants, who are nominated by their employer, will be individuals who have upper management potential. Involvement in this program will increase their abilities to be effective managers of technology. Each participant will devote two years of part-time study towards obtaining this degree. The program will consist of courses broadcast to the work locations via NTU's satellite network interwoven with seven one-week periods where the participants are brought together as a group. The students would also work on a project of interest to the sponsoring organization. Because the participants maintain work continuity, though at a reduced level, there will not be the usual reentry problems experienced by those pursuing full-time study.

We would like to solicit your best estimate of the number of students your organization will identify to participate in this new degree program. The plan is to initiate the program in the summer of 1989. The total cost for the two years will be \$25,000. This includes tuition and fees as well as room and board for the seven one-week residencies. Enrollment in this program is limited. If your institution would like to become involved in this program, send the name of the contact person as soon as possible to Roy Mattson at NTU.

Enclosed is a summary of NTU's Management of Technology Degree program. Please contact us if you have any questions.

Arizona State University
Boston University
Colorado State University
Georgia Institute of Technology
Illinois Institute of Technology
Iowa State University

Michigan Technological University
North Carolina State University
Northeastern University
Oklahoma State University
Purdue University
Southern Methodist University

University of Alaska
University of Arizona
University of Florida
University of Idaho
University of Kentucky
University of Maryland

University of Massachusetts
University of Minnesota
University of Missouri-Rolla
University of South Carolina
University of Washington
University of Wisconsin-Madison

NTU MANAGEMENT OF TECHNOLOGY PROGRAM

DESCRIPTION

Management of technology has been identified as one of the top national priorities especially in view of the intensity of international competition. In 1987, the Manufacturing Studies Board through the auspices of the National Research Council performed a study and published a report that has become the center piece for actions that should be taken. These recommended actions focus on education and research as the number one priorities. The prognosis was that an extended period of time would be required to get the required research and education in place. It was observed that because management of technology was a new discipline and inter disciplinary in nature, the traditional university would have great difficulty in bringing together the required educational program.

Because of the pressing needs and requirements emanating from NTU's constituency, a development program was initiated in March, 1987. The goal was to develop a master's program in management of technology. It was felt that NTU could establish true national leadership in bringing such a graduate program together on a timely basis capitalizing on its strengths as a non traditional university. It would not be bound by departmental lines and the best of courses could be brought from the best academic and industrial sources. This program could also serve as a prototype for other universities in launching their programs.

A development program was put into place and was funded through grants from Eastman Kodak, GE, Xerox, IBM and AT&T. The initial phase focused on the format of the program and specification of the curriculum. That phase has been completed and the second phase of development has been initiated. This second phase deals with specific course developments. An Industrial Executive Advisory Committee as well as a National Executive Advisor was established to give advise and council. The Curriculum Committee was chaired by Dr. Dan Berg from RPI. The members of both committees are listed in the attachments.

The Curriculum Committee concluded that this program would follow a different format than other NTU graduate programs. All the students would enter the program together and complete the degree requirements in two years. Televised courses would be taken at the work locations (ITV sessions) following the current mode of NTU delivery. During the two year period, the students will be brought together for seven one-week intense sessions at different university campuses and settings. These sessions would facilitate cross pollination between participants. During the one-week residencies (R sessions), there would be guest lectures and seminars with the participation of the top authorities from industry, government, and academe. The participants would also work on a project during the course of study as part of the degree requirements. This might be a project of interest to the sponsoring organization, relevant to their needs. There will be extensive usage of electronic mail, computer conferencing and facsimile transmissions to link the students to the faculty and each other.

The participants will be taking two courses at a time so that the workload will be 40-50% of a full study program. The profile of a typical participant would include an undergraduate technical degree, at least five years of work experience in governmental or industrial areas related to technology and technical disciplines. There will be both managers and non managers in the program. They should be individuals who have higher management potential. It is an intense program of study. The degree will be realized in two years. The participants will maintain work continuity. Therefore, there will not be the usual reentry problems experienced by those pursuing full time study.

The plan is to initiate the program in the summer of 1989. The total cost per student for the two years will be \$25,000. This includes tuition and fees as well as room and board for the seven one-week residencies. Travel to and from the residency locations would be in addition to this. The \$25,000 would be paid in two equal installments at the beginning of each year. Enrollments will be limited to ensure an outstanding learning experience.

NTU-MOT NATIONAL EXECUTIVE ADVISOR

Dr. Ralph Landau
Chairman, Listowel, Inc.
New York City, NY

NTU-MOT INDUSTRIAL EXECUTIVE ADVISORY COMMITTEE

William Braun
Vice President & Director of
Research & Development
Motorola, Inc.

Roger P. Heinisch
Vice President & Deputy
Science & Technology
Honeywell Corporation

Roland Schmitt
President
Rensselaer Polytechnic Inst.

Kevin Considine
Vice President and Director
Tektronix Laboratories

Charles House
Corporate Engineering Director
Hewlett-Packard Corporation

Thomas Smith
Xerox Corporation

Bill M. Cullom
Manager, Human Resource Div.
Information Systems, Dept.
E. I. duPont de Nemours & Co.

Frederick Porter
Vice President & General Manager
Manufacturing Resources Division
Eastman Kodak Company

Patrick A. Toole
Senior Vice President
& Group Executive
Information Systems &
Technology Division
IBM Corporation

Dale Harris
Executive Director
Strategic Technology
Pacific Bell - Room 3S453

CURRICULUM COMMITTEE - PHASE 1

Dr. Dan Berg
Dr. Alden Bean
Dr. R. Burgelman
Dr. J. Goldhar
Dr. B. Goldsmith
Dr. W. Hamilton
Dr. Ken Colmen

RPI (Chairman)
Lehigh University
Stanford University
Illinois Institute of Technology
Carnegie Mellon University
The University of Pennsylvania
SRI International

NTU PLANNED PROGRAM IN MOT

In a world of increasing international competition, this is an education program responding to the industrial and governmental need for managers who can capitalize on bringing the advancements in technology into business processes and products.

- * Start up in Summer of 1989 . . . All students brought together at start
- * Students selected and sponsored by their company or organization
- * Workload approximately half time
- * Degree requirements completed in two years . . . student cohorts
- * Tuition, room and board and other fees \$25,000
- * Two year plan
 - .. Seven one-week residencies on different campuses
 - .. ITV courses at students' work location from different universities
 - .. project throughout two years as part of degree requirements
- * Student Profile
 - .. undergraduate technical degree
 - .. 5-10 years experience in governmental or industrial areas related to technology and technical disciplines
 - .. working professionals, both managers and non-managers
 - .. nominated by the company and in most cases high management potential
- * Cross-Pollination
 - .. extensive usage of electronic mail and computer conferencing
 - .. campus residencies
 - .. projects and seminars over the NTU network
 - .. faculty office hours over the network

MOT ISSUES (from NRC report)

ISSUES AND RESPONSIBILITIES SPECIFIC TO MOT FALLING IN THE AREA LINKING MANAGEMENT AND ENGINEERING/SCIENCE

I. Strategic/Long Term Issues Relating to Technology

- entrepreneurship (managing innovation)
- research, development, engineering and operations strategic planning
- national and international policies (regulatory, trade, environmental)
- forecasting/assessment
- technological alliances (sourcing/leveraging), marketing/technical linkage (product conceptualization design, support)
- managing for technological change (obsolescence/discontinuity)
- acquisition and joint venture negotiations

II. Interfunctional Policy Issues Relating to Technology

- entrepreneurship (internal ventures)
- technology transfer
- sociotechnical systems design (man/machine interface)
- organizational interfaces
 - a. marketing/R&D
 - b. manufacturing/R&D
 - c. administration/R&D

III. Current RDE&O Issues

- project management
 - a. internal/multiorganizational
 - b. small/big
 - c. simple/complex
- managing technical professionals/organizations
- managing quality/productivity
- productivity through technology
- crisis management
- R&D management—systems/process
- new product development
- vendor management
- training of R&D/technology managers

IV. Technology Support Services and Issues

- management information systems, development and utilization
- human resources management, labor-management negotiations
- law (licensing, intellectual property/joint venture)
- risk/reward analysis
- technological economics
- ethics and social impacts
- expert systems in technology management

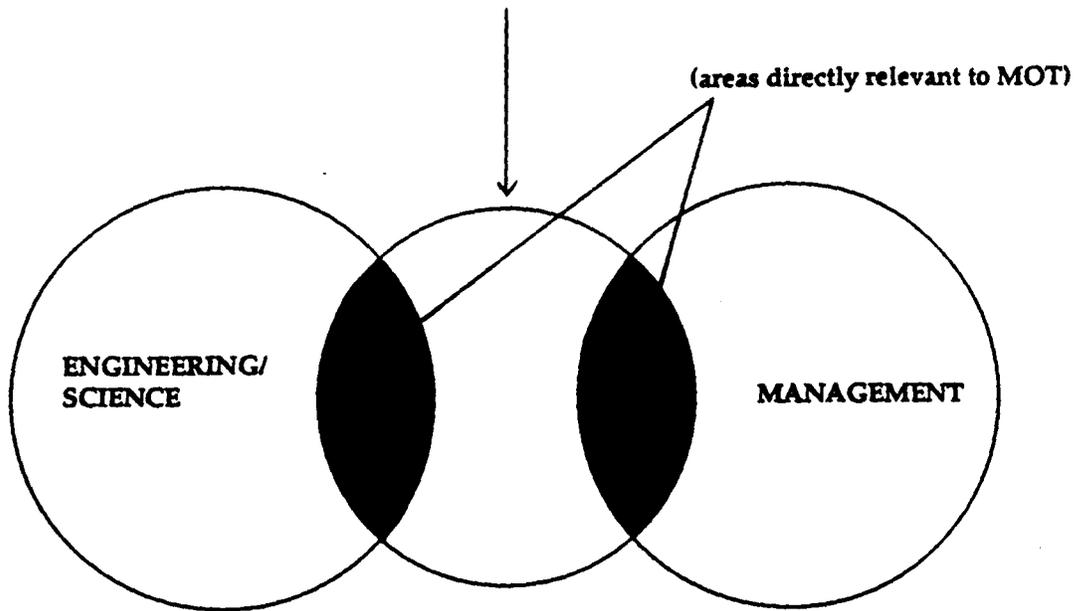
MOT

The Management of Technology links engineering, science and management disciplines to plan, develop and implement technical capabilities to shape and accomplish the strategic and operational objectives of an organization.

KEY ELEMENTS

- **Identification and evaluation of technological options**
- **Management of R&D, including determination of project feasibility**
- **Integration of technology into the companies overall operation**
- **Implementation of new technologies in a product and/or process**
- **Obsolescence and replacement**

MANAGEMENT OF TECHNOLOGY



- Discipline-based Knowledge
- Engineering Systems
- Computing Applications
- Manufacturing Technology
- Design (DFA, etc.)¹
- Risk Analysis
- Control Theory
- CAD/CAM²
- Quality Assurance/Statistics
- Operations Research
- MIS/DSS³
- Reverse Engineering
- Awareness of Available Technologies
- Strategic/Long-term Issues Relating to Technology
- International Issues Relating to Technology

- RDE&M⁴ Current Operations Issues
- Technology Support Services and Issues
- Finance
- Marketing
- Business Policy/Strategy
- Control/Accounting
- Organizational Behavior
- Human Resource Management
- Production and Operations Management
- R&D Management
- Managerial Decision Theory/Statistics/Operations Research
- Macroeconomics/International Trade
- Microeconomics
- MIS/DSS³

¹DFA: Design for Automation or Assembly.

²CAD/CAM: Computer-Aided Design and Manufacturing.

³MIS/DSS: Management Information Systems and Decision Support Systems.

⁴RDE&M: Research, Development, Engineering and Manufacturing

FIGURE 2 MOT Links, Issues, and Responsibilities (from NRC report)

TWO YEAR COURSE SEQUENCE

R1.....ITV1R2.....ITV2.....R3.....ITV3.....R4.....ITV4R5.....ITV5R6.....ITVR7.....Graduate
(summer 89) (June 91)

- All students will work as cohorts, starting the program together and finishing the program together in two years.
- The commitment from the corporations for the student participants will be much greater than for the current NTU graduate programs. The student commitment will approximate at least a half-time educational work load.
- The R periods are one week residencies on campuses. These will be intense periods offering cross-pollination opportunities among students and faculty.
- The ITV periods are at the students' work locations with the courses being taken via ITV from the various sources.
- During the ITV periods, the students will be taking two courses (I, II on ITV Chart) as well as working on a project (III on ITV Chart). The project will take place during the two year duration and can be a project of interest to the student and his company.
- All the students will be brought together at the beginning of the program (R1 period).

NATIONAL TECHNOLOGICAL UNIVERSITY

**MANAGEMENT OF TECHNOLOGY
PROGRAM FORMAT**

SEMESTER:	#1 Fall '89	#2 Spring '90	#3 Summer '90	#4 Fall '90	#5 Spring '91	#6 Summer '91	#7 Fall '91
RESIDENCY PROGRAM*	R-1 Program Foundations & Philosophy	R-2 Tech, Ind Structure & Economic Performance	R-3 Tech & Business Unit	R-4 RD&E Organ & Management	R-5 Technology Innovation & Entrepreneurship	R-6 Social, Political & Legal Issues In S&T	R-7 Technology & Global Econ, Final Rpts on Field Projects
CREDITS:	(1)	(1)	(1)	(1)	(1)	(1)	(3)
ITV PROGRAM:							
ITV:	I-1 Tech & Econ Anal	I-2 Mgrl Acctg & Tech Systems	I-3 Bus Unit Strategy & Operations	I-4 Managing & Leading Tech People	I-5 Taking Tech to Market	I-6 Strategic Mgmt of Technology	
CREDITS:	(3)	(3)	(3)	(3)	(3)	(3)	
ITV:	II-1 Socio-Tech Systems	II-2 Fin Analysis & Tech Programs	II-3 Quality Mgmt	II-4 Manu. Systems Design	II-5 Managing Tech Programs & Projects	II-6 Analysis of Emerging Tech	
CREDITS:	(3)	(3)	(3)	(3)	(3)	(3)	
ITV:	III-1 Field Project Tutorial	III-2 Field Project Tutorial	III-3 Field Project Tutorial	III-4 Field Project Tutorial	III-5 Field Project Tutorial	III-6 Field Project Tutorial	
CREDITS:	(0)	(0)	(0)	(0)	(0)	(0)	
CUMULATIVE CREDITS:	(7)	(14)	(21)	(28)	(35)	(42)	Graduation (45)

*Residency Program sessions are one week in length and take place one week before the ITV semester begins.

MANAGEMENT OF TECHNOLOGY

Course Sequence

1st Year

R1: Orientation: Program Foundations and Philosophy

1st Semester:

ITV I-1 Technology and Economic Analysis

II-1 Socio-Technical Systems

III-1 Field Project Tutorial

R2: Technology, Industry Structure & Economic Performance

2nd Semester:

ITV I-2 Managerial Accounting & Technical Systems

II-2 Technology and Financial Decisionmaking

III-2 Field Project Tutorial

R3: Technology and the Business Unit

3rd Semester:

ITV I-3 Business Unit Strategy & Operations

II-3 Quality Process Management

III-3 Field Project Tutorial

Course Sequence

2nd Year

R4: R,D&E Organization & Management

4th Semester:

- ITV I-4 Managing & Leading Technical People
- II-4 Manufacturing Systems and Technology
- III-4 Field Project Tutorial

R5: Technology, Innovation & Entrepreneurship

5th Semester:

- ITV I-5 Taking Technology to Market
- II-5 Managing Technical Programs & Projects
- III-5 Field Project Tutorial

R6: Social, Political & Legal Issues in S&T

6th Semester:

- ITV I-6 Strategic Management of Technology
- II-6 Analysis of Emerging Technologies
- III-6 Field Project Tutorial

R7: Technology and the Global Economy; Final Reports on Field Projects.

RESIDENCY PROGRAM

The purpose of the residency program is to develop among the students a common frame of reference for the program as a whole; to supplement and reinforce materials presented during the previous semester's courses; and to provide transitions to new material being presented in subsequent courses. Emphasis is upon interaction among the students, case discussions, and meetings with guest lecturers and panelists. The first Residency session provides the overall foundations of the program; the last session, which requires two weeks, involves the presentation of final project reports by the students, along with an extensive discussion of the international dimensions of technology management.

Index: R1

Title: Technology Management: Foundations and Philosophy

Objectives

To review the issues and problems that have created the need for technology management as a distinctive field of endeavor; to describe the scholarly disciplines that provide the educational foundations of the field, and to prepare the class as a whole for the program to come.

Description

Presents the basic facts about the role of R&D and technological innovation in economic growth and development. Reviews the concerns and conclusions of the NAE Workshop on "Technology Management: The Hidden Competitive Advantage". Presents the rationale for the present program in terms of managerial needs and career opportunities. Guest speakers from industry and government.

Lectures and case studies on:

- o The process of innovation from R&D to final uses*
- o Sources of innovation*
- o Linking R&D to manufacturing and marketing*
- o Product versus process innovation*
- o Innovation from the users viewpoint*
- o Organizing for innovation*
- o Creativity and management of professionals*
- o Problems of new products; entrepreneurs and intrapreneurs ventures.*

ITV COURSE DESCRIPTIONS

First Year

Index: ITVI-1

Title: *Technology and Economic Analyses*

Objectives

To provide an overview of economic theory and analysis at the macro and micro levels, and to develop a working knowledge of methods for the analysis of technological change in economic systems.

Description

Assumes a background equivalent to undergraduate microeconomics and macroeconomic theory. Develops the theoretical and empirical basis for understanding the productivity effects of technological change in economic systems. Develops the relationship between technological change and industry structure. Presents applications of economic analysis to the effects of technological change within the firm.

Index: ITVII-1

Title: *Socio-Technical Systems*

Objectives

To provide an understanding of the relationship between technology and social norms, values and institutions; and of the social basis for resistance to and acceptance of technological change.

Description

At the macro level, examines the processes associated with the formation of social institutions associate with technology, such as professional societies, standard-setting agencies, R&D institutes and assesses their impact on technological growth and development. At the micro level, examines the social basis for technological rigidities with the firm, and the impacts of technological change on the work force. Assumes the equivalent of an undergraduate course in organizational behavior.

Index: ITVI-2

Title: *Managerial Accounting and Technical Systems*

Objectives

To provide an understanding of the accounting process and the use of accounting systems and information for reporting, decisionmaking and control purposes; to develop a working knowledge of the way product and process innovations impact cost and revenue streams and how these impacts are treated in accounting systems.

Index: R2

Title: Technology, Industry Structure and Economic Performance

Objectives

To build upon the basic economic and socio-technical concepts introduced in the first semester, and understanding of the relationship between technological change and the economic performance and institutional structure of firms, industries and nations.

Description

- o Effect of technology on industry structure and economic performance**
- o Effect of industry structure on the rate and direction of technological innovation, the adoption of new technology and productivity**
- o Sources and performance of R&D activities**
- o International trade in technology and intellectual property**
- o Public policy for science, technology and innovation**
- o Economics of innovation and technology diffusion**

Index: R3

Title: Technology and the Business Unit

Objectives

To consolidate and expand through use of case studies and guest lecturers the material presented in the second semester; to introduce the areas to be emphasized in semester three.

Description

A series of case studies in R&D, manufacturing and marketing with emphasis on the integration of the three functions in terms of product line management. Emphasis on similarities and differences in managerial control systems and practices across the functions. Attempt to develop ground rules for cross-functional integration and control.

Index: R4

Title: R D & E Organization and Management

Objectives

To provide an understanding of the organization and management practices of research, development and engineering units and institutions in all sectors of the economy and internationally.

Description

A comprehensive review of scientific and technical community world-wide will be presented, with an emphasis on mechanisms available to facilitate information sharing and communications within this community, as well as approaches used to maintain and protect

Description

Presents a survey of analytic tools used in managerial decisionmaking that require accurate and systematic accounting data; and explains how such data are generated and maintained in modern computer-based information systems. Describes how technology-based firms can and do treat the costs associated with R&D and the commercial introduction of new products and processes. Explores current issues in managerial accounting relating to the "appropriate" treatment of the costs associated with technological change.

Index: ITVII-2

Title: Technology and Financial Decisionmaking

Objectives

To develop an understanding of the financial requirements of R&D, technological innovation and commercial development, and to provide a working knowledge of the financial models and tools of financial analysis appropriate to the management of technology.

Description

Reviews the financial literature dealing with the analysis of the R&D/new technology investment problem and presents relevant analytic tools. Reviews literature and findings that relate financial decisions to shareholder wealth and stock valuation. Develops a working knowledge of the statistical and data analysis techniques underlying financial decision-making models. Presents relevant theoretical models, including options theory, multi-criteria decisionmaking, and capital budgeting.

Index: ITVI-3

Title: Business Unit Strategy and Operations

Objectives

To survey challenges and approaches to managing the R&D, manufacturing and marketing functions of a firm operating as a strategic business unit. To create a background for later work on the role and impact of changing technology on these functions.

Description

This course introduces the concept of business strategy at the SBU level and discusses specific organization, planning and decision models useful in managing the marketing, manufacturing and R&D functions. Specific topics in manufacturing will include: types of production systems, process and job design, equipment and technology choices, capacity planning, quality control and the role of manufacturing in the strategy of the business unit. The marketing segment will cover the marketing mix (price, design, distribution and communications) decisions, marketing strategies, positioning and segmentation and new product problems. The R&D segment will describe the types and levels of technical effort required to support and sustain alternative business strategies across the stages of the product life cycle.

Index: ITVII-3

Title: Quality Process Management

Objectives

To give the student a comprehension of the underlying principles, methodologies and techniques in establishing, operating and managing quality programs in an enterprise.

Description

There will be an introduction of the fundamental tools, concepts and methodologies related to the management of quality. Included will be discussions on requirements, specifications, prevention cost of quality and fundamentals of quality control. These concepts will be integrated in a systematic and structured way leading to a comprehensive process for managing a total quality program. There will be examples of successes and failures at the functional levels with studies of the primary factors leading to success or failure.

ITV COURSE DESCRIPTIONS

Second Year

Index: ITVI-4

Title: *Managing and Leading Technical People*

Objectives

To give insight on the most effective methods for organizing the technical resource and functions for maximum creativity, productivity both from a short and long range perspective while maintaining a technical professional environment.

Description

Examines the tasks carried out by professionally trained scientists, engineers and support personnel in R&D, manufacturing and marketing functions, and assesses the contribution of these activities to effective technical programs. The emphasis is on selecting and developing an effective technical work force, given potentially conflicting organization goals. These might include achieving balance between demands for efficiency, quality and productivity, and the need for technological innovation and novel ideas in a highly specialized technical work force. Landmark studies on the motives, expectations, communications styles and career paths scientists, engineers and technicians are reviewed. The impact of different organization forms and supervisory styles on individual and group performance is examined.

Index: ITVII-4

Title: *Manufacturing Systems and Technology*

Objectives

To give the student an appreciation of the range of technologies available for manufacturing use with an emphasis on the integration of information technology with traditional process operations.

Description

The first half of this course will review the full range of technologies for metal and non-metallic processes including machining, forming, joining assembly (robot) etc. and the use of "exotic tools" such as lasers, water jets, chemical milling, etc.

The second half of this course will discuss the use of computers and telecommunications for manufacturing information systems and process/machine control. Topics include CAD, CAM, CIM, FMS, LAN's, controllers, etc.

Index: ITVI-5

Title: *Taking Technology to Market*

Objectives

To develop an understanding of the process of commercializing technology, and of the managerial skills and professional expertise needed to support a strong commercial development effort.

Description

Reviews what is known about factors that affect the success and failure of product innovations, enhancements and incremental technical changes. Reviews alternative approaches to coupling the R&D function to the marketing function and the marketplace. Examines the problem of accelerating the pace of technological innovation within and across product families and the impacts of such changes on cost and product quality.

Index: ITVII-5

Title: *Managing Technical Programs and Projects*

Objectives

To present methods used in organizing and managing technical programs and in selecting, staffing, managing individual projects.

Description

Compares and contrasts "classical" approaches to the organization of technical functions (by disciplines) with the program/project management approach. Presents strengths and weaknesses of each and examines hybrid approaches, such as matrix management. Deals with the issue of balancing the risks in an R&D program. Reviews approaches to selecting, monitoring and terminating R&D projects. Presents recent developments in methods for linking R&D programs to organizational goals.

Index: ITVI-6

Title: *Strategic Management of Technology*

Objectives

To develop understanding of the process of technology strategy formulation, implementation and management in a multi-business firm, and of the integration of business strategy with technology strategy.

Description

Develops skill in various methods of technology planning and forecasting, including both subjective/judgmental and statistical methods. Acquaints students with available databases useful for technical planning and forecasting purposes. Provides opportunities for students to develop competitive technical assessments. Deals with issues of resource allocation

proprietary interests. Presentations on commonly used practices in career development for scientific and technical employees. Review of emerging mechanisms for inter-sectoral cooperation and collaboration in R&D.

Index: R5

Title: *Technology, Innovation and Entrepreneurship*

Objectives

To understand the factors that impede innovation and the adoption and utilization of new and improved technologies, products and provisions both within and outside the firm, and to identify ways of overcoming them.

Description

Potential sources of and users of technology within and external to the firm are identified, along with factors that contribute to successful or unsuccessful transfers of technology along the paths that link sources to users. Within the firm, we examine the acceptance and adoption of both internally generated innovations, as well as those initiated by, or available from external vendors. The roles of gatekeepers, champions and sponsors are reviewed. We also study the problems of "commercializing" internally generated or acquired product improvements and innovations intended for sale to external customers.

Index: R6

Title: *Social, Political and Legal Environment of Science and Technology*

Objectives

To provide an understanding of the social, political and legal framework within which technology is operating today and projections for the future.

Description

There will be extensive use of prominent guest lecturers from the private sector as well as the government and other sources. The topics that will be covered will include:

- o *Ethics, personal values and corporate guidelines*
"fair competition" pricing, bidding, combinations in restraint of trade, individual rights and obligations
- o *Intellectual Property*
patents, copyrights, protected information publication
assignment of rights
employment contracts and releases
- o *Contracts and commercial practice*
purchase, leases, licenses
bidding procedures
- o *Recent legislation and regulatory agencies*
merchantability, warranties, implied obligations
liability for subsequent use and modifications

to R&D and technical activities across multiple business units, and measuring overall R&D performance and productivity.

Index: ITVII-6

Title: Analysis of Emerging Technologies: Information, Materials and Biotech

Objectives

To provide an understanding of how these new technologies have developed and evolved over time, and how these changes have influenced industry structure growth and productivity; to assess the likely impacts of these technologies on future economic and competitive conditions in specific industries.

Description

Information Technologies:

An extensive analysis of the roles that information technology play in the overall operation of an enterprise with a primary focus on computer and telecommunications technologies. The spectrum of usage extending from tracking to on line real time control systems will be examined. Usage of systems in the different functions of the enterprise such as manufacturing control will be studied. The role of information technology in linking the functional areas together in a continuum and the linkage of subsystems will be examined. Data-base and data-based management systems and their current and future implications will be explored. There will be examples of the current and future usage of expert and knowledge based systems. There will be ample study of futures in information technologies and their relevance to business such as speech recognition and fiber optics in communication systems.

Materials Technologies:

An extensive analysis of the development and commercial exploitation of materials technologies and their impacts on industrial and economic affairs. Materials research and development have led to major new industries in the past forty years. These include computers, plastics, synthetic fibers and rubbers, and nuclear power. Emerging materials such as superconductors, synthetic polymers, ceramics, fiber optics and fiber composites may have similar impacts in the future. Materials processing technologies associated with new and emerging materials will also be examined. Case studies will be used to explore the managerial issues associated with innovation in the materials industries.

Biotechnology:

An extensive analysis of the emerging field of biotechnology and its many industrial impacts. While potential applications in human therapy commands much attention, there are many plant and animal applications as well. The "industry" and its technology management practices will be reviewed. Public policy concerns of major significance, such as the patentability of life forms, will be analyzed. The field also provides an opportunity to examine the strengths and weaknesses of emerging technology management practices, such as joint ventures and R&D partnerships.

- hazardous substances and processes*
- standards agencies*
- o Adjudication of disputes*
 - legal*
 - arbitration*
- o Employee relations*
 - legal and contractual obligations*
 - recent additions to US labor law*
 - EEOC, affirmative action, INS regulations*
- o Significant difference abroad*
 - in import/export*
 - in licensing*
 - in manufacturing abroad*
 - employee rights, layoffs, work permits*
 - restrictions on ownership, nationality of officers*
 - repatriation of investment, profits*
 - intellectual property*
 - currency regulations*
 - non-tariff barriers to trade*
 - quota, CoCom, standards agencies*

Index: R7

Title: Technology and the Global Economy

Objectives

To focus on global issues in technology and economic competitiveness and to identify problems and issues that are likely to affect the rate and direction of technological activity in the next decade and beyond.

Description

Review of primary international themes and issues covered by the program. Presentations and panel discussions by scholars and practitioners concerned with international affairs. Assessment of the competitive impact of increasing global parity of nations with respect to scientific and technical competence. Identification of key global challenges for technology management, and possible mechanisms for their resolution.

PEPPERDINE UNIVERSITY

SCHOOL OF BUSINESS AND MANAGEMENT

PROGRAM DESCRIPTION

MASTER OF SCIENCE IN TECHNOLOGY MANAGEMENT

APRIL 1989

FOR ADDITIONAL INFORMATION PLEASE CONTACT

DR. RICHARD C. KARHLER, DIRECTOR, TECHNOLOGY MANAGEMENT PROGRAM

MASTER OF SCIENCE IN TECHNOLOGY MANAGEMENT

This specialized 40-unit graduate management program was designed to address the need for increasing industrial productivity as outlined by the President's Commission on Competitiveness and the National Research Council's Task Force on the Management of Technology.

The increasing rate of international competition and the rapid diffusion of science and technology across national borders, when viewed in combination with decreasing national, business and product life cycles, will continue to create a dynamic and complex business environment.

In order to prepare managers to anticipate and effectively compete in the international technology-driven business environment, this program has set the following objectives: (1) to provide perspectives, concepts and tools to anticipate the opportunities and challenges presented by accelerating international technological change; (2) to provide managers from different functional areas with a shared understanding of the nature and process of technological innovation; (3) to develop a common business language that will assist functional managers enhance technological innovation in their organization; (4) to explore elements of cross-cultural management, and to experience these issues during field trips abroad; (5) to understand marketing and financial aspects of technological innovation within the framework of a global economy; and (6) to examine the linkages between technology and business strategies in creating competitive advantage.

Since technology may be effectively employed in new products, processes or services, this program has been developed to be of benefit to managers from all functional areas, not only in technology organizations but also, in manufacturing, distribution or service organizations who wish to explore the utilization of technology to achieve competitive advantage. A typical class will have participants from marketing, finance, operations, human resources, and research and development functions representing a broad industrial base.

The program is offered over a five-trimester period with classes scheduled every third weekend from 2:00 PM to 10:00 PM on Friday and 9:00 AM to 5:00 PM on Saturday. Considerable outside preparation is required for each weekend session.

The typical class size is 20 students in order to provide a seminar atmosphere to encourage group discussions and individual participation. The members of the class will stay together throughout the program to enhance the management team building and learning process.

In addition to the formal course work, there are a number of additional required activities including: a four-day, live-in Effective Management Workshop, two field trips abroad, a weekend Management Computer Simulation Workshop, completion of a Technology Management project, and other specialized seminars as may be prescribed by the Technology Management Program Committee.

Regulations Concerning a Second Master's Degree and the M.B.A. Option

A student who has already received an M.B.A. degree from a regionally accredited university may earn the M.S. Degree in Technology Management by the successful completion of 28 units of prescribed courses consisting of Trimester II, Trimester III, Trimester IV, and the Technology Management Project which may be taken concurrently in Trimester IV or in the subsequent trimester. In addition, participation in the Effective Management Workshop, the Management Computer Simulation Workshop, and additional seminars as may be determined by the Technology Management Program Committee, will be required.

A student has the option to pursue a course of study to earn the M.B.A. degree in lieu of the M.S. in Technology Management degree. If the M.B.A. option is chosen, the student must first complete all requirements of the Technology Management Program and subsequently complete an additional sixteen units of coursework as prescribed by the Technology Management Program Committee.

Effective Management Workshop

The Technology Management Program begins with a four-day, live-in Effective Management Workshop. The objectives of this workshop are to:

- o Introduce the extraordinary impact of technology upon all dimensions of the organization - an impact which takes place within the context of constantly shifting domestic and international social, economic, political and market forces.
- o Review the entire program and develop working relationships with faculty and other key resources.
- o Introduce special research methodology and learning approaches that require a balance between logic and intuition.
- o Build a learning team by focusing on self-understanding and interpersonal communication. During this process, the privacy and individuality of the students will be respected and valued. However, each student is expected to be willing to examine and learn from one's own behavior and the behavior of others in the class.

International Field Trips

In order to obtain first hand knowledge on technology topics and techniques as viewed and practiced internationally, each technology management class will take two, twelve day trips abroad during the program.

The field trips will be scheduled for selected locations in the Pacific Rim and in Europe. The participants will attend local university lectures, meet with industrial and government representatives, and visit scientific and industrial facilities which exhibit the latest in technology developments.

The field trips will be conducted in Trimesters III and IV. A technology management program professor will accompany the class and coordinate the learning activities.

Management Computer Simulation Workshop

During the fifth trimester, all members of the class and their professors participate in a weekend business-decision simulation workshop. Competitive teams, assisted by computers, compete against one another in a realistic and dynamic business environment. This workshop is designed to provide an opportunity for students to integrate, apply, and enhance their newly acquired managerial skills and knowledge.

Technology Management Project

One of the major requirements for graduation from the Technology Management Program is the successful completion of a written strategic or implementation plan for a technology oriented project which will be of significant benefit to the participant's organization.

The preparation and presentation of the project will be part of the fifth trimester under the direction of the course professor and with the assistance of an additional professor who will serve as the participant's project advisor.

It is expected that the scope and quality of the project will be demonstrated by the participant's mastery of the technology management concepts, topics, and issues covered in the previous trimesters of the program.

Admission Requirements for the M.S. in Technology Management

Following are minimum requirements for admission into the program:

1. A bachelor's degree from a regionally accredited four-year college or university is required.
2. A minimum of seven years professional experience, at least two years of which must be in a management position, is required. A completed Education and Work History Form must be sent to the School of Business and Management, Technology Management Program Office, 400 Corporate Pointe, Culver City, California 90230.
3. A completed Application for Admission form with a \$35 check for the non-refundable application fee made payable to Pepperdine University must be sent to the School of Business and Management, Technology Management Program Office, 400 Corporate Pointe, Culver City, California 90230.
4. An official transcript with its baccalaureate degree posted and mailed directly by the registrar from the college or university which granted the undergraduate degree must be sent to the School of Business and Management Admissions Office.
5. An acceptable score on the Miller Analogies Test (MAT) or a satisfactory score on the Graduate Management Admissions Test (GMAT) taken within the last five years is required.

6. A letter of recommendation from an executive at the student's place of employment is required.
7. A personal interview with a Technology Management Program professor is required.
8. Final selection to the program will be made by the Technology Management Program Committee.
9. All students in the Technology Management Program shall have direct access to a Personal Computer with a hard disc and a telecommuting modem. Each student must have some proficiency with the following software: Electronic Spreadsheet, Word Processing, and E-Mail. In addition, each student must, with minimum training, be able to "boot up" new software as introduced in the program. These new software programs will be part of various courses during the program, and form an integral aspect of the learning.

While acceptance to the program may allow a student to enroll for 45 days as an Unclassified student, admission to Pepperdine University will not be considered until the application file is complete. Admission will be confirmed by a letter from the Dean of Admission.

Standards of Measurement of Achievement

Satisfactory completion of 40 units and other program requirements are necessary for graduation. Maximum time for completion of the degree is eight trimesters. On completion of the fifth trimester, leaves are not permitted; a student must be enrolled continuously until the program is completed. Registration is for one unit each in the sixth, seventh, and eighth trimesters, if additional time beyond completion of the course work is needed.

The quality of a student's work must be kept at a 3.0 grade point average or better throughout the program. Courses in which the quality of work is lower than "C-" must be repeated. Students who wish to repeat a course in which a "grade lower than "B" was awarded must petition the Program Committee which will, in turn, make a recommendation to the associate dean. Courses may be repeated only one time; however, in cases where courses have been repeated, both course grades remain on the transcript and count toward the cumulative grade point average.

Students' academic records are reviewed at the end of every trimester. If the quality of a student's work falls below a 3.0 average, the student is placed on probation (warning status), informed of a specific time period in which the quality of work must be raised, and advised of any other conditions for removing the probationary status.

A student is subject to academic dismissal for any of the following deficiencies:

1. failure to perform at least at a 3.0 level in the first trimester of enrollment;

2. failure to perform course work at an average cumulative level of 3.0;
3. failure to perform at a 3.0 level during a trimester in which a student is on probation;
4. failure to raise average cumulative performance to a 3.0 level within two trimesters of enrollment after being placed on probation; or
5. performing at less than a 3.0 level in more than two courses.

Course Requirements for the M. S. in Technology Management

The M. S. in Technology Management program requires 40 units of course work taken in the following sequence

	<u>Trimester I.</u>	<u>Human and Cultural Issues in Technology Management</u>	
Human Resource Mgmt	MSTM 650	Leading People in Innovation and Change	(4)
Int'l organizations	MSTM 651	Managing Organizations in Multi-Cultural Environments	(4)
	<u>Trimester II.</u>	<u>Impact of Science and Technology</u>	
History of Science	MSTM 652	Understanding the Process and Impact of Science	(4)
Proj. Mgmt (R & D)	MSTM 653	Managing the Research and Development Organization	(4)
	<u>Trimester III.</u>	<u>Improving Productivity Through Technology</u>	
Technology Survey	MSTM 654	Scanning of Emerging Technologies	(4)
Proj. Mgmt	MSTM 655	Implementing Technology Applications	(4)
	<u>Trimester IV.</u>	<u>Commercializing Technology Developments</u>	
Tech. Marketing	MSTM 656	Bringing Technology to Market	(4)
Finan. Mgmt	MSTM 657	Acquiring and Managing Resources	(4)
	<u>Trimester V.</u>	<u>Strategic Role of Technology</u>	
Strategic Mgmt	MSTM 658	Strategic Management of Technology	(4)
Research Project	MSTM 659	Technology Management Project	(4)

Course Descriptions for the M.S. Degree in Technology Management

Trimester I: Human and Cultural Issues in Technology Management

In an era influenced increasingly by advancing technology, world markets and global economics, human and cultural factors are becoming even more significant to enlightened leadership. In this trimester, participants explore these issues by first developing a collaborative learning team. This team of students, professors and cultural representatives with a general systems orientation examines the myriad of sub-systems which are related to managing people in multicultural environments. Distinguished persons from both diplomatic and business sources who are expert in diverse cultural areas will be invited discussants. Reading, computer inter-active cases, experiential exercises and hands-on research serve as vehicles to link theory and management practice.

MSTM 650. Leading People in Innovation and Change (4)

Concentration on the human issues in initiating and coping with technological and other changes is the focus of this course. Creating a corporate culture for innovations, managing professional technologists, building effective project teams, assimilating technological change, initiating and implementing strategic alliances in environments where growth may be driven by either internal or external forces are explored. This course will also include transitional issues - both in terms of moving from one technology to another and in moving from one organizational life cycle stage to another.

MSTM 651. Managing Organizations in Multi-Cultural Environments (4)

As the world of management becomes even more dynamic, complex and competitive it is critical that organizations become increasingly effective in adapting to multi-cultural functioning. The capability for leading a technologically driven international organization demands an understanding of, and facility in, many diverse cultures. One's own cultural values and habits must be examined in juxtaposition to the cultural expectations and taboos of other environments. Initiating and growing new ventures both internal and external to the organization are explored through action research in domestic and cross cultural contexts.

Trimester II: Impact of Science and Technology

The trimester focuses on the impact of scientific and technological developments on society in general and the business environment in particular. The emphasis will be on the nature of the invention-innovation-diffusion process and the role that R & D can play in the development of new products, processes, markets and organizations. Invited distinguished university and industry researchers will discuss long term trends in major scientific areas of interest.

MSTM 652. Understanding the Process and Impact of Science (4)

This course introduces the history and process of scientific developments in order to understand the nature of technological convergencies, synergies and discontinuities. A number of key areas or scientific developments will be reviewed in order to create a framework for assessing future technology applications. Specialized topics from areas such as information technology, bioengineering, and the material sciences will be discussed. The impact of science on society and the business environment will be examined in relation to national and international research and development policies.

MSTM 653. Managing the Research and Development Organization (4)

This course focuses on the R & D function as a key element in the formulation and implementation of the organization's strategic plan. Topics will include: long term technology forecasting methods, internal technology assessments, the acquisition of technology, and domestic and international technology transfer. Particular attention will be on the management of R & D projects, new product development, and the interface between the R & D, marketing and operations functions in the organization.

Trimester III: Improving Productivity Through Technology

It is widely recognized that economic benefits accrue to those nations and organizations which achieve productivity leadership through the effective application and management of technology. The focus of this trimester will be the examination of emerging technologies and management techniques that have a potential for creating significant productivity improvements within the organization's value chain. Field trips to operational facilities, both domestic and abroad, will illustrate the development of technology applications in various organizational and geographical settings.

MSTM 654. Scanning Emerging Technologies (4)

This course will examine the linkage between technological change, competitive advantage and industry structures. Industry and university specialists will present the status and future trends of emerging technologies such as robotics, computer aided engineering, artificial intelligence/expert systems, and others. Emphasis will be on a technology assessment of the organization's internal value chain and the potential that the emerging technologies might offer for significant productivity gains.

MSTM 655. Implementing Technology Applications (4)

The focus of this course will be the analysis, implementation and management of technology in the operational environment. The role and responsibilities of the project manager will be reviewed together with an examination of current project management techniques. A variety of specialized methods and approaches such as flexible manufacturing systems, total quality control, computer integrated manufacturing, and others will be discussed.

Trimester IV: Commercializing Technology Developments

The promise of new technologies can be realized to the degree that executives reconsider the programs for marketing their products and services, as well as the procedures for acquiring and managing financial resources. The marketing function is being affected by more concentrated customer bases, severe timetables, and heavy fixed investment. Shorter product life cycles and higher risk environments typical of technological settings means that traditional approaches to financial statements and capital management are not adequate. Further challenge is introduced by the need to effect these changes in a global environment in which the term "domestic economy" may no longer have any meaning. As with the previous trimester, in-class case discussions will be enriched via a field trip to technological ventures being commercialized abroad.

MSTM 656. Bringing Technologies to Market (4)

This course will explore the balancing of market-driven and technology-driven approaches, researching appropriate markets and establishing sales potential, and incorporating changes in consumer expectations and behavior in the marketing program. Special consideration will be given to the design, testing and modification of flexible implementation programs in order to anticipate and successfully overcome competitive responses. Emphasis will be placed on exploiting technology's contributions throughout the value chain in product design, packaging, promotion, and distribution.

MSTM 657. Acquiring and Managing Resources (4)

This course will examine the financial assets required, payoffs, and risks for technological investments. The capital structure of technology firms and sources of funding for technology ventures will be explored. The acquisition of capital in international financial markets, managing currency exchange fluctuations, and capital movements within and between countries will be discussed. Current topics such as the development and structuring of strategic financial alliances, and projecting the effects of management actions on stock values and capital structures will be introduced.

Trimester V: Strategic Role of Technology

The theme of this trimester is the role of technology and innovation in the formulation and implementation of the organization's strategic thrust. The emphasis will be on the integration of technology into the vision, mission and management of a dynamic, competitive, organization. Business cases, the management computer simulation, resource speakers, and current strategic issues will be utilized to explore the many potential roles of technology in the organization.

MSTM 658. Strategic Management of Technology (4)

This course begins with a review of the strategic management process. Emphasis will be on technology as a strategic resource, and the linkages between strategic and technology planning. Non-traditional organizational forms will be examined including management of strategic alliances, networks and joint ventures within the cultural framework of the organization. Additional management topics such as the protection of intellectual property and ethical issues in the international arena will be discussed. Business cases, the management computer simulation, and other learning methods will be utilized to examine the role of technology management in the organization.

MSTM 659. Technology Management Project (4)

This course will provide an opportunity to prepare and present an integrated technology-oriented business project of significant importance to their organization utilizing the concepts, topics and methods learned during the program. The project may be strategic or operational in nature, as approved by the course professor. The student will also have a project advisor as appropriate for the project subject.

MSTM 699. Graduate Directed Studies (1-4)

Directed study is based on guided reading and independent study, supervised by one member of the faculty.

PEPPERDINE ADDRESSES THE CHALLENGE OF MANAGING ACCELERATING INTERNATIONAL TECHNOLOGICAL CHANGE WITH THE MASTER OF SCIENCE IN TECHNOLOGY MANAGEMENT DEGREE PROGRAM.

In order to prepare managers to anticipate and effectively compete in the international technology-driven business environment, Pepperdine University School of Business and Management will offer the Master of Science in Technology Management degree beginning in September 1989.

The specialized 40-unit graduate management program was designed to address the need for increasing industrial productivity as outlined by the President's Commission on Competitiveness and the National Research Council's Task Force on the Management of Technology. Dr. Richard Kaehler, Chairman of the M.S. in Technology Management program, has met extensively with executives and faculties of leading national and international business schools to create a program designed to provide managers with the tools to effectively manage the accelerating international technological changes in today's business environment.

Since technology may be effectively employed in new products, processes or services, this program has been developed to be of benefit to managers from all functional areas, not only in technology organizations but also, in manufacturing, distribution or service organizations who wish to explore the utilization of technology to achieve competitive advantage. A typical class will have participants from marketing, finance, operations, human resources, and research and development functions representing a broad industrial base.

The program will be conducted over a five-trimester period with classes scheduled every third weekend from 2:00 P.M. to 10:00 P.M. on Friday and 9:00 A.M. to 5:00 P.M. on Saturday. In addition to the formal course work, there are a number of additional required activities including: a four-day, live-in Effective Management Workshop, two field trips abroad, a weekend Management Computer Simulation Workshop, and the completion of a technology management project.

A student also has the option to pursue a course of study to earn the M.B.A. degree in lieu of the M.S. in Technology Management degree. If the M.B.A. option is chosen, the student must first complete all requirements of the Technology Management Program and subsequently complete an additional two trimesters of course work as prescribed by the Technology Management Program Committee.

A student who has already received an M.B.A. degree may earn the M.S. Degree in Technology Management by the successful completion of three trimesters of prescribed courses and the Technology Management Project, as well as, participation in the various program workshops.

MASTER OF SCIENCE IN TECHNOLOGY MANAGEMENT

The integrating theme for the program is the strategic management of technology in the global competitive environment.

TRIMESTER THEMES

I. Human and Cultural Issues In Technology Management	II. Impact of Science And Technology	III. Improving Productivity Through Technology	IV. Commercializing Technology Developments	V. Strategic Role Of Technology
--	---	---	--	--

TRIMESTER COURSES

<u>MSTM 650</u> Leading People In Innovation And Change	<u>MSTM 652</u> Understanding The Process and Impact Of Science	<u>MSTM 654</u> Scanning Emerging Technologies	<u>MSTM 656</u> Bringing Technologies To Market	<u>MSTM 658</u> Strategic Management Of Technology
<u>MSTM 651</u> Managing Organizations In Multi-Cultural Environments	<u>MSTM 653</u> Managing The Research And Development Organization	<u>MSTM 655</u> Implementing Technology Applications	<u>MSTM 657</u> Acquiring And Managing Resources	<u>MSTM 659</u> Technology Management Project

SPECIALIZED SEMINARS

Effective Management Workshop	Resource Speakers From Industry & Universities Local Visitations	International Field Trip Pacific Rim	International Field Trip Europe	Management Computer Simulation Workshop
-------------------------------------	--	--	---------------------------------------	---

This specialized 40 unit, 20 month, graduate management program was designed to prepare managers to anticipate and effectively compete in the international technology-driven business environment. Since technology may be effectively employed in new products, processes or services, this program has been developed to be of benefit to managers from all functional areas, not only in technology organizations but also, in manufacturing, distribution or service organizations who wish to explore the application of technology to achieve competitive advantage.

How Do You Survive on the Cutting Edge of Competition?

YOU PREPARE. If you are one of today's new breed of corporate managers, you must possess the knowledge and skill to contend with rapid technological innovation. Innovation in products, services, processes and strategies. You must be prepared to manage more than just day-to-day business affairs. You must be prepared to manage technology in your organization:

Polytechnic University, New York's largest and most important technological university, now offers an executive master's degree program in **Management of Technology (MOT)**, developed to meet the needs of working executives. If you want to acquire the knowledge and skills necessary to compete effectively in markets that are increasingly technological and constantly changing, you need look no further than Polytechnic University, where today's new breed of corporate managers will be trained.

State-of-the-art courses and concepts in the management of technology include:

- the management of R&D
- effective use of MIS
- effects of new technology on competitive strategy
- internal technology venturing
- effects of government policy on innovation
- strategic alliances for technology acquisition
- organizational behavior and management in innovative corporations

Polytechnic's Executive MOT Program classes start January, 1990. Classes meet every other week on Fridays and Saturdays at our Westchester Graduate Center in Hawthorne, New York. For information and application materials, call or write:

DR. A. GEORGE SCHILLINGER
Program Director, MOT
POLYTECHNIC UNIVERSITY
333 Jay Street
Brooklyn, NY 11201
(718) 260-3058 or (718) 260-3760



Polytechnic
UNIVERSITY

Today's University for Tomorrow's Technology

Honeywell Consultants, Ltd.

SUITE 1102, MIDWEST PLAZA BUILDING WEST, 801 NICOLLET MALL
MINNEAPOLIS, MINNESOTA 55402
TELEPHONE 612/870-5557

October 23, 1989

Professor Wychiel Shulman
University of Minnesota
107 Lind Hall
207 Church Street SE
Minneapolis, MN 55455

Subject: Master's Degree in Management of Technology

Dear Professor Shulman:

Thank you for sending the copy of the draft proposal for the Master's Degree in Management of Technology program. It affords me the opportunity to once again state that there is a very strong need in industry for this kind of technical management training, which supplements the excellent engineering training available at the University of Minnesota.

More specifically, there are very strong needs in industry for skilled technical managers, and much more attention must be given to supplementing their education with appropriate courses in finance, communications, marketing, manufacturing, etc. Additionally, it is important that more informal courses, such as seminars and the like, be established to address some of the more subjective management topics dealing with day-to-day problems.

As a member of the Curriculum Advisory Committee, I am pleased that we have developed a set of courses which does a good job of addressing some of these needs. It's been a pleasure working with members of Dean Infante's staff, as well as representatives of the Carlson School of Management, during the development process.

There are many interested and well-qualified candidates in industry, and I am sure that you will have no trouble attracting a large number of them to this offering. It is a particularly good outlet for those technical individuals who have had a number of years of experience and have shown a strong aptitude for a technical management career.

I am looking forward to continuing to work with you and members of the University staff in the future.

Sincerely,

Matthew A. Sutton

Matthew A. Sutton
Former Executive Vice President
Defense & Marine Systems
Honeywell Aerospace & Defense

MAS:jo

3M Engineering Systems Division

3M Center
St. Paul, Minnesota 55144-1000
612/733 1110



October 24, 1989

Dr. Yechiel Shulman
Acting Director
Center for the Development of
Technology Leadership
University of Minnesota
107 Lind Hall
207 Church Street
Minneapolis, Minnesota 55455

Dear Dr. Shulman:

There are a variety of engineering courses that develop and reinforce the technical skills required for product design. Through the application of these skills, designers create functionality, giving value to the final product. They also provide differentiating features, which are important for the competitive success of a business.

However, a perfect technical solution does not assure commercial success. In addition to its technical features, every product must meet cost and time constraints. These are issues of technology management rather than technical development, but they are equally significant to the success of the enterprise.

An effective technology manager must know when to make a decision, when to stop development and commit to manufacturing, when to add resources, and when to release a product for sale. The tools required for these decisions include a variety of planning and program management techniques. An individual skilled in the use of these tools complements the best technical specialists to create a competitive commercialization team.

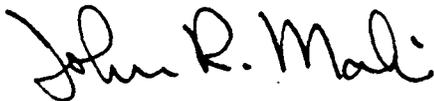
However, we have not emphasized within our engineering curriculum the management skills required to meet this need. The proposed Masters program in Technology Management provides a new vehicle for developing these skills, with particular focus on the practicing engineer. An engineer who recognizes the need to balance his technical tool set with fundamental management skills will now have an available development option.

Dr. Yechiel Shulman
Page 2
October 24, 1989

The Master of Science program in Technology Management brings into focus the value related issues, which are essential to successful commercialization of a product, providing the kernel for future technology management growth. It is needed by all those who wish to direct the commercial applications of technology.

I support the program and ask those who can influence its success to provide their personal support as well.

Sincerely yours,



John R. Maki
Technical Director
3M/Engineering Systems Division

JRM/mi

Honeywell

CLINTON O. LARSON
Corporate Vice President
Operations

November 1, 1989

NOV

University

E.F. Infante
Dean, Institute of Technology
University of Minnesota
105 Walter Library
117 Pleasant Street S.E.
Minneapolis, MN 55455

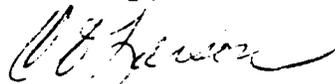
Dear Jim:

I recently had the pleasure of receiving an update on the progress of the University's Center for Development of Technological Leadership. The Honeywell Foundation has made a significant contribution to this effort, and I was pleased to hear of the progress made to date.

A key component of the center's programs will be the new Masters Program in the Management of Technology. This long overdue and much needed educational program shows every promise of providing the right combination of both a technological and a management knowledge base. I commend you, your colleagues at the Institute, and your colleagues at both the Carlson School of Management and the College of Liberal Arts for this thoughtful endeavor.

Please indicate, as appropriate, Honeywell's support for this new graduate program. We are eager to continue to work with you through the development and implementation process.

Sincerely,



C.O. Larson

COL/cab

cc: JE Chenoweth
P. Hoven
RP Heinisch
L. Sellers
LR Weisberg



NRG Energy, Inc.

Dr. Yechiel (Jack) Shulman
Acting Director
Center for Development
of Technological Leadership
University of Minnesota
107 Lind Hall
207 Church Street S.E.
Minneapolis, MN 55455

1221 Nicollet Mall Suite 731
Minneapolis, Minnesota 55403
Telephone (612) 330-6760
Fax (612) 330-6759

*A Subsidiary of
Northern States Power Company*

October 26, 1989

Dear Dr. Shulman,

During the recent past I served on your industry advisory committee formed to assist with initiating a Master's Degree program entitled **Management of Technology**. This program is intended for Engineers who are already employed by Industry and who are in or would want to pursue management/leadership positions.

At that time I was General Manager of the Plant Engineering and Construction Department at Northern States Power Company (NSP). About four months ago I accepted my present position of Director of Operations and Engineering for NRG Energy, Inc., a subsidiary of NSP.

I assure you that I wholeheartedly support your **Management of Technology** Master's Degree program and will do my best to communicate program value to Engineering managers and other potential Master's Degree candidates both at NSP and NRG.

Because NSP employs much larger numbers of engineers than does NRG, perhaps Pete Schappa, General Manager of Plant Engineering and Construction, or Dr. Max DeLong, Manager of Engineering, would be better on your advisory committee for the future. But that can be discussed at a later date.

In summary, we at NSP/NRG believe your Master's Degree program is very much needed and you should have no difficulty in filling minimum future student enrollment requirements.

Very truly yours,

Donovan D. Bohn
Director of Operations and Engineering

cc: Max DeLong
Pete Schappa

*Designing, constructing
and operating cost-effective
and environmentally clean
power plants*



MTS SYSTEMS CORPORATION

BOX 24012, MINNEAPOLIS, MINNESOTA 55424
TELEPHONE 612-937-4000 TELEX 29-0521 MTSSYSNPE
FAX 612-937-4515

30 October 1989

Professor Yechiel Shulman,
Acting Director
Center for the Development of Technological Leadership
University of Minnesota
107 Lind Hall
207 Church Street S.E.
Minneapolis, MN 55455

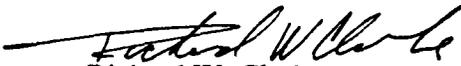
Dear Jack:

I wish to express my strong support of your proposed Master of Science program in Management of Technology. The need for engineers and scientists who are trained in the principles of management has never been greater. If U.S. industry is to be competitive in world markets, its technical and general managers must have a thorough base in technology, as well as a good grounding in the tools and the practices of management. Conventional courses of study do not satisfy this need. It is high time that American universities recognize this need and address it accordingly with appropriate graduate level programs.

I commend the University of Minnesota for recognizing this need and offering this program. Industry in our state can only benefit from participating in this effort. We will be looking forward to a productive cooperation between our company and the University.

Sincerely yours,

MTS SYSTEMS CORPORATION


Richard W. Clarke,
Corporate Vice President

RWC:fl



UNIVERSITY OF MINNESOTA
TWIN CITIES

Center for the Development of Technological Leadership
107 Lind Hall
207 Church Street S.E.
Minneapolis, Minnesota 55455
(612) 624-5747

November 7, 1989

To: Kenneth C. Zimmerman, Associate Dean
Graduate School

From: Yechiel Shulman 
W.R. Sweatt Chair
Acting Director, Center for the Development of Technological Leadership

Subject: Additions and Corrections to proposal for the Master of Science in Management
of Technology Program

Enclosed please find:

1. A letter of support from Dean Nantell of the Carlson School of Management.
2. Three additional letters of support from local industry received since the proposal was submitted. These are to be added to Appendix II.
3. Revised pages 2,3,5,27,28. These pages should replace the original pages bearing these numbers. These revisions were due to changes in the proposed budget.



TO: Dean Robert Holt

FROM: Tim Nantell *T Nantell*
Acting Dean

SUBJECT: Program Proposal for a Master of Science in Management of Technology

DATE: November 6, 1989

This proposed program represents a joint program, requiring the participation of IT, the Carlson School and other units as well. Such efforts can be difficult, but they present the university with many benefits. Problems and programs rarely fit into neat departments. We are happy to be able to participate in this imaginative approach to addressing the management of technology.

We spent a good deal of time over the last year visiting with technology firms regarding the desirability of exactly this kind of program. Although we have some concerns relative to how it competes with existing Carlson programs, CDTL and IT have shown genuine interest in designing the program so that it adds to the university offerings, as opposed to cannibalizing existing programs.

We expect to be a significant contributor of faculty. We think we have the expertise required and existing faculty are very interested in influencing the content of the program. In addition, as we understand it, the finances of the program are such that the faculty resources displaced by this program can be replaced at full cost.

I want to reinforce Dean Infante's comments regarding tuition, matching state support, and costs. The level of faculty talent, program support and facilities required to make this type a program a success are substantial. We know -- we have been offering an Executive MBA program to an audience and in a format similar to those proposed for this program. The program meets a demand and it addresses one of the major issues discussed in MSPAN. For these reasons, I will join with Dean Infante in raising the fundamental policy questions regarding how the university should be determining its support of this program.

c: Jim Infante
Gordon Beavers
Fred Beier
Carl Adams
Jack Shulman

Honeywell

CLINTON O. LARSON
Corporate Vice President
Operations

November 1, 1989

NOV

UNIVERSITY

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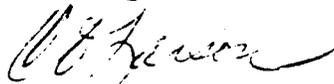
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Please indicate, as appropriate, Honeywell's support for this new graduate program. We are eager to continue to work with you through the development and implementation process.

Sincerely,



C.O. Larson

COL/cab

cc: JE Chenoweth
P. Hoven
RP Heinisch
L. Sellers
LR Weisberg



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Acting Director
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A Subsidiary of
Northern States Power Company

October 26, 1989

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Donovan D. Bohn
Director of Operations and Engineering

cc: Max DeLong
Pete Schappa

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BOX 24012, MINNEAPOLIS, MINNESOTA 55424
TELEPHONE 612-937-4000 TELEX 29-0521 MTSSYS ENPE
FAX 612-937-4515

30 October 1989

Professor Yechiel Shulman,
Acting Director
Center for the Development of Technological Leadership
University of Minnesota
107 Lind Hall
207 Church Street S.E.
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Sincerely yours,

MTS SYSTEMS CORPORATION

A handwritten signature in cursive script, appearing to read "Richard W. Clarke".

Richard W. Clarke,
Corporate Vice President

RWC:fl

6. Expected student interest in the program during the first year of operation and when the program reaches full operating level:

	<u>First Year - 1990-91</u>		<u>Full Operation - 1992-93</u>	
	Number	Hours	Number	Hours
	Expected	Generated	Expected	Generated
Program Enrollees	25		55	
Program Graduates	0		25	

7. Projected Costs of the Program:

UNIVERSITY OF MISSISSIPPI
 DEPARTMENT OF COMMUNITY DEVELOPMENT
 100 UNIVERSITY BLVD
 JACKSON, MISSISSIPPI 39208
 (601) 978-2100

	<u>First Year - 1990-91</u>				<u>Full Operation - 1992-93</u>			
	New		Reassigned		New		Reassigned	
	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost
a. Faculty	<u>1</u>	<u>\$ 100,000</u>	<u>1</u>	<u>\$ 100,000</u>	<u>2</u>	<u>\$ 200,000</u>	<u>2</u>	<u>\$ 200,000</u>
b. Acad. Profess.	<u>1</u>	<u>\$ 35,000</u>	<u> </u>	<u>\$ 0</u>	<u>1</u>	<u>\$ 40,000</u>	<u> </u>	<u>\$ 0</u>
c. Civil Service	<u>1/2</u>	<u>\$ 13,250</u>	<u>1</u>	<u>\$ 30,000</u>	<u>1</u>	<u>\$ 21,150</u>	<u>1 1/2</u>	<u>\$ 45,000</u>
d. Equip., Supplies		<u>\$ 25,000</u>		<u>\$ 0</u>		<u>\$ 55,000</u>		<u>\$ 0</u>
e. Space Rental		<u>\$ 0</u>		<u>\$ 0</u>		<u>\$ 0</u>		<u>\$ 0</u>
f. One-time Costs		<u>\$ 20,000</u>		<u>\$ 0</u>		<u>\$ 0</u>		<u>\$ 0</u>
g. Other		<u>\$ 41,750</u>		<u>\$ 0</u>		<u>\$ 91,850</u>		<u>\$ 0</u>
h. Total		<u>\$ 235,000</u>		<u>\$ 130,000</u>		<u>\$ 408,000</u>		<u>\$ 245,000</u>

8. Expected Sources of Funds for Program:

	<u>First Year - 1990-91</u>		<u>Full Operation - 1992-93</u>	
	Dollar Amount	% of Annual Expend.	Dollar Amount	% of Annual Expend.
a. State	\$ <u>0</u>	<u> </u>	\$ <u>0</u>	<u> </u>
b. Tuition	\$ <u>123,750</u>	<u>34 %</u>	\$ <u>272,250</u>	<u>42 %</u>
c. Federal	\$ <u>0</u>	<u> </u>	\$ <u>0</u>	<u> </u>
d. Endowment Income	\$ <u>125,000</u>	<u>34 %</u>	\$ <u>125,000</u>	<u>19 %</u>
e. Other	\$ <u>116,250</u>	<u>32 %</u>	\$ <u>255,750</u>	<u>39 %</u>
f. Total	\$ <u>365,000</u>	<u>100 %</u>	\$ <u>653,000</u>	<u>100 %</u>

9. Governing Board Preliminary Approval Date:

10. System Verification:

 Authorized Institution or System Signature

 Title

 Date

3. Cost of the Program

This program will not require the use of public tax funds or any other public resources. It will be financed entirely by endowment income, tuition and fees.

The program cost breakdown, as summarized in Section I.7 above, is as follows (note that the following figures include fringe benefits but do not include any overhead rate; an asterisk (*) denotes New):

I. <u>Implementation (1990-91)</u>	
a. Faculty:	
H.W. Sweatt Chair in Technological Leadership(*)	\$100,000
1 FTE reassigned faculty	100,000
b. Academic Professional:	
1 Program Coordinator(*)	35,000
c. Civil Service: 1 FTE reassigned secretary	
1/2 FTE new secretary(*)	13,250
d. Equipment and Supplies etc. (*)	25,000
e. One-time costs: Office eqpt, promotional material(*)	20,000
f. Other: books, accommodations, meals etc.	41,750
g. Total program costs:	<u>\$365,000</u>
II. <u>Full Operation (1992-93)</u>	
a. Faculty:	
H.W. Sweatt Chair in Technological Leadership(*)	\$100,000
W.R. Sweatt Land Grant Chair in Tech. Leadership(*)	100,000
2 FTE reassigned faculty	200,000
b. Academic Professional:	
1 Program Coordinator(*)	40,000
c. Civil Service:	
1 1/2 FTE reassigned secretary	45,000
1 FTE new secretary(*)	21,150
d. Equipment and Supplies etc. (*)	55,000
e. Other: books, accommodations, meals etc.	91,850
e. Total Program costs:	<u>\$653,000</u>

Remark on program cost: These figures reflect a portion of the total cost of the operation of the Center for the Development of Technological Leadership allocated to this program.

F. Implementation

1. Time Schedule

Subject to approval by the University of Minnesota Board of Regents and the Minnesota Higher Education Coordinating Board, it is planned for the first group of students to attend the program starting in the fall Quarter, 1990. By fall 1992, the program is expected to be in full operation.

2. University Resources Required

This program will not require the use of additional tax funds or any other public resources. No state subsidy funding is expected, at least initially. However, all tuition income is considered as marginal revenue and will be retained by the University and accrue to the program. The program will be financed entirely by endowment income (\$2.5 million over five years endowed by the Honeywell Foundation, matched by PUF funds) and by tuition & fees. No additional physical facilities, except for the use of an existing lecture room for one full day per week, are needed. Access to computational facilities and existing library resources will be required.

(Note that the following figures include fringe benefits but do not include any overhead rate; costs are designated as new (*) or as reassigned costs.)

I. <u>Implementation (1990-91)</u>		
a. Faculty:		
H.W. Sweatt Chair in Technological Leadership(*)		\$100,000
1 FTE reassigned faculty		100,000
b. Academic Professional:		
1 Program Coordinator(*)		35,000
c. Civil Service: 1 FTE reassigned secretary		
1/2 FTE new secretary(*)		13,250
d. Equipment and Supplies etc. (*)		25,000
e. One-time costs: Office eqpt, promotional material(*)		20,000
f. Other: books, accommodations, meals etc.		41,750
g. Total program costs:		<u>\$365,000</u>

II. Full Operation (1992-93)

a. Faculty:

H.W. Sweatt Chair in Technological Leadership(*)	\$100,000
W.R. Sweatt Land Grant Chair in Tech. Leadership(*)	100,000
2 FTE reassigned faculty	200,000

b. Academic Professional:

1 Program Coordinator(*)	40,000
--------------------------	--------

c. Civil Service:

1 1/2 FTE reassigned secretary	45,000
1 FTE new secretary(*)	21,150

d. Equipment and Supplies etc.(*):

	55,000
--	--------

e. Other: books, accommodations, meals etc.

	91,850
--	--------

e. Total Program costs:

	<u>\$653,000</u>
--	------------------

Remark on program cost: Part of these figures reflect that portion of the total cost of the operation of the Center for the Development of Technological Leadership allocated to this program.

3. Extra-University Resources

It is anticipated that a select number of people from industry, with proper credentials and qualifications, may serve on project advisory committees in the program.

HANDOUT
11/21/89

**University of Minnesota
Center for the Development of Technological Leadership
Master of Science in Management of Technology**

Program Fact Sheet

The Program:

- * Master of Science in Management of Technology (MOT), a two-year part-time interdisciplinary graduate program.
- * Participating units are the Institute of Technology, Carlson School of Management, College of Liberal Arts and the H.H. Humphrey Institute of Public Affairs.

The Audience:

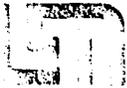
- * Individuals with a bachelor's degree in engineering or physical science and a minimum of five years professional experience in their technical field;
- * Practicing engineers or scientists who are, or expect to be, in technology management positions.
- * Students are expected to have specific knowledge in statistics, micro and macro economics, mathematical modeling.

The Curriculum:

- * Total required credit hours: 52.
- * 46 credits are represented by courses in the following areas:
 - Communication in organizations
 - Managerial accounting
 - Management of professionals
 - Economics of technology and development
 - Financial management
 - Marketing of advanced technology systems and products
 - Strategic technology management
 - Recent advances in technology
 - Project management
 - Technology management seminar
 - Manufacturing for competitive advantage
 - Quality management and reliability
- * 6 credits are represented by a required Project

Vicki

Office of the Dean



UNIVERSITY OF MINNESOTA
TWIN CITIES

Graduate School
Johnston Hall
101 Pleasant Street S.E.
Minneapolis, Minnesota 55455-0421

27 November 1989

Professor Yechiel Shulman
Acting Director
Center for the Development of
Technological Leadership
107 Lind Hall
East Bank Campus

Dear Professor Shulman:

As you know, the Graduate School Executive Committee, at its meeting on 21 November, voted unanimously to approve the proposal for an M.S. degree program (Plan B) in Management of Technology. This action followed recommendation by the Social Sciences Policy and Review Council on 8 November, and by the Physical Sciences Council on 13 November. You will recall the line of questioning by the Physical Sciences group and that Council's motion to endorse the proposal, but with the understanding that no student will be excluded from the program on the basis of an affiliation, or lack of an affiliation, with a sponsoring agency. The Graduate School will expect the program, when finally approved by the University, to honor the spirit of the Council's motion.

The proposal will be forwarded to the Board of Regents with a request for their initial consideration of the document in January 1990.

Sincerely yours,

Robert T. Holt
Dean

RTH/vf

cc: Professor Darrell A. Frohrib
Professor John Fraser Hart
Dean E. F. Infante
Dean Timothy J. Nantell
Dean Kenneth Zimmerman

GRADUATE SCHOOL

JUL 12 1990

OFFICE OF THE DEAN



UNIVERSITY OF MINNESOTA
TWIN CITIES

Center for the Development of Technological Leadership
107 Lind Hall
207 Church Street, S.E.
Minneapolis, Minnesota 55455

Voice: (612) 624-5747

FAX: (612) 626-0261

Internet: shulman@mailbox.cdtl.umn.edu

July 11, 1990

C: BM
LN
KZL

To: Robert T. Holt
Dean, Graduate School

From: Y. Shulman
Director, CDTL

Subject: Admission to the Master of Science in the
Management of Technology Program

This is in response to your memo of May 31 regarding the above, and confirms our discussion of yesterday.

For a number of reasons, both pedagogical and others, the limit on enrollment in the MS-MOT program has been set at 40 students. Based on the number of applications to date, we expect the total number of applicants to be near this limit.

The Applicant Profile we described in our May 15 memo was set deliberately without a formal minimum GPA requirement. Although we will certainly consider the applicant's undergraduate record, we strongly believe that for this program, which is aimed at practicing technical professionals with a minimum of five years of experience, the applicant's professional track record should weigh much more heavily in the decision process. In addition, we will consider in the admission process the three letters of recommendation from the applicant's supervisors and upper management, and the results of the personal interview conducted with each applicant by myself and/or Carl Adams. Some of the criteria used in the evaluation are: suitability to pursue graduate studies, potential for technical leadership, degree of maturity and commitment, and seriousness of purpose.

With regard to the application deadline, based on our discussion it is my understanding that all applications received by the deadline, even though they may lack the transcript(s), will be considered for admission for Fall 1990.

cc: Carl Adams



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Plant Biology
220 Biological Sciences Center
1445 Gortner Avenue
St. Paul, Minnesota 55108

(612) 625-1234
FAX: 612-625-5754

17 October 1989

Dr. K. C. Zimmerman
Associate Dean, Graduate School
325 Johnston Hall
Minneapolis Campus

Dear Dean Zimmerman:

Enclosed please find the final version of the proposal to form a graduate program in Plant Biological Sciences. In essence the proposal is to abolish the Botany Graduate Program and to change the name of the Plant Physiology Program to Plant Biological Sciences. With the restructuring of the two programs the committee which developed the proposal thought that it was an appropriate time to redefine curriculum and thesis requirements. These changes include a broader curriculum exposure and a well-defined thesis proposal. We are convinced that our proposed restructuring of plant sciences on the St. Paul Campus will lead to Minnesota being one of the premier universities in the U.S. in plant studies.

The rationale and background for this restructuring are given in the text. Briefly, however, the proposal is the fruition of almost two years of planning. The document was prepared over the last nine months by an intercollegiate committee of 12 individuals representing faculty and graduate students from Agronomy and Plant Genetics, Horticulture, Genetics, Ecology, and Botany. Their efforts resulted in the proposal being overwhelmingly supported by the graduate faculties of Botany and Plant Physiology. The final vote was 35 in favor of restructuring with one opposing vote. Thus, the faculty has demonstrated that they are willing to exert the effort to put the program in place.

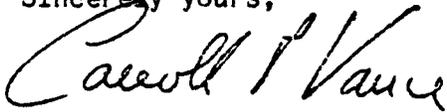
The proposal has been discussed with and approved by administrators, both deans and department heads, on the St. Paul Campus. A letter reflecting such support from Deans Magee and Wharton should arrive at your office within the next two weeks.

The proposed restructuring of graduate programs in plant sciences is dependent upon your continued financial and moral support. We anticipate that the block grant allocation to the two programs will remain intact and perhaps even be increased. Any efforts that the Graduate School can make to enhance the attractiveness of the DGS position for such a large program would also be appreciated.

In conclusion, the committee would like to have our proposal for restructuring considered by the next meeting of the Plant and Animal Science Policy and Review Council.

I look forward to your comments and your consideration.

Sincerely yours,



Carroll P. Vance
Director of Graduate Studies
in Plant Physiology and Chairperson.
Committee to Develop Plant Biological
Sciences Graduate Program

CPV:emh .

cc: Dean K. W. Wharton
Dean P. T. Magee

Proposal for a
Graduate Program in Plant Biological Sciences

Committee Members: Mike Bartolo, John Carter, Chris Cole, Ed Cushing,
Wes Hackett, Bud Markhart, Liza Martinez, Dave McLaughlin, Neil Olszewski, Tom
Soulen, Carroll Vance.

Background

During early 1988 Vice President Allen (Agriculture) and Dean Magee (Biological Sciences) established a committee to evaluate the status and future of plant sciences on the St. Paul Campus. One of the primary recommendations of the Allen-Magee Plant Science Committee was that action be taken to evaluate the desirability and feasibility of establishing an interdepartmental graduate program in plant studies that would combine the existing graduate programs in Botany and Plant Physiology.

In the final stages of the reorganization of the Department of Botany into the Department of Plant Biology (late 1988), the Directors of Graduate Studies (DGS) of the Botany and the Plant Physiology Graduate Programs were requested, by the acting head of Plant Biology, to establish an ad hoc committee to act upon the recommendation of the Allen-Magee Plant Science Committee.

At the request of the DGSs, members of the combined graduate faculties of Botany and Plant Physiology met on two separate occasions to consider the possibility of merging the two programs.

Although a number of questions and concerns were identified, it was agreed that a new program resulting from such a merger might offer distinct advantages over the existing programs. A committee of five members of each faculty and three students was formed to consider the matter and to prepare a draft proposal if such were deemed appropriate. Committee members agreed at their second meeting to work on a proposal for a single program, thinking that graduate training in plant studies at the University of Minnesota could be enhanced significantly by formation of such a program.

Rationale and Benefits

The present graduate faculties in Botany and in Plant Physiology number 21 and 36, respectively. The Botany Graduate Program faculty is comprised primarily of members of the Plant Biology Department. In contrast, the Plant Physiology Graduate Program faculty members are widely dispersed among seven departments and three colleges. Furthermore, ten members of the Botany Graduate Faculty also hold appointments in the Plant Physiology Graduate Program. Currently there are 23 and 32 graduate students in the Botany and Plant Physiology Programs, respectively. Because of the considerable overlap in the faculty membership of the two programs a consolidated Botany/Plant Physiology Graduate Group would be comprised of 46 faculty (only ten more than the present Plant Physiology Program, Appendix III) and 55 graduate students.

The first and foremost benefit of such a merger would be the enhancement of graduate education in the plant sciences at Minnesota due to a strengthening of the graduate student curriculum. Such strengthening would come about by new requirements that would expose the student to the diversity of plant biology and also allow specialization in formalized areas not now provided by existing programs. The anticipated result would be a more flexible curriculum and graduate study programs more closely tailored to a student's primary interest. Additionally, the merger could provide a critical mass of active

faculty and students involved in research that is currently under-represented.

A second major benefit of a union would be an enhanced image of plant biology at Minnesota. Consolidation into a single graduate group could serve to heighten our visibility as a major element of the Life Sciences at Minnesota. If this were achieved we could benefit from more favorable recognition from the University administration and from greater interest from prospective graduate students.

Lastly, merging the two groups would increase efficiency due to consolidation of administrative functions. Because administration of the two groups is presently handled in the Plant Biology office, this would simply involve the elimination of repetitive tasks required for both groups. The functions of the executive and other committees would be carried out by committees elected from the joint membership, thus reducing faculty time in committee meetings.

Need for Program

The need for plant scientists with comprehensive background and basic training in ecology, systematics, physiology, structure, and biotechnology, providing the fundamental base for specialized research is documented in at least four national reports: 1) New Directions for Bioscience Research in Agriculture, National Academy of Sciences (1985); 2) Time to Revive Systematics, Science 230:1227 (1985); 3) NSF Report on Biotechnology, Science 231:212 (1986); and 4) Crop Productivity Research Imperatives Revisited (1986), eds. M. Gibbs and C. Carlson. The particular needs for Ph.D.s with such basic training is clearly demonstrated by recent faculty searches in Agronomy, Plant Biology, Horticulture, Forestry, and Plant Pathology.

A comprehensive graduate program offering a Ph.D. in the basic plant sciences would be unique to the University of Minnesota in the state of Minnesota. Moreover, such a program does not exist in neighboring states in the upper midwest. A second unique feature of this program would be the capability to examine plants from the subcellular and molecular to the whole plant and community levels of biological organization. This feature allows graduate students the opportunity to obtain course, teaching, and research experiences over diverse multidisciplinary areas. Such exposure will increase the student's marketability for future employment and enhance their ability to obtain extramural funding during their postgraduate careers.

Program Structure

1) Objectives

The objectives of the graduate program in Plant Biological Sciences is to provide graduate students with: 1) an integrated framework and cognitive structure for understanding plant biology; 2) skill: for the synthesis of information and the recognition of researchable problems of significance; and 3) the capabilities for independent scholarship, with attributes necessary for professional development.

2) Administrative Structure

Primary administrative responsibility for the conduct of program affairs will be vested in the Director of Graduate Studies (DGS). The DGS will be elected by a majority vote of the program faculty and will serve for a period of three years. The DGS cannot serve more than two consecutive terms. Substantial departures from existing program guidelines will be subject to majority approval of the existing program faculty.

On matters that require a broader base of input from the various areas of specialization within the program, the DGS will consult with a committee of additional graduate faculty members who will serve as a Steering Committee (SC). The role of the SC will be to consult with and advise the DGS on policy, interdepartment and intercollegiate matters, graduate faculty nominations, etc. The SC in collaboration with the DGS will also be responsible for review of faculty participation in the program.

3. Committees

A. Steering Committee: The Steering Committee (SC) shall be comprised of the DGS and four elected members. The elected members shall be selected from and represent each of the four major areas of specialization (emphasis):

Area A - Cell and Molecular Biology

Area B - Plant Physiology

Area C - Plant Structure, Diversity, and Development

Area D - Ecology, Systematics, and Evolution

Members of the SC will be elected by the graduate faculty to serve two-year terms staggered such that two persons are elected each year. The SC shall assist the DGS in administrative matters as outlined in item 2 above.

B. Exam Committee: The Exam Committee (EC) shall be comprised of four members appointed by the DGS and will serve a one-year term. The DGS shall select one member to represent each area of specialization (emphasis). The committee members will elect a chair. The EC will be responsible for all matters pertaining to the written preliminary examination for the Ph.D.

C. Admissions Committee: The Admissions Committee (AC) shall be appointed by the DGS and be comprised of four members, one representing each area of specialization (emphasis). The DGS will serve as ex officio member of this committee. The AC will meet as a whole as necessary for timely processing of applications.

The first charge to this committee will be to review current admissions

procedures of several programs and to develop a mechanism that will provide appropriate communication to the Plant Biological Sciences faculty regarding the pool of applicants and admission status of each applicant.

D. Curriculum Committee: The Curriculum Committee (CC) shall be appointed by the DGS and be comprised of one member representing each of the four areas of specialization (emphasis). The CC will have responsibility for any necessary review of program courses as well as overall curriculum. The CC shall continuously evaluate whether the courses taught effectively facilitate the program's students passing of written and oral preliminary exams and prepare the student for a career in plant biology.

The first charge of this committee shall be to evaluate whether the program should develop a core series of courses. The second charge shall be to develop guidelines for M.S. and Ph.D. thesis proposals.

E. Financial Aid Committee: The Financial Aid Committee (FAC) shall be appointed by the DGS and be comprised of one member representing each of the four areas of specialization (emphasis). The FAC shall be responsible for evaluation and distribution of all awards. This committee, in collaboration with DGS, will be responsible for nominating students for Graduate School Fellowships, Doctoral Dissertation Fellowships, and other endowed fellowships (e.g., Louise T. Dosdall Fellowship for Women in Science). An additional role for the FAC shall be to advise the DGS regarding the amount and number of travel awards for students to participate in annual meetings.

The first charge to this committee will be to evaluate current awards given by Botany and Plant Physiology and to recommend changes for fair and equitable competition among current students. This committee will also recommend any revisions to current awards.

F. Colloquium Committee: The Colloquium Committee shall be comprised of two faculty, two students, and two post-doctoral research associates and be appointed by the DGS. The Colloquium Committee will be responsible for organizing a weekly seminar series. The series will be arranged around invited presentations by outside speakers, program graduate faculty, and by students enrolled in the seminar course.

4. Membership in the Plant Biological Sciences Graduate Faculty

All current members of the graduate faculties of Plant Physiology and Botany will become members of the Plant Biological Sciences Graduate Program (see Appendix I). Future members of the graduate faculty for Plant Biological Sciences will be chosen so as to maintain excellence and focus in the basic plant sciences.

A. Procedure for Application to the Graduate Faculty

- a. Indicate to the Director of Graduate Studies an interest in membership and willingness to fulfill responsibilities.
- b. Provide the DGS with:
 1. A letter indicating the rationale for one's interest in the Plant Biological Sciences graduate program.
 2. Curriculum vitae.
 3. A copy of three recent and representative reprints or "in press" manuscripts.
- c. If it would be informative for the purposes of considering the appointment, present a seminar which faculty could attend.
- d. A favorable vote by the Steering Committee is required to forward the recommendation to the Graduate School. The final decision on admission is made by the Graduate School.

B. Criteria for Membership

Criteria for maintaining active membership in the graduate faculty will be based on service in one or more of the following:

1. Advising graduate students.
2. Participation in graduate level teaching (courses, directed studies, lab rotations, seminars).
3. Committee membership and activity.
4. Presentation of seminars.

The nature and level of faculty participation in the program will be reviewed at five year intervals by the Steering Committee. The Steering Committee will request from each Plant Biological Sciences Graduate Program member documentation of activity in the program. Results of the review will be brought to the attention of Department Heads to be placed in the respective faculty member's personnel dossier. Faculty members who fail to participate in the program will be requested to resign or to provide just cause for lack of activity.

C. Identification of Faculty Specialization Areas

Upon appointment to the graduate faculty each member will identify their area(s) of specialization from the four identified in item 3A. No more than two areas may be selected. Identification with a specific interest area makes one eligible for serving as a committee representative for that area.

5. Admission Requirements for Prospective Students

Incoming graduate students are ordinarily expected to have completed coursework in differential and integral calculus, organic and inorganic chemistry, genetics, plant and animal biology, and one year of physics. For students of demonstrated ability, background deficiencies can be made up during the first year of graduate studies. All students admitted will have an advisor identified.

Applicants should submit three letters of recommendation from persons familiar with their academic and research capabilities; scores from the General and Subject Test (biology) of the Graduate Record Examination; a complete set of transcripts; and a statement of interests, goals, and objectives. Students may enter the program at any time, but the deadline for certain fellowship applications is January 15.

Because verbal and written communications are integral facets of the Plant Biological Sciences Graduate Program, non-English language foreign applicants are required to have a minimum TOEFL score of 500. Upon establishing residency at the University of Minnesota, non-English speaking students are required to take the Spoken English Assessment Kit Test (SPEAK). Students scoring below 230 on the SPEAK test must take the two course series ESL Listening and Speaking.

6. Program Description

I. Course Requirements

Course requirements for each graduate student will depend upon both past training and future goals but it is expected that all will have the following elements in common:

- i) Multidisciplinary Core Curriculum
- ii) Thesis Proposal
- iii) Specialization in a Specific Area of Knowledge

i. Multidisciplinary Core Curriculum

Students are expected to take a minimum of six courses, comprised of at least one course from each discipline area and two or more from the primary area of specialization.*

The discipline areas and courses that will satisfy distribution requirements are:

Area A: Cell and Molecular Biology

PBio 5141 Cell Biology
PBio 8287 Plant Molecular Biology
PlPa 5109 Biochemistry-Molecular Biology of Fungi
Agro 8230 Cytogenetics

Area B: Plant Physiology

PlPh 5131 Survey of Plant Physiology
PlPh 5182 Plant Metabolism
PlPh 5183 Water, Minerals, and Translocation
PlPh 5184 Plant Growth and Development
Hort 5041 Environmental Physiology of Plants

Area C: Plant Structure, Diversity, and Development

PBio 5103 Algae, Fungi & Bryophytes
PBio 5231 Introduction to the Algae
PBio 5111 Cell, Tissue & Organ Development

PBio 5105 Morphology of Vascular Plants

Area D: Ecology, Systematics, and Evolution

EBB	5014	Ecology of Plant Communities
EBB	5052	Theoretical Population Ecology
EBB'	5016	Ecological Plant Geography
PBio	5221	Plant Molecular Evolution and Population Biology
Hort	8023	Evolution of Crop Plants

*With the approval of the student's advisory committee 3 credit hours in either seminar courses and/or directed studies can satisfy one course requirement.

ii. Thesis Proposal

A thesis proposal will be required of all M.S. Plan A and Ph.D. students. The thesis proposal shall be a scholarly development of the thesis project and should include identification of the problem, survey of the literature, materials and methods, experimental design and anticipated achievements.

iii. Degree Requirements

I) Master's Degree Requirements

1) The program should be completed in approximately two years with a minimum GPA of 2.8. The student must file an official program no later than the 3rd quarter of registration. All requirements must be completed within 7 years, starting with the oldest work listed on the official degree program. A final oral examination is required by the Graduate School.

2) Plan A (with thesis)

a) The program must have at least 20 credits in the major field and 8 credits in one or more related fields, making a total of 28 quarter credits. If a minor is selected, 9 or more credits are required in a single field, and they must be approved by the Director of Graduate Studies of that field. The six core curriculum courses taken to satisfy the M.S. requirement may also satisfy the Ph.D. course requirements.

b) After the topic for the thesis has been selected, the composition of the advisory committee may be altered by the DGS depending upon the recommendations of the adviser and/or the advisory committee.

c) A brief thesis proposal will be required. The proposal will deal with background, rationale, and anticipated results for the project.

d) A seminar dealing with the results of the thesis research is expected of all candidates. This seminar shall be presented in the program's Colloquium Series.

3) Plan B (without thesis)

a) The minimum credit requirement is 44. Of these, at least 20 credits must be in the major field and a minimum of 8 credits in one or more related fields outside the major; the remainder are to be chosen by agreement among the student, the adviser, and the advisory committee. If the student selects a designated minor field, the minimum is 9 credits and must be approved by the DGS of that field.

b) While a thesis project is not required, all Plan B candidates shall develop a thesis proposal that shall be presented as part of the Student Thesis Proposal Colloquium.

4) All M.S. candidates are required to participate for one quarter in a teaching or training experience. Prior to the student's involvement as a teaching assistant, he/she will be required to take a teaching methods course (Agronomy 8000 or equivalent).

II. Ph.D. Requirements

1. In addition to the requirements stated in the graduate school bulletin, other than the 6 course from the multidisciplinary core curriculum, there are no set course requirements for the Ph.D. Appendix I gives sample programs.

2. The program should be completed in 3-4 years for students holding an M.S. and 4-5 years for students holding a B.S.

3. The official program should be filed not later than the end of the 2nd year. Candidacy for the degree is established after the oral preliminary examination has been passed. A written preliminary examination in the major is required and must be passed before the oral can be scheduled.

4. The written and oral preliminary examinations shall be taken as expeditiously as possible and no later than the second year in residence.

5. The written examination will be given once each year, during the break between winter and spring quarters. Six weeks before that date students taking the exam will be given 16 research papers, consisting of four papers from each of the following areas:

1. Plant cell and molecular biology;
2. Plant physiology;
3. Plant structure, diversity, and development;
4. Plant ecology, systematics, and evolution.

The examination will be given over two days, divided into four three-hour periods. Three questions will be posed in each area and students will answer all three. The questions will be designed to test understanding as exemplified by the assigned papers. Protocols, grading, and retaking of the written exam are described in detail in Appendix II.

6. The oral preliminary examination will be scheduled soon after passing the written preliminary examination. The oral examination committee shall be comprised of five members of the graduate faculty and will be chaired by someone other than the student's advisor. Members of the students Research Advisory Committee may serve on the oral examination committee. While the oral examination is designed to evaluate the student's comprehension of his/her area of specialization, this exam may also include broader concepts and one phase may deal with the thesis proposal.

7. The thesis proposal shall be completed by the end of the second year of residence. The proposal shall be developed along the lines of a grant proposal application. A seminar dealing with the thesis proposal shall be presented to program students and faculty as part of the Student Thesis Proposal Colloquium.

Prior to the scheduling of the oral preliminary exam, the thesis proposal must be approved and accepted by the students Research Advisory Committee. Questions regarding the thesis proposal may comprise one phase of the oral exam.

Each student shall have a Research Advisory Committee. This committee shall, with the approval of the DGS, be student and advisor selected and be made up of no less than three members. Committee members will be responsible for reading, editing, and approving the thesis proposal. Research Advisory Committee members may serve as members on the student's oral examining committee and final thesis examining committee.

8. All Ph.D. students are required to participate for two quarters in a teaching or training experience. Prior to involvement as a teaching assistant he/she will be required to take a teaching methods course (Agronomy 8000 or equivalent). Students having prior experience in teaching may petition the DGS to waive this requirement.

Course instructors will be required to provide an evaluation of student teaching assistants (up to one page). This evaluation will become a part of the student's file.

9. Two non-credit seminars are required for all Ph.D. students. One, presented near the end of the second year in residence, shall deal with the subject matter of the student's thesis proposal. The second, presented near the end of the student's program, shall be a presentation of research results. The second seminar shall be presented as a part of the Plant Biological Sciences Colloquium.

10. Exceptions to the time schedule for these requirements may be made upon petition to the Director Graduate Studies.

Appendix I. Sample Ph.D. Programs

Agro 8230	Cytogenetics	4 cr
PBio 5111	Plant Cell, etc. Development	5 cr
PBio 5141	Plant Cell Biology	3 cr
PBio 5182	Plant Metabolism	3 cr
PBio 5184	Plant Growth and Development	3 cr
PBio 5221	Plant Molecular Evolution	3 cr
PBio 8287	Plant Molecular Biology	3 cr
PBio xxxx	Seminars	2 cr
BioC 5751/2	General Biochemistry	8 cr
BioC 8225	Tracer Techniques	3 cr
GCB 8131/2	Adv. Genetics I, II	8 cr
EBB 5014	Ecol. of Plt. Communities	5 cr
EBB 5052	Theoret. Population Ecology	4 cr
PBio 5103	Algae, Fungi, Bryophytes	5 cr
PBio 5131	Survey Plant Physiology	4 cr
PBio 5141	Plant Cell Biology	4 cr
PBio 5801	Plains and Boreal Flora	5 cr
PBio xxxx	Seminars	2 cr
Stat 5021	Statistical Analysis I	5 cr
EBB 5044	Evolution	4 cr
EBB 5601	Limnology	4 cr
FW 8452	Conservation Biology	3 cr
PBio 5111	Plant Cell etc. Development	5 cr
PBio 5131	Survey Plant Physiology	4 cr
PBio 5141	Plant Cell Biology	4 cr
GCB 5xxx	Molecular Biology	4 cr
Agro 8230	Cytogenetics	4 cr
PBio 5221	Plant Molecular Evolution	3 cr
PBio xxxx	Seminars	2 cr
GCB 8148/9	Adv. Cell Biology I, II	8 cr
BioC 5002	Topics in Biochemistry	3 cr
PlPh 5723	Plant Hormones, Tissue Culture	3 cr

M.S. programs could include 5-6 "major" courses (as long as total credits = 20), plus 8 additional credits, possibly chosen from the following:

Biol 5001 (Biochemistry), BioC 5002 (Topics in Biochem.)

Stat 5021, 5301 (Designing Experiments)

GCB 5033 Population/Quant. Genetics

GCB 5035 Intermed. Cell Biology

PBio 5132 Plant Physiology Lab

GCB 5052 Quantitative Techniques in Cell Biology

GCB 5001, 5002 Scanning, Transmission EM Lab

(or some of the courses included in the 3 programs above)

A number of these courses also would be appropriate in Ph.D. programs.

Appendix II. Ph.D. Written Examination in Plant Biological Sciences

Purpose. The Ph.D. written examination is given by the graduate faculty in Plant Biological Sciences to evaluate a student's ability to read, comprehend, and critically evaluate the literature in plant biology and to write clearly and precisely about current questions within plant biology as a whole.

Administration. All students admitted for the Ph.D. degree in Plant Biological Sciences must take the written examination no later than spring of their second year after admission, except that students who enter with a Master's degree are expected to take the examination before spring of their first year after admission. The written examination must be passed before the preliminary oral examination can be taken.

Any student, including those who enter with only a bachelor's degree, may take the examination in the spring of the first year of study, and well-prepared students are encouraged to do so. A non-passing score for a first-year student who takes the examination will not be included in the student's permanent file, and the student may retake the examination or its parts in spring of the second year without prejudice. Students who voluntarily take the examination in their first year thus increase their chances of successfully completing the requirement both by having experienced the examination before their second year and by having up to three opportunities to pass it.

The examination will be given once each year in March, during the break between winter and spring quarters. Six weeks before that date, students who are taking the examination will be given a set of 16 research papers drawn from the literature in plant biology. These will consist of four papers in each of the following general areas:

- Plant cell and molecular biology
- Plant physiology
- Plant structure, diversity, and development
- Plant ecology, systematics, and evolution

The papers will ordinarily report the results of current research, but classical research papers in plant biology may also be included.

The examination will be given over two days, divided into four three-hour periods, one period for each of the four areas. Three questions will be posed in each area, and students will answer all three, with a total examination time for the area of three hours. The questions are designed to test understanding of the area as exemplified by the assigned papers, and a single question may refer to only one, or to more than one, or the four papers assigned. Fresh copies of the papers will be supplied with the examination, but no other materials are permitted.

The answers of a student will be identified only by an individual code number given to the student by the graduate secretary. This anonymity helps to

ensure that the answers will be graded without prejudice or bias. A student's identity will not be revealed until all examinations have been graded and the results, tallied by the graduate secretary, have been discussed and evaluated by the examination committee.

Examination Committee. An examination committee will be appointed by the Director of Graduate Studies, consisting of one faculty member for each of the four areas of the exam. One of the four members will serve as chair of the committee. Each member will also chair an area subcommittee, consisting of all graduate faculty who volunteer papers and questions for that area. Each member of the graduate faculty is expected to suggest at least one paper, with an accompanying question, to at least one subcommittee. The subcommittees will meet to review the papers and questions submitted, to select those to recommend for their area, to clarify questions where necessary, to discuss and agree upon the criteria to be used in grading answers to each question, and to assign three graders for each question.

The examination committee will meet to review the questions recommended by the subcommittees in order to eliminate overlap among areas, check the clarity of the questions, and ensure balance in the entire examination. When necessary for clarification, the committee may refer a question back to the subcommittee that recommended it.

The chair of the examination committee is responsible for preparing and administering the examination and, following the examination, for distributing the answers to the graders assigned to each question.

Evaluation of the examination. The answers for each question will be read and graded by three faculty members assigned by the subcommittee for that area, following the criteria established by the subcommittee for that question. The three readers will grade answers on a scale of 5 (outstanding), 4 (very good), 3 (acceptable), 2 (nearly acceptable), 1 (unacceptable). For each student's answer, the scores of the three readers will be averaged to determine the score for that question. If the scores for one question differ by more than two units on the scale, the graders will meet to discuss and resolve their differences, or a fourth reader may be appointed by the subcommittee chair.

The scores for the three questions in each area will be averaged to obtain a score for that area. An average of 3.0 or greater is required to pass an area.

If a student's score for only one area is below 3.0, but not below 2.0, the student can correct that deficiency either by retaking that area of the examination the following year or by satisfactorily completing a course of directed study in that area. The result of the directed study will be evaluated by a member of the subcommittee in that area and reported to the Director of Graduate Studies.

If a student's score for an area is below 2.0, or if the scores for two or more areas are below 3.0, the student must retake those areas of the examination the following year. The examination or its parts may be retaken only once. A score below 3.0 on any area that is retaken constitutes a

failure of the examination.

Students who fail the Ph.D. written examination a second time (or a third time for those students who enter the program without a Master's degree and take the examination in their first year) will be permitted to assemble a written file to document their record of productivity in the program and to demonstrate why the examination results may not indicate their potential. This appeal must be submitted to the Director of Graduate Studies within two weeks after the announcement of the examination results, and it must be accompanied by a letter of support from the student's advisor. The file submitted should be at least as complete as that of a prospective student applying to the program and should include other documentation the student believes may be relevant to the appeal, such as teaching evaluations, details about research capabilities, and letter or comments from faculty members who have worked closely with the student and wish to support the student's appeal. This file will be reviewed by the examination committee, which will make the final decision whether to allow the student to continue in the program. A student who is allowed to continue must then take an individually designed written examination within three months of the date the decision is made. Failure to pass this examination excludes the student from continuing toward the Ph.D. degree in the Plant Biological Sciences Program.

Appendix III. Faculty Vitae

DEBORAH L. ALLAN - Assistant Professor, Soil Science

BA - Grinnell College, Iowa, 1973

MA - University of Pennsylvania, 1976

MS - California Polytechnic State University, 1983

PhD - University of California, Riverside, 1987

Current Research Interests

Mechanisms of plant adaptation to nutrient stressed environments; characterization and quantification of plant root exudates and their effects on nutrient availability; effects of cell wall binding on plant nutrition.

Journal References:

Allan, D.L. and W.M. Jarrell. Proton and copper adsorption to maize and soybean root cell walls. *Plant Phys.* In Press.

Rosen, C.J., D.L. Allan and J.J. Luby. Influence of N source and solution pH on growth and nutrition of two Vaccinium clones. *J. Am. Soc. Hort. Sci.* In Press.

JUDITH BERMAN - Assistant Professor, Plant Biology

BS - Cornell University, Ithaca, NY, 1979

PhD - Weizman Institute of Science, Rehovot, Israel, 1984

Weizman Postdoctoral Fellow - Cornell University, 1984-86

Current Research Interests

The molecular structure and function of chromosomes, particularly their termini, the telomeres; identification and characterization of TBA, a protein activity that binds specifically to yeast telomere DNA sequences; investigation of the role of this protein in vivo; the cloning and analysis of plant and algal telomere DNA sequences; analysis of the molecular events that occur at chromosome ends during genome rearrangements; analysis of the molecular basis of the chromosome "healing" process.

Journal References:

Berman, J., C.Y. Tachibana and B-K. Tye. Identification of a telomere binding activity in yeast. Proc. Nat'l. Acad. Sci. (USA), 83:3713-3717, 1986.

Berman, J., S. Eisenberg and B-K. Tye. An agarose gel assay that permits detection of DNA binding proteins in yeast cell extracts. Methods Enzymol., 155:528-537, 1987.

Berman, J., J.M. Gershoni and A. Zamir. Expression of nitrogen fixation genes in foreign hosts: Assembly of nitrogenase Fe protein in Escherichia coli and in yeast. J. Biol. Chem., 260:5240-5243, 1985.

DAVID D. BIESBOER - Associate Professor, Plant Biology

BA - Calvin College, 1973

MS - Illinois State University, 1975

PhD - Indiana University, 1979

NSF Postdoctoral Fellow - Indiana University, 1980

Current Research Interests

Anatomy and physiology of plants with emphasis on secondary metabolism in plant tissue cultures; the physiology and biology of the weed leafy spurge; nitrogen cycling in wetland plants.

Journal References:

Eckardt, N. and D.D. Biesboer. Ecological aspects of nitrogen fixation (AR) associated with plants of a Minnesota wetland community. Canadian Journal of Botany 66:1359-1363, 1988.

Duvall, M. and D.D. Biesboer. Anatomical distinctions between the pistillate spikelets of the species of wild-rice (Zizania, Poaceae). American Journal of Botany 75:157-159, 1988.

Stamm, E.J., D.L. Wyse and D.D. Biesboer. Development of common milkweed (Asclepias syriaca) root buds following emergence from lateral roots. Weed Science 36:758-763, 1988.

ROBERT BRAMBL - Professor, Plant Biology

AB - Hendrix College, 1965

PhD - University of Nebraska, 1969

NIGMS and NCI Postdoctoral Fellow - Stanford University, 1969-71

Current Research Interests

Organelle biogenesis and cell development. Regulation of expression of nuclear and mitochondrial genes for mitochondrial proteins; translocation of enzyme subunit proteins into mitochondria and assembly into the mitochondrial membranes; regulation of expression of heat shock genes and functions of heat shock proteins; stabilization and translation of functional latent messenger RNAs. The organisms used for many of these studies are the germinating sexual and asexual spores of Neurospora crassa and germinating embryos of maize.

Journal References:

Brambl, R., and N. Plesofsky-Vig. Pantothenate is required in Neurospora crassa for assembly of subunit peptides of cytochrome c oxidase and ATPase/ATP synthase. Proc. Natl. Acad. Sci., USA 83:3644-3648, 1986.

Plesofsky-Vig, N. and R. Brambl. Two developmental stages of Neurospora crassa utilize similar mechanisms for responding to heat shock but contrasting mechanisms for recovery. Molec. Cell. Biol. 7:3041-3048, 1987.

Brambl, R., N. Plesofsky-Vig, J.R. Hammet and P.J. Russell. Preserved polyadenylated ribonucleic acid in dormant conidia of Neurospora crassa and new RNA synthesis during spore germination. Exp. Mycol. 11:317-330, 1987.

WILLIAM R. BUSHNELL - Professor, Plant Pathology, and
Research Plant Physiologist, Agricultural Research
Service, U. S. Department of Agriculture

AB - University of Chicago, 1951
BS - Ohio State University, 1953
MS - Ohio State University, 1955
PhD - University of Wisconsin, 1960

Current Research Interests

Physiology of host-parasite interaction in plants with emphasis on specificity and expression of resistance. Micromanipulation and microinjection as experimental techniques for living specimens; fluorescence and video light microscopy.

Journal References:

Koga, H., R.J. Zeyen, W.R. Bushnell and G.G. Ahlstrand. Hypersensitive cell death, autofluorescence, and insoluble silicon accumulation in barley leaf epidermal cells under attack by Erysiphe graminis f. sp. hordei. Physiol. Mol. Plant Pathol. 32:395-409, 1988.

Liu, Z., W.R. Bushnell and R. Brambl. Potentiometric dyes are sensitive probes for mitochondria in intact plant cells: Kinetin enhances mitochondrial fluorescence. Plant Physiol. 80:1385-1390, 1987.

Bushnell, W.R., K. Mendgen and Z. Liu. Accumulation of potentiometric and other dyes in haustoria of Erysiphe graminis in living host cells. Physiol. Mol. Plant Pathol. 31:237-250, 1987.

JOHN V. CARTER - Professor, Horticultural Science and Landscape Architecture

BA - Whittier College, 1962

PhD - Purdue University, 1967

Postdoctoral Fellow - University of Pittsburgh, 1968-1970

Assistant and Associate Professor of Chemistry, Adams State College, 1970-1974

Postdoctoral Fellow - University of Minnesota, 1974-1976

Current Research Interests

Freezing injury and cold acclimation in higher plants; effects of low temperature and dehydration on stability of plant microtubules; effect of growth temperature on microtubule dynamics and composition.

Journal References:

Huner, N.P.A., J.V. Carter and F. Wold. Effects of reducing agent on the conformation of the isolated subunits of ribulose biphosphate carboxylase-oxygenase from cold-hardened and unhardened rye. *Z. Pflanzenphysiol.* 106:69-80, 1982.

Guy, C.L. and J.V. Carter. Characterization of partially purified glutathione reductase from cold-hardened and unhardened spinach leaf tissue. *Cryobiol.* 21:454-464, 1984.

Carter, J.V. and S.M. Wick. Irreversible microtubule depolymerization associated with freezing injury in Allium cepa root tip cells. *Cryo-letters* 5:373-382, 1984.

IRIS CHARVAT - Associate Professor, Plant Biology

BS - University of Illinois, Urbana, 1963

MS - University of Illinois, Urbana, 1964

PhD - University of California, Santa Barbara, 1973

Current Research Interests

Mycorrhizal associations in cattails, purple loosestrife, and other related plants: spore germination studies and role in the environment. Development of the lytic compartment in fungi and mycorrhizal associations. EM localizations of hydrolases to mark the compartments. Regulation of acidic hydrolases, especially phosphatases, in Schizophyllum commune, a wood rotting fungus. Activities and isozyme patterns in wild-type and mutant strains grown under stress and non-stress conditions.

Journal References:

Lilly, W.W. and I. Charvat. Activities and isozymes of acid phosphatase in Schizophyllum commune: A Re-examination. *Mycologia*, 79:314-319, 1987.

Charvat, I. and F. Tang. Vesicular arbuscular mycorrhizae in Typha. XIV International Botanical Congress. West Berlin, West Germany. 418, 1987.

Charvat, I. "Symbiotic fungi in roots of higher plants." Association for Biology Laboratory Education. Chapter 7, 131-137, 1988.

R. KENT CROOKSTON - Professor of Crop Management
& Director of Sustainable Agriculture

BS - Brigham Young University, 1968

MS - University of Minnesota, 1970

PhD - University of Minnesota, 1972

Agriculture Canada Postdoctoral Fellow - Lethbridge Expt. Station, 1972

Current Research Interests

Field research on applied and sustainable aspects of crop management including: explaining, and determining how to best exploit, the crop rotation effect; visual and physiological monitoring of the field maturation of corn; development of the "decision case method" for agriculture; international crop production.

Journal References:

Crookston, R.K. and S. Ouattar. Maize in the Mediterranean cropping system-- modifying its growth to combat drought. In J.P. Srivastava, E. Porceddu, E. Acevedo and S. Varma (ed.) Drought tolerance in winter cereals. John Wiley & Sons, Chichester, England. 339-348, 1987.

Francis, C., A. Jones, K. Crookston, K. Wittler and S. Goodman. Intercropping corn and grain legumes: a review. Am. J. Alternative Ag. 1(4):159-164, 1987.

Crookston, R.K. and J.E. Kurle. Using the kernel milk line to determine when to harvest corn for silage. J. Production Ag. 1:293-295, 1988.

SHARON L. DESBOROUGH - Professor, Horticultural Science

BA - Microbiology, Southern Illinois University, 1958

MA - Microbiology, Southern Illinois University, 1959

PhD - Genetics, University of Wisconsin, 1967

Current Research Interests

Chromosome mapping in Solanum with isozyme gene markers using diploid inter- and intraspecific hybrids. Inheritance of the endosperm protein, Solin, and its subunits for use as genetic markers and hybrid seed identification. Potato processing quality as it relates to membrane stability, measured by peroxidation of unsaturated tuber membrane lipids.

Journal References:

- Desborough, S.L. Chapter "Potato Proteins", ed. P.H. Li, in Potato Physiology, Acad. Press, NY, 1985.
- Smith, J.A. and S.L. Desborough. The endosperm seed protein Solin: Biochemical characterization, induction by ABA and species-specific subunits. Theor. Appl. Genetics. 74:739-745, 1987.
- Liedl, B.E., T. Kosier, and S.L. Desborough. HPLC isolation and nutritional value of a major tuber protein. Amer. Pot. 64:545-558, 1987.

JOHN F. DOEBLEY - Assistant Professor, Plant Biology
& Director of the Herbarium

- BA - West Chester State College, Pennsylvania, 1974
MA - Eastern New Mexico University, 1976
PhD - University of Wisconsin, Madison, 1980

Current Research Interests

The use of RFLPs as marker loci (1) to study the genetic basis of morphological traits important in the evolution of maize, (2) to quantify the amount and distribution of genetic variation in plant populations, (3) to clarify phylogenetic relationships.

Journal References:

- Doebley, J.F., W.T. Renfro and A. Blanton. Restriction site variation in the Zea chloroplast genome. Genetics 117:139-147, 1987.
- Doebley, J.F., J.F. Wendel, J.S.C. Smith, C.W. Stuber and M.M. Goodman. The origin of cornbelt maize: the isozyme evidence. Econ. Bot. 42:120-131, 1988.
- Doebley, J.F. and J.F. Wendel. Application of RFLPs to plant systematics. Current Communications in Molecular Biology, Cold Spring Harbor Laboratory (in press). 1989.

J. STEPHEN GANTT - Assistant Professor, Plant Biology

- BS - University of Michigan, 1975
PhD - University of California, Irvine, 1982

Current Research Interests

We are currently interested in the structure, evolution and expression of nuclear-encoded plastid ribosomal protein genes, the mechanisms by which herbicides that block carotenoid biosynthesis alter the expression of nuclear-encoded plastid genes, and the structure and expression of plant histone H1 genes.

Journal References:

Gantt, J.S. and J.L. Key. Isolation of Nuclear Encoded Chloroplast Ribosomal Protein cDNAs. *Mol. Gen. Genet.* 202:186-193, 1986.

Gantt, J.S. and J.L. Key. Molecular Cloning of a Pea H1 Histone cDNA. *Eur. J. Biochem.* 166:119-125, 1987.

Gantt, J.S. Nucleotide Sequences of cDNAs Encoding Four Complete Nuclear-Encoded Plastid Ribosomal Proteins. *Curr. Genet.* 14:519-528, 1988.

BURLE G. GENGENBACH - Professor, Agronomy and Plant Genetics,
and Plant Biology

BS - University of Nebraska, 1966

MS - University of Nebraska, 1968

PhD - University of Illinois, 1971

Postdoctoral Research Associate - University of Illinois, 1971-72

Current Research Interests

Research is focused on biochemical and developmental genetic systems of higher plants, especially maize. The primary research areas include studies of molecular genetic regulation of specific enzymes in lysine and fatty acid biosynthetic pathways, mitochondrial genome expression and genetic behavior, and molecular characterization of plastid and amyloplast biogenesis in developing maize endosperm.

Journal References:

Wise, R.P., D.R. Pring and B.G. Gengenbach. Mutation to male fertility and toxin insensitivity in T-cytoplasm maize is associated with a frameshift in a mitochondrial open reading frame. *Proc. Nat. Acad. Sci. (USA)* 84:2858-2862, 1987.

Wise, R.P., A.E. Fliss, D.R. Pring and B.G. Gengenbach. URF13-T of T cytoplasm maize mitochondria encodes a 13 kD polypeptide. *Plant Molec. Biol.* 9:121-126, 1987.

Peschke, V.M., R.L. Phillips and B.G. Gengenbach. Discovery of transposable element activity among progeny of tissue culture-derived maize plants. *Science* 238:804-807, 1987.

FLORENCE K. GLEASON - Associate Professor, Plant Biology

BS - Loyola University, Chicago, IL, 1964
MS - Northwestern University, Evanston, IL, 1966
PhD - University of Iowa, 1971

Current Research Interests

Role of small redox proteins, thioredoxin and glutaredoxin, in plant metabolism using cyanobacteria as a model system. Structure - function relationships of thioredoxins and glutaredoxins using naturally occurring and "engineered" variants. Regulation of ribonucleotide reduction and cell division in photosynthetic organisms. Isolation and characterization of cyanobacterial secondary metabolites and the biological activity of these compounds.

Journal References:

- Das, A.K., B.C.W. Hummel, F.K. Gleason, A. Holmgren and P.G. Walfish. Bacterial and mammalian thioredoxin systems activate iodothyronine 5'-deiodination. *Biochem. & Cell Biol.*, 66, 460-464, 1988.
- Mallipudi, L.R. and F.K. Gleason. Characterization of a mutant of Anacystis nidulans R2 resistant to the natural herbicide, cyanobacterin. *Plant Sci.*, in press, 1989.
- Gleason, F.K., C-J. Lim, M. Gerami-Nejad and J.A. Fuchs. Characterization of Escherichia coli thioredoxins with altered disulfide ring size, manuscript submitted, 1989.

JOHN W. GRONWALD - Plant Physiologist - USDA/ARS
and Adjunct Associate Professor,
Department of Agronomy and Plant Genetics

BS - University of Illinois, 1969
MS - University of Illinois, 1976
PhD - University of Illinois, 1979
Postdoctoral Research Associate - University of California, Riverside, 1979-1982

Current Research Interests

The mechanism of action of herbicides, in particular those that inhibit acetyl-CoA carboxylase in monocots; the biochemical basis for herbicide resistance; the role of glutathione S-transferase and cytochrome P-450 monooxygenase in herbicide detoxification in plants.

Journal References:

- Gronwald, J.W., E.P. Fuerst, C.V. Eberlein and M.A. Egli. Effect of herbicide antidotes on glutathione content and glutathione S-transferase activity of sorghum shoots. Pestic. Biochem. Physiol. 26:66, 1987.
- Gronwald, J.W., R.N. Andersen and C. Yee. Atrazine resistance in velvetleaf due to enhanced atrazine detoxification. Pestic. Biochem. Physiol. 1989 (In press).
- Burton, J.D., J.W. Gronwald, D.A. Somers, J.A. Connelly, B.G. Gengenbach and D.L. Wyse. Inhibition of plant acetyl-coenzyme A carboxylase by the herbicides sethoxydim and haloxyfop. Biochem. Biophys. Res. Commun. 148:1039-1044, 1987.

WESLEY P. HACKETT - Professor, Bailey Endowed Chair
in Environmental Horticulture

- BS - University of California, Davis, 1953
MS - University of California, Davis, 1959
PhD - University of California, Davis, 1962

Current Research Interests

• Physiology of flowering, adventitious root and bud initiation, juvenility and reproduction maturation, the relation of phenylpropanoid and flavonoid metabolism to morphogenesis with major emphasis on perennial species.

Journal References:

- Hackett, W.P., R.E. Cordero and C. Srinivasan. Apical meristem characteristics and activity in relation to juvenility in Hedera. In: J. Atherton (ed.). Manipulation of Flowering. Proc. 45th Easter School in Agricultural Science. Univ. of Nottingham, U.K. pp. 93-99, 1987.
- Geneve, R.L., W.P. Hackett and B.T. Swanson. Adventitious root initiation in debladed petioles from the juvenile and mature phases of English ivy. J. Amer. Soc. Hort. Sci. 113:630-635, 1988.
- Hackett, W.P. Donor plant maturation and adventitious root formation. In: Adventitious Root Formation in Cuttings. T.D. Davis, B.E. Haissig, and N. Sankhla (eds.). Dioscorides Press. Portland, OR 97225. 1988.

GARY H. HEICHEL - Plant Physiologist, USDA-ARS
Adjunct Professor, Agronomy & Plant Genetics

BS - Iowa State University, 1962
MS - Cornell University, 1964
PhD - Cornell University, 1968

Current Research Interests

Research on the limitations of symbiotic dinitrogen fixation and carbon assimilation to forage productivity, and on the cycling of nitrogen in crop communities and cropping systems. Strategies to breed alfalfa for increased dinitrogen fixation capability.

Journal References:

- Cralle, H.T. and G.H. Heichel. Photosynthate partitioning in alfalfa before harvest and during regrowth. *Crop Sci.* 28:948-953, 1988.
- Heichel, G.H., D.K. Barnes, C.P. Vance and C.C. Sheaffer. Dinitrogen fixation technologies for alfalfa improvement. *J.Prod.Agric.* 2:-, 1989.
- Anderson, M.P., G.H. Heichel and C.P. Vance. Nonphotosynthetic CO₂ fixation by alfalfa (Medicago sativa L.) roots and nodules. *Plant Physiol.* 85:283-289, 1987.

ALAN B. HOOPER - Professor, Genetics and Cell Biology

BA - Oberlin College, 1959
PhD - John Hopkins University, 1964

Current Research Interests

Electron transfer and energy transduction in the ammonia- and nitrite-oxidizing autotrophic bacteria (nitrifiers). Microbial transformation of inorganic nitrogen and halogenated hydrocarbons. Evolution of microbial N-oxide oxidoreductases.

Journal References:

- Arciero, D., T. Vanelli, M. Logan and A.B. Hooper. Degradation of Trichloroethylene by the ammonia-Oxidizing Bacterium Nitrosomonas europaea. *Biochim. Biophys. Res. Commun.* 159:640-643, 1989.
- Hooper, A.B. Biochemistry of the Nitrifying Lithoautotrophic Bacteria pp239-265 in Autotrophic Bacteria, Schlegel, H.G. and Bowein, B. (eds.) Science Tech. Madison, WI, 1989.

Balny, C. and A.B. Hooper. Effect of solvent, pressure and temperature on reaction rates of the multiheme hydroxylamine oxidoreductase; evidence for conformational change. Eur. J. Biochem. 176:273-279, 1988.

ROBERT J. JONES - Professor, Plant Physiology

BS - Fort Valley State College, 1973

MS - University of Georgia, 1975

PhD - University of Missouri, 1978

Current Research Interests

The physiological aspects of regulation of kernel developing in maize studied in vitro and in situ; characterization of physiological and molecular biological events that occur shortly after pollination which modulate subsequent kernel growth and development; phytohormonal and environmental control of cell division and amyloplast initiation; regulation of starch synthesis and cytokinins metabolism.

Journal References:

Jones, R.J., J.A. Roessler and S. Quattar. Thermal environment during cell division in maize: Effects on kernel sink capacity. Crop Science 25:830-834, 1985.

Jones, R.J. and M.L. Brenner. Distribution of abscisic acid in maize kernels during grain filling. Plant Physiol. 83:905-909, 1987.

Griffith, S.M., R.J. Jones and M.L. Brenner. In Vitro sugar transport in Zea mays L. kernels: I. Characteristics of sugar absorption and metabolism by developing maize endosperm. Plant Physiol. 84:457-471, 1987.

WILLARD L. KOUKKARI - Professor, Plant Biology

BS - Michigan State University, 1957

MS - Michigan State University, 1959

PhD - University of New Hampshire, 1962

Postdoctoral - Brookhaven National Laboratory, 1965-1967

Current Research Interests

Physiology of biological oscillations and timing mechanisms especially short period oscillations; studies on the biological control of perennial weeds with competitive species.

Journal References:

Koukkari, W.L. and S.B. Warde. Rhythms and their relations to hormones. IN: Encyclopedia of Plant Physiology. New Series. Vol. 3 Eds. Pharis, R.P. and D.M. Reid. Springer-Verlag, Berlin. pp. 37-77, 1985.

Henson, C.A., S.H. Duke and W.L. Koukkari. Rhythmic oscillations in starch concentration and activities of amylolytic enzymes and invertase in Medicago sativa nodules. Plant and Cell Physiol. 27:233-242, 1985.

Koukkari, W.L. The broad spectrum of plant rhythms. Adv. Biosci. 73:31-41, 1988.

SAGAR V. KRUPA - Professor, Plant Pathology

BS - Andhra University, India, 1959

MS - University of Wisconsin, 1968

PhD - University of Uppsala, Sweden; 1971

Current Research Interests

Modeling atmospheric processes, and the effects of air pollutants and climatology on crop growth and productivity. Modeling responses of trees to sulphur pollution.

Journal References:

Krupa, S. and R.N. Kickert. An analysis of numerical models of air pollutant exposure and vegetation response. Environ. Pollut. 44(2):127-158, 1987.

Krupa, S.V. and W.J. Manning. Atmospheric ozone: Formation and effects on vegetation. Environ. Pollut. 50:101-137, 1988.

Legge, A.H., J.C. Bogner and S.V. Krupa. Foliar sulphur species in pine: A new indicator of a forest ecosystem under air pollution stress. Environ. Pollut. 55:15-27, 1988.

PAUL H. LI - Professor, Laboratory of Plant Hardiness, Department Horticultural Science and Landscape Architecture

BS - Taiwan National University, 1956

PhD - Oregon State University, 1963

Current Research Interests

Temperature stress physiology; plant cold hardiness.

Journal References:

Fennell, A. and P.H. Li. Temperature response of plasma membrane in tuber-bearing Solanum species. Plant Physiol. 80:470-472, 1986.

Tao, D.L. and P.H. Li. Classification of plant cell cryoprotectants. J. Theoret. Biol. 123:305-310, 1986.

Zhang, L.X., P.H. Li, and M.J. Tseng. Amelioration of chilling injury in rice seedlings by mefluidide. Crop Sci. 27:531-534, 1987.

ALBERT H. MARKHART, III - Associate Professor, Horticultural Science and Landscape Architecture

BA - Gettysburg College, 1973

MA - Duke University, 1975

PhD - Duke University, 1978

Postdoctoral Research Associate - Duke University, 1978-1979

Current Research Interests

The biochemical, physiological, morphological mechanisms of plant responses to stress conditions; primarily, the role of membrane changes that are associated with photosynthetic performance and maintenance of water balance during water and temperature stress. General water relations in plants: forces, fluxes, and resistances associated with water and nutrient uptake by roots, and the mechanisms by which stomata control water loss.

Journal References:

Markhart III, A.H. Comparative water relations of Phaseolus vulgaris L. and Phaseolus acutifolius Gray. Plant Physiol. 77:113-117, 1985.

Hanson, P.J., E.I. Sucoff and A.H. Markhart III. Quantifying apoplastic flux through red pine root systems using trisodium, 3-hydroxy-5, 8, 10 pyrenetrisulfate. Plant Physiol. 77:21-24, 1985.

Markhart III, A.H. Chilling injury: A review of possible causes. Proc. ASHS Symposium on Environmental Stress. Hort. Sci. 21:1329-1333, 1988.

DAVID J. McLAUGHLIN - Professor, Plant Biology

AB - Brown University, 1962

PhD - University of California, Berkeley, 1968

NIH Postdoctoral Fellowship - University of Copenhagen, Denmark, 1968-1969

Current Research Interests

Evolutionary relationships of the basidiomycetes analyzed using ultrastructural features of nuclear division, basidia and vegetative cells; basidium development and function; environmental control of fruitbody development; Minnesota fungal flora.

Journal References:

- Bourett, T.M. and D.J. McLaughlin. Mitosis and septum formation in the basidiomycete Helicobasidium mompa. *Can. J. Bot.* 64:130-145, 1986.
- Kleven, N.L. and D. J. McLaughlin. Sporulation of the basidiomycete Pachnocybe ferruginea in aerial and aquatic environments. *Mycologia*, 80:804-810, 1988.
- Boehm, E.W.A. and D.J. McLaughlin. Phylogeny and ultrastructure in Eocronartium muscicola: Meiosis and basidial development. *Mycologia*, 81:98-114, 1989.

NEIL E. OLSZEWSKI - Assistant Professor, Plant Biology

BS - University of New Hampshire, 1976

PhD - University of Minnesota, 1983

Postdoctoral - Harvard Medical School

Current Research Interests

The research interests are directed toward understanding the molecular mechanisms of gibberellin action in plant growth and development; the molecular characterization of the bacilliform non-enveloped plant virus group.

Journal References:

- Chory, J., Voytas, D., Olszewski, N. and Ausubel, F. Gibberellin-induced changes in the population of translatable mRNAs and accumulated polypeptides in dwarfs of maize and pea. *Plant Physiol.* 83:15-23, 1987.
- Olszewski, N.E., Martin, F.B. and Ausubel, F.M. Specialized binary vector for plant transformation: Expression of the Arabidopsis thaliana AHAS gene in Nicotiana tabacum. *Nucleic Acids Research* 16:10765-10782, 1988.
- Olszewski, N.E., Gast, R.T. and Ausubel, F.M. A dual-labeling method for identifying differentially expressed genes: use in the identification of cDNA clones that hybridize to RNAs whose abundance in tomato flowers is potentially regulated by gibberellins. *Gene* 77:155-162, 1989.

JAMES A. PERRY - Associate Professor, Forest Resources

BS - Colorado State University, 1968
MA - Western State College, Colorado, 1973
PhD - Idaho State University, 1981

Current Research Interests

Ecosystem responses to stress: experimental manipulation of whole ecosystems (e.g., lakes, stream channels, temporary ponds, coastal tide pools). Stresses have included acid, chlorine, ammonia, pesticides, physical disturbance, and complex land use patterns. Responses among benthic invertebrates, algae, macrophytes, bacteria, and fungi; terrestrial and aquatic decomposition rates in various community types. Tropical aquatic ecology. Dynamics of microbial communities (algae, bacteria, fungi) on decomposing leaf surfaces; use of SEM and X-Ray Microanalysis as tools for assessing ecological properties. Water quality monitoring, watershed management, international economic development, social forestry.

Journal References:

- Cudlip, L.S. and J.A. Perry. Is in-lake carbon processing phased to correlate with availability? Decomposition of Decodon verticillatus (L.) Ell. and Ceratophyllum demersum L., in Cedar Bog Lake, Minnesota. Archiv. Hydrobiol. 111:383-396, 1986.
- Perry, J.A. and N.H. Troelstrup Jr. Whole Ecosystem Manipulation: A Productive Avenue for Test System Research? Environ. Toxicol. Chem 7:941-951, 1988.
- Perry, J.A., R. Zeyen, M. Newsom and G. Ahlstrand. X-ray microanalysis of leaf litter decomposing in lakes. BioScience 39:260-263, 1989.

DOUGLAS C. PRATT - Professor, Plant Biology

BS - University of Minnesota, 1952
MA - University of Minnesota, 1959
PhD - University of Minnesota, 1960
AEC Postdoctoral Fellow, Chemistry Department, University of Minnesota, 1960-62

Current Research Interests

The physiology and ecology of emergent aquatic vegetation; the potential use of aquatic vegetation for nutrient removal from waste water, and for biomass production.

Journal References:

- Penko, J.M. and D.C. Pratt. Effects of Bellura obliqua Walk. on Typha latifolia L. productivity and biomass allocation. Journal of Aquatic Plant Management 24:49-54, 1986.
- Garver, E.G., D.C. Pratt and D.R. Dubbe. Seasonal Patterns in Accrual and Partitioning of Biomass and Macronutrients in Typha spp. Aquatic Botany 32:115-127, 1988.
- Dubbe, D.R., E.G. Garver and D.C. Pratt. Production of Wetland Biomass in Minnesota, U.S.A. Biomass 17:79-104, 1989.

IRWIN RUBENSTEIN - Professor, Plant Biology

- BS - California Institute of Technology, Pasadena, 1953
PhD - University of California, Los Angeles, 1960
NIHM Postdoctoral Fellow - John Hopkins University, Baltimore, 1960-1963
Sr. NIHM Postdoctoral Fellow - Genetics Research Unit, Carnegie Institute of Washington, Cold Spring Harbor, NY, 1969-1970

Current Research Interests

The structural organization and functional regulation of the genes of the maize genome; the isolation and characterization of genes from the multigene families encoding the zein proteins and the rRNA genes; expression of plant genes and their regulation.

Journal References:

- McMullen, M.D., B. Hunter, R.L. Phillips and I. Rubenstein. The structure of the maize ribosomal DNA spacer region. Nucleic Acids Res. 14:4953-4968, 1986.
- Rubenstein, I. and D.E. Geraghty. The genetic organization of zein. In: "Advances in Cereal Science and Technology", Vol. VIII, (Y. Pomeranz, ed.), American Association of Cereal Chemists, St. Paul, MN. (pp. 297-315), 1986.
- Larkins, J.C., J.P. Hunsperger, D. Culley, I. Rubenstein and C.D. Silflow. The organization and expression of a maize ribosomal protein gene family. Genes and Development (In Press), 1989.

CAROLYN D. SILFLOW - Associate Professor, Genetics and Cell Biology
and Plant Biology

- BS - Pacific Lutheran University, 1972
PhD - University of Georgia, 1977
NIH, ACS Postdoctoral Fellow - Yale University, 1978-1981

Current Research Interests

Tubulin gene expression during flagella growth in Chlamydomonas. The regulation of tubulin gene expression during development in plants. The mode of action of anti-microtubule herbicides.

Journal References:

Silflow, C.D., D.G. Oppenheimer, S.D. Kopczak, S.E. Ploense, S.R. Ludwig, N. Haas and D.P. Snustad. Plant tubulin genes: Structure and differential expression during development. Dev. Genet. 8:435-460, 1987.

Ranum, L.P.W., M.D. Thompson, J.A. Schloss, P.A. Lefebvre and C.D. Silflow. Mapping genes in Chlamydomonas using restriction fragment length polymorphisms. Genetics 120:109-122, 1988.

James, S.W., L.P.W. Ranum, C.D. Silflow and P.A. Lefebvre. Mutants resistant to anti-microtubule herbicides map to a locus on the uni linkage group in Chlamydomonas reinhardtii. Genetics 118:141-147, 1988.

STEVE R. SIMMONS - Professor, Agronomy and Plant Genetics

BS - Purdue University, 1968

MS - Colorado State University, 1974

PhD - University of Minnesota, 1977

Current Reserach Interests

Ecological physiology of cereal development; photomorphogenesis, nutrient accumulation and remobilization; photoassimilate partitioning and remobilization; plant design strategies in relation to agronomic production systems.

Journal References:

Simmons, S.R. and J. Lauer. Shoot photoassimilate partitioning patterns during the tillering phase in spring barley. In Phloem Transport. Allan R. Liss Publishers, NY, 519-526, 1986.

Chafai, A. and S.R. Simmons. Quantitative translocation of photoassimilates from nonsurviving tillers in barley. Crop Sci. 28:969-972, 1988.

Lauer, J. and S.R. Simmons. Canopy light and tiller mortality in spring barley. Crop Sci. 29:420-424, 1989.

ALAN G. SMITH - Assistant Professor, Department of Horticultural Sciences and
Landscape Architecture

BA - University of Nebraska, 1978
MS - Iowa State University, 1981
PhD - University of Florida, 1985
Postdoctoral Associate, Monsanto Co., 1985-1988

Current Research Interests

Research interests include the physiology and molecular genetics of plant development. My approach to plant development has been to use flowers as a system to study cell differentiation and organ morphogenesis. A first step toward studying gene expression during flower production is the isolation of molecular clones of genes that are expressed only in flowers. The clones are used in experiments to determine the function of the genes and the mechanisms that regulate their expression. These analyses involve contemporary methods in molecular biology to define the temporal and spatial expression patterns of these genes as well as transformation of engineered genes into plants to manipulate flower morphogenesis. Effects of specific changes in the regulatory or functional domains of a gene can be directly measured by introduction of the altered gene into plants. Mutants that affect the fertility or morphology of the flower are used in combination with the cloned genes to study abnormal flower development.

Journal References:

- Smith, A.G., C.S. Gasser, K.A. Sachs, S. McCormick, M.A. Hinchee, R. Horsch and R.T. Fraley. Regulated expression of floral-specific genes. IN: Molecular Biology of Plant Nuclear Genes, Vol. 6, I.K. Vasil and J. Schell, eds., Academic Press, Inc., NY. (In Press).
- Gasser, C.S., K.A. Budelier, A.G. Smith, D.M. Shah and R.T. Fraley. Isolation of tissue-specific cDNAs from tomato pistils. The Plant Cell 1:15-24, 1989.
- Smith, A.G., M.A. Hinchee, and R. Horsch. Cell and tissue specific expression localized by in situ RNA hybridization in floral tissues. Plant Mol. Biol. Reporter. 5:237-241, 1987.

DAVID A. SOMERS - Assistant Professor, Agronomy and Plant Physiology

BS - University of Maine, 1974
MS - Washington State University, 1977
PhD - Washington State University, 1983

Current Research Interests

Tissue culture and in vitro genetic manipulations; crop plant transformation; microinjection of plant cells; gene transfer, biochemistry of herbicide resistance; amino acid metabolism.

Journal References:

Wright, R.L., D.A. Somers and R.L. McGraw. Somatic hybridization between birdsfoot trefoil and Lotus conimbricensis Willd. Theor. Appl. Genet. 75:151-156, 1987.

Somers, D.A., P.R. Birnberg, W.L. Petersen and M.L. Brenner. The effect of conditioned medium on colony formation from "Black Mexican Sweet" corn protoplasts. Plant Sci. 53:249-256, 1987.

Burton, J.D., J.W. Gronwald, D.A. Somers, J.A. Connelly, B.G. Gengenbach and D.L. Wyse. Inhibition of plant acetyl-coenzyme A carboxylase by the herbicides sethoxydim and haloxyfop. Biochem. Biophys. Res. Comm. 148:1039-1044, 1987.

THOMAS K. SOULEN - Associate Professor, Plant Biology

BA (Mathematics) - University of Wisconsin, 1957

MS (Biochemistry) - University of Wisconsin, 1961

PhD (Biochemistry) - University of Wisconsin, 1963

Current Research Interests

Metabolism of higher plants, with emphasis on nitrogen metabolism, especially as it relates to development; factors influencing flowering and vegetative growth of Lemna.

Journal References:

Soulen, T.K. and L.C. Olson. Glutamate dehydrogenase activity in soybean, and the effect on it of amino acids and growth substances. Planta 86:205-208, 1969.

Duke, S.H., W.L. Koukkari and T.K. Soulen. Glutamate dehydrogenase activity in roots: distribution in a seedling and storage root and the effects of red and far-red illuminations. Physiol. Plant. 34:8-13, 1975.

Jahnke, L.S. and T.K. Soulen. Effects of manganese on growth and restoration of photosynthesis in manganese deficient algae. Z. Pflanzenphysiol. 88:83-93, 1978.

JOSEPH R. SOWOKINOS - Professor, Horticulture and Landscape Architecture

BA - Nebraska State Teachers College, Wayne, 1963
MS - University of North Dakota School of Medicine, 1965
PhD - University of North Dakota School of Medicine, 1969

Current Research Interests

Factors that control processing potato quality during growth and storage; How stress (cold, handling, anoxia, senescence) influences carbon partitioning at the molecular level; Identification of key genes whose products correlate highly with a potato clone's sugar content in storage; assist in the screening of hundreds of advanced breeding clones for identifying germplasm which demonstrates stress-resistance and superior processing characteristics.

Journal References:

Sowokinos, J.R., P.H. Orr, J.A. Knoper and J.L. Varns. Influence of potato storage and handling stress on sugars, chip quality and integrity of the starch (amyloplast) membrane. *Am. Potato J.* 65:213-226, 1987.

Lulai, E.D., J.R. Sowokinos and J.A. Knoper. Translucent sweetening in Kennebec potatoes (Solanum tuberosum L.) II. Alterations in lipid enzyme activities, mitochondria morphology and concentration of starch granules. *Plant Physiol.* 80:424-428, 1986.

Sowokinos, J.R., E.C. Lulai and J.A. Knoper. Translucent sweetening in Kennebec potatoes (Solanum tuberosum L.) I. Alteration in amyloplast membrane integrity, enzyme activities, sugars and starch content. *Plant Physiol.* 78:489-494, 1985.

EDUARD J. STADELMANN - Professor, Horticultural Science, Plant Physiology,
Adjunct Professor, Plant Biology

BA - (equiv.) 1. Bundesrealgymnasium, Graz, Austria, 1939
PhD - University of Innsbruck, Austria, 1953
Priv.Doc. - University of Freiburg, Switzerland, 1957

Current Research Interests

Passive transport through plant cell membranes as tools for testing their variability between cell and plant species. Changes in passive solute permeability by external factors. Protoplasmic qualities and their changes with external conditions. Plant cell solute potential. Effect of water stress on the plant cell protoplasm.

Journal References:

- Lee-Stadelmann, O.Y. and Ed. Stadelmann. Plasmolysis and Deplasmolysis. In: Fleischer, S. and R. Fleischer (eds.): Biological Transport (Biomembranes, Part U), Methods in Enzymology, 174, in press. New York: Academic Press.
- Stadelmann, Ed.J. and O.Y. Lee-Stadelmann. Passive Permeability. In: Fleischer, S. and R. Fleischer (eds.): Biological Transport (Biomembranes, Part U), Methods in Enzymology, 174, in press. New York: Academic Press.
- Lee-Stadelmann, O.Y., I. Chung, and Ed. Stadelmann. Plasmolysis of Glycine max mesophyll cells - The use of octylguanidine and its implications in protoplast isolation. Plant Sci. 38, 1-7, 1985.

EDWARD I. SUCOFF - Professor, Forest Resources

- BS - University of Michigan, 1955
MS - University of Michigan, 1956
PhD - University of Maryland, 1960

Current Research Interests

Environmental Physiology: aluminum toxicity, root/shoot communication, Anoxia, water stress.

Journal References:

- Andersen, C.P., E.I. Sucoff, R.K. Dixon and A.H. Markhart III. Effects of phosphorus deficiency on root hydraulic properties in Fraxinus pennsylvanica. J. Experimental Botany. In Press.
- Zhao, X.J., E.I. Sucoff and E.J. Stadelmann. Al^{3+} and Ca^{2+} alteration of membrane permeability of Quercus rubra root cortex cells. Plant Physiol. 83: 159-162, 1987.
- Andersen, C.P., E.I. Sucoff and R.K. Dixon. The influence of low soil temperature on the growth of vesicular-arbuscular mycorrhizal Fraxinus pennsylvanica. Can. J. For. Res. 17: 951-956, 1987.

CARROLL P. VANCE - Professor, Plant Physiology and Plant Physiologist USDA-ARS

- BA - East Tennessee State University, 1966
PhD - Ohio State University, 1971
NRC (Canada) Postdoctoral Fellow - University of British Columbia, 1972-1974

Current Research Interests

The role of plant genes in controlling nitrogen fixation and nitrogen assimilation; biochemistry and physiology of plant-microbe interactions; selection for biochemical and physiological traits to improve nitrogen fixation; biochemical and molecular aspects of plant disease resistance.

Journal References:

Vance, C.P., M.E. Egli, S.M. Griffith and S.S. Miller. Plant regulated aspects of nodulation and N₂ fixation. Plant, Cell, Environ. 11: 413-427, 1988.

Miller, S.S., K.L.M. Boylan and C.P. Vance. Alfalfa root nodule CO₂ fixation III. Immunological studies of nodule phosphoenolpyruvate carboxylase. Plant Physiol. 84:501-508, 1987.

Snapp, S.S. and C.P. Vance. Asparagine biosynthesis in alfalfa (Medicago sativa L.) root nodules. Plant Physiol. 82:390-395, 1986.

CLIFFORD M. WETMORE - Professor, Plant Biology

BS - Michigan State University, 1956

MS - Michigan State University, 1959

PhD - Michigan State University, 1965

Current Research Interests

My research has dealt with monographic and floristic studies and morphological/anatomical studies including growth of the symbionts and ultrastructure investigation. I have had extensive collecting experience in many parts of the world. Recent research is directed toward studying lichens as indicators of air quality. Some lichens are collected for elemental analysis to determine the accumulation of sulfur and 15 other elements in the thallus.

Journal References:

Wetmore, C.M. Lichen floristics and air quality. Bibl. Lichenol. 30:55-65, 1988.

Wetmore, C.M. Lichens and air quality in Indiana Dunes National Lakeshore. Mycotaxon 33:25-39, 1988.

Wetmore, C.M. Lichens of Sleeping Bear Dunes National Lakeshore. Mich. Bot. 27 111-118, 1988.

SUSAN M. WICK - Assistant Professor, Plant Biology

BS - Oregon State University, 1972

PhD - Stanford University, 1979

Postdoctoral Fellow - The Australian National University, 7/1979-12/1980

Research Fellow - The Australian National University, 1/1981-12/1985

Current Research Interests

Plant cell biology, development and morphogenesis, with particular emphasis on the role of the cytoskeleton in the control of morphogenesis; elucidation of microtubule dynamics and the behavior and composition of their initiation and organization sites throughout development; allergen deposition during pollen development.

Journal References:

Wick, S.M. Immunofluorescence microscopy of tubulin and microtubule arrays in plant cells. III. Transition between mitotic/cytokinetic and interphase microtubule arrays. *Cell Biol. Int. Rep.* 9:357-371, 1985.

Gunning, B.E.S. and S.M. Wick. Preprophase bands, phragmoplasts and spatial control of cytokinesis. *J. Cell Sci. Suppl.* 2:157-179, 1985.

Wick, S.M. Immunolocalization of tubulin and calmodulin in meristematic plant cells. In: *Calcium Binding Proteins*, M.P. Thompson, ed., CRC Press, 1988.

DONALD L. WYSE - Professor, Weed Scientist, Agronomy and Plant Genetics

BS - Ohio State University, 1970

MS - Michigan State University, 1972

PhD - Michigan State University, 1974

Current Research Interests

Perennial weed control in agronomic crops and the impact of herbicides on water quality. Areas of research include: a) influence of tillage on perennial weed development and control; b) perennial weed biology; c) mechanisms of bud dormancy in perennial weeds; d) use of biotechnology to develop herbicide tolerant crops; and e) impact of herbicides on surface and groundwater quality.

Journal References:

Magnusson, M.V. and D.L. Wyse. Tolerance of soybeans (Glycine max) and sunflowers (Helianthus annuus) to fall applied dicamba residues. Weed Sci. 35:846-852, 1987.

Magnusson, M.V., D.L. Wyse and J.M. Spitzmueller. Canada thistle (Cirsium arvense) propagation from stem tissue. Weed Sci. 35:637-639, 1987.

Boerboom, C.M. and D.L. Wyse. Influence of glyphosate concentration on glyphosate absorption and translocation in Canada thistle (Cirsium arvense). Weed Sci. 36: 291-295, 1988.

1/26/90

MEMORANDUM

TO: Graduate School Executive Committee Files

FROM: V. Field

RE: Plan B Project for M.S. Degree in Plant Biological Sciences

The Plan B project is not clearly addressed in the proposal for an M.S./Ph.D. degree program in Plant Biological Sciences. According to Professor Carroll P. Vance, the thesis proposal described on the attached page will serve as the Plan B project for students who elect to complete the M.S. degree with this option.

a) The minimum credit requirement is 44. Of these, at least 20 credits must be in the major field and a minimum of 8 credits in one or more related fields outside the major; the remainder are to be chosen by agreement among the student, the adviser, and the advisory committee. If the student selects a designated minor field, the minimum is 9 credits and must be approved by the DGS of that field.

b) While a thesis project is not required, all Plan B candidates shall develop a thesis proposal that shall be presented as part of the Student Thesis Proposal Colloquium.

4) All M.S. candidates are required to participate for one quarter in a teaching or training experience. Prior to the student's involvement as a teaching assistant, he/she will be required to take a teaching methods course (Agronomy 8000 or equivalent).

II. Ph.D. Requirements

1. In addition to the requirements stated in the graduate school bulletin, other than the 6 course from the multidisciplinary core curriculum, there are no set course requirements for the Ph.D. Appendix I gives sample programs.

2. The program should be completed in 3-4 years for students holding an M.S. and 4-5 years for students holding a B.S.

3. The official program should be filed not later than the end of the 2nd year. Candidacy for the degree is established after the oral preliminary examination has been passed. A written preliminary examination in the major is required and must be passed before the oral can be scheduled.

4. The written and oral preliminary examinations shall be taken as expeditiously as possible and no later than the second year in residence.

5. The written examination will be given once each year, during the break between winter and spring quarters. Six weeks before that date students taking the exam will be given 16 research papers, consisting of four papers from each of the following areas:

1. Plant cell and molecular biology;
2. Plant physiology;
3. Plant structure, diversity, and development;
4. Plant ecology, systematics, and evolution.

The examination will be given over two days, divided into four three-hour periods. Three questions will be posed in each area and students will answer all three. The questions will be designed to test understanding as exemplified by the assigned papers. Protocols, grading, and retaking of the written exam are described in detail in Appendix II.



UNIVERSITY OF MINNESOTA
TWIN CITIES

School of Public Health

OCT 19 1989

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October 18, 1989

TO: Social Sciences Policy and Review Council
of the Graduate School

FROM: Donald Bell, Assistant Dean and Director, MBA Program
George O. Johnson, Program Director, MHA Program

RE: Combined MBA/MHA Degree Program Proposal

Enclosed is a proposal for a combined program with the Master's in Hospital and Health Care Administration (MHA) and the evening advanced placement program of the MBA. The purpose of the proposal is to use existing University resources and programs to meet a growing market force in the health care industry. While the number of students involved will be small, graduates of a combined MBA/MHA will be in unique positions to have a significant impact on the management of health care resources. In order to achieve the combined MBA/MHA, we are asking your approval for students to double count 23-27 credits which is beyond the maximum of 12 credits.

The proposal has been developed in consultation with the faculty of both programs; if you have any questions, we would be pleased to provide any additional needed information.

We look forward to your review and comments.

PROPOSAL FOR A COMBINED MBA/MHA DEGREE PROGRAM

I. INTRODUCTION

Health care in the United States has grown into a large, complex industry. Consumers demand increased resources and reduced costs. Organizations have become larger and more sophisticated in financing and delivering services. More for-profit organizations have become active, many of which have non-profit subsidiaries. Many non-profit organizations now also have for-profit subsidiaries. The mix of for-profit and not-for-profit organizations demands managers with more varied skills who are able to understand the issues and challenges of both types of organizations.

In response to the changes in health care in the last ten years, in 1982 the MHA program began revamping its curriculum to reflect these changes. Coursework in financial management, human resource management and strategic management was added to the core curriculum. Faculty from the Carlson School of Management were recruited to teach the courses, beginning a strong, productive relationship between the MHA and MBA programs. As the MHA program became more management focused, the synergy between the MBA and MHA programs became apparent. The basic activities involved in management - planning, organizing, staffing, directing, controlling - have become crucial to sound use of health care resources. MHA students, wishing to specialize in an area such as marketing, finance, or strategy, began concentrating their electives in the Carlson School. A few students completed both an MBA and an MHA with much redundant course material in their program of study. Last year, the MHA and MBA programs began planning an integrated curriculum that will meet the goals of both degree programs and provide students with skills needed to manage a large, complex health care organization.

The unique overlap in curriculum concerns and content is illustrated in Figure 1. The first year of the MHA program provides an intensive introduction to management theory and functions, with classroom applications in the field of health care. This course sequence qualifies students for advanced placement into the MBA program.

During students' second MHA year they are encouraged to use electives to develop a content area specialty. Students may choose health related areas, such as long term care administration, or a management area such as marketing, finance, etc. The programs of students choosing a management specialty area have significant overlap with the advanced placement MBA program of study. In both cases, students are using electives to develop an area of concentration as outlined by the appropriate department in the Carlson School of Management.

Figure 2 is an example of a program of study for a student with a concentration in finance, and identifies the content by course number and title and courses which are double counted toward each degree.

FIGURE 1

MHA AND MBA

CURRICULUM/CONTENT COMPARISON

<u>MHA Program</u>	<u>Overlap Between Programs</u>	<u>MBA Program</u>
MHA - Year 1:		Prerequisite courses: Students must have 4 of the following to qualify for advanced placement for the MBA; remainder are taken as part of advanced placement MBA program.
Statistics	Required	Statistics
*Financial Accounting	Required	Financial Accounting
*Managerial Accounting	Required	Managerial Accounting
*Finance	Required	Finance
*Operations Research	Required	Operations Management
*Human Resources Mgmt.	Required	Human Resources Mgmt.
Management Elective	Elective/Required	Marketing Management
		Decision Sciences
Health Services Management		
Medical Care Organizations		
Problem Solving		
Quantitative Methods		
Residency and Clerkship		
MHA - Year 2:		ADVANCED PLACEMENT MBA
		Communications/Computer Access
		Problem Formulation
Organizational Behavior	Required	Organizational Behavior
Health Economics		
Health Law		
*Strategic Management	Required	Strategic Management
Applied Management Project	Required	Applied Management Project
or Thesis		
Policy Elective	Elective/Required	Business, Gov't, Macroecon
Industry Elective		

Electives to total 82 credits		Electives to total 54 credits

Electives form an area of concentration	Required	Electives form an area of concentration

*indicates MHA courses presently taught by Carlson School of Management faculty

FIGURE 2

EXAMPLE OF A STUDENT PROGRAM

(Student programs will vary by previous education, experience and type of concentration selected by student)

Year One, Fall Quarter:

PubH 5404 Statistics (4 cr.)
PubH 5742 Management of Health Care (4 cr.)
PubH 5791 Medical Care Organizations (3 cr.)
PubH 5756 Financial Accounting (4 cr.)

Year One, Winter Quarter:

PubH 5720 Mgmt Communications and Organizational Behavior (3 cr.)
PubH 5744 Problem Solving (4 cr.)
PubH 5757 Managerial Accounting
PubH 5760 Operations

Year One, Spring Quarter:

PubH 5761 Quantitative Methods (3 cr.)
PubH 5759 Financial Management (4 cr.)
MBA 8015 Human Resources Management (4 cr.)
MBA 8050 Operations Management (4 cr.)
MBA 8005 Communications and Computer Access (1 cr.)

Year One, Summer Session:

PubH 5746 Summer Residency and Clerkship (3 cr.)

Year Two, Fall Quarter:

MBA 8045 Marketing Management (4 cr.)
xBFin 8150 Theory of Finance (4 cr.)
xBFin 8200 Interest Rates (4 cr.)
*PubH 5793 Health Economics (3 cr.)
*PubH 5772 Multihospital Systems and Academic Medical Centers (3 cr.)

Year Two, Winter Quarter:

xMBA 8055 Business, Government and Macroeconomics (4 cr.)
xBFin 8700 Capital Management (4 cr.)
xBFin 8701 Investment Portfolio (4 cr.)
*PubH 5753 Strategic Management (3 cr.)
PubH 5745 Management Project (2 cr.)

Year Two, Spring Quarter:

xMBA 8070 Problem Formulation (5 cr.)
xBFin 8703 Futures (4 cr.)
*PubH 5796 Health Law (3 cr.)
PubH 5745 Management Project (3 cr.)

(*) indicates MHA coursework used to fulfill MBA requirements

(x) indicates MBA coursework used to fulfill MHA requirements

II. GOALS AND OBJECTIVES

A. Purposes and Goals - To prepare students for leadership roles in the health care industry. Students will combine a strong background in the structure, issues and challenges of the health care industry with knowledge of a focused area of management such as marketing, finance, etc. in order to develop the skills necessary to manage in a complex and volatile environment.

Students seeking the MHA/MBA are expected to be those interested in multi-institutional health organizations that have a mix of for-profit and not-for-profit structures, and students interested in consulting. We anticipate approximately 8-10 students per year to graduate from the combined program.

B. Admissions Requirements and Procedures

1. Anticipated Student Audience - Two groups of students are expected to make use of the MBA/MHA program:

a. Students with backgrounds in management who are seeking a MBA/MHA at the time they apply. The goal of these students in graduate school is to earn both an MHA and an MBA;

b. Students in their first year of the MHA program who develop an interest in the MBA. MHA students use their elective credits to develop a focused area of concentration. Students may choose a health care interest area, such as long term care administration, ambulatory care administration, or policy analysis, or students may choose a functional area such as marketing, finance, operations management, etc. It is expected that the students in the latter category will be those interested in the combined MHA/MBA.

2. The proposed program is intended for students entering graduate school at this time. The combined program is not intended to serve students who already hold either an MHA or an MBA.

3. Students must apply and be accepted independently to the MHA program and to the advanced placement MBA evening program. The Admissions Committee for each program will have complete responsibility for reviewing and deciding the admissibility of applicants. Appendices 1 and 2 summarize admissions information for the MBA and MHA programs and indicate the similar nature of applicant pools and accepted students.

a. Timing - Students accepted for Fall Quarter into both the MHA and MBA Programs will defer their MBA acceptance and begin Spring Quarter. The coordinators for the MHA and MBA programs will confer and confirm the list of these students each Fall, with a copy sent to the Graduate School.

C. Course of Study - Students will spend the first year in the MHA program, taking required coursework that will steep them in the knowledge needed for management in the health care industry. Their second year will combine the required coursework from the MBA program with electives that are appropriate to the goals of both programs. Students must develop a concentration in a management field of study. Degree plans for each program will be approved and signed by the advisor in each program. Degree requirements may be individualized, depending on previous academic or professional background of the student.

Minimally, students will take 42 credits of coursework in the Carlson School of Management. Twelve (12) credits of MHA coursework will be used as electives to meet the MBA requirement of 54 credits. In the MHA program, students will complete required coursework (55-56 credits, depending on whether students choose a thesis or management project) and use MBA coursework to complete the remaining 23-27 credits of elective coursework. Given the significant overlap in the two curricula, and the large number of credits needed for graduation, the number of courses double counted is in acceptable proportion to the degree requirements and content expected from graduates of both programs.

The enclosed sample programs of study in Appendices 3 and 4 illustrate the sequence of coursework and registrations for a combined MHA/MBA. For comparison, Appendix 5 is the program of study for the MHA program.

III. COMPARISON WITH SIMILAR PROGRAMS

Master's in Health Administration programs fall into two categories: programs housed in the health sciences with close ties to a school of management (such as Minnesota), and programs which are administered through a school of management. Students in the latter programs receive an MBA with a concentration in Health Administration.

Students in combined MBA/MHA programs such as that being proposed, receive the benefit of a focused curriculum in health care, in addition to developing a specialty in a management area. Of the top 10 health management programs in the country, seven are health-sciences based: University of Michigan, University of Minnesota, Ohio State University, University of North Carolina, Washington University, University of Washington, Medical College of Virginia, University of Iowa, George Washington University, Duke, Boston University, University of Pittsburgh. Five of these sponsor formal MBA/MHA programs.

The Minnesota MHA Program is ranked second nationally; a combined MBA/MHA program such as that being proposed will enable the program to continue to compete nationally for top students. There is growing demand in the health care industry for highly skilled managers able to manage in a variety of environments. Graduates with an MHA/MBA have been very well received in the industry. Nationally, prospective students also are demanding and using combined programs more such as the MBA/MHA, MHA/J.D., or MHA/MPA. The combined MHA/MBA will enable Minnesota to meet these growing market demands.

IV. QUALITY CONTROL

A. Curriculum - The integrity of a curriculum is monitored by faculty. The faculty of both the Carlson School of Management and the School of Public Health are in full support of the attached proposal. The proposed curriculum meets accreditation guidelines set forth by the American Association of Colleges and Schools of Business (AACSB) which accredits the MBA program, and the Accrediting Commission on Education for Health Services Administration (ACEHSA) which accredits the MHA Program.

B. Faculty - No new faculty resources will be needed for the combined program; existing coursework and faculty would be used to fulfill requirements. Appropriate graduate faculty appointments will be processed as needed.

C. Student Progress - Monitoring of student progress will be the responsibility of the faculties of the School of Management and the School of Public Health. Each program will monitor student academic progress according to its own standards and procedures. A student terminated from one program may be permitted to continue in the other program, assuming satisfactory progress in the other program and review and approval by the faculty. In such an instance, the commitment to admit will be honored, but the student can only complete the program in which enrollment is still active.

V. IMPLEMENTATION

The program will be implemented as soon as it receives formal approval. The program can be implemented with current faculty and resources. Because student programs will vary depending on previous experience and coursework, the following will guide students in planning their programs and registration patterns:

A. Graduate School Residency Requirement - Students must be registered for at least three quarters as a Graduate School student (4th quarter of residency in MBA is obtained through transfer of MHA credits).

B. MBA and MHA Registration Requirement - Because of the funding structures of the MBA and MHA programs, students will:

1. Register and pay for 42 credits as an MBA student. Actual courses registered and paid for can be either MBA or Public Health courses.

2. Students will register in the School of Public Health during Fall Quarter whenever possible to meet financial goals.

3. Students' plans of study to meet curriculum requirements are not limited by college of registration, as long as above residency and financial requirements are met.

VI. APPENDICES

- Appendix 1 - MHA Admissions Information
- Appendix 2 - MBA Admissions Information
- Appendix 3A - Program of study for student beginning MBA
portion of program Spring Quarter, Year 1
- Appendix 3B - Credit distribution of student pursuing
Program of Study #1
- Appendix 4A - Program of study for student beginning MBA
portion of program Fall Quarter, Year 2
- Appendix 4B - Credit distribution of student pursuing
Program of Study #2
- Appendix 5 - MHA Program of Study

APPENDIX 1

MHA ADMISSIONS INFORMATION

1983-1989

<u>Means</u>	<u>CL'91</u>	<u>CL'90</u>	<u>CL'89</u>	<u>CL'88</u>	<u>CL'87</u>	<u>CL'86</u>
Grade Point	3.29	3.44	3.26	3.25	3.36	3.34
GMAT Verbal	35	38	37	36		
GMAT Quant	34	34	31	35		
GMAT Total	573	591	565	587		
GRE Verbal	517	533	554	505	525	553
GRE Quant	636	613	608	597	595	592
GRE Analytic	618	604	647	593	574	600
GRE Total	1771	1750	1809	1695	1694	1746
Men	16	19	14	10	13	16
Women	14	11	16	23	14	15
Age	25.7	26.5	25.5			
Median Age	24.0					
Total Apps	125	91	115			
Completed Apps	109	81	92	69	65	80
Interviewed	67	59	64			
Accepted Apps	39	39	41	39	32	33
Enrolled	30	30	30	33	27	27
From college	10	10	13	7	9	6
With experience	20	20	17	26	18	21
health care exp.	15	16	12	18	13	17

APPENDIX 2
MBA ADMISSIONS PROFILES
Summer 1986 - Fall 1989

	<u>F'89</u>	<u>SS'89</u>	<u>F'88</u>	<u>SS'88</u>	<u>F'87</u>	<u>SS'87</u>	<u>F'86</u>	<u>SS'86</u>
Total Apps	379	172	434	205	344	199	225	166
Admits	190	126	170	131	159	147	165	143
Matrics	95	74	98	76	88	94	104	106
Avg GPA	3.20	3.40	3.14	3.39	3.21	3.35	3.23	3.32
Avg GMAT	578	583	582	584	577	580	571	570
verb	34	36	35	- - -	- Data Unavailable	- - -	- - -	- - -
quant	36	35	36	- - -	- Data Unavailable	- - -	- - -	- - -
Avg Age	27.8	26.4	26	26	26	26	26	28
range	21-43	21-43	21-45	21-40	22-44	22-36	21-38	21-44
Minority	4-4%	3-4%	5-5%	2-3%	6-7%	1-1%	3-3%	2-2%
Men	76-80%	50-68%	67-68%	45-59%	60-68%	63-67%	67-64%	79-74%
Women	19-20%	24-32%	31-32%	31-41%	28-32%	31-33%	37-36%	27-26%
Previous Grad/Prof Degrees	13%	5%	8%	3%	3%	1%	10%	5%

APPENDIX 3A

MHA/MBA Plan of Study #1
revised 10-18-89

Fall Quarter	Winter Quarter	Spring Quarter
<u>15 Credits</u>	<i>Year One</i> <u>14 Credits</u>	<u>16 Credits</u>
Register as MHA	Register as MHA	Register as MBA
PubH 5756 (4 cr) Financial Acct (8030)	PubH 5757 (4 cr) Managerial Acct (8035)	MBA 8005 (1 cr) Computer Access
PubH 5404 (4 cr) Statistics (8020)	PubH 5720 (3 cr) (8010) Mgmt Communications	PubH 5759 (4 cr) Health Care Finance (8040)
PubH 5742 (4 cr) Mgmt Hlth Care Org	PubH 5760 (3 cr) Operation Research (8025)	MBA 8015 (4 cr) Human Resources (5747)
PubH 5791 (3 cr) Medical Care Organ	PubH 5744 (4 cr) Problem Solving	PubH 5761 (3 cr) Quant Methods
		MBA 8050 (4 cr) Operations Management

SUMMER RESIDENCY AND PubH 5746 Clerkship (3 cr)

<u>18 Credits</u>	<i>Year Two</i> <u>17 Credits</u>	<u>14 Credits</u>
Register as MHA	Register as MBA	Register as MBA
MBA 8045* (4 cr) Marketing Management	MBA 8055* (4 cr) Bus, Gov't, & Macro	MBA 8070 (5 cr) Problem Formulation
MBA Concentration (4 cr)	PubH 5753 (3cr) (8060) Strategic Mgmt/Erickson	PubH 5796 (3 cr) Health Law
MBA Concentration (4 cr)		
PubH 5793 (3 cr) Health Econ	PubH 5xxx (2 cr) Project/Thesis	PubH 5xxx (2 cr) Project/Thesis
MHA Bracket Elective (3 cr)	MBA Concentration (4 cr)	MBA Elective (4 cr)
	MBA Concentration (4 cr)	

Credit Totals

MBA Credits	42	MHA Credits	55
MHA credits	<u>12</u>	MBA credits	<u>27</u>
Total for graduation	54	Total for graduation	82

APPENDIX 3B

ACCELERATED MBA-MHA DEGREE PROGRAM
 PLAN OF STUDY #1
 revised 8-1-89

TOTAL CREDIT DISTRIBUTION

	MHA	MBA	Comments
Fall Quarter - Year 1	15	0	Health section of Financial Accounting (Tranter)
Winter Quarter - Year 1	14	0	Health section of Managerial Accounting (Tranter)
Spring Quarter - Year 1	7	9	Health section of Finance (Nantell)
Summer Session	3		
Fall Quarter - Year 2	6	12	MBA 8045 accepted as MHA bracket elective in Management
Winter Quarter - Year 2	5	12	MBA 8055 accepted as MHA bracket elective in Policy Health section of Strategy (Erickson)
Spring Quarter - Year 2	5	9	
Summer Session	-	-	
TOTALS	55	42	

**APPENDIX 4A
MHA/MBA Plan of Study #2
revised 10-18-89**

Fall Quarter	Winter Quarter	Spring Quarter
<u>15 Credits</u>	<i>Year One</i> <u>14 Credits</u>	<u>14-15 Credits</u>
Register as MHA	Register as MHA	Register as MHA
PubH 5756 (4 cr) Financial Acct (8030)	PubH 5757 (4 cr) Managerial Acct (8035)	PubH 5759 (4 cr) Health Care Fin (8040)
PubH 5404 (4 cr) Statistics (8020)	PubH 5760 (3 cr) Operations Management (8025)	PubH 5747 (3 cr) Human Resources (8015)
PubH 5742 (4 cr) Mgmt Hlth Care Org	PubH 5720 (3 cr) (8010) Mgmt Communications	PubH 5761 (4 cr) Quant Methods
PubH 5791 (3 cr) Medical Care Organ	PubH 5744 (4 cr) Problem Solving	Elective (3-4 cr)

SUMMER RESIDENCY AND PubH 5746 Clerkship (3 cr)

<u>16 Credits</u>	<i>Year Two</i> <u>18 Credits</u>	<u>14 Credits</u>
Register as MBA	Register as MBA	Register as MBA
MBA 8005 (1 cr) Computer Access	MBA 8055 (4 cr) Bus, Gov't & Macro	MBA 8070 (5 cr) Problem Formulation
MBA 8045 (4 cr) Marketing Management	MBA 8060 (4 cr) Strategy & Policy	PubH 5796 (3 cr) Health Law
MHA Industry Bracket (3 cr)	PubH 5xxx (2 cr) Project/Thesis	PubH 5xxx (2 cr) Project/Thesis
MBA 8050 (4 cr) Operations Management	MBA Concentration (4 cr)	MBA Concentration (4 cr)
MBA Concentration (4 cr)	MBA Concentration (4 cr)	

**Summer Session I
Register as MHA**

PubH 8796 (3 cr)
Health Econ
MBA Elective (4 cr)

Credit Totals

MBA Credits	42	MHA Credits	59
MHA credits	<u>12</u>	MBA credits	<u>23</u>
Total for graduation	54	Total for graduation	82

APPENDIX 4B

**ACCELERATED MBA-MHA DEGREE PROGRAM
PLAN OF STUDY #2
revised 8-1-89**

TOTAL CREDIT DISTRIBUTION

	MHA	MBA	Comments
Fall Quarter - Year 1	15	-	Health section of Financial Accounting (Tranter)
Winter Quarter - Year 1	14	-	Health section of Managerial Accounting (Tranter)
Spring Quarter - Year 1	14	-	Health section of Finance (Nastell)
Summer Session	3		
Fall Quarter - Year 2	3	13	MBA 8045 accepted as MHA bracket elective in Management
Winter Quarter - Year 2	2	16	MBA 8055 accepted as MHA bracket elective in Policy; Health Section of Strategy (Erickson)
Spring Quarter - Year 2	5	9	
Summer Session	3	4	
TOTALS	59	42	

APPENDIX 5
 UNIVERSITY OF MINNESOTA / SCHOOL OF PUBLIC HEALTH / PROGRAM IN HOSPITAL AND HEALTHCARE ADMINISTRATION
 MHA PROGRAM OF STUDY (CLASS OF 1991)

PHASE	CONTENT			ELECTIVES
I. INTRODUCTION TO HEALTHCARE ADMINISTRATION:				
<u>Fall Quarter (15 credits)</u>	<u>Winter Quarter (14 credits)</u>	<u>Spring Quarter (14 credits)</u>		
Management of Health Care Organizations PubH 5742 (3 cr.)	Management Communications PubH 5720 (3 cr.)	Human Resources Management PubH 5747 (3 cr.)	<u>Policy and Environment:</u>	
Statistical Decision-Making PubH 5404 (4 cr.)	Managerial Accounting in Health Organizations PubH 5757 (4 cr.)	Operations Research and Control Systems PubH 5760 (3 cr.)	PubH 5790 Med Soc (4 cr.) F PubH 5794 Policy (3 cr.) W	
Financial Accounting in Health Organizations PubH 5756 (4 cr.)	Principles of Problem Solving in Health Services Organizations PubH 5744 (4 cr.)	Quantitative Methods Applied in Health Administration Problems PubH 5761 (4 cr.)	*PubH 8750 Alt. Patterns (4 cr.) F PubH 8795 Adv. Econ. (3 cr.) S PubH 5861 Health Insurance	
Public Health and Medical Care Organizations PubH 5791 (3 cr.)	Elective (3 cr.)	Health Care Financial Management PubH 5759 (4 cr.)	*PubH 8790 Politics (3 cr.) W MBA 8055 MacroEcon (4 cr.) FW	
Health Services Organizations in the Community PubH 5792 (1 cr.)			<u>Management:</u>	
			PubH 5754 Marketing Health Care (4 cr.) S PubH 5758 Fin. Statement Analysis (4 cr.) F PubH 5741 Org. Theory (3 cr.) F PubH 5752 Fac. Plan (3 cr.) W PubH 5745 Adv. Problem-Solving (3 cr.) S	
II. SUMMER RESIDENCY AND PubH 5746 CLERKSHIP (3 credits)				
III. ADVANCED COURSES AND SPECIALIZATION IN HEALTHCARE ADMINISTRATION:				
<u>Fall Quarter (12 credits)</u>	<u>Winter Quarter (12 credits)</u>	<u>Spring Quarter (12 credits)</u>		
Economic Aspects of Health Care PubH 5793 (3 cr.)	Strategic Management PubH 5753 (3 cr.)	Legal Considerations in Health Services Administration PubH 5796 (3 cr.)	<u>Industry Sector:</u>	
Electives (9 cr.)	Thesis or Management Project (2 cr.)	Thesis or Management Project (2-3 cr.)	PubH 5713 HMOs (3cr.) W PubH 5772 Multis & Acad. Med. Cntrs. (3 cr.) F	
	Electives (7 cr.)	Electives (6-7 cr.)	PubH 5749 Services to Aging (3 cr.) F	
			<u>Non-Bracket Elective:</u>	
			PubH 5766 Applied Field Research I (2 cr) F	
IV. ADMINISTRATIVE FELLOWSHIP/POSITION				

*offered alternate years

Revised 09/11/89

UNIFORM PROGRAM
INVENTORY AND
PROPOSAL FORM

SECTION I
Program Proposal Abstract and Cover Sheet
(See Attached Instructions)

1 Unit, Campus or College University of Minnesota Code No. 2

I. General Information

A. Program Title M.S./Ph.D. Program in Toxicology

B. Program Review Category: Regular
(check one) Experimental (If Experimental, give Reporting Date: / /)

C. Proposed Implementation Date: 7 / 1 / 90

D. Program Length: Total Cr/hr 92 Classroom 56 Laboratory 36 thesis cr.

E. Administrative Unit Immediately Responsible for Program: Graduate School

F. Describe the Program (in 50 words or less):

The science of toxicology incorporates expertise from numerous disciplines
to provide comprehensive descriptions of the adverse effects of foreign agents
on biological systems. The proposed program provides a cost-effective mechanism
for intergrating existing faculty resources to address the increasing demand
for well-qualified investigative toxicologists for laboratory research
positions.

G. Expected student interest in the program during the first year of operation, and when the program reaches full operating level:

	90/91 First Year: (Yr.)		93/94 Full Operation: (Yr.)	
	Number (Headcount) Expected	Student Credit or Contact Hours	Headcount Capacity	Student Credit or Contact Hours
a. Enrollment				
Program Enrollees	4	148	16-24	415-623
Other Students	6	60	10	100
Total	10	208	26-34	515-723
b. Program Graduates/Completers	0	---	4-6	---

UNIFORM PROGRAM INVENTORY
AND PROPOSAL FORM

Section II

M.S./Ph.D. Program in Toxicology

1. Summary Description of Program

Objectives. The program is designed to accomplish the following objectives: 1) Attract from a national pool the brightest, most highly motivated candidates to enter the Ph.D. Program in Toxicology. Although the intent of the Program is to provide doctoral training in toxicology, the opportunity for granting a Master's degree in toxicology will be reserved for those students who either experience a change in career objectives or fail to complete the preliminary examinations. 2) Provide a rigorous curriculum explicitly designed to afford students a comprehensive and solid foundation in the various perspectives of toxicology. Selected new courses in toxicology will be coordinated with existing curricula in biochemistry, physiology, pharmacology, and statistics to insure the most cost-effective curriculum for the program. 3) Provide a selection of suitable elective courses to best complement the educational objectives of each student. The entire curriculum is designed to encourage the completion of all course requirements and initiation of the thesis research as early as possible in the program. Every measure has been taken to encourage the completion of all program requirements and graduation in a total of four years. 4) Complement the curricular exchange of information with invited guest seminars from renowned expert toxicologists to provide timely discussions of the most recent advances in the field. 5) Provide students with a broad selection of laboratory research opportunities with faculty from throughout the University who are distinguished in a wide array of specialty areas in toxicology. 6) Provide a formal interdisciplinary Ph.D. program in toxicology which will eventually receive international recognition for its unique qualities of orchestrating an extremely diverse, multidisciplinary faculty to provide comprehensive expert training in the broad science of toxicology. 7) Train highly qualified toxicologists to meet the increasing demands of the State of Minnesota and of the Great Lakes region for Ph.D. scientists to assume positions of leadership in research institutions devoted to safeguarding and improving the quality of life through investigative toxicology research.

Admission Requirements. Candidates for the M.S./Ph.D. Program in Toxicology will have earned a Bachelor's degree or its foreign equivalent from a recognized institution of higher education. Matriculants will be expected to have completed a minimum of a full year each of biology, organic chemistry and physics as well as mathematics through calculus. The standardized General (Aptitude) Test of the Graduate Record Examinations will be required of all applicants. Four-to-six candidates are expected to be admitted into the Ph.D. Program each year with an equal number of graduates completing the requirements annually beginning the fourth year.

University Resources. A preliminary survey identified more than 50 faculty members of the University of Minnesota who expressed interest in developing and contributing to the implementation of a Ph.D. Program in toxicology. Collegiate units represented by the faculty include: the School of Medicine, the Medical School, the College of Biological Sciences, the College of Science and Engineering, the College of Veterinary Medicine, the College of Pharmacy, the Colleges of Agriculture and Forestry, the School of Public Health, the Hormel Institute, the Gray Freshwater Biological Institute, and the Natural Resources Research Institute. Collectively, the faculty bring a very diverse and comprehensive expertise to the study of toxicology. Essentially all of the faculty identified continue to be actively involved in sponsored basic scientific research and maintain well-equipped, state-of-the-art laboratories. Since

toxicology requires minimal elaboration of equipment beyond those used in the respective traditional disciplines, implementation of the proposed program requires only that the existing laboratory facilities along with privileges of library and animal care services be available to support the graduate student thesis research.

A key element to the cost-effectiveness of the proposed program is that it draws from existing faculty and courses for its strength. Although none of the above mentioned faculty have made any commitments to the program, the very favorable response reflects a broad faculty interest. Furthermore, since the majority of the curriculum required for the major is currently offered by various departments, implementation of the program necessitates the development of only a few new courses dealing with the principles of toxicology. Accordingly, the program is designed to provide a rigorous and comprehensive education at a very nominal cost to the University.

Annual recurring expenses of the program are tabulated below. The figures are calculated on the basis of an estimated total of 20 graduate students enrolled once the program is in full operation. It is expected that all students enrolled in the Program will receive some form of financial assistance; typically teaching or research assistantships sponsored either by state or investigator-initiated extramural research funds. Exceptional candidates will be nominated for Graduate School fellowships.

<u>Annual Budget</u>		
	<u>First Year</u>	<u>Fourth and Subsequent Years</u>
Personnel		
DGS (0.20 FTE release-time)	\$8,000	\$8,000
Secretary (0.25 yr 1; 0.5 yr 4)	\$5,750	\$11,500
Graduate student assistantships (Investigator-supported RA)	\$40,000 (-)	\$200,000 (\$120,000)
SE&E		
Office supplies	\$1,500	\$2,500
Instructional supplies	\$3,000	\$6,000
Books, journals, etc.	\$1,000	\$1,000
Student recruitment	\$4,000	\$4,000
Travel		
In-state faculty travel	\$4,000	\$6,000
Guest lecturers and seminars	\$3,000	\$3,000
Annual Graduate Student Symposium	\$5,000	\$8,000
Sub-total	\$ 75,250	\$250,000
Start-up Costs (1989/90)	\$13,000	-
Total	\$88,250	\$250,000
(Investigator-supported RA)	(-)	(\$120,000)
Total Institutional Support	\$88,250	\$130,000

Extramural Resources. It is expected that the majority of advanced students in the program will receive research assistantships supported by investigator-initiated research grants, contracts or cooperative agreements. Graduate student support will also be sought from private industries and from both federal and private agencies and research foundations. Additional applications will be developed for extramural programmatic funding of both graduate student stipends and operational expenses, such as NIH training program applications. Finally, the close proximity and collaboration between University faculty and the U.S. Environmental Protection Agency (ERL-Duluth) and selected research institutes such as the Natural Resources

Research Institute, the Hormel Institute, and the Gray Freshwater Biological Institute as well as assorted industrial corporations provide several unique opportunities to utilize their expertise and resources to supplement and enhance the dimensions and quality of the proposed program.

2. Need for the Proposed Program

The science of toxicology has grown as a response to increasing public awareness of the need to safeguard the environment and human health from noxious agents and to limit the risks associated with the production, transport, marketing, application, and disposal of synthetic chemical agents. Exposure of man and animals to environmental and agricultural chemicals, drugs, and natural toxins has resulted in numerous well documented cases of illness and death and/or problem residues passed on to man or the environment. Examples of such include lead and mercury poisoning, polybrominated biphenyl toxicosis, aflatoxicosis, dioxin and chlorinated biphenyl residues in fish, and environmental spills of petroleum products. Excessive exposure to toxic agents can result in economic losses in terms of agricultural production, health care expense and destruction of the environment.

Increasing public awareness and insistence on maintaining the quality of life drives the demand for greater numbers of toxicologists to assume leadership positions in research institutions. This demand for well-trained toxicologists continues to grow with the increasingly more stringent regulation of the safety of consumer products and the risks associated with agents released into the environment. Despite the influx of students into this area since the 1970's, toxicology continues to enjoy one of the more favorable job markets for recent Ph.D. graduates. Ph.D graduates in toxicology are heavily recruited for post-doctoral positions as well as for positions in industry and in state and federal governmental agencies devoted to investigative laboratory research. These individuals are instrumental in supervising the conduct of basic laboratory research designed to provide fundamental knowledge to support the identification and quantification of health risks which serve as the basis for establishing regulatory guidelines to minimize the potential hazards associated with the production, marketing, use, or disposal of noxious agents.

Recent historical data collected by the Society of Toxicology documents the growing demand for Ph.D. toxicologists, especially in the the Great Lakes region, and the professional consensus is that this favorable job market will continue for quite some time. A 1987 survey by the Society of Toxicology revealed a total of 66 Ph.D degree-granting programs in toxicology in the U.S., ranging from a joint departmental degree to more elaborate multidisciplinary programs. Minnesota was not represented in the roster of colleges and universities having graduate programs in toxicology, despite the fact that the Great Lakes region enjoys one of the most favorable ratios of job openings-to-applicants in the U.S. for Ph.D. toxicologists.

The interdisciplinary nature of toxicology continues to attract some of the brightest and most highly motivated students from a variety areas. Inquiries are routinely received from aspiring candidates interested in achieving advanced graduate training in this field; however, the lack of an official program limits our ability to meet their demands. Although some of these students enroll in one of the more traditional departments with the intent of specializing in toxicology, the majority apply to toxicology Ph.D. programs offered by out-of-state universities. Consequently, Minnesota loses some of its brightest baccalaureates to other states having official Ph.D. degree-granting programs in toxicology.

Implementation of the M.S./Ph.D. Program in Toxicology will allow us to retain these bright students at the University of Minnesota as well as to attract high quality graduate students from a national pool. A minor in toxicology will provide expanded opportunities to students enrolled in other disciplines and may thus benefit several other graduate programs in recruiting qualified graduate students. The existence of the program at the University will also benefit both the recruitment and retention of some of the nation's most distinguished basic science faculty having scholarly interests in toxicology. Finally, implementation of this interdisciplinary program will improve the productive collaboration between participating

faculty and provide new opportunities for applying for extramural toxicology-related training and programmatic funding as well as faculty and student awards for which the University is currently ineligible.

3. Mission

The mission of the proposed program is to draw together faculty from various academic disciplines from throughout the University to collaborate in providing the highest possible quality Ph.D. program in toxicology. The emphasis of the program will be to train students in the conduct and supervision of laboratory-based research in the various aspects relevant to the investigation of toxicology. The proposed program differs from the more traditional Ph.D. programs in its multidisciplinary scope, pulling together faculty from several distinct academic units to collectively offer the best possible instructional expertise and diversified laboratory research opportunities. Rather than limiting the focus to a specific sub-specialty, the program derives strength from its broad, all-inclusive scope which maximizes faculty participation and enriches opportunities for student research.

Such an interdisciplinary graduate program is not unprecedented in the University of Minnesota. The recently approved Ph.D. Program in Neuroscience is an example of a successful graduate program which incorporates faculty from numerous disciplines into a single cohesive unit. The multidisciplinary nature of these programs not only provides greater dimension to comprehensive graduate education, but also appeals to the current sentiment of funding agencies which have come to recognize the value of interdisciplinary collaboration to investigative research programs.

The proposed program will greatly advance the educational objectives of the University and of the State. By carefully orchestrating the cooperative efforts of faculty from throughout the University, the program will facilitate improved relations and productivity among faculty from various collegiate units. Furthermore, the offering of a Ph.D. in toxicology will provide opportunities to those students seeking such an education and will directly address the growing demand by employers and the public in general for addressing the more rigorous mandates for safeguarding environmental and human health concerns from the noxious effects of the ever increasing numbers of synthetic agents being produced annually.

4. Comparative Program Analysis

No other M.S./Ph.D. program in toxicology is currently offered by institutions of higher education in the state of Minnesota. Until recently, the Environmental and Occupational Health Division of the School of Public Health at the University of Minnesota offered an M.S./Ph.D. specialty tract in toxicology with a major in Environmental Health. The M.S. program was curriculum-based and trained students in the applied science of identifying, quantifying and evaluating the potential risks associated with putatively toxic agents in the environment that may be detrimental to human health in the public, occupational, residential, or institutional domains. Career placement was usually with local, state, or federal health agencies, industrial quality control units, or private consulting firms. Students in the Ph.D. program receive extensive training in laboratory research culminating in a written dissertation; however, the opportunities for research are severely limited by the small number of faculty affiliated with this program. The recent withdrawal from a full-time to a half-time position with the University by the principal faculty member responsible for the toxicology tract has disrupted the continuation of the training programs. The future of graduate level training in toxicology through the Division of Environmental and Occupational Health remains to be determined by the incoming chairperson and the Dean of the School of Public Health.

Although there may be minor redundancies in selected portions of the basic introductory curriculum, there are significant and distinct differences in the emphasis of the two Ph.D. programs. The proposed M.S./Ph.D. Program in Toxicology is laboratory-intensive, with a focus on training students in the conduct of investigative research. Most graduates will assume careers with academic, private or governmental institutions heavily engaged in scientific

research and development. Accordingly, graduates from the proposed program will be trained in the generation and interpretation of basic scientific data which are the fundamentals used by the applied toxicologists to establish regulatory guidelines.

The proposed program was developed in collaboration with Dr. Jeffrey B. Stevens, Assistant Professor of Environmental and Occupational Health to insure comprehensive, yet distinct, training in both the investigative research and applied disciplines of toxicology. Dr. Stevens developed and is principally responsible for training in toxicology in the Division of Environmental and Occupational Health. Existing commitments by the faculty in the Environmental and Occupational Health division limit the extent of collaboration with the proposed program; however, the two programs will undoubtedly complement and advance the quality of the other. Implementation of the proposed multidisciplinary M.S./Ph.D. Program in Toxicology may alleviate some of the burden on the Environmental Health major as well as provide greater opportunities for Ph.D. students in this program to gain more diversified training in the classroom as well as additional faculty advisors for the thesis research. Having both the basic science and public health programs will provide a broader perspective and added dimension to the comprehensive investigation of toxicology.

Historically, the Department of Pharmacology on the Minneapolis campus has offered specialized training in biochemical toxicology. However, several of the faculty members responsible for the specialization have left the University. The current faculty are in the process of reorganizing and redesigning the specialty offerings.

Iowa and Wisconsin are the only neighboring states which currently offer Ph.D. programs in toxicology. An interdepartmental major in toxicology, with a focus in the agricultural sciences, was recently established at Iowa State University in Ames. The University of Wisconsin at Madison, in addition to the traditional pharmacology and toxicology program, has a well-established, highly recognized multidisciplinary program in environmental toxicology which currently receives training grant support from the National Institute of Environmental Health Sciences. The program incorporates faculty from a variety of disciplines to contribute to both the curriculum and research components of the Ph.D. training experience. Despite the success of these programs, recent surveys indicate that they fail to meet the regional demand for Ph.D. trained toxicologists. Neither the University of Iowa, the Medical College of Wisconsin, nor any of the institutions in either North or South Dakota offer advanced graduate training in toxicology.

5. Duplication

The proposed program does not duplicate any elements of other graduate programs offered by institutions of higher education in the state of Minnesota.

6. Cost/Benefit

By training students in the science of investigative toxicology research, the proposed program will contribute to the advancement of knowledge and technologies to better safeguard both human and animal health as well as the environment. Graduates from the program will fill important research positions in academic, pharmaceutical, chemical or governmental institutions. Advancements in basic scientific research, under the direction of graduates from the Program, will not only contribute to the regulation of existing toxic materials, but will also advance current understanding and technologies in limiting the toxicity in the design and development of new products or synthetic procedures. Regionally, the increasing public awareness of environmental concerns as they relate to Minnesota's rich natural resources and the growing tourism industry will benefit directly from the advancements achieved through basic toxicology research as will corporations involved in product development and marketing. The establishment of an official toxicology program will not only help attract and retain distinguished faculty, but the Program may be viewed as a highly valued resource by new industries considering Minnesota as a possible site of residency. It is of particular significance

SECTION III

Jan. 17, 1989
(Date)

Proposal for: Ph.D. Program in Toxicology
Submitted by the: Toxicology Committee
of the : Graduate School

The proposal has been reviewed and approved by:

APPROVED CERTIFICATION

ADDITIONAL APPROVALS

[Signature] 2/2/89
Chair, Toxicology Committee,
Graduate School (Date)

[Signature]
Dean, Graduate School (Date)

[Signature] 2-2-89
Dean, School of Medicine, Duluth (Date)

Vice President, Health Sciences (Date)

[Signature] 3 Feb-89
Dean, College of Science &
Engineering, Duluth (Date)

C. Eugene Allen 2/7/89
Vice President, Agriculture,
Forestry, & Home Economics (Date)

[Signature] 12/6/89
Dean, Medical School (Date)

[Signature] 2/2/89
Vice Chancellor, Acad. Affairs (Date)

[Signature] 2/3/89
Dean, College of Pharmacy (Date)

[Signature] 2/3/89
Chancellor, UM, Duluth (Date)

[Signature] 2/6/89
Dean, College of Vet. Medicine (Date)

Vice President, Acad. Affairs (Date)

[Signature] 2/11/89
Dean, School of Public Health (Date)

Approval by Regents: _____
(Date)

[Signature] 2/6/89
Dean, College of Biol. Sciences (Date)

First Reading by CAC: _____
(Date)

[Signature] 2-7-89
Dean, College of Agriculture (Date)

Second Reading by CAC: _____
(Date)

Recommendation by the MHECB: _____

(Date)

Confirmation by Regents: _____
(Date)

Section III: The Proposal to establish an M.S./Ph.D. Program in Toxicology

A. Introduction Public awareness and concern for hazards associated with the introduction of foreign substances into our diet, either directly or via the food chain, into our homes or places of business, or into the environment in general has proliferated in the recent past. The technological revolution of the early 1970's has been manifested in the synthesis of an enormous number of new commercial products designed to improve our standard of living. Unfortunately, these advances are not without cost. Accompanying the development of new consumer products is the liability for the eventual release or disposal of these agents into our environment. Of equal and perhaps greater concern is the evolution of incalculable amounts of by-products of the synthetic processes and the ultimate disposal of these wastes. The public has responded by demanding greater consumer protection against possible hazards associated with the intended or incidental exposure to these new products as well as insisting on increased accountability for the safe disposal of the end-products. This increasing public awareness and concern has led the establishment of the Environmental Protection Agency, the Occupational Safety and Health Administration, and the Consumer Products Safety Commission along with the enactment of several laws governing the strict enforcement of accountability for assuring minimal human health or environmental hazards associated with the production, use, and disposal of both naturally occurring and synthetically produced noxious agents.

Because of the enormity of these mandates, the federal government initiated several programs to encourage Universities to redirect their expertise to provide for the training of qualified students to address these concerns for the identification, detection, assessment, and regulation of putative toxins in our environment. The prioritization of toxicology by federal policy is evidenced by the relatively favorable funding of investigator-initiated research, as well as by the establishment of several institutional program project and training grants in toxicology. From an academic perspective, toxicology represents one of the more rewarding areas of opportunity in scientific investigation.

The job market for graduates in investigative toxicology mirrors this public sentiment. A cursory review of advertisements in such periodicals as Science reveals numerous positions for employment in various academic institutions and industries, as well as in governmental agencies. The federal government is expanding its staff of toxicologists to keep pace with the increasing public demands for toxicity testing, policy making, and enforcement. This, in turn, is manifested in industry as requirements for more intensive toxicity testing to satisfy the new and more strict governmental regulations. Toxicology is second, perhaps, only to molecular biology in the number of professional positions advertised in Science. Many of the local positions in regulatory toxicology have been filled by graduates of the Environmental Health major in the School of Public Health; however, the market for toxicologists to conduct basic laboratory research has yet to be formally addressed by the University or State of Minnesota.

Both faculty and student interest in toxicology have been evident for several years. Courses relating to toxicology, developed to supplement the more traditional disciplines, have enjoyed high enrollments and several students have expressed an interest in expanding their education beyond the currently offered curriculum. Although several faculty of the University of Minnesota identify primarily with toxicology and numerous others have peripheral interests, no formal mechanism exists to foster collaboration among these faculty. Consequently, the professional expertise in toxicology remains a very fragmented, poorly coordinated effort of individuals scattered throughout the University. It was the recognition of this shared interest in toxicology and the lack of a mechanism to foster collaborative scholarly activity that led to the establishment of the Chemical Toxicology Research Center in 1985. The mission of this Center is to encourage improved collaboration among faculty holding primary appointments in various collegiate units to enhance scholarly activity in toxicology, both in terms of multidisciplinary research programs and expanded educational opportunities for interested students.

Deliberate and careful planning by faculty contributing to the mission of the Chemical Toxicology Research Center lead to the convening of a committee by the Dean of the Graduate School in January, 1987 for the purpose of investigating the feasibility for developing a graduate program in toxicology. As part of its assignment, the committee gathered data reflecting both faculty interest and career placement potential. The final report of the committee documents wide support for a Ph.D. program in toxicology by faculty from throughout the University. The analysis identified over 50 faculty members of the University of Minnesota who, although making no firm commitments, expressed interest in developing and contributing to the implementation of a Ph.D. program in toxicology (Appendix C). However, a core faculty of 22 individuals has been identified (page 21) who have indicated a willingness to serve in both advising and teaching capacities for the proposed program. Collegiate units represented by the faculty include: the School of Medicine, the Medical School, the College of Biological Sciences, the College of Science and Engineering, the College of Veterinary Medicine, the College of Pharmacy, the Colleges of Agriculture and Forestry, the School of Public Health, the Hormel Institute, the Gray Freshwater Biological Institute, and the Natural Resources Research Institute. Collectively, the faculty demonstrate a very diverse and comprehensive expertise to the study of toxicology. A survey of prospective employers regarding career placement revealed a similarly strong endorsement for developing a Ph.D. program to train highly qualified toxicologists to meet the increasing demand for investigative research toxicologists in academic institutions, industry, and governmental agencies. As a result of this feasibility analysis, the Dean of the Graduate School commissioned the current committee in November, 1987 to develop a formal proposal for implementing an intercollegiate, multidisciplinary M.S./Ph.D. Program in toxicology at the University of Minnesota.

B. The Proposed Program

Although the proposed program is officially an M.S./Ph.D. Program in Toxicology, the opportunity to receive a Master's degree in Toxicology will be reserved for those students who either experience a change in their career objectives or fail to satisfy the requirements for graduation. Students will not be recruited for the Master's degree in Toxicology. Accordingly, the program is designed specifically for granting the Ph.D. degree and the program is referred to throughout the text as the Ph.D. Program in toxicology. The cost-benefit factor is attractive in that the proposed program is designed to take advantage, on a purely voluntary basis, of existing faculty expertise and to employ existing courses as much as possible to achieve its goals. Only nominal elaboration of existing University resources is required to implement the program.

Objectives. The program is designed to accomplish the following objectives: 1) Attract from a national pool the brightest, most highly motivated candidates to enter the Ph.D. Program in Toxicology. 2) Provide a rigorous curriculum explicitly designed to afford the students a comprehensive and solidly founded perspective of toxicology. Selected new courses in toxicology will be coordinated with existing curricula in biochemistry, physiology, pharmacology, and statistics to provide the most deliberate and cost-effective curriculum for the program. 3) Provide a selection of suitable elective courses to best complement the educational objectives of each student. The entire curriculum is designed to encourage the completion of all course requirements as early as possible to allow students to initiate their thesis research early in the program. Every measure has been taken to encourage the completion of all program requirements and graduation in a total of four years. 4) Complement the curricular exchange of information with invited guest seminars from renowned expert toxicologists to provide timely discussions of the most recent advances in the field. 5) Provide students with a broad selection of laboratory research opportunities with faculty from throughout the University distinguished in a wide array of specialty areas in toxicology. 6) Earn national and international recognition for the unique qualities of integrating an extremely

diverse faculty from throughout the University to provide comprehensive, expert training in the broad science of toxicology. 7) Train highly qualified toxicologists to meet the increasing demands of the State and the Great Lakes region for Ph.D. scientists to assume positions of leadership in research institutions devoted to safeguarding and improving the quality of life through investigative toxicology research.

Admission Requirements. Candidates for the M.S./Ph.D. Program in Toxicology will have earned a Bachelor's degree or its foreign equivalent from a recognized institution of higher education. Matriculants will be expected to have completed a minimum of a full year each of biology, organic chemistry and physics as well as mathematics through calculus. Applicants deficient in some of the undergraduate course requirements can be accepted into the Program with the provision that the prerequisites be satisfied within the first year of the Program. The standardized General (Aptitude) Test of the Graduate Record Examinations will be required of all applicants. Applications will be collected by the Graduate School and evaluated by an Admissions Committee appointed by the Graduate Faculty in Toxicology. Four-to-six candidates will be admitted into the Ph.D. Program each year with an estimated equal number of graduates completing the program annually beginning the fourth year.

Curriculum. The curriculum for the Ph.D. in Toxicology is designed to accomplish the following objectives: 1) Provide students with an introduction to the basic principles essential to a comprehensive understanding of science of investigative toxicology. 2) Limit the curricular requirements to allow the students to initiate their thesis research projects as early as possible. 3) Utilize existing courses in biochemistry, physiology, pharmacology, and statistics as part of the core curriculum in order to minimize the number of new courses required and thus maximize the efficiency with which the curricular element of the program is achieved. 4) Provide the students with ample opportunities to become familiar with the faculty so that they are best prepared to select a thesis advisor as early as possible during the program. This will be accomplished by incorporating guest faculty lectures in the curriculum in toxicology as much as possible and by providing numerous guest seminars by visiting faculty. In addition, an annual graduate student symposium will be offered during which faculty and advanced students in Toxicology will be invited to present results of their most recent research. Such a program will not only provide additional exposure of new students to the available opportunities for their thesis research, but it will also serve an important medium for developing skills for more formal scientific presentations by the students. 5) Design the curriculum such that, to the extent possible, the requirements can be accomplished on either the Duluth or Twin Cities campuses, depending on which laboratory the individual students select for their thesis research. In order to ensure the offering of the required courses on both campuses without duplicating lectures, selected toxicology courses will be broadcast by interactive two-way audio and video transmission. The system, as designed with the assistance of Information and Media Resources, will provide bidirectional interactive exchange between students and faculty on the separate campuses and will allow for origination of the presentation from either location. This technology has proven to be an effective means of broadcasting graduate level courses in other disciplines and relieves both students and faculty from travelling between campuses for individual lectures or course sequences. Furthermore, by eliminating the travel demands, faculty participation is enhanced as is the quality of the material presented. The majority of courses required of students beyond the second year will be electives in toxicology or a supporting field which consist, for the most part, of courses currently offered by the more traditional disciplines and can easily be accomplished on either campus. 6) By limiting the curricular requirements of the program, it is intended that each student will be able to fulfill all the requirements for graduation, including their thesis research, within four years.

The following delineates the minimum core curriculum required of all students during the first two years of the Toxicology Program. The 1992/93 and 1993/94 academic years are

selected for purposes of illustrating the overlap between the orientation of new students and the culmination of the Txcl 5001 lab course just prior to the graduate student colloquium. With the exception of the Txcl-prefixed courses, all courses are currently offered and listed in the Graduate School Bulletin. Detailed course descriptions are appended to the application (Appendix A). It is expected that, on approval of the program, several additional 8000-level toxicology graduate courses will be developed to supplement the curricular offerings to advanced students in the program.

Program for First Year Students

August 17-19 Orientation of entering students to the program. This session will be required of all in-coming students and will be devoted to familiarizing the students with the various opportunities available to them on the different campuses. Included in the orientation will be an overview of the science of toxicology and how the program is coordinated between the various campuses to provide cohesive training.

August 20 and 21 Annual graduate student research colloquium consisting of the convening of all students and as many faculty as possible for a two day scientific exchange. The site of the colloquium will rotate between campuses and housing will be arranged through the program. The program will include social events and will be highlighted by a keynote address by an invited speaker. The essence of the colloquium will be to encourage the interaction between students and faculty from the different campus and to provide cohesion to the program.

	<u>Duluth</u>	<u>Twin Cities</u>
Fall Quarter	Chem 5336 (4cr) Phsl 5901 (7cr)	BioC 5751 (4cr) Phsl 5440 (3cr)
Winter Quarter	Chem 5337 (4cr) Phsl 5902 (4cr) Math 5561 (4cr)	BioC 5752 (4cr) Phsl 5441 (3cr) Stat5021(5cr) or Pubh 5400(4cr)
Spring Quarter	Phcl 5212 (4cr) Txcl 5214 (4 cr; via video transmission)	Phm 5680 (4cr)
Summer Quarter		
July 5 - August 18	Txcl 5001 (5 cr)	
	This is an elective lecture/laboratory course in environmental toxicology sponsored (in the form of summer stipends and operational costs) by the Duluth branch of the U.S. EPA.	
August 19 and 20	Annual Graduate Student Colloquium	

Program for Second Year

	<u>Duluth</u>	<u>Twin Cities</u>
Fall Quarter	Txcl 5215 (4cr; via video transmission) Txcl 8101 - Seminar (1cr; via video transmission) Txcl 8888 - thesis credits (var) Advanced electives	Advanced electives
Winter Quarter	Txcl 5216 (4cr; via video transmission) Txcl 8101 - Seminar (1cr; via video transmission) Txcl 8888 - thesis credits (var) Advanced electives	Advanced electives
Spring Quarter	Txcl 8214 - Advanced mechanisms (2 cr; via video transmission) Txcl 8101 - Seminar (1cr; via video transmission) Txcl 8888 - thesis credits (var) Advanced electives	Advanced electives

The proposed compressed video system is technologically feasible and, in conjunction with an orientation session and periodic minisymposia, will provide for the implementation of a high quality, readily accessible and cohesive Ph.D. program between the two geographically separate campuses. To insure its success, the system will be evaluated annually and modified to address inadequacies expressed in questionnaires distributed to the students and faculty. Should the system fail to meet the desired goals, the drafting committee proposes, as an alternative, that the core sequence of 3 courses be delivered via an intensive summer session. The tentative plans would be for all students completing their first year of the program to convene in Duluth for a series of half-day lectures by guest instructors for 6 consecutive weeks. In conjunction with this would be an optional afternoon environmental toxicology laboratory course (Txcl 5001) sponsored by the U.S. EPA. The details of this alternate plan remain to be finalized contingent on the effectiveness of the proposed two-way video system. A letter is on file from the Director of the Environmental Research Laboratory-Duluth insuring financial support for this lab course for at least five years.

Beyond these required courses, students must also complete at least 18 credits in a minor or supporting field in one or more of the basic sciences and 36 thesis credits (Grad 8888) to graduate. Depending on the minor selected, a written preliminary examination may be required. The curriculum for the supporting field must be approved by both the examining committee and the Director of Graduate Studies in Toxicology. Students will be expected to maintain a 3.0 GPA throughout their studies. In view of the extremely broad, interdisciplinary scope of toxicology, the list of possible courses which may be elected for the supporting program is lengthy and varied. Students may elect to specialize in the biological, medical, or environmental elements of the science, and the subspecialties may include patho-cytomorphological evaluation, pharmacokinetic characterization, an emphasis on analytical chemical detection, or a more environmental perspective of the science. The extensiveness of the possibilities precludes a comprehensive delineation of individual elective courses; however, examples of existing elective courses for different hypothetical minors and supporting fields follow:

Supporting Field in Pharmacology (Duluth)

- Phcl 5101-5102 Pharmacology (12 cr)
- Phcl 5410-5411 Advanced Pharmacology (4 cr)
- Phcl 5216 Immunopharmacology (2 cr)
- Math 5561 Applied Statistical Analysis (4 cr)

Minor in Chemistry (Duluth)

- Chem 5710 Structural Chemistry (5 cr)
- Chem 5730 Synthesis (4 cr)
- Chem 5750 Kinetics and Mechanisms (4 cr)
- Chem 8241 Methods of Separation (4 cr)
- Chem 8541 Organic Synthesis (4 cr)

Minor in Pharmacology (Minneapolis)

- Phcl 5510-5111 Pharmacology (9 cr)
- Phcl 8110-8111 Advanced Pharmacology (4 cr)
- Phcl 8208 Neuropsychopharmacology (3 cr)
- Phcl 8217-8218 Problems in Invest. Pharmacology (4 cr)

Supporting Field in Histocytology (Duluth)

- Path 5805 Principles of Human Pathology (10 cr)
- Anat 8123-8133-8143-8153 Human Microscopic Anatomy (8 cr)

Supporting Field in Neurotoxicology (Duluth)

- Anat 5533 Human Neuroanatomy (5 cr)
- Phsl 5807 Neurophysiology (5 cr)
- Phsl 5425 Neuroendocrinology (2 cr)
- Phsl 5451 Techniques in Neurophysiology (2 cr)
- MdBc 5501 Neurobiochemistry (2 cr)
- Txcl 8213 Neurotoxicology (2 cr)

Supporting Field in Biochemistry (Duluth)

- Chem 5335 Biochemical Techniques (3 cr)
- Chem 8340 Advanced Biochemistry (4 cr)
- Chem 5710 Structural Chemistry (5 cr)
- Biol 5254 Genetics of Prokaryotes (5 cr)
- Chem 5750 Kinetics and Mechanisms (4 cr)

Minor in Biochemistry (BioC or MdBc)

- BioC/MdBc 5753 General Biochemistry (4 cr)
- BioC/MdBc 8206-8207 Cell Signalling and Metabolic Regulation (8 cr)
- BioC/MdBc 8230 Advanced Topics in Membrane Biochemistry (4 cr)

and one of the following:

- MdBc 8219 Biochemistry of Specialized Tissues (4 cr)
- BioC 5744 Analytical Biochemistry (4 cr)

Supporting Field in Veterinary Pharmacology

- VB 5401-5403 Veterinary Pharmacology (12 cr)
- Phcl 8110-8111 Advanced Pharmacology (4 cr)
- Phcl 8211 Physiological Disposition of Drugs (3-4 cr)

Supporting Field in Medicinal Chemistry and Pharmacognosy

- BioC 8225 Tracer Techniques (3 cr)
- GCB 5048-5049 Advanced Cell Biology (8 cr)
- MdBc 8230 Advanced Topics in Membrane Biochemistry (3 cr)
- MChP 8114 Natural Toxins (2 cr)
- Pubh 5400 Quantitative Methods in Biological Sciences (4 cr)

Supporting Field in Medicinal Chemistry

- Pubh 5400 Quantitative Methods in Biological Sciences (4 cr)
- MedC 8600 Chemical Aspects of Drug Metabolism and Bioactivation (2 cr)
- MedC 5600 General Principles of Medicinal Chemistry (4 cr)
- MChP 8114 Natural Toxins (2 cr)
- Chem 5305 Intermediate Organic Chemistry (4 cr)
- MedC 8800 Medicinal Chemistry Laboratory Techniques (2 cr)

Supporting Field in Veterinary Pathology

- Path 8108-8110 Pathobiology (9 cr)
- VPB 5523 Pathology of Spontaneous Diseases of Lab Animals (3 cr)
- VPB 8530 Oncology (4 cr)
- VPB 8532 Comparative Veterinary Neuropathology (2 cr)

Supporting Field in Diagnostic Investigation

Phar 5680 Pharmacokinetics (4 cr)

Phar 8420 Pharmacokinetics (4 cr)

Chem 5126 Modern Analytical Chemistry (4 cr)

Chem 5122 Advanced Analytical Chemistry (4 cr)

Chem 5133 Chemical Instrumentation and Analysis (3 cr)

Chem 5139 Chromatography and Separation Science (3 cr)

Example thesis titles include:

Enzymological modulation of anticholinesterase toxicity.

Mechanisms of lipid peroxidation in copper deficiency.

Synergism between permethrin and organophosphate insecticide toxicity.

Physical chemical determinants of the metabolic detoxification of haloalkanes.

Reactivity-based hazard assessment for electrophilic mutagens.

Ethylene dibromide-induced nephrotoxicity mediated by thionyl free radicals.

Molecular mechanisms of aflatoxin oncogenesis in Transgenic mice.

Induction of vitamin K1 epoxide reductase by 3-methylcholanthrene.

Assessment of the popliteal lymph node assay for detecting autoimmunogens.

Mechanism of aldehyde-mediated contact hypersensitivity in guinea pigs.

Dinitrobenzene exacerbates phthalate-induced testicular toxicity.

N-Acetylcysteine rescue from methylmercury intoxication.

Biodegradation of chlorinated biphenyls and dioxins in benthic ecosystems.

Tri-*o*-cresoyl phosphate protection from the embryocidal effect of malathion.

Relating carcinogenicity to chemical structure.

Structural relationships in the biopersistence of halogenated biphenyls.

Pathologic mechanism of furazolidone-induced cardiomyopathy.

Absorption of toxins across the porcine epidermis.

Mechanism of fluorocitrate and fluoroacetate neurotoxicity.

Mechanisms of seizurgenesis induced by organophosphorus pesticides.

Quantitative prediction of toxicological properties of molecules.

Biochemical mechanism of cell killing by elevated intracellular calcium.

Bioactivation and reactivity of toxic and carcinogenic arylamines.

Graduation/Completion Requirements: In addition to completing the curriculum for the major and minor or supporting field, students will be required to pass both a written and an oral preliminary examination prior to completing the Ph.D. Program. The preliminary written examination will be administered by the graduate faculty to all students after completing the majority of the required course curriculum and will typically occur in the spring quarter of the second year. The examination will be written to gauge the students' abilities to integrate basic principles from various disciplines to provide a critical opinion on selected issues in toxicology. The exams will be collected and scored by selected members of the Graduate Faculty. Satisfactory performance is required for the student to continue in the program.

The oral preliminary examination will be administered after successful completion of the preliminary written examination. Every effort will be made to accomplish this before the end of the second year but no later than the first quarter of the third year of enrollment in the program. The examination will be administered by the Graduate Faculty according to Graduate School regulations and all students will be required to pass the oral examination to continue in the Ph.D. program. Those students who experience a change in career objectives may be offered the opportunity to pursue a Plan A or Plan B Master's degree in toxicology pending approval by the Graduate Faculty.

The focus of the proposed M.S./Ph.D. Program in Toxicology is to provide extensive training in basic laboratory research at the doctoral level culminating in the oral defense of a written dissertation. The program is designed to maximize the opportunities and time allotted to

the students to perfect their investigative research technique under the direct supervision of a member of the Graduate Faculty in toxicology. Publication of the students' research manuscripts in prominent peer-reviewed journals will be strongly encouraged.

C. Educational and Social Need for the Program

The science of toxicology has grown as a response to increasing public awareness of the need to safeguard the environment and human health from noxious agents and to limit the risks associated with the production, transport, marketing, application, and disposal of synthetic and natural chemical agents. Exposure of man and animals to environmental and agricultural chemicals, drugs, and natural toxins has resulted in numerous well documented cases of illness and death and/or problem residues passed on to man or the environment. Examples of such include lead and mercury poisoning, polybrominated biphenyl toxicosis, aflatoxicosis, dioxin and chlorinated biphenyl residues in fish, and environmental spills of petroleum products. Excessive exposure to toxic agents can result in economic losses in terms of agricultural production, health care expense and destruction of the environment.

Increasing public awareness and insistence on maintaining the quality of life drives the demand for greater numbers of toxicologists to assume leadership positions in research institutions. This demand for well-trained toxicologists continues to grow with the increasingly more stringent regulation of the safety of consumer products and the risks associated with agents released into the environment. Despite the influx of students into this area since the 1970's, toxicology continues to be one of the more favorable job markets for recent Ph.D. graduates. Ph.D. graduates in toxicology are heavily recruited for post-doctoral positions as well as for positions in industry and in state and federal governmental agencies devoted to investigative laboratory research. These individuals provide critical supervision to the conduct of basic scientific research leading to advancements in our understanding of the occurrence and mechanisms of chemical-induced adverse health effects. This basic information is instrumental to improving the precision in the detection and quantification of health risks, thereby facilitating the establishment of regulatory guidelines to insure minimal hazards associated with the production, marketing, use, or disposal of naturally occurring and synthetically produced noxious agents.

The 1987 annual report of the Society of Toxicology indicates that the career placement for Ph.D. toxicologists continues to be very favorable. The number of advertised positions for Ph.D. graduates listed at the annual meeting of the Society has increased each year since the inception of the placement service in 1984 and has more than doubled since 1985. In contrast, the number of applicants has remained fairly constant. Geographical analysis of the data reveals that the Great Lakes region continues to be one of the most favorable markets for Ph.D. toxicologists. The data indicate that states in this region (OH, IN, IL, IA, MN, WI, and MI) have registered higher ratios of the number of job openings to prospective applicants than any other region nationally. The number of positions posted for the Great Lakes region has almost doubled since 1986 and the data for 1988 project a critical job surplus. Accordingly, the favorable career placement for toxicologists is especially prominent in the Great Lakes region where there appears to be a very real shortage of graduates from toxicology Ph.D. programs to meet the employer demand.

Responses from prospective employers to a letter distributed by the Chemical Toxicology Research Center to assess the marketability of students trained in toxicology reiterate the increasing needs for well qualified toxicologists at the Ph.D. level to supervise investigative research programs. Although the majority of respondents projected limited placement of Master's graduates in basic toxicology, the appeal for Ph.D. trained research toxicologists was virtually unanimous. This increasing need for Ph.D. toxicologists is not likely to resolve in the near future as the public continues to become more educated and involved in environmental and consumer regulatory policy making.

In view of the interdisciplinary nature of toxicology, it attracts some of the brightest and most highly motivated students. The faculty routinely receive inquiries from aspiring candidates interested in achieving advanced graduate training in this field; however, the lack of an official program limits our ability to respond to their demands. The frequency of these inquiries has increased over the past few years; however, with no such graduate program in toxicology available, the students are forced either to enroll in one of the more traditional departments with the intent of specializing in toxicology or to apply to toxicology Ph.D. programs offered by out-of-state universities. Our experience indicates that the majority elect to transfer out of state to obtain an official degree in toxicology. Consequently, Minnesota loses some of its brightest baccalaureates to other states having official Ph.D. degree-granting programs in toxicology.

Implementation of the M.S./Ph.D. Program in Toxicology will allow the University of Minnesota to retain these bright students as well as to attract high quality graduate students from a national pool. The provision of a minor in toxicology may also benefit other programs by expanding opportunities for specialization in toxicology, thereby enhancing their success in attracting qualified candidates for graduate school. The existence of the program at the University will also benefit both the recruitment and retention of some of the nation's most distinguished basic science faculty having scholarly interests in toxicology. Implementation of this interdisciplinary program will also improve collaboration between participating faculty, thereby enhancing their productivity both in terms of publication and research support as well as providing new opportunities for applying for extramural toxicology-related training and programmatic funding as well as faculty and student awards for which the University is currently ineligible. Finally, the State and region will benefit from the supply of well-trained Ph.D. toxicologists to fill the numerous vacancies in various educational institutions, industries, and governmental agencies devoted to safe-guarding and improving the quality of life through basic investigative toxicology research.

It is estimated that 4-6 candidates for the Ph.D in Toxicology will be admitted each year with 16-24 students enrolled once the program is in full operation. In addition, up to 20 additional students will be peripherally associated with the program, either enrolled in selected courses or registered for a minor in Toxicology. It is expected that, once the program is in full operation, an average of 5 students will graduate with a Ph.D. in Toxicology each year.

D. Comparison with Similar Programs

A 1987 survey by the Society of Toxicology revealed a total of 66 Ph.D degree-granting programs in toxicology in the U.S., ranging from a joint departmental degree, such as pharmacology and toxicology, to more elaborate multidisciplinary programs. Minnesota was not represented in the roster of colleges and universities having graduate programs in toxicology, despite the fact that the Great Lakes region enjoys one of the most favorable ratios of job openings-to-applicants in the U.S.

No other M.S./Ph.D. program in toxicology is currently offered by institutions of higher education in the state of Minnesota. Until recently, the Environmental Health major in the School of Public Health at the University of Minnesota offered an M.S./Ph.D. with an emphasis in toxicology. The program was curriculum-based and trained students in the applied science of identifying, quantifying and evaluating the potential risks associated with putatively toxic agents in the environment that may be detrimental to human health in the public, occupational, residential, or institutional domains. Career placement was usually with local, state, or federal health agencies, industrial quality control units, or private consulting firms. The Ph.D. with a major in Environmental Health elaborates on this curriculum to include a thesis research project. Students in the Ph.D. program receive extensive training in laboratory research culminating in a written dissertation; however, the opportunities for research are severely limited by the small number of faculty affiliated with the program. The recent withdrawal from a full-time to a half-time appointment with the University by Dr. Stevens has, at least

temporarily, disrupted the offering. The continued viability and future emphasis in toxicology by the Division of Environmental and Occupational Health has yet to be determined by the incoming chairperson and the Dean of the School of Public Health.

The proposed M.S./Ph.D. Program in Toxicology differs significantly in that it is laboratory-intensive, with a focus on training students in the conduct of investigative research. Most graduates will assume careers with academic, private or governmental institutions heavily engaged in scientific research and development, rather than regulatory toxicology. Accordingly, graduates from the proposed program will be trained in the generation and interpretation of basic scientific data which are the fundamentals used by the applied toxicologists to establish regulatory guidelines to insure the well-being of public health.

The proposed program was developed in collaboration with Dr. Jeffrey B. Stevens, Assistant Professor of Environmental and Occupational Health to insure comprehensive, yet distinct, training in both the investigative research and applied disciplines of toxicology. Although the Ph.D. with an emphasis in Environmental Health shares some of the same curricula, the limited capacity fails to meet either student or employer demand and students do not receive an official degree in Toxicology. Existing commitments by the faculty of the Environmental and Occupational Health division limit the extent of collaboration with the proposed program, however, the two programs will undoubtedly complement and advance the quality of the other. Implementation of the proposed multidisciplinary M.S./Ph.D. Program in Toxicology may alleviate some of the burden on the Environmental and Occupational Health faculty as well as provide greater opportunities to students in this program to gain more diversified training; both in the classroom as well as additional faculty advisors for the thesis research. Having both the basic science and public health programs will provide a broader perspective and added dimension to the comprehensive investigation of basic toxicological research.

An emphasis in biochemical toxicology has also been offered to graduates in the Department of Pharmacology on the Minneapolis campus. This specialized training was initiated a number of years ago, however, several of the principal faculty members have since left the University. Consequently, the nature of the training has changed dramatically and the current faculty are reorganizing and redesigning the offerings in the various specializations.

Iowa and Wisconsin are the only neighboring states which offer Ph.D. programs in toxicology. An interdepartmental major in toxicology, with a focus in the agricultural sciences, was recently established at Iowa State University in Ames. The University of Wisconsin at Madison, in addition to the traditional pharmacology and toxicology program, has a well-established, highly recognized multidisciplinary program in environmental toxicology which currently receives training grant support from the National Institute of Environmental Health Sciences. The program incorporates faculty from a variety of disciplines to contribute to both the curriculum and research components of the Ph.D. training experience. Despite the success of these programs, they fail to meet the increasing demand by employers for Ph.D. trained toxicologists in the Great Lakes region. Neither the University of Iowa, the Medical College of Wisconsin, nor any of the institutions in either North or South Dakota offer advanced graduate training in toxicology beyond that traditionally received in the respective Departments of Pharmacology.

E. Quality Control

Faculty: The following faculty have been selected by the committee as distinguished scientists actively involved in investigative research in toxicology and have demonstrated a willingness to be principally responsible for the implementation and operation of the program. Although the individuals may identify primarily as basic scientists in other disciplines, the type of research and their scholarly expertise is clearly recognized as implicit to the comprehensive investigation of the various facets of the toxicological sciences. The table provides a brief synopsis of the scholarly productivity of these individuals. Included in the data are: 1) The average annual total direct costs (TDC) for grants, contracts, or cooperative agreements awarded to the investigators since 1980 or since their appointment to the University, whichever is most recent. 2) Pending grant applications which includes approved budgets for fiscal year 1988 and beyond. 3) The average number of refereed publications generated each year since 1980 or since receiving a faculty appointment. 4) The total number of review articles or book chapters published between 1980 and 1987. 5) The total number of Master's or Ph.D. students or post-doctoral fellows for which the investigator has served as the major advisor. Specific details describing the accomplishments of these faculty are available in the appended copies of their individual vitae (Appendix B). Upon approval of the program proposal, selected individuals from this list will be recommended to the Dean of the Graduate School for approval as charter members of the Graduate Faculty in the M.S./Ph.D. Program in Toxicology and will provide administrative governance to the program. Additional applications for Graduate Faculty status will be solicited and reviewed in accordance with the criteria outlined in the Governance section.

Faculty	Appointment	Annual TDC	Pending Appl.	Refereed Pubs. per year	Reviews & Book Chapt. 1980-1987	MS	Advising PhD P-docs	
Abul-Hajj, Y.J.	Prof. of Med. Chem. & Pharmacognosy	\$51,300	\$320,805	4.00	3	0	5	3
Basak, S.C.	Adj. Asst. Prof. of Biochemistry, NRRRI	N/A	N/A	3.25	5	0	0	0
Bradbury, S.P.	Adj. Asst. Prof., Pharmacology, US EPA	N/A	N/A	1.00	0	0	0	0
Brown, D.R.	Asst. Prof. of Veterinary Biology	\$90,000	\$250,000	4.25	9	1	4	0
Carlson, R.M.	Professor of Chemistry	\$104,396	\$228,327	2.00	2	17	1	9
Czarnecki, C.M.	Professor of Veterinary Biology	\$11,914	\$78,015	3.25	3	1	1	0
Drewes, L.R.	Professor of Biochemistry	\$161,000	\$817,040	2.38	1	7	1	3
Felice, L.J.	Asst. Prof. of Veterinary Diag. Invest.	\$11,577	\$48,912	3.00	0	0	0	0
Hanna, P.E.	Prof. of Med. Chem. & Pharmacology	\$22,600	\$807,009	1.88	2	1	8	5
Larson, A.A.	Assoc. Prof. of Veterinary Biology	\$73,732	\$429,197	4.00	1	3	2	4
Lovrien, R.E.	Professor of Biochemistry	\$52,680	\$220,000	2.00	6	4	6	4
Magnuson, V.R.	Professor of Chemistry	\$41,400	\$45,000	2.29	0	2	0	1
Mirocha, C.J.	Professor, Plant Pathology	\$312,500	\$156,000	6.75	18	15	14	7
Murphy, M.J.	Asst. Prof. of Veterinary Diag. Invest.	\$26,131	\$37,197	1.50	2	0	0	0
Nagasawa, H.T.	Prof. of Medicinal Chemistry	\$123,944	\$279,152	4.00	0	1	4	2
Pfeiffer, D.R.	Prof. & Head, Hormel Institute	\$429,834	\$730,000	3.63	4	0	1	12
Prohaska, J.R.	Assoc. Prof. of Biochemistry	\$49,317	\$125,000	3.25	9	3	0	0
Singh, A.K.	Asst. Prof. of Veterinary Diag. Invest.	\$20,000	\$449,196	2.13	0	0	0	0
Shier, W. T.	Prof. of Med. Chem. & Pharmacognosy	\$51,608	\$205,867	3.00	13	3	4	4
Sparber, S.B.	Professor of Pharmacology	\$108,940	\$599,000	7.75	7	3	12	20
Wackett, L.P.	Asst. Prof. of Biochem., Gray FBI	\$109,000	\$1,618,020	1.67	3	0	0	0
Wallace, K.B.	Assoc. Prof. of Pharmacology	\$49,379	\$600,280	2.13	0	3	0	0

In addition to these principal faculty, a preliminary analysis identified more than 50 faculty members of the University of Minnesota who, although not requested to make any firm commitment to the program, expressed interest in developing and contributing to the implementation of a Ph.D. program in toxicology. Collegiate units represented by the faculty include: the School of Medicine, the Medical School, the College of Biological Sciences, the College of Science and Engineering, the College of Veterinary Medicine, the College of Pharmacy, the Colleges of Agriculture and Forestry, the School of Public Health, the Hormel Institute, the Gray Freshwater Biological Institute, and the Natural Resources Research Institute. Collectively, the faculty demonstrate a very diverse and comprehensive expertise to the study of toxicology. A brief description of these faculty is tabulated in Appendix C.

Governance: Primary administrative responsibility for implementing the M.S./Ph.D. Program in Toxicology will be vested in the Director of Graduate Studies (DGS) selected by the full membership of the Graduate Faculty. Membership to the Graduate Faculty in toxicology will be governed by the Graduate School Constitution. Criteria for evaluation of faculty in the Toxicology Program include:

- 1) Members shall be actively engaged in toxicological research as evidenced by membership in professional societies, continuing extramural research support and by publications in professional refereed journals.
- 2) Members shall be qualified and willing to serve on examining committees or as advisors to degree candidates.
- 3) Members shall provide significant contributions to graduate-level courses in toxicology on a routine basis.
- 4) Members shall be willing to present toxicology research seminars.
- 5) Members shall be willing to contribute to the implementation of the toxicology program by serving on various standing or ad hoc committees.

Faculty membership will be reviewed at 5 year intervals to insure continued active support and fulfillment of responsibilities to the Program.

Program Review: Periodic internal and external reviews will be conducted under the direction of the DGS in conjunction with the Graduate School to insure the continued productivity and effectiveness of the M.S./Ph.D. Program in Toxicology. Results from the reviews will be submitted to the Graduate School along with suggested remedial steps for resolving any deficiencies identified in the process.

F. Implementation

Time-Table: The proposed implementation date for the M.S./Ph.D. Program in Toxicology is July 1, 1990. One-time start-up costs are requested prior to the official implementation of the Program to allow for setting up an office, finalizing the details of the program, and for publicizing the program and recruiting the first class of candidates. Although these start-up funds are requested for the 1989/1990 academic year, the costs are included in the first year of the Program, 1990/1991, for accounting purposes. The program will run continuously throughout the year with the matriculation of 4-to-6 new students each fall.

Budget:

Annual recurring expenses of the program are tabulated below. The figures are calculated on the basis of an estimated average of 20 graduate students enrolled once the program is in full operation and are not adjusted for annual inflationary increases. All first-year students will receive teaching or research assistantships whereas the advanced students will compete for stipend support from the Graduate School as well as from other sources, including investigator-initiated research grants. Exceptional matriculants will be nominated for Graduate School Fellowships. Essentially all of the faculty identified for the program continue to be actively involved in sponsored basic scientific research and maintain well-equipped, state-of-the-art laboratories. Since toxicology requires minimal elaboration of equipment beyond that used in the respective traditional disciplines, implementation of the proposed program requires only that the existing laboratory facilities along with privileges of library, animal care, and related support services be available to support the graduate student thesis research.

	<u>Annual Budget</u>			
	<u>1990/91</u>	<u>1991/92</u>	<u>1992/93</u>	<u>1993/94</u>
Personnel				
DGS (0.20 FTE release-time)	\$8,000	\$8,000	\$8,000	\$8,000
25-50% secretary	\$5,750	\$11,500	\$11,500	\$11,500
Graduate Student TA/RA	\$40,000	\$90,000	\$140,000	\$200,000
(Investigator-supported RA)	(-)	(\$30,000)	(\$70,000)	(\$120,000)
SE&E				
Office supplies	\$1,500	\$2,000	\$2,500	\$2,500
Instructional supplies	\$3,000	\$4,000	\$5,000	\$6,000
Books, journals, etc.	\$1,000	\$1,000	\$1,000	\$1,000
Student recruitment	\$4,000	\$4,000	\$4,000	\$4,000
Travel				
In-state faculty travel	\$4,000	\$5,000	\$5,000	\$6,000
Guest lecturers and seminars	\$3,000	\$3,000	\$3,000	\$3,000
Annual Graduate Student Symposium	\$5,000	\$6,000	\$7,000	\$8,000
Sub-total	<u>\$75,250</u>	<u>\$134,500</u>	<u>\$187,000</u>	<u>\$250,000</u>
Start-up Expenses (1988/89)	<u>\$13,000</u>	-	-	-
Total	<u>\$88,250</u>	<u>\$134,500</u>	<u>\$187,000</u>	<u>\$250,000</u>
(Investigator-supported RA)	(-)	(\$30,000)	(\$70,000)	(\$120,000)
Total Institutional Support	<u>\$88,250</u>	<u>\$104,500</u>	<u>\$117,000</u>	<u>\$130,000</u>

Sources of Funding for the Ph.D. Program in Toxicology

	<u>89/90</u> (Start-up)	<u>90/91</u>	<u>91/92</u>	<u>92/93</u>	<u>93/94</u>
<u>Annual Total Direct Costs</u>	\$13,000	\$75,250	\$134,500	\$187,000	\$250,000
Expected Federal Funding	-	-	\$30,000	\$60,000	\$100,000
Expected Private Funding	-	-	-	\$10,000	\$20,000
State/Tuition/Fees	<u>\$13,000</u>	<u>\$75,250</u>	<u>\$104,500</u>	<u>\$117,000</u>	<u>\$130,000</u>

Commitments of State Support

\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____
\$ _____	Beginning _____	_____	Signature _____	(Date) _____

Extramural Resources. It is expected that the majority of advanced students in the program will receive research assistantships supported by investigator-initiated research grants, contracts or cooperative agreements. Graduate student support will also be sought from private industries and from both federal and private agencies and research foundations. Furthermore, once the program is approved, applications will be developed for extramural programmatic funding of both graduate student stipends and operational expenses. Finally, the close proximity and collaboration between University faculty and the U.S. Environmental Protection Agency, selected industrial corporations and the Hormel Institute, the Gray Freshwater Biological Institute, and the Natural Resources Research Institute provide unique opportunities to utilize their expertise and resources to supplement and enhance the dimensions and quality of the proposed program.

APPENDIX A
Course Descriptions for the Core Curriculum in Toxicology

Chem 5336-5337. Biochemistry. (4 cr each, \$3310, \$3311; prereq 3513 or 3532 or 3542 and Math 1296; physical chemistry recommended; 4 hrs lect)
Introduction to the properties of biochemically important compounds and their interactions in living systems with emphasis on bioenergetics, enzyme mechanisms, major metabolic pathways, and metabolic regulation.

BioC 5751-5752. General Biochemistry. (4 cr per qtr, \$MdBc 5751-5752-5753; prereq 3 qtrs organic chemistry, 2 qtrs physical chemistry, 1 qtr biochemistry or #)
Comprehensive discussion of structure, function, metabolism, and metabolic regulation of components in biological systems.

PhsI 5440-5441. Quantitative Physiology. (3 cr; prereq 1 yr each of college chem, physics, math through integral calculus)
Diffusion, surface tension and mechanics of respiration, circulation, digestion, and locomotion. Chemical aspects of blood, respiration, renal function, nutrition, and metabolism. Endocrine, sensory, neuromuscular, and central neural functioning.

PhsI 5907-5908. Human Physiology. (7cr each; prereq 5541, 5542, and #; not open to med students) Pozos, staff
This course presents a comprehensive overview of medically related physiological function. All major organ systems are covered both as individual systems and as they interrelate with the rest of the human body.

Stat 5021. Statistical Analysis I. (5 cr, \$3012; prereq college algebra)
Intensive version of 3011-3012, designed for graduate students needing statistics as research technique.

Math 5561. Applied Statistical Analysis. (4 cr; prereq 3320, 3562 or equiv; 3 hrs lect, 1 hr lab)
Analysis of variance techniques as applied to scientific experiments and studies. Randomized block designs, factorial designs, nesting. Checking model assumptions. Using statistical computer software.

PubH 5400. Introduction to Biostatistical Methods in the Biologic and Health Sciences. (4 cr; prereq Biol 1009, Chem 1004-1005, Math 1111 or Math 1201 or #)
Staff
Basic biostatistical methods for design and analysis of clinical and laboratory studies in biology and health sciences. Condensed and accelerated course for advanced undergraduate and graduate students or those training for careers in health professions or biological sciences.

PubH 5261. General Environmental Toxicology. (3 cr) Stevens
Application of basic biochemical, anatomical, and physiological principles to field of environmental toxicology; assessment of potential health hazards; approaches to solution of problems.

PubH 5262. Toxicokinetics and Metabolism of Environmental Agents. (3 cr; prereq 5261 or #) Stevens
Toxicokinetic models for chemical distribution and fate; quantitative toxicological relationships; bioavailability; chemical monitoring.

MedC 5320. Therapeutic Agents I. (3 cr; prereq Phar 5440) Staff
Factors involved in drug absorption, distribution, excretion, metabolism, mechanism of action, receptor interaction, and rational drug design; therapeutic properties and uses of individual pharmacological drug categories from structure-activity standpoint. Agents used as pharmaceutical aids and adjuncts.

Phm 5680. Pharmacokinetics. (4 cr; prereq 5620, Math 1221) Zimmerman
Kinetics of drug absorption, distribution, metabolism, and excretion in humans. Bioavailability, the plateau principle and effect of patient variability on dosing regimens.

Phcl 5212. Drug Metabolism and Disposition. (4 cr; prereq Chem 3512-3513 or equiv or #) Knych, Wallace.
Lectures and discussion of the principles governing the absorption, distribution, metabolism, and elimination of drugs and other foreign chemicals in animal systems, including a discussion of dose-dependent transitions in the kinetics of xenobiotic disposition.

Phcl 5214. Principles of Toxicology. (3 cr; prereq Biol 3243 or Chem 3512-3513 or equiv or #) Wallace, staff.
Basic principles and current issues regarding mechanisms of toxicity of drugs and foreign chemicals suspected to cause adverse health effects.

Phcl 8211. Physiological Disposition of Drugs. (2 cr; prereq BioC 5752 or equiv or #) Quebbemann, staff
Principles underlying pharmacokinetics, biotransformation, and excretion of drugs.

Phcl 8214. Toxicology. (3 cr; prereq MdBc 5101 or equiv or #). Babson.
Lectures on toxic effects and mechanisms of intoxication of drugs and foreign chemicals known to adversely alter the health and ecology of humans and animals.

VDI 8792. Seminar in Veterinary Toxicology. (2 cr; prereq Grad standing or #). Murphy.
Livestock and small animal intoxication with insecticides, heavy metals, rodenticides, poisonous plants, mycotoxins, herbicides, and drugs or drug combinations.

Txcl 5001. Environmental Toxicology. (5 cr; prereq Grad standing or #) Bradbury, McKim, Wallace, staff.
A laboratory-intensive orientation to environmental chemistry and toxicology with an emphasis on fresh water aquatic toxicology. The course is supported by the Duluth branch of the U.S. EPA with the majority of the lectures and laboratory experiences provided by EPA staff scientists.

Txcl 5215. Organ System Toxicology. (3 cr; prereq Grad standing or #). Wallace, staff.
Elaboration of basic principles in toxicology to include detailed discussions of the mechanisms of target organ toxicity of various putatively noxious agents.

Txcl 5216. Chemical Toxicology. (3 cr; prereq 5215). Wallace, staff.
Discussion of factors relating to the mechanism and severity of chemical class-specific toxicity. Material will include a chemical structure-activity approach to toxicity.

Txcl 8101. Seminar: Toxicology. (1 cr each; prereq Grad standing or #) Wallace, staff.
Invited guest seminars in investigative toxicology with emphasis on contemporary issues.

Txcl 8214. Mechanistic Toxicology. (2 cr; prereq Grad standing or #). Wallace.
Discussions of the subcellular/molecular mechanisms of xenobiotic-induced toxicity including defense or reparative processes operative in determining the extent of the response.

Grad 8877. Thesis Credits: Master's. (1-16 cr per qtr; Plan A only).

Grad 8888. Thesis Credits: Doctoral. (1-36 cr per qtr).

NOTE: Courses with the Txcl prefix represent new courses which will be submitted upon approval of the proposed Ph.D. Program in Toxicology.

APPENDIX B
**Curriculum Vitae for the Faculty who will be Principally
Responsible for Implementing the Ph.D. Program in Toxicology**

List of Faculty Included:

Yusuf J. Abul-Hajj, Prof. Med. Chem. & Pharmacog.	College of Pharmacy
Subhash C. Basak, Adj. Asst. Prof. of Biochemistry	Natrl. Resources Res. Inst.
Steven P. Bradbury, Adj. Asst. Prof. of Pharmacol.	U.S. EPA, ERL-Duluth
David R. Brown, Asst. Prof. of Veterinary Biology	College of Vet. Medicine
Robert M. Carlson, Professor of Chemistry	College of Sci. & Eng.
Caroline M. Czarnecki, Prof. of Veterinary Biology	College of Vet. Medicine
Lester R. Drewes, Professor of Biochemistry	School of Medicine
Lawrence J. Felice, Asst. Prof. of Vet. Diag. Invest.	College of Vet. Medicine
Patrick E. Hanna, Prof. of Med. Chem. & Pharmacol.	College of Pharmacy
Alice A. Larson, Assoc. Prof. of Veterinary Biology	College of Vet. Medicine
Rex E. Lovrien, Professor of Biochemistry	College of Biological Sci.
Vincent R. Magnuson, Professor of Chemistry	College of Sci. & Eng.
Chester J. Mirocha, Professor of Plant Pathology	College of Agriculture
Michael J. Murphy, Asst. Prof. of Vet. Diag. Invest.	College of Vet. Medicine
Herbert T. Nagasawa, Prof. of Medicinal Chemistry	College of Pharmacy
Joseph R. Prohaska, Assoc. Prof. of Biochemistry	School of Medicine
Ashok K. Singh, Asst. Prof. of Vet. Diag. Invest.	College of Vet. Medicine
W. Thomas Shier, Prof. Med. Chem. & Pharmacog.	College of Pharmacy
Sheldon B. Sparber, Professor of Pharmacology	Medical School
Lawrence P. Wackett, Asst. Prof. of Biochemistry	Gray Freshwater Biol Inst.
Kendall B. Wallace, Assoc. Prof. of Pharmacology	School of Medicine

APPENDIX C

Faculty Expressing an Interest in Contributing to a Toxicology Ph.D. Program

Research Area #	Topic	No. of Faculty Involved
1	Analytical	3
2	Aquatic	8
3	Biodegradation	5
4	Bone	3
5	Developmental	5
6	Ecology/Ecotox.	3
7	Environmental	11
8	Enzymology	3
9	Genetic	5
10	Histo/Cyto-Pathol	7
11	Immunotox.	4
12	Mechanism	7
13	Metabolism	8
14	Metals	3
15	Microbial/Viral	6
16	Molecular	4
17	Mycotox/Fungi.	4
18	Neuroendocrin.	12
19	Neuro-Psych/Behavior	3
20	Pesticides	3
21	Pharmacokinetics	5
22	Structure/Activity	3
23	Tumorigenesis	4

<u>Last Name</u>	<u>First Name</u>	<u>Department</u>	<u>College/School</u>	<u>Campus</u>	<u>Res. Area</u>
Pfeiffer	Douglas R.	Biochem.	Hormel Inst.	Austin	12
Niemi	Gerald J.		NRRI	Duluth	3,6,7
Basak	S. C.	Chemistry	Sci. & Eng.	Duluth	2,22,23
Bradbury	Steven	Pharmacol.	EPA-Duluth	Duluth	2,7,12,13,20,22
McKim	James M.		EPA-Duluth	Duluth	2,7,21
Mount	Donald		EPA-Duluth	Duluth	2,7
Wackett	Lawrence P.	Biochem.	Gray FBI	Navarre	3,8,13,15,16
Adams	Alice	Micro.	Medicine	Duluth	9,16,23
Downing	Steve	Anatomy	Medicine	Duluth	10
Drewes	Lester	Biochem.	Medicine	Duluth	1,18
Forbes	Donna	Anatomy	Medicine	Duluth	18
Haller	Edward W.	Physiol.	Medicine	Duluth	18
Hoffman	Richard	Behavior.	Medicine	Duluth	19
Huntley	Thomas E.	Biochem.	Medicine	Duluth	4,5,14
Johnson	Art	Immunol.	Medicine	Duluth	5,11,15
Knych	Edward	Pharmacol.	Medicine	Duluth	18,21
Prohaska	Joseph R.	Biochem.	Medicine	Duluth	11,14,18
Regal	Jean F.	Pharmacol.	Medicine	Duluth	11
Severson	Arlen R.	Anatomy	Medicine	Duluth	4,5,10,14
Theisen	Charles	Anatomy	Medicine	Duluth	5
Trachte	George	Pharmacol.	Medicine	Duluth	18
Wallace	Kendall B.	Pharmacol.	Medicine	Duluth	8,12,13,18,20
Hershey	Anne	Biology	Sci. & Eng.	Duluth	2,6,7
Carlson	Robert M.	Chemistry	Sci. & Eng.	Duluth	2,3,23
Hedman	Steve	Biology	Sci. & Eng.	Duluth	9,16,23
Hicks	Randall	Biology	Sci. & Eng.	Duluth	2,3,6,7,15
Magnuson	Vince	Chemistry	Sci. & Eng.	Duluth	2,7,22
Garry	Vincent F.	Lab. Med.	Medicine	Mpls	9
Hrushesky	Bill	Lab. Med.	Medicine	Mpls	10
Sparber	Sheldon B.	Pharmacol.	Medicine	Mpls	5,18,19
Abul-Hajj	Yusuf J.	Med. Chem.	Pharmacy	Mpls	3,7,15
Fletcher	Courtney	Social	Pharmacy	Mpls	21
Hanna	Patrick E.	Med. Chem.	Pharmacy	Mpls	8,9,13
Nagasawa	Herbert T.	Med. Chem.	Pharmacy	Mpls	12,13
Rahman	Y. E.	Pharm.	Pharmacy	Mpls	12
Shier	W. Thomas	Med. Chem.	Pharmacy	Mpls	9,10,12,16
Barber	Donald E.	Env. Occ. Hlth.	Public Health	Mpls	7
Jung	Hans-Joac	Animal Sci.	Agriculture	St. Paul	17
Mirocha	Chester J.	Plant Pathol.	Agriculture	St. Paul	17
Liener	Irvin E.	Biochem.	Biochemistry	St. Paul	15,17
Conti-Tronconi,	B. M.	Biochem.	Biol. Sci.	St. Paul	18
Fuchs	James	Biochem.	Biol. Sci.	St. Paul	7,13
Brown	David R.	Vet. Biol.	Vet. Medicine	St. Paul	18
Czarnecki	Caroline M.	Vet. Biol.	Vet. Medicine	St. Paul	10
Felice	Larry	Vet. Diag. Invest.	Vet. Medicine	St. Paul	1,13,21
Larson	Alice A.	Vet. Biol.	Vet. Medicine	St. Paul	18,19
Leininger	Joel	Vet. Pathol.	Vet. Medicine	St. Paul	10
Murphy	Michael J.	Vet. Diag. Invest.	Vet. Medicine	St. Paul	12,13,21
Newman	John A.	Vet. Pathol.	Vet. Medicine	St. Paul	11,15
Singh	Ashok	Vet. Diag. Invest.	Vet. Medicine	St. Paul	1,18,20
Stowe	C. M.	Vet. Diag. Invest.	Vet. Medicine	St. Paul	7
Walser	Mary	Vet. Pathol.	Vet. Medicine	St. Paul	4,10,17

**APPENDIX D
Itemized Budget**

Recurring Annual Operating Expenses Beginning the First year 1990/91:

- \$ 8,000- 20% faculty FTE plus fringe benefits at 29%: Augmentation for the Director of Graduate Studies may take a variety of forms: for a faculty member on a B appointment, the augmentation may be used for summer support. Faculty on an A appointment may use up to \$2,000 plus fringes for salary augmentation with the remainder used as release-time.
- \$ 5,750- 25% Secretary plus fringe benefits to assist in the implementation of the program.
- \$ 40,000- Four 50%-time graduate student stipends at \$10,000 each to support all first-year students.
- \$ 1,500- Office supplies, postage, duplication costs, telephone station charges, long-distance telephone charges, miscellaneous expenses.
- \$ 3,000- In-state travel expenses to reimburse faculty for trips between campuses for purposes of meetings, lectures, and seminars essential for the efficient implementation of the intercollegiate program.
- \$ 1,000- Books, journals, and miscellaneous printed materials, on-line retrieval charges.
- \$ 4,000- Nation-wide student recruitment expenses: brochures, on-site visits, seminars.
- \$ 4,000- Instructional supplies, equipment service and maintenance charges.
- \$ 3,000- Travel and honorarium expenses to support the invitation of one nationally renowned toxicologist per quarter to visit the campuses and present a formal seminar to the faculty and students in toxicology.
- \$ 5,000- Annual graduate student symposium.

\$75,250

Beginning in 1991 and recurring annually thereafter:

In addition to adjusting the preceding expense categories for inflation, two additional State-sponsored 50% TA/RA graduate student stipends (\$20,000 beginning 1991/92) are requested to support those students in their second year who may experience a temporary lapse in extramural funding for their thesis project. One additional recurring graduate student stipend, at \$10,000, is requested to be initiated in each of the third (beginning 1992/93) and fourth (beginning 1993/94) years of the Program. It is assumed that several of the students will be supported during their second through fourth years by investigator-initiated extramural grants, contracts, or cooperative agreements. The Program-sponsored, recurring stipends are essential to insure the continuity of the research programs for each individual student and will be allocated only as needed to insure the uninterrupted progress of the research program for the individual candidates

Summary of the phasing in of recurring State-supported graduate student stipends (50% TA/RA) from 4 the first year (1990/91) to 8 beginning the fourth year (1993/94) of the program:

1990/91	\$40,000	(4 state stipends for 4 students)
1991/92	\$60,000	(6 state stipends for 9 students)
1992/93	\$70,000	(7 state stipends for 14 students)
1993/--	\$80,000	(8 state stipends for 20 students)

Additional Long-term needs:

Implicit to the successful implementation of the proposed program is the eventual expansion to include additional faculty and matriculants. Along with the progressive growth of the Toxicology Program will be the need to acquire new or added expertise in selected sub-specialties as the science and related technologies evolve. Accordingly, it is anticipated that additional FTE faculty line-items will be requested for recruiting new faculty with demonstrated proficiency in selected areas. It is hoped that within 5 years 1.5 line-item FTE (at ca. \$60,000 plus fringe benefits) will eventually be dedicated to the Toxicology Program to support three 50% entry-level faculty positions. The positions will be allocated by the Program to various tenure-granting departments as matching money to support the hiring of additional faculty in the toxicological sciences. Although these positions are not necessary for the implementation of the Program as proposed, the recruitment of additional faculty active in the area of toxicology will enrich the quality of the Program and provide potential for added growth as the success of the Program is demonstrated over the years. Examples of faculty likely to be sought over the next five-to-ten years are those having expertise in such specialties as drug metabolism, genetic/molecular toxicology, environmental engineering, or reproductive toxicology. Many of these positions may be filled by cooperative efforts between the faculty in Toxicology and the Department Heads and Deans of the various academic units as they recruit to fill vacancies created by the normal attrition of current faculty positions.

UNIVERSITY OF MINNESOTA
DULUTH

Graduate School
431 Darland Administration Building
10 University Drive
Duluth, Minnesota 55812-2496

February 1, 1989

GRADUATE SCHOOL

FEB 03 1989

OFFICE OF THE DEAN

Dean Robert T. Holt
University of Minnesota
Graduate School
333 Johnston Hall
101 Pleasant Street SE
Minneapolis, MN 55455

Dear Dean Holt:

You have recently received the final revised version of a proposal for the M.S./Ph.D. program in Toxicology from Kendall Wallace on behalf of the committee which developed this program. As you know, this program has been reviewed by the Graduate Faculty Committee on this campus and received unanimous approval at the January 18, 1989, meeting.

Professor Wallace attended the Graduate Faculty Committee meeting and heard the comments of Committee members. In general, the tone of the comments was very positive with only minor suggestions being offered.

I understand that the appropriate academic Deans from this campus have approved the proposal for a graduate toxicology program. This project has received careful development by Professor Wallace and his Committee and a thorough review on this campus.

I strongly support this proposal and urge your favorable consideration.

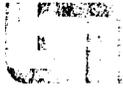
Sincerely,



John T. Hatten
Assistant Dean

JTH/mj

cc: Professor Ken Wallace



UNIVERSITY OF MINNESOTA
DULUTH

Office of the Dean

School of Medicine
10 University Drive
Duluth, Minnesota 55812-2487

GRADUATE SCHOOL

JAN 30 1989

OFFICE OF THE DEAN

January 25, 1989

Robert T. Holt
Dean, Graduate School
321 Johnston Hall
101 Pleasant Street, S.E.
Minneapolis, MN 55455

Dear Bob:

I want to lend my strongest support to Ken Wallace and his proposal for an M.S./Ph.D. Program in Toxicology. As you may recall from our earlier discussions, I have identified the Toxicology Program as one of our major priorities for the School of Medicine.

This program addresses a critical, unmet need within the University of Minnesota. As I understand, there is a strong demand for graduates with M.S. and Ph.D. degrees in toxicology to serve in universities and industry throughout the country. Ken's program, through its intercollegiate and intercampus efforts, will bring faculty together from divergent specialties to educate these students to help fill this need. To date, the entire State of Minnesota offers no graduate training program in this field, thus forcing interested applicants to attain their advanced degrees out of state.

By my review, this proposal is well conceptualized, outlining a very logical and broad series of courses. This should put the graduate student in an ideal position to select from some of the University's most gifted faculty to complete her or his thesis project. The program also will have a "critical mass" of graduate students, thus providing sufficient opportunity for them to stimulate and learn from each other, as well as from their faculty advisors.

I give my strongest support to Ken Wallace and his M.S./Ph.D. Program in Toxicology. It is well constructed, academically sound, and fills a critical need within the University and for the State at large. If I can answer any additional questions, please do not hesitate to contact me.

Sincerely,

Ronald D. Franks, M.D.
Dean

RDF/ljd

cc Kendall B. Wallace, Ph.D.



UNIVERSITY OF MINNESOTA
TWIN CITIES

College of Pharmacy
Health Sciences Unit F
308 Harvard Street S.E.
Minneapolis, Minnesota 55455

GRADUATE SCHOOL

FEB 06 1989

OFFICE OF THE DEAN

February 6, 1989

Robert Holt, Dean
Graduate School
University of Minnesota
321 Johnston Hall

Dear Bob:

I am writing to let you know that I have endorsed the proposal for an interdisciplinary M.S./Ph.D. Program in Toxicology. Faculty in the College of Pharmacy have expressed an interest in support of and participation in, the proposed toxicology graduate program. As I discussed with you when I first came to the University, I was surprised to find that an interdisciplinary toxicology program did not exist. My surprise was based upon two factors: the substantial number of faculty across many disciplinary areas and colleges within the University who were engaged in toxicology related research; and secondly, the importance that such a program could have for the state and its many interests in environmental and quality of life issues.

I am very pleased that a number of faculty members have taken on the leadership to make the commitment to develop a proposed program. The list of faculty given in the proposal, who would be principally responsible for implementing the Ph.D. Program in Toxicology, describes the range of interests in the program and the strong potential for important interdisciplinary research. This program could clearly benefit students and research programs across the University.

Sincerely,

A handwritten signature in cursive script, appearing to read 'G. Banker'.

Gilbert S. Banker, Ph.D.
Dean and Professor

jh289.11



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Veterinary Diagnostic Investigation
College of Veterinary Medicine
1943 Carter Avenue
St. Paul, Minnesota 55108
(612) 625-8787

February 7, 1989

FEB 07 1989
OFFICE OF THE DEAN

Robert Holt
Dean, Graduate School
University of Minnesota
Minneapolis, Minnesota

Dear Dean Holt:

I am writing on behalf of the Department of Veterinary Diagnostic Investigation in support of the proposed M.S./Ph.D Program in Toxicology in the Graduate School. Our department has three faculty members, Drs. L.J. Felice, M.J. Murphy and A.K. Singh who are working full-time in veterinary toxicology. The veterinary toxicology program has been expanded during recent years, with an increase from 0.5 to 3.0 faculty FTE in the program. Our programs in professional education and public service are well developed and productive and our faculty research program is becoming productive. The graduate training component of our program remains to be developed in the future.

We believe that the creation of the proposed toxicology program in the Graduate School would be of substantial benefit to our department because it would help to attract graduate students with an interest in veterinary toxicology to our college, increase opportunity for collaborative research with faculty in other University departments, enhance opportunity for research grant funding, and foster professional development through graduate courses, seminars and graduate student advising.

For these reasons, we urge you to give favorable consideration to this proposed program.

Sincerely,

Martin E. Bergeland, DVM, PhD
Chairman

MEB:mt

UNIVERSITY OF MINNESOTA
TWIN CITIES

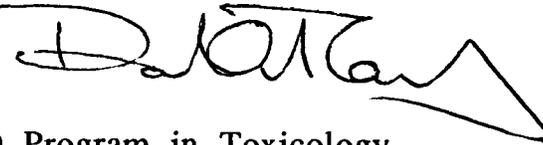
February 13, 1989

Office of the Dean
College of Veterinary Medicine
1365 Gortner Avenue
St. Paul, Minnesota 55108
(612) 624-9227

FEB 13 1989
OFFICE OF THE DEAN

TO: Dean Robert Holt

FROM: David G. Thawley
Interim Dean



SUBJECT: Support of Ms/PhD Program in Toxicology

I wish to provide my enthusiastic support for the initiation of the proposed MS/PhD program in Toxicology. within the College of Veterinary Medicine. Ten faculty members have indicated an interest in joining such a program. These faculty originate in three departments. Six of these who originate from the departments of Veterinary Biology and Veterinary Diagnostic Investigation would be principally responsible for implementing the Colleges contribution to the program.

In an age in which there is increasing awareness of environmental contamination and its effects on the earths flora and fauna, the development of a collaborate toxicology program seems an appropriate decision for the University of Minnesota. Currently the CVM has no graduate program of its own in which faculty can focus their interests in toxicology. Recently the college has hired several faculty with primary interests in the field, and these young faculty would benefit greatly from the establishment of the proposed program.

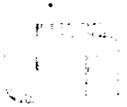
My perception is that the College of Veterinary Medicine would benefit from the existence of a graduate program in Toxicology. Some of these benefits are outlined below:

1. A degree program to offer to those students already coming here who are interested in toxicology.
2. A means of attracting graduate students who are interested in toxicology to the CVM.

3. Increased collaborative research efforts of faculty inside and outside the CVM.
4. Faculty professional development by offering graduate courses and seminars in their discipline of interest.
5. Enhanced opportunities for grant funding due to demonstrated interest in toxicology.

Thank you.

cc: Acting Vice President Perlmutter
Dr. M. Bergeland, Chair
Veterinary Diagnostic Investigation



UNIVERSITY OF MINNESOTA
TWIN CITIES

Environmental and Occupational Health
School of Public Health
Box 197 Mayo
420 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 626-0900

GRADUATE SCHOOL

MAR 3 1989

OFFICE OF THE DEAN

2-28-89
C. L. W.
VF

March 1, 1989

MEMORANDUM

TO: Dr. Robert T. Holt, Dean, Graduate School

FROM: Dr. Donald E. Barber, Division Head *D Barber*

SUBJECT: Program in Toxicology

This memo is written as requested in the attached letter from Dr. Kendall B. Wallace. It puzzles me how our position concerning the proposed toxicology program at Duluth was interpreted to be one of opposition based on possible conflict of interest with the activities in the Division of Environmental and Occupational Health, School of Public Health.

We do not object to the establishment of a Program in Toxicology. There is no conflict of interest with programs in the Division of Environmental and Occupational Health.

DB:kb

cc: R. Kane
I. Greaves
K. Wallace
M. Kjelsberg
E. Benson
J. Stevens



UNIVERSITY OF MINNESOTA
DULUTH

Chemical Toxicology Research Center
10 University Drive
Duluth, Minnesota 55812-2496

February 16, 1989

Donald E. Barber, Ph.D.
Chair, Division of Environmental and Occupational Health
University of Minnesota
School of Public Health
1155 Mayo Memorial Bldg., Box 197

Dear Dr. Barber,

In reviewing the proposal for an M.S./Ph.D. Program in Toxicology, the Program Review Committee of the Health Sciences Policy and Review Council expressed concern regarding a possible conflict with the emphasis in environmental toxicology in your Division. I understand that Jeff Stevens has discussed this with you and that you've corresponded with Ian Greaves to verify his viewpoint. I believe Dean Kane has also discussed this with you and as I understand, none of you perceive a conflict between the proposed program and the long-range objectives of your Division regarding a Ph.D. program in environmental toxicology. This is no accident since input from your faculty was sought in writing the proposal to avoid such a situation and instead to offer an initiative which complements the interests of your faculty. In order to address this concern by the subcommittee, I'd appreciate your generous cooperation by providing a letter of support addressed to Dean Holt of the Graduate School clarifying your position on this matter. Specific reference to the lack of conflict with the Environmental Health program and to your endorsement of this collective effort between faculty from various academic units would be most helpful.

Please copy the letter to; Marcus Kjelsberg
Chair, Health Sciences Program Review Committee
Department of Biometry
Box 197 Mayo Memorial Bldg.

and to; Ellis S. Benson
Chair, Health Science Policy and Review Committee
Department of Laboratory Medicine and Pathology
Box 198 UMHC

Thank you for your cooperation and support. Please call should you have any questions.

Sincerely,

Kendall B. Wallace, Ph. D.
Chair, Toxicology Graduate Committee

UNIVERSITY OF MINNESOTA
DULUTH

Department of Pharmacology
School of Medicine
10 University Drive
Duluth, MN 55812-2487

cc K3
VF
3/13/89 MAR 10 1989
GRADUATE SCHOOL
OFFICE OF THE DEAN

UNIVERSITY OF MINNESOTA
TWIN CITIES

Environmental and Occupational Health
School of Public Health
Box 197 Mayo
420 Delaware Street S.E.
Minneapolis, Minnesota 55455
(612) 626-0900

March 7, 1989

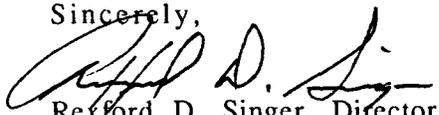
Robert T. Holt, Ph.D., Dean
Graduate School
University of Minnesota
321 Johnston Hall
Minneapolis Campus

Dear Dean Holt:

At the request of Dr. Wallace, I am writing to you regarding the proposed M.S./Ph.D. Program in Toxicology. For the past several years, we have offered a Toxicology emphasis track for M.S. and Ph.D. students majoring in Environmental Health under the direction of Dr. Stevens. Dr. Stevens has recently converted from full-time to half-time status. While we have a formal search underway for a new full-time faculty member with expertise in Environmental or Occupational Toxicology, we do not anticipate having the person available before next September. At the same time, we have hired a new Head of the Division of Environmental and Occupational Health who will start on July 1st. The division is administratively responsible for the Environmental Health major.

Because of the above changes, the Environmental Health major is in a transitional state with regard to the Toxicology emphasis track. By the very nature of our program we are concerned with human exposure to toxicants in the ambient environment and the workplace, and it is most likely that we will continue some emphasis in Toxicology in the future although we cannot say at this time exactly what direction it might take. In any event, we do not believe that the proposed M.S./Ph.D. program conflicts to any great extent with what we have been doing or may do in the future, and we do not oppose the creation of such a program. At the same time, because of our transitional state, we are unable to offer any faculty or laboratory support to the proposed program although we would welcome any of those students into any of our courses that might be appropriate to their interests.

Sincerely,



Rexford D. Singer, Director of Graduate Studies and
Health Sciences Policy and Review Council Representative
Environmental Health

- cc: M. Kjelsberg, Chair, Program Review Committee, Health Sciences Policy and Review Council
- E. Benson, Chair, Health Sciences Policy and Review Council
- D. Barber, Head, Division of Environmental and Occupational Health



October 18, 1989

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL RESEARCH LABORATORY - DULUTH
6201 CONGDON BOULEVARD
DULUTH, MINNESOTA 55804

GRADUATE SCHOOL

OCT 20 1989

OFFICE OF THE DEAN

Robert T. Holt, Ph.D.
Dean, Graduate School
University of Minnesota
321 Johnston Hall
101 Pleasant Street S.E.
Minneapolis, MN 55455

Dear Dean Holt:

I am writing to express the enthusiastic support of the Environmental Research Laboratory-Duluth (ERL-D) for the proposed Ph.D. graduate program in toxicology. There is no question that Ph.D.-trained toxicologists are in great demand and that the faculty of the University of Minnesota possesses the expertise to deliver a high-quality program. I would hope that our professional staff will be able to contribute to the excellence of the program by sharing our expertise in environmental chemistry and aquatic toxicology with prospective students. Cooperative interactions between the staff of our facility and UMD over the past several years have been mutually rewarding and productive. We've been able to support an average of \$250,000 per year in cooperative agreements with several faculty at UMD, most of whom have been designated as participants in the proposed toxicology program. I expect continued cooperation and exchange with the advent of the graduate program, and as we build on our staff of toxicologists.

ERL-D has a nationally-recognized staff of experts in aquatic biology, environmental chemistry and analytical toxicology who would be encouraged to participate in the proposed program. In addition, we continue to offer the use of our state-of-the-art analytical chemistry and environmental toxicology facilities to UMD faculty and students for research purposes. We have continuously sought to involve our staff in both undergraduate and graduate training by bringing students and post-doctorates in to our labs to assist with various research projects. I expect that if the graduate program is approved, our professional staff would not only present isolated guest lectures in toxicology, but would also assume principal responsibility for coordinating selected courses in focused areas of the discipline. I view this as an excellent opportunity for professional development for the staff at ERL-D and will do everything I can to encourage their participation. I believe ERL-D has much to offer to the program and would benefit tremendously by offering our facilities and research supervision to toxicology students. I have discussed these possibilities with Professor Ken Wallace and I am excited by the prospects for increased collaboration.

As I have indicated to Professor Wallace and to Vice Chancellor Robert Carlson, I will be willing to delegate my staff to establish and implement a lecture/laboratory course in environmental toxicology. In addition, we intend to create a cooperative agreement for basic research in toxicology using aquatic animals which will enable graduate students to work in our laboratories as well as at UMD.

I will pursue a Memorandum of Understanding between this facility and UMD to support this course for a period of at least five years with the commitment to do what I can to extend our involvement indefinitely as long as there is mutual interest.

Sincerely,

A handwritten signature in cursive script, appearing to read "Gilman D. Veith".

Gilman D. Veith
Director

cc: Professor Kendall B. Wallace



UNIVERSITY OF MINNESOTA
TWIN CITIES

Graduate School
Johnston Hall
101 Pleasant Street S.E.
Minneapolis, Minnesota 55455-0421

18 December 1989

Professor Kendall B. Wallace
Department of Pharmacology
308 School of Medicine Building
University of Minnesota
Duluth, Minnesota 55812

Dear Professor Wallace:

As you know, the Graduate School Executive Committee, at its meeting on 21 November, voted unanimously to approve the proposal for a joint-campus (Twin Cities/Duluth) degree program in Toxicology at the M.S. and Ph.D. levels. This action followed recommendation by three Policy and Review Councils: Health Sciences, Physical Sciences, and Plant and Animal Sciences.

The proposal approved by the Executive Committee incorporates the modifications cited in your letter of 16 October 1989 to me, namely: 1) the core curriculum will be provided on both campuses by interactive two-way audio and video transmission, coupled with an orientation session, frequent symposia, and an annual graduate student research colloquium, and 2) should this delivery mode prove ineffective, it will be replaced by an intensive summer program at Duluth, funded initially by the U.S. Environmental Protection Agency (EPA). (If the use of electronic telecommunications to provide the core curriculum works well, the funding committed by the EPA's Environmental Research Laboratory at Duluth will be used instead to support--via student stipends and operational costs--an elective lecture and laboratory course to be offered at Duluth in the summers.)

I have forwarded the proposal to the Board of Regents with a request for their initial consideration of the document in January 1990.

Sincerely yours,

Robert T. Holt
Dean

RTH/vf

cc: Dean Gilbert S. Banker
Dean David M. Brown
Dean Ronald D. Franks
Professor Darrell A. Frohrib
Professor Lael Gatewood
Dean John T. Hatten
Dean Robert L. Kane

Dean Mark Luker
Dean Paul T. Magee
Professor David E. Smith
Dean David Thawley
Dean Wesley K. Wharton
Dean Kenneth Zimmerman



UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Entomology
219 Hodson Hall
1980 Folwell Avenue
St. Paul, Minnesota 55108

Phone: (612) 624-3636
FAX: (612) 625-5299

May 24, 1989

Robert Holt, Dean
The Graduate School
321 Johnston Hall
Minneapolis Campus

Dear Bob:

Enclosed is the report of the Ad Hoc Committee on off-campus Graduate Programs which you appointed in January.

We have studied the Rochester program extensively and I think that we have a good understanding of the issues. I believe the report is reasonably comprehensive without being lengthy and I hope that it serves the needs for which it is intended. I plan to be at the Physical Science Policy and Review Council on June 1 to answer questions. If further information is needed please let us know and we will try to provide it.

I appreciate the opportunity to serve on a committee with such members as Jerry Moss and Bill Warner. Both of them participated fully, attended meetings faithfully and gave serious thought and consideration to this issue. I also appreciate the enormous help of Dennis Clayton who provided us with all of the background information, coordinated the meetings and travel, kept the minutes and provided the final copy of the report.

Sincerely yours,

Richard L. Jones
Professor and Head

RLJ/dr
Enclosure
cc: Clayton, Moss, Warner



1988

1988

EDUCATION RESEARCH
EXTENSION

Report Of The Ad Hoc Committee On Off-campus Graduate Programs

I. General

The ad hoc committee (Professors Richard Jones, Chair, Jerome Moss, William Warner and Mr. Dennis Clayton, *ex officio*) was appointed by Dean Robert Holt of the Graduate School on 27 January, 1989 to 1) develop guidelines appropriate to the offering and expansion of University of Minnesota graduate programs at Rochester and 2) develop a brief preliminary assessment of the Rochester program to this point. The charge specifically referred to graduate programs at Rochester and not to the extensive CEE course offerings, and other University programs at Rochester. The committee cautions that this report addresses only master's degree programs and the addition of Ph.D. programs could require a different analysis. The committee was established in response to the legislative appropriation for the University to establish master's degree programs in Electrical Engineering, Computer and Information Sciences and Technology Management in Rochester, Minnesota.

The ad hoc committee met with Ettore Infante, Professor and Dean of the Institute of Technology; David Fox, Professor and Head of Computer and Information Sciences; Professor Vernon Albertson, Associate Head, Electrical Engineering; Professor Richard Kain, Director of Graduate Studies for Electrical Engineering, Professor Marvin Stein, Director of Graduate Studies for Computer and Information Sciences; Professor K. Kumar, Director of the UNITE Program; Professors John Carlis, Arthur Van Rheenan, Larry Kinney, and James Held, instructors for the face-to-face courses fall and winter quarters of academic year 1988-1989 at the Rochester Center; and Ms. Carol Lund, Director of the Rochester Center. The committee visited the Rochester Center; Mr. Clayton visited the Quad-City Graduate Center in Rock Island, Illinois.

II. Policy Issues Regarding Outreach Programs

Throughout the committee's deliberations, the issue of the University of Minnesota's commitment to and obligation for providing graduate programs at off-campus sites arose. The University is Minnesota's land grant institution and, as such, has an obligation to provide outreach programs. However, the term "outreach" encompasses a wide range of educational activities. The University has supported such activities as Continuing Education and Extension, the Minnesota Extension Service, the UNITE program, the Evening

MBA program, and late afternoon classes to assure reasonable accessibility to a wide clientele. In addition, the Graduate School, in 1976, established guidelines for the promotion of graduate education opportunities for non-traditional students. Since that time, a new type of outreach graduate program, off-campus graduate centers, has developed in many parts of the country. These graduate centers offer master's degrees in their entirety and incorporate live and televised instruction in their mode of delivery. This is the model used for the development of the master's degree programs in Electrical Engineering and Computer and Information Sciences in Rochester.

Graduate centers could be needed elsewhere in the State. Since an underlying theme of Commitment to Focus is that we stop trying to be all things to all people and concentrate our resources on those things that we do best, a statement of policy and commitment for the University is necessary before continued development and expansion of these programs is advised.

Recommendation No. 1

We strongly recommend that the Dean of the Graduate School encourage the President and Board of Regents to establish a clear position on the University's commitment to providing graduate programs at off-campus sites. In addition, a central officer should be assigned the responsibility of coordinating all outreach programs at Rochester.

Clearly, the various University of Minnesota programs in Rochester need definition and coordination at a common point in the University to utilize resources efficiently and effectively and ensure the ultimate success of the venture.

The committee feels that a central issue with regard to the graduate program at Rochester is one of quality. If the program is to be expanded or even maintained, the issue of quality must be addressed both in regard to the teaching of courses in Rochester as well as to the impact of the program on Twin City program quality. Another issue is one of feasibility. The committee recommends that criteria for success be established (including the wise use of resources) and an evaluation of the program be done at the end of three or five years. The committee feels that a sunset clause to any new program would be appropriate; the program should be continued only if success is achieved.

III. Background and Assessment of Rochester Program to Date

The 1988 legislature appropriated \$300,000 to the University of Minnesota to establish master's degree programs in Electrical Engineering, Computer and Information Sciences, and Technology Management in Rochester during the 1988-1989 academic year. A significant component of the new program is the offering of face-to-face courses in addition to the existing one-way visual, two-way audio televised UNITE offerings already available at the Mayo Clinic and IBM facilities. The legislative initiative was in response to several studies and surveys by the Rochester community which indicated a strong demand and need for master's degrees in Electrical Engineering, Computer and Information Sciences and Technology Management. The surveys also indicated a need for a Master of Business Administration degree but no provision for this degree program was made in the legislation. The legislature, in April, 1988, specified implementation for fall quarter, 1988.

In response to the legislative initiative, the University established a graduate program in Rochester. In addition to the existing UNITE offerings, six face-to-face courses in Electrical Engineering and Computer and Information Sciences were taught during the 1988-1989 academic year.

Fall quarter

EE 8170, Fluctuating Phenomena (Professor A. Van Rheenan)

CIS 5702, The Principles of Data Base Systems (Professor J. Carlis)

Winter quarter

EE 5865, Coding Techniques and Application (Professor L.L. Kinney)

CIS 5703, Data Base System Design (Professor J. Held)

Spring quarter

EE 5703, Introduction to Detection and Estimation Theory (Professor A.H. Tewfik)

CIS 8511, Advanced Concepts in Artificial Intelligence (Professor W.B. Thompson)

Of five Computer Science applications to the Graduate School from Rochester fall quarter, four were admitted and one denied admission. Of eight Electrical Engineering applicants, seven were admitted to the Graduate School and one denied admission.

According to the instructors teaching the courses, the quality of Rochester students is comparable and sometimes above the quality of Twin Cities students. They believe that enrollment is "promising" with class sizes ranging from eight to twenty three and that access to library and computer facilities has been adequate. Advising is good since most Rochester students have more interaction with the faculty (student/faculty ratio is

better) than Twin Cities students. As with any start-up program, the faculty spent considerable time advising students on the logistics of application, admission and registration. However, the instructors felt that the one three hour lecture-per-week format adversely affected the quality of class instruction. The format was more stressful for instructors and students and did not permit the student/faculty interaction outside the classroom usually associated with classes offered in the traditional one-hour session. However, the committee recognizes that the suitability of a particular mode of delivery depends upon the type of course offered and the nature of the academic discipline. To date, Rochester courses have been general in nature and have not made heavy use of laboratories, libraries or computers. Consequently, our assessment of the program is not generalizable to other proposed programs that might have different needs.

Several instructors expressed concern about the contrasting needs for theory-oriented courses to support the degree program and the professional development courses desired by Rochester. It is the committee's view that the determination and fulfillment of the need for individual applied courses supporting professional development can be met by CEE while a clearly defined program of courses leading to a master's degree must be stipulated by the appropriate graduate faculty.

Finally, several instructors commented that the Rochester program provides an excellent opportunity to interact with high quality students who challenge the faculty to show the applications of their teaching. In addition, new University/industry projects could be established although none have been to date.

Recommendation No. 2

We recommend that the possibility of reverse UNITE be explored for delivery of face-to-face courses for outreach graduate centers. UNITE has proved an effective means of course delivery to a remote location. If physical facilities are available, a UNITE course could be taught partly from the Twin Cities campus and partly from the off-campus site. For example, a faculty member could go to Rochester once a week for advising and consultation and teach a one-hour session which could be televised through UNITE to the Twin Cities. The remaining session(s) could be taught using UNITE from the Twin Cities.

IV. Impact of the Rochester Program on the Twin Cities Campus

If the results of the establishment of remote master's degree program were advantageous for Rochester, there were negative effects on Twin Cities faculty and students. Faculty had to be retrieved from sabbatical and quarter leaves to teach at Rochester. This practice undermines the purpose of leaves and solves the instructional shortage problem only temporarily. Courses have been rearranged in the Twin Cities so that faculty could teach in Rochester. The specific request for senior faculty to teach at Rochester effectively gives Rochester students higher quality instructors than many Twin Cities graduate and undergraduate students. Electrical Engineering and Computer and Information Sciences are among the most stressed programs on the Twin Cities campuses. Undergraduate students routinely cannot get into courses in these Twin Cities programs. The establishment of graduate programs at Rochester could have a significant negative impact on Twin Cities program planning, as well as a negative impact on the morale of an already stressed faculty. For example, according to Graduate School enrollment figures, 247 master's and doctoral students registered in Electrical Engineering in fall, 1988. In the same quarter, 250 graduate students registered in Computer and Information Sciences. To improve the quality of its instruction and advising, Computer and Information Sciences is striving to reduce the number of graduate students to about 200 or seven students per faculty member. To maintain the Rochester program without adding faculty will create logistical difficulties and will contribute to the inaccessibility of faculty for Twin Cities students.

Recommendation No. 3

If off-campus graduate programs are to be maintained or expanded, the committee recommends that they be equivalent to Twin Cities programs and be adequately funded by the State.* The committee feels that relieving a faculty member of two classes on the Twin Cities campus for each taught face-to-face at Rochester is a reasonable cost and parallels successful graduate center programs such as the one at Virginia Polytechnic Institute and State University. The Committee recommends that as new faculty are added, a contractual obligation to teach some courses off-campus be negotiated. Over a period of years, a senior faculty with a

* Adequate funding would be total cost involved including instructional, administrative, equipment, and indirect costs. According to a 11/14/88 report prepared by Dean E. Infante, the total estimated cost for the academic year 1988-1989 would be \$533,263 against the \$300,000 State special appropriation.

commitment to teach at off-campus sites would evolve. This implies that these programs should be inloaded. The committee advocates this position. We would not get the necessary faculty commitment and resulting program quality on an overload basis. Another option for relieving the workload of faculty would be the use of a limited number of adjunct faculty members to teach at Rochester or other off-campus sites. However, before adjunct faculty are utilized, they must be properly oriented and prepared by the graduate program concerned.

Since faculty feel that driving time constitutes a major loss, consideration should be given to alternative travel modes to get faculty members to Rochester. Flying is a common practice at universities with outlying education centers. Even flying costs would be a relative bargain for Rochester compared to establishing another University with the expertise to offer graduate programs in Electrical Engineering and Computer and Information Sciences.

V. Principles and Guidelines for Outreach Graduate Programs

To accommodate a growing interest in providing outreach graduate programs, the Graduate School, in 1976, constituted the "Graduate School Ad Hoc Committee Concerning Opportunities for Graduate Study" chaired by Professor Norine Odland. That committee recommended policies and guidelines to ensure and promote access to quality master's degree programs for non-traditional students. Our committee feels that the policies set out in the Odland Committee's report are still valid and appropriate (a synopsis of that committee's policy statements is attached). However, the Odland Committee could not anticipate the development of off-campus graduate centers offering master's programs in their entirety. To ensure quality graduate programs at Rochester or other graduate centers, the committee examined the Odland Report for appropriate recommendations to determine if any new principles should apply.

When the graduate programs were established in Rochester last year, in the interest of time, the usual procedures for graduate faculty review were bypassed at two levels: 1) the graduate program faculty; 2) the graduate faculty as represented in the Physical Sciences Policy and Review Council and the Graduate School Executive Committee. The responsibility of the graduate program faculty is to determine the need for and to propose new graduate programs and modes of delivery. The general graduate faculty's responsibility is to review those proposals to insure that quality degree programs and modes of delivery are offered. Given the

need to immediately implement the legislative initiative and since graduate faculty committees do not meet over the summer, the Committee recognizes why the graduate faculty review process was bypassed.

Recommendation No. 4

The committee recommends that the existing Graduate School guidelines specified in the Odland Report and expanded upon by the Clayton 7/25/89 memorandum be used for the establishment and maintenance of quality off-campus graduate programs. To ensure adherence to the Graduate School Constitution, which requires graduate faculty review of new graduate programs and modes of delivery, and to secure faculty participation in and commitment to outreach master's degrees, future programs or the expansion of programs should follow the graduate faculty review process. The Committee completely supports the Odland Report which states that "the major responsibility for planning and implementing change to benefit the non-traditional student lies within the graduate faculty of the specific department or program." However, it is clearly the responsibility of senior administrators and planners to encourage appropriate programs where needs have been identified. The Committee also emphasizes the Odland Report statement that the "non-traditional graduate students interests will be best served if faculty and administrators approach this matter systematically and build a foundation that will persist over time rather than approach it on a piecemeal basis without consideration of how the elements might best fit together and thus ensure its rise and fall to no ones lasting benefit." According to Dr. Janet Lessner, Director of the 20-year old Quad-Cities Graduate Center, faculty involvement and commitment to off-campus graduate programs are absolutely essential to a successful program. The Committee agrees with this assessment and believes that faculty involvement and commitment is the only guarantee for success.

VI. Areas of Expansion at Rochester

We did not specifically investigate needs for additional graduate programs at Rochester. The proposed Technology Management program is perceived to be a need but the program has not yet been formulated. There was some indication that a nutrition program would be well received. Also, there was a discussion of the need for a "Master of Liberal Arts" program. The Department of Rhetoric has been approached about offering a technical communications master's degree and they are interested in pursuing the issue. Any new

program or expansion of a program should be reviewed by the graduate faculty. The committee feels there is an urgent need to address the issue of coordination of new graduate programs if quality programs are to be maintained at Rochester and the Twin Cities. While this report deals only with graduate degree programs, we are concerned about coordination and the effective and efficient use of University resources. The pressure to institute new programs is heavy and the committee feels that it is urgent to address the Twin Cities coordination of potentially proliferating programs at Rochester before expansion takes place.

Recommendation No. 5

In addition to a central coordination of outreach programs at Rochester and faculty review of all new programs, the committee recommends that there should be no promise of a graduate degree in Technology Management, Master of Liberal Arts or other new programs until one has been established with an approved graduate faculty and reviewed on the Twin Cities campuses .

The committee recognizes the University's obligation to provide outreach programs. However, the implementation demands with respect to time in the establishment of the first off-campus graduate programs at Rochester led to bypass of the normal processes. The committee emphasizes that these processes are extremely important and are essential to the success of such programs. Because the Rochester Center is the first off-campus home of graduate programs for the University of Minnesota, it is critical that it be established properly. It will serve as a model for potential expansion to other geographical areas.

Excerpts from the Graduate School Ad Hoc Committee
Concerning Opportunities for Graduate Study (the Odland Report)

Faculty and administrators at all academic levels should reexamine the nature and intensity of their commitment to the accommodation of needs of the non-traditional graduate student, and renew efforts to effect reasonable responses to those needs within the framework of the unit's complete mission and in light of its entire constituency.

The major responsibility for planning and implementing change to benefit the non-traditional student lies with the graduate faculty of the specific department or program.

The non-traditional graduate students' interests will be best served if faculty and administrators approach this matter systematically and build a foundation that will persist over time, rather than approach it on a piecemeal basis without consideration of how the elements might best fit together-- and thus ensure its meteoric rise and fall to no one's lasting benefit.

New graduate programs at the master's level should be designed for the non-traditional student in program fields where the faculty deems it appropriate. All proposals for graduate programs for non-traditional students should be submitted for review and approval by the appropriate Policy and Review Council prior to final action by the Graduate School in order to ensure that high standards of quality are represented in the programs so designed.

In order to ensure high standards of quality in the graduate programs designed for non-traditional students, the following criteria should be employed by the Policy and Review Councils in the process of review: (These criteria are those which require particular attention in the case of proposals for non-traditional students. They are not meant to preclude attention to criteria generally applied to traditional graduate programs, nor to preclude additional criteria appropriate to the particular program field.)

- A. Need for the program should be demonstrated with evidence that there is a non-traditional clientele who will be interested in the program and who will be admissible to the Graduate School. While there will always be exceptions, students will be those who, because of their full-time employment or other commitments, cannot attend day school.
- B. Admission to the program should be through the regular procedures of the Graduate School. Criteria used for admission and for granting degrees should be the same as those used for programs in day school in terms of academic qualities expected.
- C. Faculty with full or associate graduate status should be encouraged to teach the majority of the course offerings in the program. Faculty proposing a program, and the Policy and Review Councils should be alert to the abuses of overload teaching and the possible detriment which overload teaching can be to effective teaching in graduate programs. For example, lack of resources would not be sufficient reason to staff new programs largely with faculty on overload basis.

- D. Programs proposed for non-traditional students should provide specific identification of courses available in the program and the structure of anticipated degree programs in terms of these courses.
- E. Facilities and resources should be adequate for study. Resources of libraries, laboratories, computers, etc., should be described with specific information about hours, locations, etc. Proposals involving instruction in off-campus settings bear a special burden in being creditable in this regard.
- F. Administration of the program should be done through the Graduate School. Plans for administering the programs, including record keeping, should be worked out completely before the program is begun.
- G. Tuition and fees for non-traditional graduate students should be at the same credit-hour cost as for day school graduate students.

C. Recommendations

1. A full-time Associate Dean should be appointed.

The administrative officer for graduate education on the UMD campus should be upgraded to a full-time position. This officer would report to both the Dean of the Graduate School and to the Vice Chancellor for Academic Administration at UMD. S/he would have the title "Associate Dean" in recognition of certain increased responsibilities. It should be noted that a similar recommendation was made in the 1984 report of the UMD Task Force. Specifically:

- a. Provided with an appropriate discretionary budget, the Associate Dean should take an active role in promoting UMD's educational, business, and research resources. Acting in many ways as a "Dean of Research", s/he should pursue interactions between appropriate UMD faculty and regional businesses, industries, government, and other educational institutions. This office should also seek ways that new and existing practitioner-oriented graduate programs can be more responsive to the needs of northeastern Minnesota, as well as Minnesota as a whole.
- b. The UMD Associate Graduate Dean should be a voting member of the UMD Administrative Committee and should serve as the voice of graduate education on the UMD Library Policies Committee.
- c. In a manner analogous to that performed on the Twin Cities campus by the Graduate School Dean, the UMD Associate Dean should be involved in the promotion and tenure process for all UMD faculty, should review all such files, and should make recommendations to the Vice Chancellor for Academic Administration. It is recognized that implementation of this would fall under the purview of collective bargaining.
- d. In order to facilitate the UMD graduate student experience and to improve retention, this office should be responsible for the approval of graduate student programs of study and clearance for graduation.
- e. This office should assist the UMD Graduate Faculty Committee by performing technical reviews of graduate faculty nomination files and graduate course proposals. Final approval of these nominations and course proposals should remain vested within the Graduate Faculty Committee.
- f. The Associate Dean should serve as a liaison between the UMD campus and the Graduate School to assist in the evaluation of applications from international graduate students. This office

should also take a more active role in providing orientation services for international graduate students.

- g. The Associate Dean should be responsible for the preparation of bulletin copy for the graduate sections of both the UMD and the Twin Cities bulletins. This would include the contents of the materials, their formats, and their placement within the bulletins.

2. There should be an expansion of the role of the UMD Graduate Faculty Committee.

Concerning the structure and duties of the existing Graduate Faculty Committee, we make the following recommendations:

- a. The Chair of this Committee should continue to be a constitutionally designated voting member of the Graduate School Executive Committee.
- b. The Chair should also be designated as a member of the Review Committee for the Graduate School Dean.
- c. The Chair should receive the results of all UMD graduate program reviews for information.
- d. While the oversight of graduate faculty nominations and course proposals at the 5000- and 8000-levels remains an important part of this Committee's responsibilities, recommendation "1" above would allow the Committee to address larger programmatic issues. Before transmittal to the appropriate policy and review councils, this Committee should review proposals for all new graduate programs involving UMD graduate faculty.
- e. The UMD Graduate Committee should be an integral part of the interview and final selection process for the UMD Associate Graduate Dean. It should also be involved in periodic reviews of the performance of that office.
- f. We reiterate the recommendations of our memorandum dated April 1, 1988 (see Appendix E) in which it was suggested that membership of this Committee consist of all UMD Directors and Associate Directors of Graduate Studies. We further recommend that the chairperson of the Committee be appointed by the Dean of the Graduate School from among nominees of the Committee selected from past or present Directors and Associate Directors of Graduate Studies at UMD. The term of the Chair should be for two years rather than the current three years.

5. Library facilities and information access need to be upgraded.

The existing substandard conditions of the UMD library and its holdings are a serious hindrance to the growth of scholarly activity at UMD. Both the UMD administration and the Graduate School are strongly urged to insist upon improved physical facilities and an operating budget more appropriate to the comprehensive nature of educational programs at UMD. Additionally, it should be recognized that acquisitions strategies should account for the fact that the resource needs of graduate students can differ significantly from those of undergraduates.

Steps should also be implemented whereby UMD graduate faculty will have greater and more immediate access to the technological and library resources of UMTC.

6. There should be a serious examination of the structures of cooperative Ph.D. level programs.

It is highly appropriate that the matter of cooperative Ph.D. level programs be addressed in light of the November 1988 UMD Strategy for Focus Plan. In that document, which has been endorsed by the Board of Regents, the development of cooperative Ph.D. programs between UMD and the Twin Cities campus was proposed. We also believe that these are highly appropriate and timely steps given the levels of competency and maturity now existent among UMD graduate programs and their faculties.

Furthermore, we call upon the Dean of the Graduate School, in consultation with graduate faculty and appropriate campus administrators, to examine the possible structures and operations of cooperative Ph.D. and other terminal degree programs involving the Duluth and Twin Cities campuses of the University of Minnesota. This examination should study existing programs and identify successful models for the development of future programs.

An increased number of qualified UMD faculty should be nominated for full membership in the graduate faculty. This can involve both cooperative Ph.D. programs as well as Ph.D. programs associated with the Twin Cities campus.

In recent discussions regarding the proposed cooperative Ph.D. program in toxicology, various logistical issues have been raised. Included among these are problems encountered when students are required to reside on, and travel between, both campuses. Considering the endorsement by the Regents for cooperative Ph.D. programs, the Graduate School and University should now provide the necessary financial resources to redress these logistical problems so that this toxicology program can be fully implemented. It is crucial that these

and other matters be addressed and resolved with utmost haste, since they have profound effects on the structure of Ph.D. level programs on the UMD campus.

UMD Graduate Faculty Committee (1988-89)

FACULTY

Bo Casserberg	Joseph Duncan	William Gemeinhardt
John Hatten (Ex Officio)	Stephen Hedman (Chair)	Thomas Kerrigan
Kjell Knudsen	Donald Maypole	Jean Regal
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