

The University Senate of Michigan Technological University

PROPOSAL 19-00

NON-DEPARTMENTAL PhD PROGRAM IN PROPULSION SYSTEMS ENGINEERING

Rapid advances in scientific knowledge and technological development require the blending of expertise from several academic departments to solve problems. The role of the individual scientist trained and working alone in a specific discipline is rapidly being replaced by a scientific team that brings individuals with different backgrounds and expertise together in a multidisciplinary approach. In recognition of this changing way in which science and engineering research is increasingly being done, the University established a non-departmental PhD in Engineering that draws on faculty from several traditional science and engineering academic departments and focuses on several nontraditional engineering specialties (Faculty Senate Proposal 3-84).

This is a proposal plan to establish a non-departmental PhD program in Propulsion Systems Engineering as a new program within the PhD in Engineering. The PhD in Engineering program is designed to provide a vehicle to serve important areas of research and education that cannot be adequately treated by traditional departments. The proposed PhD program in Propulsion Systems Engineering qualifies as such an area because it combines chemical engineering, electrical engineering, mechanical engineering, metallurgical engineering and materials science, and other engineering disciplines to fundamentally investigate and develop solutions to important problems encountered in the interdisciplinary field of propulsion systems engineering.

Proposal Background

Effective progress toward solutions to problems such as the "grand challenges" of fuel utilization, dwindling finite petroleum reserves, fuel conservation, engine emissions, increased engine efficiencies, increasing carbon dioxide levels in the global climate, and hybridization of transportation propulsion necessitates an approach which integrates interdisciplinary collaboration and fundamental science. The proposed PhD program will join faculty and students in an interdisciplinary program of high visibility to contribute to solutions for a broad range of scientifically interesting and economically significant problems. The program will be unique in its ability to simultaneously provide researchers who understand the scientific and engineering problems required for sustainable growth and researchers who understand the computational theories, methods, and experiments throughout several traditional areas of engineering.

The underlying goal of this program is to provide an opportunity for PhD students to pursue a multi-disciplinary engineering education in the area of combustion engines and propulsion systems. This program will educate highly qualified engineers and scientists that will seek to overcome technological barriers preventing the development and production of cost-effective high-efficiency vehicles and powerplants for the US market. Further, these highly qualified engineers and scientists will foster an educational process to train a future work force of automotive engineering professionals who are knowledgeable about and have experience in developing and commercializing critical advanced automotive technologies.

The study of propulsion systems has become interdisciplinary. In past years, it was essential that scientists educated in specific disciplines of engineering interact with and cross fertilize with scientists in other disciplines. Yet this cross interaction occurred only to a limited extent! Now, as industry is faced with problems that require interdisciplinary solutions, those scientists that understand and engage in interdisciplinary research, will become the leaders and problem solvers of the future. Propulsion systems of yesterday were oily mechanical marvels; today they are chemical, electrical, metallurgical, and

mechanical systems that are harmoniously integrated into complex packages. The underlying goal of this plan is to educate PhD students in this essential focus area and further:

1. encourage and promote interdisciplinary interaction of the faculty,
2. promote strong interaction with industry, develop a sense of responsibility with industry and pursue a self sustaining program, and,
3. establish collaborative arrangements and networks with universities active in propulsion systems and combustion engine study.

It is anticipated that this first class educational facility will become a national magnet for talent in the engines and propulsion systems arena. Michigan Technological University is a leader in engineering education. Faculty are internationally recognized in diesel emissions, diesel performance, alternate fuels, spray characterization, and combustion. Women and minorities will be actively recruited from the onset of the program.

Propulsion Systems Engineering Faculty Committee

Faculty must be excited about interdisciplinary study. More importantly, faculty must be knowledgeable not only in their specialized area of research but in other interdisciplinary areas as well. For example, a metallurgist must also understand the basics of tribology in the engine environment, an electrical engineer teaching controls must understand the basics of combustion chemistry and engine emissions, and a mechanical engineer must understand the nuances of organic chemistry and chemical kinetics of combustion. To reach this level of competence and enthusiasm, participating faculty have been selected to participate in this center proposal 1)based upon prior experience with propulsion systems and combustion engine design, 2)creativity and innovative accomplishments, and 3)willingness to participate in additional study of internal combustion engines and propulsion systems. Faculty participating in this plan represent a spectrum of full, associate and assistant levels at varied stages in their careers:

Duane L. Abata, Professor, Department of Mechanical Engineering and Engineering Mechanics

Carl L. Anderson, Associate Professor and Associate Chair, Department of Mechanical Engineering and Engineering Mechanics

Oner Arici, Professor, Department of Mechanical Engineering and Engineering Mechanics

Jeffery B. Burl, Associate Professor, Department of Electrical and Computer Engineering

Peck Cho, Professor, Department of Mechanical Engineering and Engineering Mechanics

Michael E. Mullins, Professor, Department of Chemical Engineering

Donna J. Michalek, Assistant Professor, Department of Mechanical Engineering and Engineering Mechanics

Karl B. Rundman, Professor, Department of Materials Sciences and Engineering

John W. Sutherland, Professor and Associate Chair, Department of Mechanical Engineering and Engineering Mechanics

Kirk H. Schulz, Department Chair, Department of Chemical Engineering

Franz X. Tanner, Associate Professor, Department of Mathematical Sciences

Song Lin Yang, Associate Professor, Department of Mechanical Engineering and Engineering Mechanics

Administrative Structure

Committee Chairperson

One Faculty Committee member will be appointed Chairperson; he/she will be appointed for a four-year term by the Faculty Committee with concurrence of the Deans of Engineering and the Graduate School. The responsibilities of the Chairperson will be:

1. overall responsibility for the quality and management of the Propulsion Systems Engineering Program.
2. update membership of the Faculty Committee, with the concurrence of the Faculty Committee.
3. approve appointments to Advisory Committees.

Committee Vice Chairperson

The position of Vice Chairperson will be nominated and elected by the Faculty Committee for an initial

term of 3 years and subsequently for a term of 4 years. This person will function as the Chairperson in case of the Chairperson's absence.

Committee Director of Admissions and Early Advising

The position of Director of Admissions and Early Advising will be nominated and elected by the Faculty Committee for an initial term of 2 years and subsequently for a term of 4 years. The Director's primary responsibility will be to make recommendations to the Faculty Committee regarding student admissions and to advise new students in the program.

Costs of the Program

There will be no start-up costs from MTU for this program; the faculty and the equipment are already here. Seven hundred and fifty thousand dollars (\$750,000) have been provided by the United States Department of Energy to develop this program. Of this amount from DOE, five hundred thousand dollars (\$500,000) is designated for fellowships for this plan over a five year period (\$100,000 per year). There is, moreover, the potential for an increase in external funding. As the interdisciplinary team begins to work together, possibilities for interdisciplinary research and increased external funding will become evident.

Admission to the Program

Students that have an undergraduate degree in engineering will be considered for admission to this PhD program. Students that have an undergraduate degree outside of engineering should obtain a Master of Science degree in engineering before being admitted to this PhD program unless it is clear to ICAP faculty that the student possesses sufficient engineering skills to be directly admitted. GRE scores and TOFEL scores (international students) will be required unless the student has received a degree from Michigan Tech.

Each student will have an Advisor who is a member of the Faculty Committee. At the latest the Advisor will be appointed during the first term of the second year after the student enters the program. The Advisor will have the primary responsibility for supervising the student's research project and for directing the student's academic and professional development. Each student will have an Advisory Committee consisting of the student's Advisor and at least four additional members. Two of the four may be from the same department as the Advisor. The other two must be from outside that department. It is possible that one of the four members be from outside of MTU (as in the case of most of the traditional departmental PhD programs). The Advisory Committee members from MTU must be members of the Graduate Faculty. The Advisory Committee members will be nominated by the Advisor in consultation with the student and subject to the approval of the Chairperson. The interdisciplinary nature of this program makes it essential that the Advisory Committee actively participate in the research project. The Advisory Committee members from MTU must be appointed early in the student's research program. They will meet at least quarterly with the Advisor and the student to review progress. At each meeting the student will present a brief written or oral progress report and will discuss progress with the committee members. It is expected that the student will meet more frequently with the Advisor and certain of the committee members in the pursuit of the research project.

Comprehensive Examination

Each student must pass the Comprehensive Examination. This examination is given in two parts: a Fundamental Knowledge part and a Dissertation Prospectus part. The Fundamental Knowledge part will be a written examination of the student's background based upon academic knowledge of fundamental principles at the baccalaureate level but at an intensity level cognizant of PhD study. The Dissertation Prospectus part will be an oral examination of the student's ability to conduct meaningful and contributory research to the field and is an in-depth examination in the area of research that the student plans to pursue. The Dissertation Prospectus part will be a presentation of the student's proposed research for the PhD degree. The Fundamental Knowledge part must be taken first or during the same testing period as the Dissertation Prospectus part, and the Dissertation Prospectus part must be taken by the end of the second year. The tests will be given (when requested) in the fall and spring semesters of each year. Each student who intends to sit for either part of the Comprehensive Examination must declare that

intention by the end of the second week of classes in the term the exam is to be taken. Each part of the exam will be administered by the student's Advisory Committee which will be composed of at least four qualified members. After each part of the exam or after both parts if both parts are taken during one testing period, the student and the student's Advisory Committee will meet to review orally the exam. A student will pass if at least three committee members of the Advisory Committee vote pass. Passing the Comprehensive Examination elevates the student to the status of Doctoral Candidate. The exam (either part) may be retaken only once with the approval of three committee members of the Advisory Committee.

If a member of the Advisory Committee is not from MTU, he/she will not be involved in the Comprehensive Examination; his/her purpose is to strengthen the actual research activities of the student's work.

The outcome of the written parts need not be disclosed to the student prior the oral part. This examination is open to all members of the MTU Graduate Faculty, though the Advisory Committee may restrict the questioning to come from only its own members and the Chairperson.

Degree Requirements

It is the intent of this interdisciplinary degree to keep course requirements as flexible as possible to reflect varying needs of students on an individual basis. There are no core course requirements that must be completed for this PhD degree. However, a student pursuing this degree should show competency in subject areas that are covered in ME-EM4220 Internal Combustion Engines. The student should also demonstrate interdisciplinary breadth in an engines/propulsion related area such as chemical kinetics, rheology, electronics, controls and control system analysis, computer design, numerical analysis, mathematical modeling, materials, materials processing, manufacturing, and/or metallurgy. The student's dissertation must involve a topic or topics which reflect subject matter relevant to Propulsion Systems.

The major thrust of the Propulsion Systems Engineering program is the integration of traditional engineering departments into a cohesive interdisciplinary research plan. Thus, every student in the program will be expected -- either in his/her past course work and/or experience or in his/her PhD work -- to be involved with discipline broadening as well as discipline depth at a fundamental level. The discipline broadening and depth must be cohesive and approved by the advisory committee.

Each student must take 30 hours of credit (semester basis) beyond the Master of Science Degree and sixty (60) hours of credit (semester basis) beyond the baccalaureate degree. This credit can be any combination of research or course work credits. All the hours must be at the Senior/Graduate level or above, and twelve (12) of the thirty (30) hours must be at the Graduate level or above. The student's advisory committee will play a significant role in determining this ratio. Students entering the program with a baccalaureate degree and wishing to obtain a Master of Science degree during pursuit of the PhD must meet the credit requirement for the Master of Science degree as set by the MTU Graduate School.

Dissertation Proposal

This is a written and oral description of the research plan made by the student to his/her Advisory Committee. The proposal should be made within one year of achieving Doctoral Candidacy (satisfactory pass on the Comprehensive Examination). The student's advisory committee must unanimously agree that the research plan is acceptable. The Chairperson will be notified of the outcome of the Dissertation Proposal. The oral proposal is open to the University community.

Research Review

At least three months prior to the dissertation defense, the student will present his/her research findings to his/her Advisory Committee for its approval. While the presentation will be oral, a written outline of significant results should be provided for committee members. The purpose of this review is to evaluate the contribution of the work as well as to assist in maintaining a focus for the dissertation. The student's Advisory Committee must agree that the research is acceptable and that the student's progress is satisfactory. The student will be allowed to repeat the research review until such approval is given.

Dissertation Defense

The research conducted by the student will be presented to the Advisory Committee as a written dissertation. An oral presentation of that dissertation will be made following the completion of the written work. The dissertation is acceptable if the Advisor and at least three members of the Advisory Committee concur on its acceptance. The oral defense is open to the University community.

Time Frame and MTU Policies

The expected time-to-completion should be about five years following the undergraduate degree, or about three years following the MS degree. Degree requirements, advising and time-to-completion expectations are subject to the current rules of the MTU Graduate School. If conflicts in policies arise, Graduate School policies have precedence.

Adopted by Senate: May 10, 2000

Approved by President: May 26, 2000< P>