

The University Senate of Michigan Technological University

PROPOSAL 21-01

FRAMEWORK FOR PROFESSIONAL MASTER OF SCIENCE DEGREES: AN INTERDEPARTMENTAL PROFESSIONAL MASTER OF SCIENCE DEGREE WITH SPECIFIC AREAS OF CONCENTRATION

The Professional Master of Science degree (Professional Science Master) is a self-contained, terminal, professional MS degree in a concentration area of science or mathematics, often in an emerging field that spans two or more traditional disciplines (e.g., bioinformatics, nanobiotechnology). It is a new type of master's degree that prepares people to work outside of academia. It is a non-thesis, course work option combined with an internship either in a research laboratory or industry. It will prepare graduates with a traditional discipline oriented background to better meet the demands of the emerging high-tech economy.

RELATED PROGRAMS: Own/Other

The Professional Science Master as a professional MS degree is a spin off from the traditional Master of Science degree at Michigan Technological University. It appears that in the Midwestern US only Michigan State and the University of Wisconsin are offering professional master's programs (see below).

RATIONAL AND NEED

The definition and need for such new professional master's degrees have been summarized and articulated by the Alfred P. Sloan Foundation (see, for example, http://www.sloan.org/programs/edu_careers.htm; <http://www.sciencemasters.com>; http://www.sloan.org/programs/supresearch_cmb.htm):

By "professional master's degree" we mean serious, intensive two-year professional degrees that qualify graduates to work as full professionals in groups engaged in high-quality research and development activities. Such professional degrees are now rare in most scientific fields, but might be seen as analogous to professional degrees that have long been highly prized in professions such as engineering, business and law,.... employers indicate a strong interest in recruiting new personnel at the master's rather than doctoral level, and thereby offer attractive alternative career paths for young people interested in science and technology. University research groups have also shown increasing interest in recruiting personnel with such backgrounds.

Or, from remarks by Sheila Tobias (13 October 1999 Commission on Professionals in Science and Technology (CPST) "Conceptualizing a New Degree"):

..., the new MS Professional Degree in the Sciences (and Mathematics) is not to be construed as just a way of accrediting or institutionalizing or allocating scarce resources to one or more emerging fields. Rather, as a way of providing and legitimizing some postbaccalaureate alternatives for science and mathematics major who: do not wish to (or cannot) do medicine or engineering; do not wish to (or cannot) do a research PhD; but who also - and this is most important for our discussion of the new MS Professional Degree - do not wish to leave science (or mathematics).

Until now, these students have had nowhere to go, except directly into industry where, as terminal BS's (or BA's) they are housed in research labs as techies. There is of course the MBA or Law option. But for many of the students we are eager to serve, such postgraduate options cause them to have to "reinvent" themselves as law or business students, and to compete with students who, while not as well schooled in mathematics or science as they are, are able to compete with them in the arts of advocacy and/or marketing . . .

Thus, like the MBA before it (the last great new degree invented in 1908), the Professional MS in Science/Mathematics is characterized not only by new subject matter, but new pedagogies and new means of evaluating applicants for admission and matriculants as well.

For examples of Professional Master's Programs in the Midwestern US see <http://www.sciencemasters.com/regional.html>.

Michigan State University

- Applied Physics
- Computational Chemistry
- Industrial Microbiology
- Integrated Pest Management
- Industrial Mathematics
- Physics - Modeling and Simulation

University of Wisconsin

- Environmental Monitoring
- Biomedical Informatics
- Computational Science

Other examples see http://www.sciencemasters.com/programs_elsewhere_science.html.

Center for Biotechnology. Northwestern University. The program has been in existence for seven years and has enrolled over 200 students. It is a professional, 13-month intensive program that offers students an education in both the science and business of biotechnology. The curriculum includes core, specialization, and elective courses. Additionally, students complete an academic and industrial residency. Full-time students are recruited, about 40 in a class, for specialization in genetic engineering/genomics; cell biology/immunology; bioengineering; bioinformatics; medicinal chemistry. Requirement for entry is a bachelor's degree in science, but not any particular science.

Biotechnology. University of Pennsylvania, jointly sponsored by Penn Engineering and Penn Arts and Sciences. There are three tracks: Basic Biotechnology (emphasizing molecular biology), Engineering Biotechnology (emphasizing bioprocess engineering central to pharmaceutical manufacturing), and Computational Biology/Bioinformatics (preparing students to handle genomic databases). Core subjects, include both science (such as recombinant DNA technology) and non-technical subjects (such as bioethics, government regulatory, and drug-approval policies and patent law). The program accepts both full- and part-time students. It takes full-time students one full year (12 months) to complete.

Master's Degree in Applied Physics with Internships in the Semiconductor Industry. Texas Tech University. A novel MS degree option in Applied Physics with a strong emphasis on electronic materials and device processing. This program, designed to be completed in less than two years, provides an opportunity for professional advancement in the form of supported internships in major semiconductor corporations located throughout the Southwest. The internships give participants the opportunity to learn the use of state-of-the-art instrumentation.

Keck Graduate Institute (KGI) is a pioneering new graduate school offering an alternative to conventional graduate programs in the biosciences. Its primary focus is developing applications from the emerging discoveries in the life sciences, and educating leaders for the biosciences industry. Its two-year professional Master of Bioscience (MBS) program offers cross-disciplinary training and research at the interfaces of science and engineering, emphasizing bioinformatics, pharmaceutical development, bioengineering, genomics and proteomics, and management, policy, and ethics.

The **Master of Science in Applied Science** at **RPI** is a professional, non-thesis, degree, that prepares graduates who have traditional discipline oriented backgrounds to function more effectively in industrial, governmental, or other occupations that are interdisciplinary in nature. It is intended to help professionals

upgrade their technical expertise and cross boundaries among disciplines. In addition to extensive science offerings, students may take applicable courses in other schools such as Management, Engineering, or Humanities and Social Sciences.

More examples of professional science master's degree programs can be found at <http://www.sciencemasters.com/fields.html>.

POTENTIAL APPLICANT POOL (http://www.sloan.org/programs/supresearch_cmb.htm)

The primary pool of students interested in such professional master's degrees are those who have recently earned a bachelor's degree in science, mathematics, or a computing science/engineering field and want to combine it with another "high-demand" area for professional jobs in one of the emerging high-tech industries. For example, there are undergraduate majors in biology, with either limited mathematics, statistics, and computer skills, or computer science majors with limited biological knowledge, who are not able to qualify for entry-level jobs in biocomputationally-intensive fields.

Another potential pool of professional master's degree students consists of current employees of companies who are seeking to upgrade or expand their skills and qualifications, or move out of the laboratory environment while still remaining in research.

It is anticipated that the Professional Science Master's degree program will promote stronger industrial partnerships both through distance education and by the development of applied research projects for the professional master's candidates. The projects could be done either on-campus or off-campus, typically at the site of one of our corporate partners. The professional master's degree particularly lends itself to short-term projects that often are required by industry. It is to be expected that the proposed professional degree meshes with the Smart Park concept and will lead to a higher level of integration and synergy between participating companies and Michigan Tech.

Different options, when introduced for a particular area of concentration, may require some additional resources, but they are anticipated to be small since the professional master's student population in a given area of concentration will be spread across different departments and/or colleges and take advantage of already existing courses as core courses for the professional degree. It is difficult to predict how many students are likely to ultimately enroll in a professional master's program. If it is similar to already existing programs, we might expect about 10-20 per option. In some ways there should be economies, since there will be more students enrolled in graduate and senior-level elective courses, which typically have low enrollments. An analysis of the enrollments in 4000-, 5000-, and 6000-level science courses during the last academic year indicates that there is excess capacity, defined as an enrollment of less than 10 students, in most graduate-level courses.

PROGRAM OPTIONS

Once the Framework for the Professional Master of Science degrees is in place, individual programs will be established by 1) departments or 2) interdisciplinary committees. Professional Science Master's programs are not intended to substitute for the tradition, disciplinary MS programs with their emphases on basic science and research tailored to individual students. A Professional Master's of Science degree oversight committee will be established within the College of Sciences and Arts to prescreen degree programs as they are proposed and to ensure quality of existing programs. This committee will initially consist of one representative from the graduate committees of each department of the College of Sciences and Arts. Representatives from graduate committees from the College of Engineering and the School of Forestry and Wood Products can be added as necessary. The committee will select its own chair.

New course descriptions, projected enrollment, program costs, equipment need, faculty resumes, library and other learning resources, and space needs must be specified when a specific program option for an area of concentration is proposed. The proposals for new program options under this umbrella will go through the normal internal approval process including the Graduate School, University Senate, Provost, and President.

Proposals for program options or areas of concentration must demonstrate that the planned professional master's degrees have realistic potential to be economically sustainable. This means that revenues from tuition and other sources (for example fellowship support from industry) should be sufficient to pay the program's costs, after an appropriate start-up period. In general, students pursuing a professional master's degree will normally not be eligible for hire as graduate assistants. Scholarships or fellowships could be available for some students, especially for a start-up period, and/or as an incentive match, but, for the most part, the professional science master students will pay full tuition and hence increase revenue to the University. Submission of grants to support creation of such degree programs is encouraged.

CURRICULUM DESIGN

The Professional Science Master will have a number of possible concentrations (for example Bioinformatics). For interdisciplinary programs, 'cognate' means a department other than those departments represented in the program or area of concentration.

ADMISSION AND DEGREE REQUIREMENTS

Students wishing to enter a Professional Science Master's degree program option are subject to Michigan Tech's general Graduate School admissions requirements for MS students. Exceptional students with degrees in areas that do not include the necessary background course work may be allowed to enter the program, but such students are likely to be required to take additional course work for no credit.

The **degree requirements** and distribution between course work and practicum/ internship credits follow those of the professional Master's of Engineering degree program which was approved by the Board of Control in the spring of 1998. The **administration** follows that of the non-departmental PhD in Engineering model because faculty constituting each option or area of concentration normally will come from two or more of the traditional departments. Each multi-departmental grouping is charged with administration of the professional science master's program in accordance with the University's rules and regulations for graduate studies and has the same degree of autonomy as an academic department does in regulating its own program. Interdepartmental activity of this type is conducted under the aegis of the Graduate School, the College of Sciences and Arts, and an interdepartmental committee (represented by a program chair). The development of an Advisory Board for any proposed program with members from industry is deemed to be necessary in assuring practicum/internship opportunities and suitably recruitment and training of the graduates of these programs.

Thus, the design and structure for all options which seek approval under the Professional Science Master umbrella are as follows:

Students in a Professional Science Master's degree program option must do the following:

- choose an advisor and advisory committee
- file a preliminary Degree Schedule form
- complete a written and oral report on a practicum
- file a final Degree Schedule form
- fulfill the campus residency requirement
- finish the degree within the prescribed time limit

In principle it is possible for students enrolled in a B.S. program to complete the degree by appropriate planning of the course schedule in one year of full-time study (plus summer internship/practicum).

The Graduate School's general requirements are described below; individual programs may have additional requirements. Students are expected to know their program's requirements.

Advisor

Initially the advisor may be the program's graduate coordinator, but as soon as possible, and by the end of the first semester in residence, a permanent advisor should be chosen. This MTU graduate faculty member advises the student on course selection and choice of practicum experience. The advisor is an important factor in the graduate student's timely and successful completion of his or her program of study.

Advisory Committee

The Advisory Committee is nominated by the program chair, usually in consultation with the advisor, and approved by one of the participating schools or colleges. At least two of the three examiners must be members of the graduate faculty and one of the graduate faculty members must be from outside the major department.

Degree Schedule

The Preliminary Degree Schedule form, available from the program chair, is used to list all the courses that the student will use for the professional science master's degree option. The completed form must be approved by the program committee and the Graduate School office during the first semester of enrollment. The Final Degree Schedule form, available from the program chair, must be filed after completion of the practicum and prior to the granting of the degree. It lists all the courses applied to the professional science master degree option, gives the advisory committee membership, provides an abstract of the practicum, and is endorsed by the student, the advisor, the program chair, the dean of sciences and arts, and the dean of the graduate school. The forms mentioned above, including additional details concerning procedures and timetables, are also available in **Keeping on Track in Graduate School**, available in department offices, in the Graduate School office, and on the Web

http://www.admin.mtu.edu/rgs/graduate/grad/grad_keeping_on_track.pdf.

Course Work

These courses must meet certain requirements, described below, and they must be approved by the advisor and the program chair. Because this degree is meant to prepare students to be more than "techies", it is necessary that they have more than just the engineering and science knowledge required of this graduate degree. Consequently, 3 credits in a business course, 3 credits in a nonacademic communication course (e.g., technical and scientific communication), and a course in research ethics are required to assure that the students have the wider range of skills and knowledge expected of project managers and coordinators in today's information and teamwork-driven workplace. Courses taken while an undergraduate at Michigan Tech may be used for graduate degree credits if the Senior Rule form (available from the department secretary) has been appropriately filed. Courses taken while a postgrad may be used on the Degree Schedule with departmental approval.

The minimum requirements are as follows:

course work -- 26-28 credits

practicum -- 2-4 credits

minimum total -- 30 credits

Distribution of course work credit

5000-6000 series (minimum) -- 12 credits

3000-4000 level (maximum) -- 14 credits

Grades

All grades must be B (3.0 on a 4.0 scale) or better in the major subject area. The programed chair can approve no more than 6 credits of C (2.0) in a cognate department. The student must maintain a cumulative grade point average of 3.0 or better in all courses taken as a graduate student.

Campus Residency Requirement

A minimum of one-half of the course work credits must be taken in residence at MTU.

Time Limit

All work required for a Professional Science Master's degree program option must be completed within five calendar years of the first enrollment in the degree program.

Description: Advanced independent study for students in a Professional Science Master's degree option. The student in consultation with his/her advisor develops and executes a project demonstrating capabilities in problem solving, communications, and decision making. The practicum/internship can be done on campus or at the site of an industrial partner. Students must submit a written report and make an oral presentation related to their project to their advisory committee.

Prereq: None

Restriction: Professional Science Master's students only.

PLANNED IMPLEMENTATION DATE

Fall 2001

ACCREDITATION REQUIREMENTS

None

REFERENCES http://www.sciencemasters.com/articles_references.html

October 2000 University Business, pp. 33-38, "The Art and Science of New Degrees", By Margaret Littman

October 2000 "Mastering Physics for Non-Academic Careers", an American Institute of Physics Report Commissioned by the Alfred P. Sloan Foundation on the Nature of Professional Physics Master's Programs in the United States

29 May 2000 Chemical and Engineering News, Vol. 78 No. 22, pp. 65-67, "Education: The New Master's"

3 April 2000 The Scientist 14[7]:41, "Designer Degrees or Academic Alchemy? Professional master's programs attempt to teach skills for today's world", By A.J.S. Rayl

28 January 2000 The Arizona Daily Star, "UA science college creating master's for industry", By Sarah Garrecht Gassen

13 October 1999 Commission on Professionals in Science and Technology (CPST), "Conceptualizing a New Degree", Remarks by Sheila Tobias at a gathering of educators, industry and government agency representatives, convened to discuss "Emerging Fields in Science"

4 June 1999 Science, pp. 1610-1611, "Reinventing the Science Master's Degree", By Mari Jensen

June 1999 Physics Today, pp. 54-55, "Professional Master's Degrees Promise Quicker Entry into Industrial Jobs", By Jean Kumagai

August 1998 Industry & Higher Education (London, UK), pp. 213-216, "The Science-Trained Professional: A New Breed for the New Century", By Sheila Tobias and Frans Birrer

Adopted by Senate: May 2, 2001

Approved by President: May 7, 2001