MIT's Master of Engineering Degree in Civil and Environmental Engineering--a first professional degree

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Introduction

Engineering is one of the few disciplines in which professional status is claimed with only a four-year undergraduate degree. It is becoming evident that such a model is not sustainable in an increasingly complicated and technological world. Employers have responded by effectively requiring a masters as entry level degree for premium civil and environmental engineering positions. Society, in turn, has responded by devaluing engineers relative to other professions. In recognition of this situation, the Board of Direction of the American Society of Civil Engineers has approved a policy statement supporting the Master's degree as the First Professional Degree for the practice of Civil Engineering at a professional level[1]. Four years ago MIT's Department of Civil and Environmental Engineering developed a new degree, seeking a unique and different post-baccalaureate experience that we hope will become the model of the first professional degree. Following is a summary of our experiences after three graduating classes.

MIT's Master of Engineering Degree in Civil and Environmental Engineering

In 1995 the Department of Civil and Environmental Engineering at MIT introduced the Master of Engineering degree. The M.Eng. degree provides additional technical depth beyond the B.S. and an educational experience aimed toward professional practice. All M.Eng. students are expected to have undergraduate degrees in engineering (mostly civil or environmental), about one-third have one or more year's of previous work experience, and about half are U.S. citizens (though many of the foreign students are U.S. permanent residents and/or have studied in the U.S.). Except for the engineering degree, which is not required for other graduate programs, admission to the Master of Engineering program is based on the same quality criteria as other programs. The profile of students, though, tends to be different, with practice the clear immediate professional objective. Graduates of our Bachelor of Science program with "B" or higher career cumulative averages are offered automatic admission into the M.Eng. program. With proper planning, our undergraduates can develop a seamless transition between undergraduate and graduate programs culminating in the B.S. and M.Eng. degrees in 5 years. They have the advantage of being able to pace requirements better and to experience a somewhat less crowded 5th year.

Additional characteristics of the M.Eng. program, include:

- Emphasis on both individual and team experiences.
- Inclusion of a practice experience as part of the curriculum.
- A relatively structured curriculum.
- Requirements for major writing and speaking experiences through a group project and individual thesis.
- Enrollment limited to 9, intensive, months.
- The program is largely self-supported.

The degree complements our traditional Master of Science degree which typically requires two years, has a more open curriculum, and emphasizes individual research, often en route to a Ph.D.

The team approach is obvious from the minute students arrive at MIT. Prior to the start of classes, the group spends a weekend in Vermont, socializing and getting to know one another. On their return to campus, they are a unified body. To reinforce team identity, the Department created new facilities exclusively for the program, including a large multi-purpose space with a dedicated network of modern PCs, configured as one would find in practice. This space serves as classroom, meeting room, computer room and sometimes bedroom! Adjacent to the main room are conference and reference library/study rooms maintained exclusively for this program.

The team approach extends beyond the 9-month program, as an active alumni network has been developed. Early in the fall Boston-area alums are invited to a reunion where they meet current students, identify job possibilities at their current firm (helpful for both students and potential employers), and discuss other professional issues on the students' minds. Alums are also helpful with our "chase-an-engineer" exercise, described below.

Presently there are four tracks or specialties offered: Environmental and Water Quality Engineering, High Performance Structures, Geotechnology, and Information Technology. The curricula corresponding to the individual tracks are fairly structured; each includes 3 required subjects, two planned electives, and one free elective. The six technical subjects is the same number as required for the Master of Science degree. Some of the subjects were created or modified for the M.Eng. program while others are part of our normal offerings.

Irrespective of specialty, all M.Eng. students take a Concepts of Engineering Practice subject which covers many of the less technical aspects of the profession--from preparing vitas and selling oneself, to project control, to running a private office, to professional ethics, etc. The subject involves constant interaction with practitioners, including a "chase an engineer" experience in which students spend a day with a practicing mentor. On Fridays, a luncheon is provided where outside speakers are invited to present a seminar on current trends in their particular discipline.

Starting in November and continuing through May, students work on a group project. The students select their project by forming interdisciplinary groups and responding to one of the "RFPs" which are let during October. The proposals include both technical and administrative/cost components and are presented both in writing and orally to prospective clients, at the end of the fall semester. Oral presentations are tape-recorded, and students are asked to critique both their own presentation and that of a classmate.

The projects are taken from large real-world engineering problems, and prepared in collaboration with outside practitioners. Environmental students have typically worked in teams of 3 or 4 students; their projects during 1998-99 encompass: (1) water resources development on the island of Cyprus, (2) appropriate waste water technology for the state of Sao Paulo, Brazil, (3) assessment of constructed wetlands and other mitigation options as part of a watershed trading program for a local town, (4) analysis of groundwater contamination and remediation options for a local landfill, and (5) 3-D numerical water quality assessment of a local estuarine system. Meanwhile students from the High Performance Structures, and Geotechnical groups are grouped in competing teams to design a technically and environmentally innovative new building for this department, and the Information Technology group is partnering with a group in Mexico to design a "virtual meeting room".

After "winning" their contract in December, student teams begin work on their project during the January Independent Activities period, when there are no formal classes. This is also a good opportunity for any group travel needed in connection with their project. This year students traveled to Cyprus, Brazil, California and Mexico. Projects are slated for completion by April 1. During the spring, students also complete an individual thesis, usually focused on a piece of the larger project: e.g., how to incorporate marshes into a numerical hydrodynamic model or design of a base isolation system for a new building. Thesis supervision is shared by faculty members throughout the department.

Evaluation

Is the program working, and how could it be improved?

One measure of success is enrollment. Student numbers are still less than the steady state goal of 60 students, but it is felt that our present enrollment of 34 students is on track to achieve established longer term objectives. The biggest problem in recruiting is competing with the aid offers that top students receive for more traditional master's degrees elsewhere. Our challenge is demonstrating the value added by investing in a packed 9-month program.

From a policy perspective, it is a struggle to find the right balance of students with and without work experience. In their technical coursework, both types of students seem to perform similarly, but in the Concepts class, which involves substantial group discussion, the experienced students have much more to offer. It is also clear that the students straight out of college benefit from the experience of their older experienced classmates.

Students have indicated they appreciate flexibility regarding choice of subjects and projects. As a consequence, the program remains as flexible as practical within available resources (e.g., having more projects requires more faculty supervision).

A most important measure of success is employer satisfaction. While many employers appreciate the independent thinking skills developed by students who have spent two years working on a research thesis as part of our Master of Science program, most recognize the need for a more "efficient" professional program, especially if most students pay their own way. And unlike many 5th year masters programs which only require additional coursework, the

practical experience afforded by the project and thesis is highly valued. Indeed, we feel that this is the most distinguishing feature of our program.

Based on exit interviews, the vast majority of our students are happy, all have jobs, with the large majority receiving multiple job interviews and more than one offer. The program enjoys a large number of "repeat" employers who have offered positions to graduates in each of the last three classes. Clearly they are satisfied with our graduates. The biggest difficulty with job placement has been for foreign students who want to remain in the country, but lack the necessary visa for permanent employment. The majority of our graduates enjoy starting salaries that are about $10,000 higher than those commanded by those with only a bachelor degree. The salary distribution is nevertheless skewed to the right, with several students with experience or specializing in our Information Technology track receiving offers near the 6 figure level.

The Future

By all accounts the M.Eng. program has been a success. It truly represents a new and welcomed product which complements other successful graduate programs. In particular, it is differentiated from our successful M.S. degree in objective and style. We foresee developing both degrees as valid master level options for the foreseeable future. The M.Eng. is designed to be exclusive and ultimately limited to 60 students a year.

We strongly believe that the professional education of civil and environmental engineers requires a Master's degree. This program's long-term goal is to make the M.Eng. (or the M.S.) a seamless and expected career path for all our undergraduate students.

Bibliography

1. ASEE, American Society of Engineering Education Newsletter, Civil Engineering Division, December, 1998.

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