Report of the Student Delegation to the

2009 Visiting Committee

Massachusetts Institute of Technology

Nuclear Engineering Department

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In preparation for the arrival of the 2009 Visiting Committee to the MIT Department of Nuclear Science and Engineering, the student chapter of the American Nuclear Society administered interviews to a representative sample of the student body. The group interviewed included four members of the junior class, ten members of the senior class, nineteen fission students, nine fusion students, and three nuclear science and technology students. Interview topics were designed so as to cover the full range of the graduate and undergraduate experiences in NSE. The following summarizes the results of the interview process.

Quality Assurance
While students report on the whole being happy to be involved with the program, they raise a number of issues with teaching, curriculum, advising, qualifying exams, and the requirements for graduation. The majority of the concerns raised by students can be summed up in a single statement: students have become increasingly concerned with the quality of the education they receive and with the perception of the program’s quality by those outside the department.

Even though this report may seem overly critical, there are several issues that have been resolved since the last student report in 2007. Students seem very pleased with current teaching, testing and content of 22.101, primarily due to stylistic changes by a young faculty member. Undergraduates have also expressed positive opinions concerning the undergraduate thesis. Finally, experimental research interest and expertise has returned to the fission track due to hiring of experienced research scientists and young faculty support. However, some challenges which had been identified in the 2003, the 2005 and the 2007 reports still remain. More worrying still are new derelictions that have been manifested. The individual areas of concern are highlighted in the following sections:

Undergraduate Curriculum
- While many students are grateful for the broad range of topics to which they are exposed as undergraduates, others wonder what they will be able to do with a degree that has such little focus. When polled about what the undergraduate curriculum best prepared them to be, the most frequent response was, “graduate students”.
- Many students would prefer a true introductory class (perhaps covering 22.011, 012, and 013) followed by selection of a specialty with the freedom to choose classes which interest them.
- The requirements for graduation are difficult to meet and constantly changing. Advisors are frequently ill-informed about these requirements. One student remarked that “the undergraduate program feels like an afterthought”.
- Students are satisfied with UROP and internship opportunities, which have been “more educational than attending class” and also useful in retaining students. However, students with interests in fusion have been actively discouraged from taking part in fusion research.
- Certain classes are ill-suited to the roles they are supposed to fill. 18.085 has been universally mentioned as inadequate and is a graduate class for which sophomores do not have the prerequisite knowledge. 18.06 is a potential replacement. 22.071 is intended to introduce feedback, but does not do this sufficiently. Students propose that this be replaced by a reactor dynamics and control class.

Recommendations: While the breadth of the undergraduate curriculum is appreciated, the students overall desire more depth in their chosen fields. Students interested in fission remark that they are unsatisfied to learn nothing about fission reactors until the junior year of study. It is recommended that new classes be introduced to meet this need, including a reactor dynamics and control class, an operational reactor safety class, and perhaps special topics classes dealing with the nuclear fuel cycle and non-proliferation issues.
Graduate Curriculum

- The relevance of 22.101, 22.105, and 22.106 in the core curriculum is frequently debated. The NST core, in particular, is ill-suited to the needs of the students.
- Many classes consist of appropriate content and are well taught. Others, however, are poorly structured and do not meet their stated objectives:
  - 22.251 is a mixture of topics from other classes. Students have expressed interest in the fuel cycle itself but this class fails to teach the desired material.
  - 22.314 is billed as an introduction to structural mechanics but does not explain fundamentals. Students feel they would be better served by taking a course II class.
  - 22.39 is intended as a review for the fission qualifying exam. It lacks leadership, is disorganized, and does not cover material useful for quals. Students like that the final oral exam is useful for quals preparation, however no feedback is given on performance.
  - 22.77 is disorganized and the instructor does not adequately explain concepts.
- Fusion and NST students are satisfied with the rigor of their coursework, but fission students are not. Instead of recommending preparatory classes to students without fission backgrounds, the fission department consistently teaches to the lowest common denominator. This is especially problematic because no higher-level classes are offered in certain areas, like reactor physics.
- Lack of needed classes is a major issue, especially in fission, as fusion and NST students are generally happy with NSE’s offerings and those of course VIII. It is currently not possible to take enough classes to complete a major in reactor physics, a sad statement since reactor physics is what truly separates the fission section of NSE from the Institute’s other engineering departments. Course material recommended by students includes:
  - Advanced reactor physics (almost unanimously mentioned by fission students), to include dynamics and advanced transport methods
  - Numerical methods for reactor physics and thermal hydraulics
  - An introduction to industry computer codes
  - Turbulent plasma transport
  - Radiation detection
  - Engineering for fusion systems
  - Non-proliferation
  - Reworking of 22.106 into a pure neutron transport class

Recommendations: Glaring deficiencies are noted in the course offerings in the fission section, most dealing with the lack of advanced classes in reactor physics. The relevant classes are not offered elsewhere in the institute because the reactor physics discipline is unique to the nuclear field. While it may be difficult to get a number of advanced physics classes started quickly, it is recommended that fission graduate students without nuclear backgrounds take 22.05 as an introductory class, which would permit increased rigor in 22.211. It is also recommended that 22.211, a qualifying exam subject, be taught by a permanent faculty member rather than a visiting scholar so that course content is more stable.

Degree Requirements

- Undergraduates generally feel their requirements for graduation are too rigid to let them explore topics that interest them. Frequent cancellation of classes and changing of requirements makes registration confusing. Since many classes are offered in spring only, students have trouble scheduling classes to meet graduation requirements.
• Most graduate students feel that the requirements for the SM degree are very low. The degree requires only 66 credits, with very loose guidelines on the type or difficulty of coursework. Combined with the lack of thesis defense, there appears to be almost no quality control on SM graduates. The program has been referred to as a “degree factory”.
• While students are confident that most PhD graduates earn their degrees for quality work, there have been incidents (<10% of graduates) raised of students being “pushed through” the program due to advisor departure, project deadline, or technical difficulty with experimental work. The feeling among many students is that there is no sufficient check on quality of work after students complete the qualifying exam.
• Students have become increasingly frustrated with awarding of PhDs for low-quality thesis work, and with the dilution of the value of their degrees by these isolated incidents.

**Recommendations:** The requirements for undergraduate graduation need to be clearly defined. The issues with class availability could be rectified by adding more flexibility to the curriculum, something the undergraduates also want. Standards for the SM degree should be higher and include a thesis defense. Stricter quality control needs to be maintained for PhDs so that students are not awarded unmeritorious doctorates.

**Graduate Diagnostic Exam**
• Quality of the diagnostic exam gets mixed reviews: some think it is an appropriate test for incoming students, others think the objective is questionable.
• Physics seems to test memorization of formulae rather than understanding of concepts.
• Math subjects seem appropriate, but remedial class (18.085) does not address needed topics.
• No feedback given upon failure.
• While not a diagnostic exam in name, an oral English competency exam should be given, followed by possible remediation.

**Recommendations:** Keep the exam, but supply equations for physics. Recommend more suitable remedial classes such as 18.03 or 18.06 depending on specific problem areas highlighted by the math diagnostic.

**Doctoral Qualifying Exam**
• Quality varies with specialty. For example, the fission exam was extremely general this year, but fusion and NST were very narrowly focused.
• Students had difficulty preparing as they were unfamiliar with changing content of core classes.
• The oral exam question was well received except in fusion, where the question tends to be extremely narrow and a poor test of analytical skill.
• It is very difficult to obtain meaningful feedback after failure.
• Quals tend to test textbook knowledge rather than potential as a researcher. Revised question formats have been proposed by students, including written paper review and integral questions for written exams.
• Many fission students think 22.106 should be replaceable with 22.70 as a quals topic
• The entire process takes too long and could be more efficiently condensed into 2-3 days rather than 2-3 weeks. This is already standard practice in course II and other departments.

**Recommendations:** The qualifying exam should be structured so as to test reasoning skills in addition to knowledge gained from coursework. Preparatory information should be made accessible, and feedback should be more readily available after the exam. Increase the relevance of the exam by allowing one section to be a choice of two topics, for example allow fission students to choose between 22.106 and 22.70 based on their respective research area.
Faculty-Student Interaction
- Undergraduates were generally very satisfied with the approachability and availability of faculty.
- Graduates however hold a very different view - they receive the impression that they are the lowest priority to an apathetic faculty and find an unwillingness to accept criticism.
- Most students desire a strong personal and professional relationship with the faculty.
- Graduate students feel that faculty interaction should foster cohesion with future peers through proper mentoring.
- Town Hall Meetings are an excellent forum; however, students must know that proper action will be taken to address their concerns.
- Another anonymous method of suggestion should exist in addition to Town Hall Meetings.
Recommendations: Increase social and intellectual engagements between faculty and students to foster an environment conducive to constructive mentoring, interaction, and openness.

Research Advising
- Most students are very satisfied with their advisors and management styles. They meet with them between 2 and 3 hours per week, and are happy that the department is well funded, and that they receive excellent compensation for their work. Most students feel that they receive appropriate guidance but not feedback.
- A small portion of students surveyed felt either micromanaged or neglected by their advisors.
- Consistently students felt that long group meetings involving dissimilar projects were not helpful to research. Furthermore, preparing Power Point presentations weekly for these meetings was not conducive to research success.
- Some students felt that they were obligated to join a research group prior to arrival at MIT based on letters sent during admissions.
- Extra-research commitment tasking and negative defining of objectives by advisors hampers student efficiency.
- A small number of students felt that their research advisor humiliated them in one form or another and could benefit from intradepartment third-party mediation.
- A few students are employed as graders for classes taught by their research advisors. These students have frequently been pressured to perform duties above and beyond those of a grader, including setup and breakdown of AV equipment for lecture, maintenance of the course website, maintenance of lecture materials and drafting of solutions to problem sets. The time devoted to these responsibilities detracts from research, but the students in question feel obligated to take on these extra tasks due to the advisor-advisee relationship.
Recommendation: While a standard management style is not something that would be appropriate, it could benefit the department to provide management coaching to faculty in need or groups with inexperienced PI’s.

Academic Advising:
- Undergraduates and fission and fusion graduate students complained of poor academic advising.
- Further complaints were that students felt pressured to take certain classes taught by the advisor and that the advising came with a great deal of bias.
- Students felt that the best advice came from senior classmates, not faculty.
Recommendations: Academic advising should neither be pro-forma nor a hostile process. It should be committed in a way that has the student’s best interest in mind. Shifting the burden of advising from a set academic advisor to the research advisor could be helpful.

Department Growth:
- Unanimously the students feel that more young and middle career faculty are needed.
- Concerns were expressed that hiring too many MIT graduates for faculty positions in our department led to a group-think mentality concerning academic and research ideas.

Recommendations: Continue to hire faculty at the rate we have seen in the last two years from diversified backgrounds. Adequately support and coach the recent young faculty to give the best possible chance at retention and tenure.

Conclusion
We feel that with proper guidance, fresh young and mid-career faculty hires, stylistic changes to curriculum, improvement of overall quality in our teaching, improvement in advising and subject content and quality assurance of our graduates that it is possible to maintain the hard earned reputation of our department. Furthermore, increasing positive student relationships with faculty on social, professional and intellectual levels will benefit our department and MIT as a whole far into the future.