Report of the Student Delegation to the 2007 Visiting Committee

Department of Nuclear Science and Engineering

MIT

October 17th 2007
Executive Summary

If the previous Visiting Committee report by the student delegation were to be distilled down to one message, it would be a need for significant growth. This was clearly reflected in both the Visiting Committee’s report and faculty response. Significant growth, however, has not been realized and does not appear forthcoming. It is evident that the Department of Nuclear Science and Engineering’s position as the preeminent program has been eroding even as indicated by US News and World Report rankings. The student delegation believes that the missing catalyst to achieving significant growth is **strong leadership** by our department. What follows in this summary describes how strong leadership will compel the department to grow and prosper.

In order to grow, the department will need additional resources. Therefore, leadership is needed to both creatively identify and aggressively pursue new funding sources. Right now we rely heavily upon the Department of Energy (which has the tendency to change their main direction every few years) for monetary resources. This practice of “putting all of our funding eggs in one basket” is problematic for obvious reasons; a better strategy is to diversify our sources. Therefore we suggest growing the department by increased involvement with the industrial sector. Synergies with industries such as reactor vendors and utilities can provide the necessary monetary resources to cover additional scholarships, fellowships and faculty. Additionally, this move would further increase student satisfaction (by having real projects which can be implemented) as well as increase public perception (MIT-NSE is solving the problems of today with innovative solutions). Since our technically trained people are a highly valued resource to industry, striking this sort of a partnership should not prove to be too difficult. Although the department’s 2004 strategic plan describes a decision to shift its intellectual identity base away from a predominant focus on industrial nuclear power to a base focused more upon research, scholarship and education in a broader sense, the delegation would like to encourage caution that we do not wander too far away from our roots which are based in industry. Thus the delegation is suggesting keeping the same intellectual identity base but growing the department in the industrial sector by encouraging management/professors to seek out additional partnership agreements which can be tied into the department and/or the MIT Energy Initiative. This push by leadership can be further enhanced by implementing a grassroots effort with our own alumni to identify and establish additional resources for the department.

In order to utilize these resources we will need both new faculty and additional students. Therefore, we must spend some time thinking about how we want to expand with new faculty and staff hires. More specifically we need a plan for how we can direct the areas to be filled and the number/type of candidates to solicit, such that the department survives as leader and is prepared to prosper. On the student side, one part of the strategic plan states that the department would like to ‘maintain approximately… 110 [graduate] students … and stabilize Department undergraduate enrollments at roughly 60 (20 sophomores per year).’ This maintenance/stabilization of student population strategy, while formerly appropriate, is no longer applicable to a field which is currently booming with opportunity. Thus in order to reflect this change in strategy, the word ‘stabilization’ should be replaced with ‘growth’ in the strategic plan.

Leadership is also needed to decide what the department’s future role should be in society. This mainly pertains to formulating a coherent vision statement for the department as well as articulating how the department can clearly become a leader in society and amongst peers. The mission statement features ‘the education of future leaders in the science and
engineering of nuclear and radiation systems’ as its first priority. While we the delegation wholeheartedly agree with this, we believe that in order to be a future leader, our graduates will need to have more in their tool bag than just excellence in technological innovation. Our graduates will have to know how to implement change in a wide variety of realms which affect the field (i.e. political, legal, etc) in order to truly be able to lead in the future. In other words our graduates should be able to say “I can deliver a fully integrated solution” rather than just say “I can deliver an innovative technological solution.” Therefore the mission statement should be modified to reflect this. We also highly encourage active participation by our leadership in the strategic plan development for the engineering school. Participation in this important discussion will undoubtedly bear fruit in the form of new innovative educational approaches and we applaud the current Dean of Engineering Subra Suresh for starting this critically needed conversation.

On the subject of educational innovation, we need leadership to develop a plan on how to revamp the undergraduate curriculum such that with an S.B. one is better prepared for a career in the nuclear industry of their choosing. The delegation thinks that additional flexibility needs to be integrated into the current undergraduate curriculum. The ability for undergraduates to pursue specific areas of interest is limited and this has led to some dissatisfaction from current undergraduates in all three areas. The delegation recognizes the importance of exposing the students to as many different areas of the field as possible in order to make well rounded leaders. However, it seems that we are currently trying to cover too much material and leaving not enough time for the students to pursue their individual educational interests. The delegation suggests that a joint faculty/student committee be formed to develop a mutually acceptable curriculum with a strong core component which features lists of approved elective courses. This task will be accomplished through a combination of reclassifying some of the current core classes as electives in addition to opening up some new elective options. This will allow each undergraduate to proactively custom tailor their educational experience in order to better position themselves to be future leaders in the area of their choosing.

Leadership from our department also needs to be demonstrated at both the Institute and national levels. The student delegation is very disappointed that there is no NSE faculty representation on the Executive Committee of the MIT Energy Initiative. If nuclear power is to be a top priority for the MITEI (as indicated in the executive summary of their report) then it seems irrational that no NSE faculty are represented on the executive board. The current leadership of the MITEI has historically demonstrated questionable support of nuclear energy and the student delegation feels that a NSE faculty presence on the Executive Committee would not only ensure accurate representation but would also provide a platform with which to communicate the innovations and benefits of nuclear energy to an international public which is becoming increasingly environmentally conscious. On the national level, our department failed to obtain any initial funding from the GNEP program. The faculty needs to have a finger on the pulse of what is going on within the federal government so that one professor (outside of the department) who says ‘MIT isn’t interested in GNEP’ when initially approached by the DOE does not completely shut us down for funding in that area. Our hesitation to jump on board and take an active role in steering this initiative cost us a significant opportunity. Finally, we encourage the department to study and provide informed guidance on all subjects of international importance to nuclear science and engineering.

While this executive summary may appear quite critical of NSE in particular and MIT in general; the delegation does not wish to leave the Visiting Committee with the impression that
students are completely unhappy. In fact, most students consider their educational experience in this department to be positive and excellent progress has been made in several of the areas discussed since the last visiting committee meeting. This progress, along with additional specific recommendations, is discussed in the remainder of the report. These suggestions reflect simply what the current NSE students feel could dramatically improve the future prospects for the department and allow us to maintain our position as the gold standard for nuclear science and engineering departments internationally.
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1 Introduction

A delegation of graduate and undergraduate students from the Nuclear Science and Engineering (NSE) Department was assembled to report to the 2007 Visiting Committee on issues of importance to the entire NSE student body. This delegation is comprised of 13 students representing most academic programs and research tracks available in the Department. The specific association of each delegation member is summarized in Table 1.

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<th>Graduates</th>
<th>Undergraduates</th>
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<tr>
<td><strong>Fission</strong></td>
<td>David Carpenter$^{1,2}$</td>
<td>Ryan Bergmann</td>
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<td>Tyler Ellis$^{1,2}$</td>
<td>Daniel Denis</td>
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<td>Craig Gerardi$^1$</td>
<td>Patrick Doyle</td>
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<td>Mike Short</td>
<td>Bronwyn Edwards$^1$</td>
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<td>Michael Stawicki$^1$</td>
<td>Kathreen Thome$^1$</td>
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<td>Bao Truong</td>
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<td><strong>Fusion</strong></td>
<td>Matt Reinke</td>
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<tr>
<td><strong>Nuclear Science and Technology (NST)</strong></td>
<td>Erik Johnson</td>
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1 American Nuclear Society (ANS) MIT student chapter officer
2 American Nuclear Society (ANS) MIT student chapter co-presidents

The executive summary presented high level issues concerning the need for strong leadership within the department so that we can grow and prosper. The remainder of this report contains more specific and smaller scope topics which pertain to undergraduate and/or graduate students. This section also discusses progress (or lack thereof) in each of these topical areas along with specific recommendations for the future.

2 Recommendations Pursuant to Undergraduate Academic Requirements

2.1 Improving the Bachelors Thesis

Our previous Visiting Committee report highlighted two problems students had with the undergraduate thesis: lack of clear and formal guidelines, and difficulty in finding an appropriate topic. We are told that the definition of what constitutes an appropriate thesis topic has been left purposefully broad and is at the discretion of the research advisor.

To help with finding topics, this year the undergraduate thesis tutorial class has arranged for presentations from multiple professors on their areas of research. Hopefully these short seminar presentations, which are advertised to the department, will be repeated in future years.
The most serious challenge now is ensuring a consistent level of quality in the S.B. theses. The department has expressed interest in discussing solutions with students, and we hope enthusiasm in addressing this issue grows as we try to make our undergraduate program larger and more successful.

2.2 Central Internship Database Development

In the last year, the department has become more aggressive in aggregating internship, scholarship, and job opportunities related to nuclear science and engineering. In cooperation with the MIT section of the American Nuclear Society, these opportunities are currently cataloged and available on the MIT ANS website, along with relevant contacts among the student body. New opportunities are also forwarded by email to graduate and undergraduate students as they are announced.

2.3 Improving Department Support of UROPs

The Undergraduate Research Opportunities Program (UROP) is a popular and important part of the undergraduate experience at MIT. In the past, a large fraction of students in the department participated in UROPs, and most that desired to were able to find projects in the department. However, there remains a difficulty in connecting students to the work they are most interested in. In part, this seems to be a failure in the clear communication of the scope and availability of projects.

In the past, different methods have been tried to disseminate UROP opportunities, and MIT does provide an online database where faculty may post their projects. Some faculty members have expressed the opinion that the students should solicit projects themselves, while many students have complained of an inability to find or gain the attention of relevant professors. The MIT ANS is considering how to use graduate students who were undergraduates in the department to serve as intermediaries in this process.

2.4 Undergraduate Tutoring

A program for tutoring on required undergraduate subjects in the department existed during the spring semester of 2006. Graduate students who were familiar with the undergraduate subjects were paid by the department to hold weekly sessions in the evenings to answer questions about class material and help on problem sets. This was used consistently by a few students and showed promise for growth, but was not reinstated the next year. There are efforts this semester to revive the program.
3 Recommendations Pursuant to Graduate Academic Requirements

3.1 22.101 Reorganization

The Department's introductory graduate course, 22.101, has appeared in the past two student delegation reports and has been discussed in department Town Hall meetings. The students appreciate how this course’s content and focus have stabilized, primarily due to the assignment of a consistent professor as lecturer for the past four years.

However, there is still a difference of opinion among the student body and faculty as to the relevance and the utility of the current 22.101 curriculum. Discussion had begun regarding revision of the curriculum to reflect the needs of today's nuclear engineering graduate students. Additionally, there has been some movement to formalize and compile the course materials to provide a better reference to supplement the course. We encourage these efforts; however, it is not clear what tangible progress has been made on either front.

We think the current priority of the department should be reviewing the course curriculum and deciding how it can be improved. As the first and only mandatory graduate course, it is critical that its deficiencies be addressed quickly.

3.2 Diagnostic Exam Remediation

The department has addressed some of the concerns about the diagnostic exams, which all new graduate students take upon entering the department. Remedial course work is required after poor performance on either the math or physics diagnostic, and in the past students have had choices of a few graduate or undergraduate courses.

Students found it difficult to find classes that would fit this remediation model and also address their specific deficiency. In response, the department has broadened the definition of remedial work to include good performance in core department classes or other classes agreed upon by the student and their academic advisor.

3.3 Better Communication of Qualifying Exam Logistics

The new format of the doctoral qualifying exams continues to be well received. Addressing comments in the last Visiting Committee report, the department did provide earlier notification to the students in 2006 (early November versus December) concerning the format, time, and place of the exam, which took place at the end of January and into the first week of February.
3.4 NST Seminar Format Change

For the past four semesters, the traditional NST doctoral seminars have been replaced with a once-a-term NST retreat. Rather than one or two students presenting a talk each week, each semester all NST students and faculty attend a one-day gathering where every student contributes a poster or a talk. Attendance and participation has improved substantially over the doctoral seminar format. In addition, by spending a full day of discussion rather than an hour or two per week, students find the exchange of ideas at the retreat to be deeper and more valuable to their education.

While most students still find it difficult to fully appreciate presentations from outside their area of expertise – owing to the very diverse research interests in NST – the change in format has been received extremely positively. We recommend the department consider replicating the retreat format in the fission and fusion tracks.

4 General Academic Recommendations

4.1 Specific Expansion Ideas for the Department

One key area in which to (re)develop the strength and diversity of the department is the application of radiological sciences to the diagnosis and treatment of disease. In the past, the department has had a significant investment in the biomedical applications of radiation. However, our strengths in this area have diminished significantly in recent years. Our department had previously enjoyed generous financial support in that field in the form of a training grant for the Radiological Sciences Joint Program (with HST); the NIH remains a potential funding resource that has not been fully utilized. Sadly, unlike many of our competitors (Wisconsin and Michigan, for example), we have also not developed research collaborations with the local teaching hospitals. Massachusetts General Hospital has active research programs in both imaging and therapy physics, and had recently approached the department to co-sponsor a course on advances in radiotherapy technology where they were willing to provide all the lectures and host the class; our department passed on this opportunity and the course was offered without our involvement. MGH has recently finished submitting another round of grant applications to the NIH; past grant awards have been in the tens of millions of dollars.

Proton therapy is another field which is about to enter an enormous growth phase. In addition to the fully operational accelerators at MGH, Loma Linda (CA), and MD Anderson (TX), accelerators are planned or under construction at U. Penn, Chicago, Washington University-St. Louis, and the Mayo Clinic. There is a huge shortage of personnel trained in their operation and overlooking this field both in terms of research and in terms of postgraduate careers for our students is a significant missed opportunity. An obvious area for development with immediate funding possibilities would be to create a research and training collaboration with MGH to prepare MIT graduates to take the lead in this growing field.
4.2 TAs and Grader Abuse

Being a small department, NSE is only allotted six Teaching Assistant (TA) appointments per year by MIT. This number is not sufficient for the department’s needs. There are seven undergraduate classes that require TAs as well as one graduate course, 22.101, that has benefited tremendously from having a TA.

In lieu of TAs, the department sometimes employs graders who are poorly compensated graduate or undergraduate students. At MIT, graders are supposed to be responsible only for grading exams, projects, and problem sets. They are not expected to answer student’s questions on course content, conduct recitations, hold office hours, write solutions, or lecture; these are supposed to be the responsibilities of a TA.

Because some students who are selected as graders understand the value of the services a TA provides, they often offer additional help to students in services such as office hours and review sessions. Often these additional tasks are implicitly requested by the faculty and acknowledged as necessary for the course. This situation is not fair to these graders, and it is not fair to the students in the underserved classes.

Ideally, the department would be given a sufficient number a TAs each year to cover its core undergraduate and selected graduate courses (such as the graduate track core classes). Alternatively, there should be additional compensation options for students that falls between the full support of a TA and the limited hourly compensation of a grader.

4.3 New Fission Experimentalist Needed

In the last Visiting Committee report, it was recommended that a new fission research scientist or engineer be hired to help create new experimental facilities. Since that time Dr. Tom McKrell, a research scientist specializing in materials and thermal hydraulics, has been hired and is working in a well-utilized fission thermal-hydraulics and nanofluids laboratory. We believe this has provided tremendous benefits to the students and their research in terms of his experience and immediate oversight.

His contributions have made it apparent that more research scientists and engineers are necessary. Current resources are being stretched thin by the expansion of undergraduate and graduate research and needs of new faculty. As the department continues to expand and strive for outstanding experimental work, additional staff is needed for the supervision of laboratories and mentoring of students.
4.4 **Better Academic Advising**

Undergraduate and graduate academic advising (separate from a student’s research advisor) continues to be a problem area. Advisors should be aware of what classes a student is required to take, what requirements they have yet to fulfill before graduation, and suggested course combinations for each semester.

This information should already be available to the department, and therefore should be synthesized and distributed to the academic advisors. Advisors should also be aware of the requirements for, and their advisees’ situation with regards to, items such as MIT HASS and CI requirements, the 5-year S.M. program, and the qualifying exam. The department needs to emphasize the importance of proactive advising to the faculty.

4.5 **Problems with the Facilities**

Some of the facilities NSE students work in are poorly maintained and do not provide a comfortable working environment. In particular, buildings NW12 and NW13 often experience leaks and inadequate climate control. In the past year, one student office in NW12 recorded a high temperate of 94°F, and a low of 36°F, and these are not records.

This issue has been raised in at least the past three student reports to the Visiting Committee and in multiple department Town Hall meetings. It is not apparent that any corrective action has been taken. It is very hard to conduct world-class research in facilities where such extremes exist.

Positively, the department has allocated some funding for the student-directed revitalization of lounge space in buildings 24 and NW12. These areas are places for students to interact, study, and relax, and we believe are an important part of a mature department.

4.6 **Reactor Utilization in Classes**

A concern in the past report was an under-utilization of the MITR-II for academic work in the department. This situation has improved in the undergraduate curriculum: there are ongoing upgrades to the neutron physics experiment at the reactor (utilized by both 22.09 and the physics department), discussions and tours of the reactor by the undergraduate reactor physics class, and two projects in the undergraduate design course involving the reactor. It is not apparent that there has been any effort to involve the reactor in graduate courses aside from the perennial 22.921 winter course.
4.7 Card Access to Department Buildings

Most of the buildings on the MIT campus, including fission and NST buildings, operate on a common access system that utilizes the MIT ID Card. This system allows students access to MIT buildings after-hours and to restricted buildings and labs in their respective departments. Unfortunately, the fusion and some parts of the fission track of NSE reside in the Plasma Science and Fusion Center (PSFC), which uses a different access system requiring a separate ID card that the PSFC administers.

Non-fusion students are not routinely provided with more than temporary access to the PSFC if their work requires it, and no procedure exists for non-fusion students to request access to the PSFC unless they have an office there. This has proven to be quite inconvenient for non-fusion students wishing to visit professors, staff, other students, and events in the PSFC and has hindered department unity. This issue has been raised with department leadership at NSE Town Hall Meetings on at least two occasions and no attempt to find a satisfactory solution has been made. All NSE students should routinely be given access to the general PSFC office spaces in buildings NW16, NW17, NW21, and NW22. In addition, the department should work to correct problems with the MIT card system and ensure that all students in the department have access to the NW12, NW13, and NW14 office spaces as well.

4.8 Town Hall Meetings

Town Hall meetings, where all department students, faculty, and staff are encouraged to meet and openly discuss problems, were introduced in the last year to mediocre success. Meetings were held over dinner in the late afternoon and were attended by the top members of faculty; however, few undergraduates have participated. Some of the concerns about the forum that have been discussed amongst students are a lack of guided discussion, lack of continuity in the discussions after meetings, lack of apparent action on discussion items, and worries about anonymity.

We believe that the intentions of the Town Hall format are good, and that it is worthwhile to have a loosely structured time when faculty, staff, and students can come together and discuss problems. After discussions with the faculty, a new process whereby students have a chance to discuss, set, and track agenda items will be introduced at the next meeting, set for early November.