Year 2-4 Project: Engineering and Applied Science Program Review
Fall 2006

1. Overview

As part of the Graduate School's Year 2-4 Project, the Faculty of Engineering reviewed its graduate program this past fall. This review was overseen by a committee that included the Director of Graduate Studies (DGS, Eric Altman) and one faculty member from each of the five Engineering and Applied Science (ENAS) departments: Victor Henrich, Applied Physics; Mark Saltzman, Biomedical Engineering; Paul van Tassel, Chemical Engineering; Jung Han, Electrical Engineering; and Sandro Gomez, Mechanical Engineering. To identify areas of concern amongst the students as well as things the students believe we are doing correctly, each committee member met with graduate students from his or her department. This information was supplemented by the on-line reviews provided by the Graduate School. The committee then met to discuss how concerns that crossed department lines should be addressed. Based on these discussions, the committee formulated a set of proposals. The DGS then held meetings with graduate students from each of the five departments and then the ENAS faculty to receive feedback on the proposals. As a result of these discussions we are prepared to implement several changes to the program beginning in the 2007-8 academic year and to study further changes to the program. In the following sections, the positive points that came out of the student reviews as well as the concerns raised about the program will be described, followed by a discussion of our responses to these concerns.

2. Positive Points

One of the driving forces for the Year 2-4 Project was the sense that in many of the Graduate School programs, students languish in the transition from course work to dissertation research. Thus, we were asked to review how well first year research rotations and experiences prepare students for transitioning to research. In ENAS, students perform "special investigations" (SIs) in each of their first two semesters in which they work in a faculty member's lab and give a presentation to a faculty committee on their efforts at the end of the semester. The students may choose to do the SIs in the same lab or different labs in the two semesters. The students receive course credit and are graded on the SIs. By and large, the students viewed these experiences positively and felt that the transition from course work to more or less full time research at the end of the first year was seamless.

Another point of emphasis was how structuring teaching requirements could ease the burden on students starting their dissertation research. At present, there is no teaching requirement in ENAS; all teaching is optional and students receive additional compensation for any teaching they do. First year students who are enrolled in four courses per semester are not permitted to teach. Not surprisingly, the students like the current system. The only concern that was raised was that some of the students felt that teaching opportunities were a bit limited in certain fields.

In addition, we were asked to get feedback on the benefits and shortcomings of the current Honors, High Pass, Pass, Fail grading system in the graduate school. The students were not dissatisfied with the current system or standards (two Honors and a High Pass average). There was more concern about the wide variability in how it is applied, and the consensus was that this would be no different if it were changed to a more conventional grading system.

3. Areas of Concern

The students expressed widespread dissatisfaction with the graduate courses. The concerns ranged from the makeup of the required courses in some of the departments, to the specific material covered in these courses, to the quality of the teaching, and finally to the widespread variability in the difficulty, expectations, and grading for the courses. More minor issues such as guidelines for appropriate courses and maintaining lists of suggested courses for each of the departments were also raised. The selection of the required courses and the content of these courses are issues that are better left to the individual departments to address; in this review we will only address the latter concerns that cut across department lines.

The issue of wide variability in expectations for courses was also raised in regard to expectations for research and in mentoring. In general, many students felt that the dissertation committees largely devolve into simply signing forms and do not provide adequate guidance or act as a check on ensuring standards for mentoring and reasonable expectations for a Ph.D. degree.

Although the students generally liked the SIs, some of the students expressed concerns that apart from the research itself, they had to pick up many things on their own that are important to becoming a successful researcher. These included subjects such as how to formulate a research proposal or thesis prospectus, how to write their first journal article, effective ways to give presentations, etc. These subjects are now generally handled in an ad hoc way by individual thesis advisors, some of the students thought a more structured approach to learning these things would be helpful.

As part of this review, we were also asked to review standards for admission to candidacy. In ENAS, admission to candidacy requires submission of a thesis prospectus approved by the student's committee and passing an oral Area Exam that includes a presentation by the student on their progress to date and their research plans. The students get two chances to pass the Area Exam by March 15 of their third year. Historically, students who have been admitted to candidacy have had a high probability of completing the program, ~90%; thus, in this regard the current system has been working well. On the other hand, there has been a widespread feeling amongst the students that the Area Exam and Thesis Prospectus are unnecessarily stressful because there have not been any well-defined ground rules for the exam that they can refer to.

The students also expressed a strong desire to have a forum where they can present their research to their colleagues and faculty. Such graduate student seminar series have had a checkered history in ENAS. For years the Applied Physics department has had a Monday evening seminar series for graduate students that has generally been well-attended and thus successful. The last few years, the Chemical Engineering Department has had an annual one day graduate symposium that includes visitors and a keynote speaker from outside as well as a symposium dinner, all organized by the graduate students. This symposium was made possible by an alumni gift and has been very successful. On the other hand, an ENAS-wide graduate student seminar series was cancelled due to lack of interest and the other ENAS departments have not had regular student seminars.

An issue raised last year in the Engelman Report was the feedback students receive on their research performance. In response to the Report, we made several changes in ENAS starting in Fall 2006 and so the student feedback in this regard does not reflect these recent

changes. Nevertheless, it should be noted that the students found the feedback that they had been receiving largely rudimentary.

4. Proposals

4.1 Courses

Some of the issues raised can be dealt with in a straightforward manner. Regarding knowledge of suitable classes, each department is prepared to maintain a list of courses outside of ENAS that students should find appropriate and useful. Regarding guidelines on appropriate courses, some of this confusion also extends to the faculty. In recent years, several students have expanded their minimum coursework into classes offered by the Economics Department and the Schools of Management and Law. This spring, the faculty will consider changing the minimum course requirements in ENAS to insure that courses counted towards the minimum contain a clear technical, scientific, or mathematical component. This change will require a vote by the faculty.

Concerns regarding the wide variability in expectations, grading, and teaching are more difficult to address as these issues can intrude on an individual faculty member's academic freedom to teach and grade a course as they deem appropriate. Nevertheless, we are taking some first steps towards addressing the problem. This will start with course evaluations. Many of us on the committee have been at Yale for more than a decade and have never received evaluations for graduate courses. We note that the on-line evaluations for undergraduate courses became available for graduate courses as well in 2005. The DGS has e-mailed all ENAS graduate students with the link to the course evaluation webpage and encouraged the students to provide constructive feedback to their instructors. This will at least be a first step towards making individual faculty aware of potential issues and will hopefully prod them into taking corrective action. If the feedback continues to be negative, we will have no choice but to change teaching assignments.

In the interest of transparency and disclosure, we also intend to compile and release past grade distributions for instructors and courses. Because of the small enrollments in many of the classes, these will be summed going back several years. The objectives of this endeavor are two-fold: 1) to provide faculty knowledge about how classes are typically graded across ENAS that can hopefully lead to coalescence around a smaller distribution; and 2) provide students a better understanding of what grades they can expect and what the grade in a specific course means.

4.2 Mentoring

The faculty and students both feel that the student oversight committees have not taken an active enough role in advising the students and providing a check on students' progress towards the degree. Both also agree that mandatory annual meetings of the committee would benefit the students and the program. There was some disagreement over whether these meetings should be individual or as a committee of the whole. For the immediate future, it is proposed that the annual meetings be held with the entire committee. During these meetings the student should be asked to leave so that the committee can discuss the student's progress and outlook, and the principal advisor should be asked to leave so that the student may freely discuss potential issues regarding mentoring. The meetings should be held after the student has completed and distributed their annual dissertation progress report so that the committee

members are abreast of their progress and plans in advance of the meeting, and after the meeting can provide constructive comments on their plans.

As with other aspects of the ENAS program, the feedback we have received suggests that the quality of the mentoring the students receive varies widely depending on the individual faculty advisor. Unfortunately, we have not had a formal mechanism to evaluate mentoring and thus serious problems have tended to fester until students get so distressed that they complain to the DGS or the Associate Dean of the Graduate School, while less serious problems have likely gone undetected. A first step towards correcting these problems is to identify them. Therefore, we propose a confidential evaluation of thesis advisors and committees. In the interest of getting a high response rate, the evaluations will be forms that students can easily fill out in a few minutes that will cover areas such as how often they meet with their advisor, how valued their input is, whether they feel they can get help when they need it, etc. The feedback will be confidential to the DGS, the Dean of Engineering, and the appropriate department chair (unless the evaluation pertains to the chair). The objectives of the survey will be to identify and correct systemic problems, to increase accountability, and if serious problems persist with individual faculty, to avoid having them serve as principal advisors.

4.3 Student Research Evaluations

As noted in Section 3 students have found the feedback they have been receiving on their research performance rudimentary. Although students receive grades for the SIs, these have historically been graded very leniently and so the grade has not conveyed a true sense of the student's performance. This has created problems in recent years, and some these issues in ENAS were amongst the problems that spurred the Engelman Report. In response to the Engelman Report, we have instituted several changes in ENAS for 2006-2007. Starting this year, in addition to a grade in the SI the students will be receiving a written evaluation of their work that explains why they received a certain grade. These evaluations will provide the students a clear understanding of where they stand in terms of their future research prospects at the end of their first two semesters. For the last several years, we have also been sending students letters notifying them when they have passed milestones, such as meeting the Honors requirement, and keeping them abreast of upcoming milestones. Students who have not met the milestones are sent letters either reminding them of the requirements or warnings that if they don't meet the requirements they will need to leave the program depending on the severity of the case.

The above is aimed at first year students, and students in years three and above receive feedback on their dissertation progress reports; thus, leaving a hole for evaluation of second year students. To address this gap, starting this spring the principal advisors will provide feedback at the end of the fourth semester to second year students. The goal is to make students aware of potential issues they need to address in preparing for their Area Exams which take place the following fall. The evaluation will be a form similar to a dissertation reader's report where the principal advisor is asked to rate various aspects of the student's performance such as mastery of research techniques, knowledge of the field, ability to communicate effectively, etc.

4.4 Admission to Candidacy: Area Exam and Thesis Prospectus

Each ENAS department is committed to documenting well-defined ground rules for the Area Exam. In addition, we are developing a format for the Thesis Prospectus modeled on

research proposals to funding agencies. As such, it will include a rigid page limit and certain mandatory sections.

In addition to these proposals, the Biomedical Engineering Department is considering testing the idea of incorporating a directed reading component to the Area Exam. If this experiment is successful, the other ENAS departments will follow suit.

4.5 Graduate Student Seminars and Symposia

Starting in 2006-2007, ENAS began requiring each Ph.D. student to give at least one public seminar on their research at Yale, excluding Area Exams and Dissertation Defenses. Because of the success of the Applied Physics Monday Evening Seminar Series and the Chemical Engineering Graduate Student Symposium and the failure of the ENAS-wide effort in this area, it was decided that each department would decide how to best to meet this requirement. The student feedback we received on this issue is spurring the remaining departments to decide on how they would like structure this aspect of their programs.

4.6 Second Year Seminar Course

To improve students' preparation for graduate research and subsequent research careers, we are considering establishing a weekly seminar course for second year students that would focus on practical issues associated with research. These would include technical writing workshops (which we have already started with Steve Shoemaker's help), seminars on how to give effective technical presentations, seminars on how research is managed and proposals are developed, seminars on expectations for a successful thesis and research career, and finally provide help in formulating a thesis prospectus.