

**Ralph E. Martin Department of Chemical Engineering
University of Arkansas
Graduate (MSChE and PhD in Engineering) Program Review for 2015-2016
Submitted: May 2016**

Overview

In August 2015, the faculty approved a plan for regular assessment of the Ralph E. Martin Department of Engineering Graduate Program. The learning outcomes for the graduate program are to assure that each student has had an opportunity to:

1. Critically analyze meaningful and technologically relevant data, and for thesis students, plan and safely conduct research;
2. Demonstrate proficiency in fundamental mathematics and chemical engineering problem solving;
3. Understand professional and ethical responsibility; and
4. Develop and use effective written and oral communication skills.

These outcomes are currently being assessment as shown in Table 1.

Table 1: Assessment of Graduate Student Learning Outcomes

Learning Outcome	Assessment Tools
1. Critically analyze meaningful and technologically relevant data, and for thesis students, plan and safely conduct research	Student performance on: <ul style="list-style-type: none"> • the candidacy exam (consisting of the student's presentation of the research proposal to the graduate committee); • thesis/dissertation defense or comprehensive exam (for the MS non-thesis option only); • annual safety quizzes (average score)
2. Demonstrate proficiency in fundamental mathematics and chemical engineering problem solving	Student performance on: <ul style="list-style-type: none"> • the candidacy exam (consisting of the student's presentation of the research proposal to the graduate committee); • thesis/dissertation defense or comprehensive exam (for the MS non-thesis option only); • graduate coursework (through GPA)
3. Understand professional and ethical responsibility	Student responses on: <ul style="list-style-type: none"> • Graduate exit interview questions
4. Develop and use effective written and oral communication skills	Student performance on: <ul style="list-style-type: none"> • the candidacy exam (consisting of the student's presentation of the research proposal to the graduate committee); • thesis/dissertation defense or comprehensive exam (for the MS non-thesis option only) Student responses on: <ul style="list-style-type: none"> • Graduate exit interview questions

Assessment

In order to regularly assess and improve the program, the Graduate Studies committee met regularly (every other month) and the program and assessment data were discussed at the department faculty meetings. Outcome 1 was assessed by student performance on the candidacy exam/thesis defense (see Table 2) and through performance on annual safety quizzes. All of the students (MS or PhD, proposal or thesis) scored above the level of good (>2.0). For the safety quizzes, 95% of students passed (score = 90% or better) the exam on the first try, with all students passing on a subsequent try. Outcome 2 was assessed by student performance on the candidacy exam/thesis defense (see Table 2) and through performance on coursework (GPA). For candidacy exam / thesis defense, student at all levels scored above a good (>2.0). As of the Fall 2015 semester, the average cumulative GPA for all Chemical Engineering graduate students was 3.77 (on a 4.0 scale), well above the minimum required for graduation (3.0), and was deemed excellent.

Table 2: Student Performance on Candidacy Exams and the Thesis/Dissertation Defense

Outcome	Student Type	Proposal or Thesis	Number students	Average Score
Outcome 1. Student has shown the ability to critically analyze meaningful and technologically relevant data, and for thesis students, plan and safely conduct research.	MS	T	3	2.2
	PhD	P	1	2.5
	PhD	T	2	2.2
Outcome 2. Student has demonstrated proficiency in fundamental mathematics and chemical engineering problem solving.	MS	T	3	2.2
	PhD	P	1	2.5
	PhD	T	2	2.3
Outcome 4. Student has developed and used effective written and oral communication skills.	MS	T	3	2
	PhD	P	1	2
	PhD	T	2	2.3

Outcome 3 was assessed by student performance on an ethics and professional responsibility question on the senior exit interview. Two students graduated and completed the exit interview in the Fall 2015 semester, and two students graduated and completed the exit interview in the Spring 2016 semester. On average, the students answered that they felt their learning was just above “good” on the question (see Table 3). Outcome 4 was assessed by student performance on the candidacy exam/thesis defense (see Table 2) and through student feedback on the graduate student exit interview. For candidacy exam / thesis defense, student at all levels scored above a good (>2.0). For the graduate exit interview question (see Table 3), the students responded that they felt their learning was just above “good.”

Table 3: Summary of Graduate Exit Interview Assessment Questions

Outcome	Number of Students	Average*
Outcome 3. Developing an understanding of professional and ethical responsibility	4	0.13
Outcome 4. A demonstration of ability to develop and use effective written and oral communication skills	4	0.38

*1—excellent; 0—good; -1—fail

External Program Review

The programs in Chemical Engineering (MS CHEG, PhD CHEG) were reviewed on March 14-15, 2016, by Dr. Andrew Zidney, Distinguished Professor of Chemical Engineering at Pennsylvania State University, and Dr. M. Nazmul Karim, Professor and Department Head of Chemical Engineering at Texas A&M University. Dr. Andrew Dowdle, Professor and Vice Chair of Political Science at the University of Arkansas, served as the internal/external reviewer for the team. The review team noted that “the Chemical Engineering faculty are strongly committed to the success of the MS and PhD programs and are excited about the opportunities for improvement. The Self-Study was well-prepared, particularly given that this was the first significant assessment of the graduate programs in Chemical Engineering in more than a decade. The Department Head and Graduate Program Coordinator should both be commended for their efforts. The Department should view this effort as the beginning of a continuous improvement cycle, using the feedback in this Review and the input from the ongoing assessment to strengthen both the graduate program and the overall assessment process.” As such, no areas of concern were identified. Instead the Review Team prepared a “roadmap for continuous improvement” in the form of recommendations that the Department will faithfully use to expand and improve its graduate mission. The recommendations were as follows:

1. The Review Team strongly recommends that the Department identify a small group of appropriate peer institutions and perform an analysis of research productivity metrics, e.g., funding, publications, citations, number of PhD students, etc., to establish appropriate benchmarks.
2. The Review Team encourages the Department to consider developing plans for a Professional Development seminar that would ensure more uniformity, and better communication, of Departmental expectations while at the same time providing graduates with important exposure to topics in research ethics, plagiarism, intellectual property, publication policies, criteria for co-authorship, etc.
3. The Review Team encourages the Department to reconsider the requirements for an MS degree with thesis; most employers would expect all MS graduates to have an Advanced Thermodynamics course (which is currently only an elective).
4. The Review Team strongly recommends that the Department re-evaluate the course requirements for the PhD and move towards a much lower minimum course credit requirement.
5. The Review Team strongly recommends that the Department eliminate the Design course as a requirement for international PhD students.
6. The Review Team stated that the Department may wish to consider increasing the expectation for PhD students to prepare two or three publications prior to receiving the degree.
7. The Review Team recommends that the Department consider ways to engage more closely with alumni of the Graduate Program, including invitations for alumni to participate in a Professional Development Seminar that would ensure that all students receive a background in research ethics, publications and peer review, requirements of co-authorship, intellectual property issues, etc.

8. The Review Team strongly recommends that the Department hire two to four new faculty in the coming years, including the possibility of hiring a mid-career faculty member who would be able to rapidly establish a highly visible research program.
9. The Review Team recommends that:
 - a. the Department consider opportunities to cover first semester of graduate student support from Department/University funds,
 - b. the University (or Graduate School) look to provide direct support for Teaching Assistants to meet the needs of the undergraduate educational programs, and
 - c. that the Department/College examine opportunities to have a staff member fully focused on developing a strong on-line presence including a strong focus on content of interest to prospective graduate students (such a staff person might be shared with another department).
10. The Review Team recommends that a plan be developed with the College/University to ensure that there is appropriate research space to accommodate future faculty hires. In addition, the Department should carefully evaluate current access to on-line journals to ensure that the library is providing adequate support for key research areas.
11. The Review Team noted that the Department needs to develop plans to significantly expand the applicant pool for the PhD program in order to expand the size of the graduate program. These efforts should begin within the next 12 months, although they will likely require several years to fully develop. In particular, it is recommended that the Department identify and foster “pipeline” institutions (both domestic and international) from where high quality graduate students can be recruited. There is also a need to develop a stronger website and marketing materials specifically targeted to prospective graduate students. The Department may wish to consider providing financial support for faculty and graduate students to visit their undergraduate institutions for recruiting new graduate students. The Department should focus on identifying higher quality graduate students, particularly from international institutions.
12. The Review Team noted that the size of the faculty needs to be increased over the next several years in order to maintain and upgrade the quality of the graduate program. The current rapid growth in enrollment in the undergraduate program is placing significant burdens on the teaching resources; the addition of new faculty would alleviate many of these challenges. Recent changes in the university administration have led to a greater emphasis on research. As the university matures into and fully embraces its research-intensive status, it is likely that there will be an increasing demand placed on faculty scholarship and external funding. The program will probably need to strengthen its research portfolio to achieve these goals and to successfully recruit top caliber Ph.D. students. The program faculty will need to enhance the national and international visibility of the program, e.g., by taking leadership positions in major professional organizations and by widely disseminating their work. Faculty will need freedom from the day-to-day maintenance of their program to undertake these endeavors.
13. The Review Team recommends that the department create a standing assessment committee consisting primarily of tenure-track faculty (in addition to the Graduate Program Coordinator). This Committee should collect data on a regular basis from other constituencies such as alumni, graduate students, and employers. This Committee should

use this information to submit recommendations for program improvement to the department on a periodic basis as appropriate.

The Department Head prepared a formal response to these recommendations, which is in the process of being reviewed for comment by the Dean of Engineering, the Dean of the Graduate School and the Provost.

The recommendations were reviewed by the Department Graduate Committee, and several action items resulted which will be sent to the faculty for discussion and formal vote during its Fall 2016 Annual Department Retreat. Specifically, the committee recommended creating a core set of four Chemical Engineering classes that all graduate students (PhD, MS with thesis, MS without thesis) are required to take: Transport I, Transport II, Advanced Reactor Design and Advanced Thermodynamics. In addition, benchmarking data for the department in comparison with other departments in the region has been collected and are summarized in Table 4.

Table 4: Benchmarking Data for Ralph E. Martin Department of Chemical Engineering, as Compared to other Chemical Engineering Departments in the Region

Benchmarking Data	UA CHEG	SE Region CHEG
# faculty	12	14
teaching load per semester	1.5	1.5
publications per faculty	2.5	3.7
expenditures per faculty	156,000	301,002
PhD students (2015)	25	43
MS students (2015)	12	17
Total grad students	37	60
PhD per faculty	2	3
MS per faculty	1	1
PhD graduates (2015)	6	6
MS graduates (2015)	6	9
MS stipend	12,000	17,709
PhD stipend	20,000	23,701

As the benchmarking data show, the department is comparable to others in the region in terms of teaching load, PhD graduates and MS students per faculty. The department is smaller (by two faculty members) than the average department in the region. The department also has a lower productivity in terms of publications per faculty, expenditures per faculty, PhD students per faculty and MS students per faculty. In addition, the benchmarking data also point out that the stipends in the department for both MS and PhD students are lower than average for the region. This correlated well with many of the suggestions from the external reviewers and will be part of the upcoming improvement process.