GRADUATE SCHOOL PROGRAM REVIEW  
DEPARTMENT OF CHEMICAL ENGINEERING  

March 21, 2008

REVIEW COMMITTEE:

CHAIR: Dominick J. Casadonte, Jr. Minnie Stevens Piper Professor and Chair, Chemistry and Biochemistry, TTU
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Vittal S. Rao, AT&T Distinguished Professor and Chair, Electrical and Computer Engineering, TTU  
OUTSIDE EVALUATOR: Jerry Y.S. Lin, Professor and Chair, Department. of Chemical Engineering, Arizona State University

OVERALL PROGRAM ASSESSMENT: Good  

Program Overview and Vision: Excellent

The Department of Chemical Engineering offers two post-Baccalaureate degree options: 1) the Master of Science degree in Chemical Engineering, which requires 30 hours, six of which are the Master of Science thesis, and 2) a Ph.D. in Chemical Engineering, which requires a minimum of 60 hours of coursework, including research, and twelve hours of dissertation.

The mission statement and vision for the Department of Chemical Engineering are well articulated in the supporting documentation and ambitious. The Department's mission is to "develop chemical engineering knowledge through research and disseminate knowledge through quality education for graduate and undergraduate students". The vision of the Department with regard to graduate studies, as articulated by the Department Chair, Dr. Nazmul Karim, is to become a top-fifty department at the national level. The Department currently has twelve faculty members and has expectations that the number of faculty will rise to fifteen within the next few years. While this number is comparable to those of the peer institutions indicated in the documentation, it is below the level of the top fifty institutions in Chemical Engineering. There are approximately 45 graduate students enrolled, with 36 at the Ph.D. level and nine seeking the Master of Science degree. External research funding has increased by 185% in the past three years, from $995,000 to $1.84M, with the total funding to the Department being $2.3M. The Department has a stated goal of increasing the number of graduate students in the Ph.D. program to 60 and the number of faculty to fifteen, yielding a student:faculty ratio of 4:1. There is little current interest in increasing the numbers of Master's students.
The largest single impediment to the achievement of the vision of the department according to the Chair, faculty, and graduate students alike is the lack of funding for graduate students during the first year of the program. The Department is not competitive in terms of the levels of funding for first-year students ($1750/mo vs $2200 - $2500/mo at top-tier schools). Only 5-6 T.A. positions are available for graduate students (about 15% of the total number of students). Graduate students are also saddled with $3,500 in fees ($5,000 in the first year). Faculty are not inclined to pay first-year students, as they are not typically research productive, with the majority of their time being spent taking the five core courses. The ability of the Department to continue to exhibit and promote the high standards they have set for themselves is becoming increasingly compromised by their inability to compete for quality international and especially domestic students. Clearly, if the Department is to follow their vision, additional human resources are needed. The Department has indicated that a modest increase in funding ($50 - 100K/year) would allow them to "top off" the current graduate assistantship to make them more competitive. This will also help alleviate some of the issues concerning the high fee base. Besides funding for graduate students, the start-up packages for faculty need to be increased to a competitive level (~ $0.5 - 1M) if the Department is going to continue to attract top-quality faculty as they have in the past. The Department estimates that it needs an endowment of $5M to accomplish its goals, and this number is in concert with the fundraising mission of the Dean of the College of Engineering. The committee has noted that in comparison with the review of six years ago, the Department has made significant improvements to their programs and has been a good steward of the resources provided.

**Faculty Productivity:** Excellent

The Department has a mixture of six Professors, three Associate Professors, and four Assistant Professors (one of the Assistant Professors will start in 2009). With regard to hiring, it is suggested by the external reviewer that the new hires focus on younger faculty (Assistant and Associate levels) in order to improve the distribution at various ranks.

The faculty members in the Department of Chemical Engineering are very productive, and are the most significant asset of the department. Four of the young faculty members have NSF CAREER awards, and several of the senior faculty members are editors of high impact factor journals and Fellows in prestigious societies within the discipline. The number of publications by the faculty in peer-reviewed journals has increased by a factor of three in the past five years to 52 in 2006, and the total number of citations has increased by a factor of five. The citation per faculty level is comparable to top fifty engineering schools. It is significant to note that these numbers have increased so dramatically with a total faculty number that has remained roughly constant between 12-14. The typical graduation rate for students is on the order of four per year. The faculty members publish approximately four papers per year and supervise four students per year, with an average expenditure per student of about $40 - 50K. These numbers compare favorably with top fifty institutions in chemical engineering. This is, on the whole, a very productive faculty. They have significantly increased their research productivity since the last review. The teaching loads for the faculty and SCH generated appear to be comparable to peer institutions, although it has been suggested that the current teaching loads cannot be maintained without the introduction of new faculty.
In order to move the Department in the direction of their shared vision, the faculty will require additional resources. It is suggested that efforts be made to pursue money for endowed chair positions. Start up packages are substandard relative to peer institutions, and every effort should be made to make the set up money not only more flexible, but also allow it to roll over into successive years.

**Quality and Quantity of Graduate Students and Graduates:**

The Department of Chemical Engineering currently has 45 graduate students, with 36 in the Ph.D. track and 9 in the Master of Science degree program. The Department typically has 60-85 applicants, and a 30-50% admission rate, with approximately 30% of those students accepting. The department graduate student population is primarily composed of international students (approximately 90% of the graduate students are not from the U.S.). These students have impressive entering statistics, with GRE scores comparable, if not better than, those of the entering class at M.I.T. The lack of domestic students is troubling, but is not atypical. Universities have trouble attracting domestic engineering students for graduate school, owing to the lucrative salaries enjoyed with a B.S. degree. Many factors play a role in the selection of graduate schools, including national ranking, stipend levels, placement of graduates, etc. As previously indicated, there are several factors that mitigate the potential for Chemical Engineering graduate students to attend Texas Tech. The Department is not competitive in terms of the levels of funding for first-year students ($1750/mo vs $2200 - $2500/mo at top-tier schools). Only 5-6 T.A. positions are available for graduate students (about 15% of the total number of students). Graduate students are also saddled with $3,500 in fees ($5,000 in the first year). If $50-75K in annual funds were available, this would reduce the fee burden for incoming students.

The quality of the graduate student population is also indicated by the research productivity enjoyed by the department. Graduation rates are consistent with peer institutions. The external reviewer has indicated although faculty members are publishing at a high rate, the majority of the work is being conducted by faculty members and postdoctoral research associates rather than graduate students. The incorporation of additional graduate students in the research culture is a potential area for improvement. All of the graduate students found meaningful employment after graduation, mostly in industry or as postdocs. The lack of students going on to academic positions is noted. In discussions with the graduate students, there was an indication by some of them that they would be interested in faculty positions, but that they feel under-prepared with regard to pedagogy to be able to be competitive.

Demographically, the number of female graduate students is at the approximate national average (21%). However, the number of African-American and Hispanic graduate students is quite small. The Department has been very successful, especially in the past three years, in developing "feeder" schools for graduate students in India and China. Discussion concerning the establishment of analogously targeted feeder schools for domestic applicants is worth pursuing.
Curriculum and Program of Study:  

Students in the Ph.D. program are required to take a minimum of 60 hours of coursework, including research, and twelve hours of dissertation. Students who follow a Master of Science track are required to take 30 hours, six of which are the Master of Science thesis. There are five required course in the Department for graduate students, which span the traditional sub-disciplines and areas of study. The elective courses for each student are determined by their research needs, and are determined though discussion with their research advisor. The students indicated that they would prefer more aggressive advising, especially in the area of taking required classes earlier in their matriculation in order to allow them to begin research at an earlier stage. The students also indicated that, while the variety of classes offered within the department is adequate, they would like the opportunity (and knowledge of opportunities) to take classes in other departments that might be more germane to their research specializations. There was a consensus opinion that a technical communication class would be a welcome addition to the curriculum.

Other points that were suggested during discussions with faculty and graduate students that are worth noting. One included collapsing two of the required graduate classes into a single math-based course in order to reduce the required number of courses from five to four. Another suggestion made was that the policies and procedures for the BS/MS degree be clarified and that the department might also consider a non-thesis option for that degree. With the salaries that are available with a B.S. degree, a Master's degree is no longer as attractive as it once was, but the five-year Master's program would give students the potential for a higher salary with relatively little loss in pay. It was also felt by the students that promoting the combined degree program and clarifying policies and procedures might lead to more domestic graduate students who are currently pursuing the B.S. degree at Tech.

Facilities and Resources:  Satisfactory -

It was pointed out during discussion and in the document provided that the department currently occupies about 61% of the space needed for the level of research that is carried out in the Department. Once the current renovation project is completed, the department will pick up about 2,500 square feet of space. Even with this renovation, the department will still be 25% short of the space suggested according to Coordinating Board guidelines. The Chemical Engineering building is one of the oldest on campus, and lacks proper ventilation. If the department has not put the ventilation reconstruction on a HEAF-CIP request, it is suggested that they do so.

The ancillary facilities appear to be, on the whole, adequate to the needs of the faculty and students. Although electronic literature access is available, access to specialized journals in chemical engineering is hit-or-miss. The user facilities in the ESB, in the Maddox Lab, and in Chemistry and Biology provide resources for instrumentation that are not available in the Department. Discussion of other needed instrumentation was mostly at the individual investigator level.
The level of support staff in the department, both with regard to administrative staff and technical support staff, is woefully inadequate for a department operating at the research level of the Department of Chemical Engineering. An increase in staff budget will almost certainly help to improve productivity at all levels.

Summary

The Department of Chemical Engineering at Texas Tech has made substantial gains in the past five years in terms of research productivity, and is now one of the most productive departments in terms of research productivity per faculty member. The graduate program has been the beneficiary of this productivity.

The Department has a stated vision of becoming a top fifty Department of Chemical Engineering. To accomplish these goals, additional resources are necessary. In order of increasing cost, these include:

1) Clarification of the policies and procedures of the B.S./M.S. program and thinking about the possible development of a non-thesis Master of Science option.

2) Additional money to support graduate stipends and fees ($50-100K each year)

3) Larger start up packages and greater flexibility in the packages ($0.5 – 1M per year)

4) The development of Chemical Engineering-specific endowed chairs ($2-6M)

5) Repair of infrastructure ($5-10M)

The Department of Chemical Engineering at Texas Tech is poised to move to the next level with regard to its graduate program. As with many programs on campus, this will not be accomplished without a resource base. Although there are some things that can be done to the program gratis to improve some of its internal workings (and these are detailed in other parts of this report), improving the number and quality of graduate students will not come without a price tag. The problem of improving the level of graduate student is not uncoupled to having adequate resources, both with regard to infrastructure and start up, to allow for a productive faculty to become even more productive and to hire new faculty members who will help propel the Department of Chemical Engineering into top fifty status.