

## **Review on Graduate Program of Mechanical Engineering, Texas Tech University**

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### **Program Overview and Vision: (Rating -- Satisfactory)**

“The mission of the Department of Mechanical Engineering at Texas Tech University is to educate, conduct research, and disseminate knowledge through **nationally recognized academic program. The vision is to be recognized as a top research and graduate mechanical engineering department in the nation** and the undergraduate mechanical engineering department of choice in Texas.”

The department currently has 23 faculty (11 Professors, 5 Associate Professors, 7 Assistant Professors), with 45 PhD and 86 MS students. The annual research expenditure for the department is about \$1.2M and the annual research grant per faculty is about \$60K.

**Faculty:** The current faculty size and the distribution in ranks is about right for the national average for the top 100 mechanical engineering departments provided that all the faculty are engaged in active research. Since the completion of the self study, the department has lost one senior faculty member (Dr. Levitas) and has hired two new assistant professors (Drs. Hui and Yang). The department has plans to recruit more faculty.

**Graduate Students:** The graduate students per faculty ratio is about right assuming that all the faculty do their fair share of mentoring MS and PhD students. However, in comparison to the top 100 mechanical engineering departments, the number of MS students should be reduced and the number of PhD students should be increased to about 60 to 65. The department plans to increase the number of PhD students in the near future.

**Research Expenditure:** The annual research expenditure for the department and the annual research grant per faculty is very low in comparison to the top 100 mechanical engineering departments. The department should aim at about \$210K annual research grant per faculty and an annual research expenditure of about \$5M.

### **Faculty and Student Survey Results:**

The number of faculty and students who participated in the “Graduate Program Reviews 2008-2009” conducted for the Mechanical Engineering Department by the Institutional Research Services was very low. Only 35% of the faculty (8 out of 23) and 18% of the graduate students (23 out of 131), responded to the survey. This is a very useful tool for the faculty and the department chair provided there is more participation from the faculty and students. During our interviews with the department chair, graduate program director, faculty, and students it became apparent that no one was made aware of such a survey and its importance was not emphasized to the parties involved.

It is recommended that for the future surveys the department chair, graduate program director, faculty and the students receive advance notice from the Institutional Research Services. In addition, it is recommended that the department chair should emphasize the importance of such a survey and encourage all the parties to participate.

### **Program Self-Study Report:**

- Some of the information provided in the tables and/or graphs in the self-study were either incorrect or misleading. Most of these will be addressed in the assessment of the different areas of the program.
- The criteria used for choosing peer institutions should be given. It was not made clear in the report how and why the particular peer institutions were chosen for comparison with the ME-TTU program.
- The web address given on page 61 for the Strategic Plan did not work. It is recommended to include a copy of the strategic plan in the report along with the department chair’s assessment report on the accomplishments made towards the goals set forth in the strategic plan.
- The resumes provided on pages 70-222 of the report are uniform in format, but there were some deviations in the individual resumes that did not help the review process. For example: (a) peer-reviewed journal publications should be separated from the conference papers and (b) grants and proposals should be listed separately.
- In the faculty interviews it was noted that the faculty is clearly not interested in this review process to improve the department’s graduate program. They were more focused on their own individual interests.

### **Faculty Productivity: (Rating -- Good)**

**Publications:** In general the graduate faculty should be commended for their publication record and their publications with their graduate students. As shown in Table III-3 of the self-study (p.18) the publications and creative activities of the full-time faculty have increased sharply over the last three years (2005-2007). However, what is missing from this table is the number of journal articles, refereed conference proceedings papers, and conference papers (refereed by abstract only). In addition, how many of these publications were co-authored with the current or past MS and PhD graduate students (some of this information appears in Table IV-12 but is incomplete). This type of detailed information would be very beneficial in accessing the quality of the publications and the productivity of the graduate students being mentored by the graduate faculty. Starting the academic year 2006-2007 the department requires that PhD students must publish a refereed journal article before graduation. The department should be commended for instituting this policy.

**PhD Degrees Awarded:** According to Figure II-1 of the self-study (p.5), the number of PhD degrees awarded from 2002- 2007 has been around 2 to 3 students. This is very low in comparison to the number of PhD students in the program during that period.

**PhD & MS Student Advisement:** From the faculty CV's and the information provided in the self-study (Table III-4, p. 19), it appears that there is an uneven distribution among the graduate faculty who are advising MS and PhD students and participating in their graduate committees. For example, 4 faculty members directed the work of 37 of the 73 MS students and 7 faculty members served on the MS committee of 72 of the 101 MS students. There are several faculty members that do not have any MS and/or PhD students as their advisee. A more even distribution of these responsibilities amongst the graduate faculty is recommended.

**Dissertation and Thesis Titles:** Pages 41-50 of the self-study list the titles of the PhD dissertations, MS Thesis, and MS reports completed by the graduate students in the department over the past six years. It is recommended to include next to each title the name of the advisor who advised the student to the completion of his/her work. Again, this information would help in assessing the productivity of the graduate faculty in advising MS and PhD students in completing their research work.

**Proposals and Grants:** The information provided in Table V-2 of self-study (p.52) appears to be incorrect and inclusive. The numbers in the table do not add up and no information is given as to how many proposals were submitted by the faculty to the different funding agencies during the review period. Again, it is difficult to assess the productivity of the faculty on the number of proposals submitted and number of grants received during the review period.

**External Research Expenditure:** The information provided in Table V-3 of the self-study (p.53) shows that the annual research expenditure is around \$1.2M which translates to about \$60K annual research grant per faculty. The annual research expenditure for the

department and the annual research grant per faculty is very low in comparison to the top 100 mechanical engineering departments. The department should aim at about \$210K annual research grant per faculty and an annual research expenditure of about \$5M.

**Faculty Workload:** The mechanical engineering department chair has recently developed a workload policy for the faculty that appears to be very reasonable. This new policy reduces the teaching load of the research faculty and would give them the badly needed release time to focus on their research and proposal writing. The department chair should be commended for developing such a policy. The new workload policy should assist the department toward achieving their mission of becoming a research oriented mechanical engineering department ranked among the top 100. It is also recommended that the chair incorporate in the workload policy some release time from teaching for the tenured faculty that have been successful researchers in past but their area of research is no longer a “hot area”. These faculty should be encouraged by the chair to re-tool and direct their talent in new emerging research areas. This in the long run should help the research mission of the department.

#### **Quality and Quantity of Graduate Students and Graduates: (Rating -- Satisfactory)**

**Quantity of Graduate Students:** The number of graduate students (131) seems appropriate given the size of the faculty (23). This is roughly about 6 students per faculty provided that majority of the graduate faculty actively participate in advising both MS and PhD students.

**Quality of New Students:** The GRE scores (quantitative and verbal) of the enrolled students listed in Figure IV-4 of the self-study (p.26) appear to be reasonable. However, to improve the quality of the incoming students, it is recommended that in the future the department only admit students with scores of 750 or higher in the quantitative section. No information was provided on the TOEFL scores of the incoming international students that makeup the majority of the graduate student population. The GPA of the new students given in Figure IV-5 of the self-study (p.27) appears to be extremely high and do not seem to be correct. A further examination of these scores is warranted.

**Demographics of Enrolled Students:** The majority of graduate students in the program are international students. The domestic graduate students are primarily Texas Tech University graduates and make up a small fraction of the graduate student population. For example according to Figure IV-3 of self-study (p.23), in 2007 only 10% of graduate students were from state of Texas. The female graduate students in the program are steadily increasing and in 2007 it was about 14%. This is close to the 15% target declared in the strategic plan. The program should be commended for almost meeting their targeted percentage. However, the percentage of the minority students (blacks and Hispanics) is still below the departmental target in the strategic plan. A more concerted effort by the department to increase diversity is recommended.

**Degrees Awarded:** According to Figure II-1 of self-study (p.5), the department on the average graduates about 17 MS students and 2 PhD students per year. The number of MS graduates is reasonable. However, as discussed before, the number of PhD graduates is low. The average time to degree in recent years (see Figure IV-6, p.28 of self-study) is about 2 and 4.5 years respectively for MS and PhD. This is consistent with most research active mechanical engineering departments in the country.

**Placement of Graduates:** Most of the department's MS graduates were employed by the industry in the state of Texas. A small percentage of the MS students stay on at TTU to pursue their PhD and very few are admitted to PhD programs at other universities. It is suggested that some of the outstanding BS and MS students be encouraged to apply to highly ranked schools. In the long run this would improve the image of the program and benefit the reputation of the ME department at TTU. According to Table IV-7 (p.30 of the self-study), from the 19 PhD graduates for the period 2002-2008, 9 graduates (about 47%) have been placed as faculty in academia across the world. This is a healthy percentage and is consistent with most research active mechanical engineering departments in the country. Placing PhD graduates in academia should be an ongoing goal for the department in order to improve its ranking.

**Graduate Student Publications:** Table IV-12 (p.38 of self-study), makes an attempt to list the publications co-authored by the graduate students. The table is incomplete and only lists the "Refereed" publications by the MS and PhD students. It is not clear from the table how many of these publications are journal publications. However, what is evident from the table is an increase in the graduate student publications over the last few years. This trend should help with the department's strategic plan to improve the quality of the graduate students in the department.

**Graduate Student Financial Support:** The department provides a stipend of \$18,000 per year for PhD students and \$16,000 per year for MS students. However, each student should pay for fees and health insurance costs that would reduce their yearly pay on the average by about \$4000. This is far below the national average of the incoming mechanical engineering students of about \$24,000/year for PhD students (\$22,000/year for MS students). The relatively low stipend is a major hurdle in attracting good quality graduate students. In order to attract quality graduate students, the department will need to work with the university to find resources and mechanisms to increase the stipend levels for PhD and MS students.

### **Curriculum and Program of Study: (Rating -- Satisfactory)**

The comments provided in this section are aimed at making the ME-TTU graduate program compatible with similar programs in peer institutions. The ME-TTU program as it stands is not compatible with similar programs in peer institutions.

**Graduate Study Manual:** In our interview with the graduate students it was noticed that the graduate students are not fully aware of all the details of the requirements for obtaining their graduate degree. There is an urgent need for a Graduate Study Manual that provides detail information about the mechanical engineering graduate programs. The manual should include such information as: Admission Procedures, ME Graduate Faculty, Master's Degree (Progress Sequence and Requirements), Doctoral Degree (Progress Sequence and Requirements), Graduate Plan of Study (General Requirements), Financial Assistance, Online Resources (TTU, ME, Graduate College, Library, ...), Graduate Course Offerings (Fall, Spring and Summer Semesters), Mathematics Requirements (Mathematics courses approved for the graduate students to take) and Course Descriptions (A short description of all the graduate courses offered by the department and their pre-requisites). The Graduate Study Manual should be handed out to all the incoming new graduate students and a pdf copy of it should be placed on the department's web page.

**MS Degree Options:** In order to help with the research mission of the department, it is recommended that the department should focus on only the "thesis option" of the master's degree and either eliminate or considerably reduce the enrollment of the students in the other two options in the master's program (nonthesis report and nonthesis coursework only options). These two options do not help with the research mission of the department and it is a drain on the departmental resources. According to the statistics provided in the self-study, close to 45% of the current students are in these two "non-research" oriented options. This is very unhealthy for the research mission of the department.

**MS Degree Requirements:** Currently the "thesis option" MS students are required to take 9 credit hours of their 24 required course work hours in one of the four areas of specialization offered by the department. To help with the research mission of the department and improve the quality of the specialized MS graduates, it is recommended that the MS students be required to take 12 credit hours (4 courses) in their area of specialization. It is also recommended that the department should provide a recommended list of mathematics courses for the MS students to take in order to fulfill their mathematics requirements. The list should contain those mathematics courses that are generally useful to engineering graduate students to help them with their graduate courses and research. An additional recommendation for the improvement of the quality of the MS graduates and fulfillment of the research mission of the department is to require all "thesis option" MS students to publish at least one conference paper based on their thesis. The MS students should also be strongly encouraged to present their paper at a national/international conference. The department should provide travel funds to the students if these funds are not available through the advisor. Again, this type of activity

provides the needed research exposure for the department and would help in recruiting students outside of the state of Texas.

**PhD Degree Requirements:** It is recommended that the department not accept PhD students into the program without a MS degree through the thesis option in Mechanical Engineering or a very closely related field. The students without an MS degree typically do not have the research maturity and the academic background to immediately make an impact to the department's ongoing research and at times the learning curve is steep and most often they bail out of the program and end up getting a master's degree. This may be an accepted practice for some "research-mature" programs but ME-TTU is not at that stage yet. To help with the research mission of the department and improve the quality of the specialized PhD graduates, it is recommended that the PhD students be required to take 12 credit hours (4 courses) in their area of specialization. It is also recommended that the department should provide a recommended list of mathematics courses for the PhD students to take in order to fulfill their mathematics requirements. The list should contain those mathematics courses that are generally useful to engineering graduate students to help them with their graduate courses and research. This list could be the same as the one recommended for the MS students. The departmental policy established for the academic year 2006-2007 that PhD students must publish a refereed journal article before graduation should be commended. It is also suggested that the PhD students about half way in their program be required to publish at least one conference paper based on their research. This could be a good starting point for the required journal paper at the end of their PhD degree. The PhD students should also be strongly encouraged to present their paper at a national/international conference. The department should provide travel funds to the students if these funds are not available through the advisor. Again, this type of activity provides the needed research exposure for the department and would help in recruiting PhD students outside of the state of Texas.

**PhD Qualifying Exam:** Currently the qualifying exam is administered after the student has completed all of his/her course work and this happens at least two years after the student has entered the program. This long waiting period puts too much investment into the student and it is difficult and unfair to the student and the faculty advisor to fail the student at this stage. It is recommended that the department institute a Preliminary Examination to be given at the end of the first year. The intent of the Preliminary Examination is to demonstrate the student's ability to prepare a worthwhile research plan and determine the student's ability to: 1) identify a problem, 2) search the literature, 3) define a theoretical, experimental, and/or computational approach, and 4) plan a research program. The student during the first month of entering the program will get with his/her designated dissertation advisor and will decide on a research topic. The student will be then asked to prepare a research proposal similar to a NSF type proposal on his/her research topic by the end of the first year. The student will then present the research proposal to his/her PhD advisory committee and the committee will then decide if the student is fit to continue in the PhD program. The existing qualifying exam or a different version of it would be the next step in the progress toward a PhD degree and should be administered after two years or so the student has been in the program.

**Course Offerings and Frequency:** The departments four year course schedule should be re-visited keeping in mind the recommendations made above. In general, there should be more fundamental courses offered on a regular basis in each of the four specialization areas. In addition, for the PhD students and some MS students, there should be several courses in each specialization area that builds on the other graduate courses in that category. This would add more depth and breathe to the program and would provide more courses for those students that have obtained their MS degree at a different institution to choose from.

**Facilities and Resources: (Rating -- Good)**

**Faculty Office Space:** The department has sufficient office space for the current faculty. However, there is no additional faculty office space available for the new faculty that will be joining the department in the Fall 2009 and future recruits.

**Graduate Student Office Space:** The department provides office space for the students with teaching and research assistantships which is consistent with other peer institutions. From the tour of the graduate student office spaces it was noticed that the space in these offices can be utilized more efficiently.

**Research Laboratory Space:** The research laboratory space appeared adequate. However, the space was poorly managed by occupying some of the laboratory space with several large and small equipment boxes. Some of the research laboratories were dirty and unorganized. The department chair should encourage the faculty in charge of these laboratories to enforce their research students to keep the space clean and presentable. This would also help with the recruiting aspect of the graduate program when prospective graduate students visit these research laboratories.

**Classrooms:** Some of the classrooms that were visited during the tour were without the new technology for classroom instructions.

**Library Resources:** The University has adequate library resources and information technology to support the graduate programs in the department.

**Computer Software:** There is a need for additional software for both instruction and research.

**Support Staff:** Support staff to meet the needs of the faculty and the graduate students appears to be adequate.