Industrial Engineering Graduate Program Review Report

Submitted to the Graduate School at Texas Tech University (TTU)

by

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SUMMARY

This report is submitted by Rasaratnam Logendran, who served as the external reviewer for the graduate program in industrial engineering (IE) at TTU, along with an internal review committee comprised of Dr. Jim Burns as Chair, and Dr. Atila Ertas and Dr. Ellen Peffley as members. The on-site reviews of the graduate program were conducted on April 27-28, 2006. Although the three MS degree programs and the PhD degree program offered by the IE Department were reviewed, at the request of the Graduate School at TTU, this report is written to emphasize the strengths, weaknesses, and needs of the PhD program. The report is organized as follows. First, the specific recommendations made are summarized. Following this, the findings are described in detail along with recommendations.
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SPECIFIC RECOMMENDATIONS

1. The department should make every effort to hire the best qualified person to fill the Bagley Chair in Engineering and do so as soon as possible.

2. In addition to the newly hired Department Chair and yet to be hired Bagley Chair in Engineering, the department should endeavor to hire at least two new faculty members and do so as soon as possible.

3. The faculty who teach distance-education courses should be additionally compensated for their efforts. The department should establish guidelines for determining this compensation, based on the additional effort put in by the faculty who teach distance-education courses.

4. The department should carefully plan for additional resources in terms of new tenure track faculty hires, over and above the ones noted in recommendations 1 and 2, to support the new PhD program in Systems and Engineering Management, and seek approval from the administration.

5. The department should not implement the new PhD program unless the approval for additional new faculty hires is received from the administration.

6. Although the department can benefit from introducing the new PhD program in Systems and Engineering Management, care should be exercised not to overgrow it. Being a PhD program primarily serving the needs of distance-education students from industry, it may lead to dilution of quality, thus compromising the department's visibility amongst peer institutions.

7. A proper balance ought to be sought between the PhD program offered for on-campus students working on research problems motivated by independent research or funded research and the new PhD program in Systems and Engineering Management offered primarily for distance-education students from industry.

8. The IE faculty should commit time to write more quality research proposals and secure more grant funding. This would pave the way for attracting more high-quality, on-campus PhD students on graduate research assistantships to work on funded projects.

9. At least one of the two tenure track positions noted in recommendation 2 should be filled by a person with strong research interests in operations research, supply chain management, and/or modeling of manufacturing and service systems engineering in general.

11. The department should strictly follow a cycle in offering courses and publish the course offerings periodically over a two-year horizon.

12. The department should stipulate a desirable minimum required quantitative score in GRE for students applying to both MS and PhD programs, to enhance the quality of incoming students.

13. The department should employ a staff person at an appropriate FTE level to oversee the maintenance of computer laboratories, and address hardware and software needs of faculty and students.

14. The department should purchase the site licenses for installing standard software packages on all student computers.

15. The department should establish a dialogue with industry experts to assess current industry needs and use them as guidelines in revising the existing curriculum, the development of new courses, and the pursuit of research. This may evolve into the creation of an industrial advisory board for the graduate program in IE, represented by experts from various types of industries.

16. The department should provide formal career planning services for students to plan their careers either in academia or industry.

17. The department should encourage doctoral students to make research presentations at national conferences, and allocate funds to support their travel.

18. The department should introduce a graduate seminar series for students, and invite subject experts from academia and industry to give seminars. The attendance in graduate seminars should be made mandatory for all on-campus IE graduate students. The potential for making these seminars available live via video for distance-education students from industry should also be explored.

19. The department should carefully plan its activities to develop a strategic plan that includes a prioritized set of goals to be accomplished in the next 5 years.
FINDINGS OF THE REVIEW

The Department, Distance-Education Programs, and the Need for Additional Faculty

The graduate program in industrial engineering (IE) at Texas Tech University (TTU) enjoys a favorable reputation within the College of Engineering (COE) at TTU. The IE department currently offers four different graduate degrees: Master of Science in Industrial Engineering (MSIE), Master of Science in Systems Engineering and Management (MSSEM), Master of Science in Manufacturing Systems and Engineering (MSMSE), and Doctor of Philosophy (PhD). MSIE is offered strictly as an on-campus degree program, while MSSEM and MSMSE are offered as on-campus, and off-campus (distance-education) degree programs at the Amarillo site.

The graduate student enrollment in IE has more than doubled over the past 4 years: 48 in 2000-2001 to 106 in 2004-2005. Approximately 65% of the students are enrolled in on-campus degree programs, while the remaining 35% are enrolled in distance-education degree programs offered at the Amarillo site. The faculty turnover in the department this past year has been significant with three faculty members leaving the department in 2005, supposedly for personal reasons. As a result, the department now has 9 full-time tenure track or tenured faculty. One of the faculty members is currently engaged in administrative duties in the COE, and another has been on sabbatical for a year, expected to be back full time in the beginning of fall 2006. Effectively, therefore, the department has been meeting the teaching, research, and advising needs of the growing graduate program, and primarily the teaching and advising needs of the somewhat stable undergraduate program with 7 faculty members in 2005-2006.

The problem is even more compounded by the distance-education programs, as significantly more effort is required to teach distance-education courses than on-campus courses. These include preparing for lectures and delivery by video from TTU or direct (face-to-face) teaching to distance students at Amarillo, which requires driving to Amarillo that is 2 hours away from Lubbock, and interacting with them by e-mail or phone calls to address questions from the material covered in class, assigned homework or projects. When lectures are delivered by video, both on-campus and distance students are enrolled in those classes. This could easily boost the graduate enrollment in a course to 25 or more, requiring additional attention and effort to administer and teach the course. There appears to be no additional compensation paid as an incentive to the faculty who commit themselves to teaching these courses for the distance-education programs. The fact that they are not additionally compensated can, in the long run, be discouraging not to teach the distance-education courses, thus resulting in the erosion of the distance-education programs.

In terms of new hires, the department has been successful in hiring a new Department Chair, expected to be on board in fall 2006. There is an unfilled ‘Bagley Chair in Engineering’ position in the department.

Recommendations:

1. The department should make every effort to hire the best qualified person to fill the Bagley Chair in Engineering and do so as soon as possible.
2. In addition to the newly hired Department Chair and yet to be hired Bagley Chair in Engineering, the department should endeavor to hire at least two new faculty members and do so as soon as possible.

3. The faculty who teach distance-education courses should be additionally compensated for their efforts. The department should establish guidelines for determining this compensation, based on the additional effort put in by the faculty who teach distance-education courses.

The New PhD Program in Systems and Engineering Management

The new hires above would put the department back at the level it was in 2005 in terms of number of faculty. However, the anticipated introduction of the new PhD program in Systems and Engineering Management in fall 2006 adds a different twist to the available faculty resources. The conversations with the IE faculty indicate that about 12 students have already applied for the new PhD program in Systems and Engineering Management and this number is anticipated to increase. The applications are received from students who are practicing engineers in industry, so they would be pursuing doctoral studies as part-time distance students. The self-study report submitted by the department on page 35 states: “The PhD in Systems and Engineering Management has been approved by the Texas Higher Education Coordinating Board and will be accepting applications for admission once the Bagley/Regents Chair in Engineering is filled.”

While making the admittance of PhD students contingent upon the hiring of Bagley/Regents Chair is a wise move, it may not be enough in terms of faculty resources for the long term vitality and growth of this new PhD program. Conjecturing that the number of applications to the new PhD program could increase to 20 and that one-third to one-half of them (7-10) are eventually admitted into the program, it will require committing substantial resources in terms of available faculty who can work with these 7 to 10 students and direct their doctoral dissertations. The dissertation research may not start as soon as the students join the program but ideas for a worthy dissertation will have to be developed by them, working jointly with their major professor, sometime during the first year with TTU for a timely completion of their doctoral degree. Assuming that the new PhD program would be implemented in fall 2006, one possible scenario would be to hire one new tenure-track faculty member in the academic year 2007-2008, and to hire another new tenure-track faculty member in the academic year 2008-2009, should the program show some growth in the second year to stabilize at a total of 10-15 PhD students.

Recommendations:

4. The department should carefully plan for additional resources in terms of new tenure track faculty hires, over and above the ones noted in recommendations 1 and 2, to support the new PhD program in Systems and Engineering Management, and seek approval from the administration.

5. The department should not implement the new PhD program unless the approval for additional new faculty hires is received from the administration.
The Impact of the New PhD Program and Faculty Research Productivity

Growing the new PhD program in Systems and Engineering Management has its advantages as well as disadvantages. The advantages are that it brings in additional PhD students, generates sizable student credit hours to justify receiving additional funding from the state, gives an opportunity for faculty with primary research interests in Systems and Engineering Management to work with additional PhD students, and disseminate their research findings through presentations at national and/or international conferences and publications in refereed journals. The disadvantages are that all of these students are expected to be part time PhD students whose education will be paid for by the companies that employ them. That being the case, there is very little motivation for faculty engaged in research pursuits with these students to actively write grant research proposals and secure funding.

The research expenditures received by faculty in the IE department has dropped from over $1 million in 2003-2004 to $378,000 in 2004-2005. Part of the reason might be that the IE faculty are spread too thin trying to keep up with the teaching, advising, and service needs of the graduate and undergraduate programs that they are unable to fully engage themselves in quality grant proposal writing. The faculty workload summary for fall 2005 made available by the Institutional Research at TTU further supports this. For the eight departments within the COE, the IE faculty workload/FTE is at 20.85, only second to Petroleum Engineering at 22.39. Research funding received by the faculty is one of the factors taken into consideration for the ranking of doctoral granting IE programs in the US by US News & World Report (USNWR).

Second, although the IE department has mechanisms in place to ensure that the distance-education students who would be admitted into the new PhD program in Systems and Engineering Management will fulfill the one-year, full-time residency requirement by enrolling full-time for two consecutive summers, their educational and research experience may not be of the same rigor as that acquired by full-time on-campus students who spend three or more years at TTU. Besides, as companies are funding their entire education, it is very likely that the topic for dissertation research is driven by the companies’ needs and is highly applications oriented. Such topics may not offer much in the way of opportunities for rigorous theory and/or methodological development as compared to the topics typically pursued by on-campus PhD students independently or on funded research. It means that focusing on the continual growth of the new PhD program in Systems and Engineering Management may come at the expense of dilution of quality that can compromise the visibility of the department amongst peer institutions. Peer assessment is one of the factors used by USNWR in the ranking of doctoral granting IE programs in the US.

Recommendations:

6. Although the department can benefit from introducing the new PhD program in Systems and Engineering Management, care should be exercised not to overgrow it. Being a PhD program primarily serving the needs of distance-education students from industry, it may lead to dilution of quality, thus compromising the department's visibility amongst peer institutions.
7. A proper balance ought to be sought between the PhD program offered for on-campus students working on research problems motivated by independent research or funded research and the new PhD program in Systems and Engineering Management offered primarily for distance-education students from industry.

8. The IE faculty should commit time to write more quality research proposals and secure more grant funding. This would pave the way for attracting more high-quality, on-campus PhD students on graduate research assistantships to work on funded projects.

The faculty seems to be active in publishing their work jointly with students in refereed journals. The average number of journal publications per year per faculty has varied from 1 to 3, which is a very good indicator of scholarly productivity. However, the quality of journal publications is as important or even more so important than the quantity. While it is hard to assess the quality of journal publications by faculty in such diverse areas of research, it appears that the quality of publications as a whole could be improved. The faculty is also generally active in professional organizations, another indicator of good faculty performance.

**Emerging Areas of Research and Restructuring of the Areas of Specialization**

Supply chain management and healthcare are two emerging areas showing a lot of promise for research and funding. The research in supply chain management, for instance, is driven mainly by OR (operations research) theory and applications, and there is a lot of potential for the department to grow in this area. Currently, the department offers graduate degrees in three primary areas of specialization: Ergonomics and Human Factors Engineering, Manufacturing and Quality Assurance, and Operations Research and Engineering Management. OR as a subject area is better fitting with Manufacturing Systems Engineering (and Service Systems Engineering) than with Engineering Management. Also, Quality Assurance is part-and-partial of Manufacturing Systems Engineering that it perhaps is not necessary to be identified separately as part of an area of specialization.

In the past five years (1999-2000 to 2004-2005), the Master of Science in Manufacturing Systems and Engineering (MSMSE) program has not graduated any students and there has only been one student enrolled in 2004-2005. There appears to be a great potential to grow the Manufacturing Systems Engineering area by recruiting new tenure track faculty with strong research interests in supply chain management and OR with preferably teaching interests in traditional IE courses. This would revive the MSMSE program by attracting interested students and, more importantly, attract PhD students with strong research interests in OR, supply chain management, and modeling of manufacturing and service systems engineering in general.

**Recommendations:**

9. At least one of the two tenure track positions noted in recommendation 2 should be filled by a person with strong research interests in operations research (OR), supply chain management, and/or modeling of manufacturing and service systems engineering in general.

10. Operations Research should be removed from engineering management as an area of specialization, and combined with manufacturing to form the following three suggested areas of specialization: 1. Ergonomics and Human Factors Engineering, 2. Operations Research,

Graduate Courses, Laboratory Facilities, and Graduate Student Office Space

The number and variety of courses offered in each of the three areas of specialization appear to be appropriate. Conversations with PhD students also indicate that the department does a good job in offering courses even when the enrollments are low, by offering them as special topics courses as they do not require a set minimum. Based on course enrollments reported on page 14 of the self-study report, there is, however, room for improvement as some of the courses are not offered strictly on a cycle such as every year, every two years, or even every three years. Not strictly following a cycle for offering courses can sometimes cause problems for students to plan their programs.

Recommendations:

11. The department should strictly follow a cycle in offering courses and publish the course offerings periodically over a two-year horizon.

The self-study report did not include a description of the department’s laboratory facilities and their capabilities. A laboratory tour, however, was provided to the review committee by the IE faculty. The department houses two research laboratories and two instructional laboratories. In addition, space is provided for graduate research assistants (GRAs) and graduate teaching assistants (GTAs) in three different offices. The research and teaching laboratory facilities seem adequate for the three different areas of specialization offered in the department. The office space allocated for GRAs and GTAs appears fully utilized, and the department may have to convert an existing classroom or something similar to it to create space to accommodate any additional GTAs and GRAs, should there be an increase in enrollment and funding to support them.

GRE Scores of Incoming Students

The graduate student handbook states that the Graduate Record Examination is required for admission into the MS and PhD programs. To be eligible for admission, there is no minimum score required in any of the three areas (verbal, quantitative, and analytical) of the GRE. One of the factors used by the USNWR in the ranking of doctoral granting IE programs in the US is the average quantitative score.

Recommendations:

12. The department should stipulate a desirable minimum required quantitative score in GRE for students applying to both MS and PhD programs, to enhance the quality of incoming students.
Current Student Feedback

A current student survey was developed by Dr. Jim Burns, review committee Chair, and was circulated among MS and PhD students. Fifteen PhD students, 2 MSIE students, 5 MSSEM students, and one MSMSE student returned the completed surveys. The survey included a total of 15 questions, with questions 2 through 11 requesting a rating by students on a scale of 1 to 5. Every one of the 15 PhD students held either a GRA or GTA position, which speaks favorably for the department's commitment to support their PhD students. Eight (5 males and 3 females) of the current PhD students also participated in an hour-long meeting with the review committee to share their views about the PhD program. The discussion below pertains to the survey summaries of only those of PhD students, ratings that indicated there is room for improvement, and issues that were brought up during conversations with them.

For the question on 'Are the facilities (personal computing labs, industrial labs, etc.) adequate,' the average score received was 3.067 on a scale of 1-5, with '1' not adequate and '5' quite adequate. Students did express concerns about various issues: some of the available equipment in the laboratory is very specialized that it can be used only with metals; inadequate air conditioning in laboratories and student offices due to the air conditioner being turned off over the weekend and after 5 p.m. on week days, and the unavailability of some standard software such as SAS, simulation software, Visio, Statistica on student computers for research and educational purposes. Currently, the department does not have a staff person to maintain the hardware and software in the computer laboratories, and address hardware and software needs of faculty and students.

Recommendations:

13. The department should employ a staff person at an appropriate FTE level to oversee the maintenance of computer laboratories, and address hardware and software needs of faculty and students.

14. The department should purchase the site licenses for installing standard software packages on all student computers.

For the question on 'Would you like to see industrial and company involvement in the program,' the average score received was 4.4 on a scale of 1-5, with '5' requesting lots of industrial involvement and '1' no industrial involvement. Clearly, a score of 4.4 indicates that almost everyone wanted to see a significantly more industry involvement in the department. The conversations with students also supported this in that they wanted to see the department periodically bring industry experts to find out the current industry-relevant topics and the industry needs in general.

Recommendations:

15. The department should establish a dialogue with industry experts to assess current industry needs and use them as guidelines in revising the existing curriculum, the development of new courses, and the pursuit of research. This may evolve into the creation of an industrial
advisory board for the graduate program in IE, represented by experts from various types of industries.

The question on ‘Is assistance provided in planning your career,’ yielded an average score 3.487 on a scale of 1-5, with ‘1’ no assistance and ‘5’ lots of assistance. This indicates that the graduate students could use more career planning services provided by the department.

Recommendations:

16. The department should provide formal career planning services for students to plan their careers either in academia or industry.

The department’s visibility can be enhanced by placing their PhDs on tenure-track faculty positions at other universities, preferably those offering doctoral degrees in IE. The doctoral students should be encouraged to make research presentations at national conferences. This would give them an opportunity to be observed and evaluated by academics in other IE departments, thus enhancing their chances of being invited for an on-campus interview and possibly be hired as tenure-track faculty.

Recommendations:

17. The department should encourage doctoral students to make research presentations at national conferences, and allocate funds to support their travel.

Graduate Seminar

Currently, there are no graduate seminars offered by the department for students. Students can greatly benefit from seminars presented by subject experts from academia and industry. These seminars would serve as a venue for learning new areas of research, and depending upon how closely related the seminar topic is to the research interests of students, the seminar may even serve as a means for identifying research problems worthy of investigating as MS thesis or PhD dissertation. The department should set aside funds to meet the costs associated with travel and honorarium for the subject experts invited to give seminars.

Recommendations:

18. The department should introduce a graduate seminar series for students, and invite subject experts from academia and industry to give seminars. The attendance in graduate seminars should be made mandatory for all on-campus IE graduate students. The potential for making these seminars available live via video for distance-education students from industry should also be explored.

Strategic Plan

The self-study report did not include any information on the department’s relative national ranking compared to other IE departments by USNWR. Nevertheless, during conversations the
faculty noted that the IE department at TTU is "ranked 33rd-35th nationally," in the recent rankings established by USNWR. While everyone strives to be ranked in the top 25, for a department this size, the faculty and students ought to be commended for earning "33rd-35th rank" in the national stage. While there are several immediate needs of the department and opportunities for it to grow are abundant, careful planning should be made to prioritize the goals for the next 5 years.

Recommendations:

19. The department should carefully plan its activities to develop a strategic plan that includes a prioritized set of goals to be accomplished in the next 5 years.
Executive Summary

In spite of significant faculty turnover, the Industrial Engineering program continues to maintain a strong graduate program at Texas Tech. The strength of the program is an outstanding faculty who are very productive and have established excellence in their missions of teaching, research and service. The profile of an “average IE faculty member" would be an individual whose typical year consists of: research expenditures of $32K to $117K, 1 to 3 research proposals submitted, 2 to 3 refereed journal articles published, 2 to 5 presentations made at technical conferences and meetings, 2 graduate and 2 undergraduate courses taught along with individual studies, research, thesis and/or dissertation hours, teaching evaluations of 4 or better on a scale of 1 to 5, and service at the local, national and international levels.

The department enjoys an excellent reputation nationally and internationally. Graduates of the IE department hold significant positions in universities and industry. Graduates of the TTU IE program currently chair 4 IE programs in the US and 2 in Taiwan. At least 4 other IE departments have been chaired by our graduates. At least 4 of our graduates have served as academic Deans and 3 have served at Vice President or equivalent positions. Faculty members have served as Presidents of international organizations as well as other significant leadership roles in their respective professional societies.

The department has seen fluctuation in graduate enrollment and has goals of increasing the current enrollment to a level of 2 to 3 doctoral students per faculty member and 4 of 6 masters students per faculty member. A new masters degree program, the Master of Science in Systems and Engineering and Management, was recently approved. The MSSEM program will be primarily a distance education program aimed at practicing engineers who desire graduate work in the area of technical management. It is expected that the program will soon reach enrollments of more than 50 students (part-time students taking 1 or 2 courses per semester). The MSSEM program is a 36 hour non-thesis degree program.

It is expected that the current faculty size (11 full-time, tenure track positions) is adequate for most of the planned graduate program expansion. An additional faculty member in the area of Engineering Management might be required if the MSSEM program becomes as popular and large as expected. Another area that will help the department achieve its desired graduate program growth is the addition of TA/RA funding. If the department had TA/RA funding provided on a permanent basis to provide at least one TA/RA per faculty member, more high quality graduate students could be attracted. It is expected that the funded research projects will provide RA funding for most graduate students. However, the availability of additional TA/RA funding would help smooth out some of the funding cycles and increase the numbers of doctoral students.