Review: Oregon State University
Mechanical Engineering Graduate
Degree Program

Review Team:

M. Grant Norton, Chair
Rob Broeren
Chris Cebra
Rick Colwell
Tom Wolpert

June 2, 2008
1. Overall Recommendation

Expand

The ME program is clearly a significant part of the College of Engineering at Oregon State University. Increasing the visibility and productivity of the program appears to be limited primarily by faculty size. With the clear indication that it is possible to recruit outstanding junior faculty into Mechanical Engineering, the Review Team recommends that resources be allocated to expand the program. As the ME program appears to be among the most productive in the college, internal resources might be reallocated to allow the recommended expansion.

2. Summary of Findings and Recommendations

Based on review of the self-study document and meetings held with administrators, faculty, and graduate students during the site visit, the Review Team makes the following recommendations:

**Recommendation 1:** Identify specific, existing collaborative interactions with international institutions and develop a plan for how these could be expanded within the programmatic effort, e.g., summer exchange program, semester abroad for collaborative research, etc.

**Recommendation 2:** The Graduate Program Chair should investigate building on existing links with institutions in China and determine whether it is possible to use current opportunities to expand the contribution of Chinese students to the ME program.

**Recommendation 3:** The Graduate Program Chair needs to develop a full recruiting plan with a budget.

**Recommendation 4:** Submit a proposal to the National Science Foundation to establish a Research Experience for Undergraduates (REU) site in ME. If such a proposal is funded it will give ME faculty access to some of the best and most highly motivated undergraduates in the United States. The effectiveness of these sites in recruiting top students into graduate school has been widely documented. They also increase recruiting opportunities for domestic PhD students.

**Recommendation 5:** Reduce required course credits to Graduate School minimums. Such a reduction would facilitate flexibility and allow students to take courses (including some at the undergraduate level) outside ME and outside the College of Engineering.

**Recommendation 6:** Emphasize the option to develop flexible interdisciplinary programs of graduate study when promoting the graduate program (e.g. on the ME program web page and in the department offer letter).
**Recommendation 7:** Continue providing the Graduate Communication Seminar and consider expanding it to two quarters or possibly the entire year.

**Recommendation 8:** Provide graduate opportunities for international exchange and collaboration.

**Recommendation 9:** Establish graduate cooperative agreements for industry internships.

**Recommendation 10:** Increase the opportunities for graduate student presentations.

**Recommendation 11:** The School should consider forming a faculty “vision” or “long-range planning” committee. Encouraging widespread faculty participation would help to foster a sense of collaboration and shared sense of future.

**Recommendation 12:** Consider the role of the Qualifying Examination and whether it is being used in the most effective way.

**Recommendation 13:** Metrics for graduate student success should be identified and tracked.

**Recommendation 14:** Form a Graduate Student Awards Nomination Committee.

**Recommendation 15:** The School should clarify/develop policies regarding the formation and maintenance of graduate committees and publication requirements for graduate degrees.

**Recommendation 16:** Form a Faculty Awards Committee. This committee should identify outstanding faculty and help nominate them for Fellow status in their respective societies and national awards available through professional societies such as MRS and ASEE.

**Recommendation 17:** The School should provide travel funds on a competitive basis (maybe matched by the Graduate School) to encourage graduate (particularly doctoral) student attendance at conferences.

**Recommendation 18:** The School should consider forming a student organization within ME.

**Recommendation 19:** The School should improve tracking for graduate alumni.

**Recommendation 20:** The School should consider creating a curriculum committee to periodically review programmatic needs and teaching activities.

**Recommendation 21:** Clarify on the web and any published documents the course requirements and how students can satisfy these requirements.
**Recommendation 22:** Provide access to student training in aspects of entrepreneurship either through the College of Engineering and/or Business and establish mechanisms for exposing students to ongoing entrepreneurial activities within the College.

**Recommendation 23:** Maintain the graduate student directory and keep School web site current.

**Recommendation 24:** Encourage student participation on committees.

### 3. Detailed Findings

#### 3.1. Introduction

The review team consisted of five members. Three of the team were serving faculty at Oregon State University. One of the external reviewers, and review team chair, was from Washington State University the other was an OSU College of Engineering alumnus (BS and MS in ME) currently at Boeing.

The review team:
- M. Grant Norton, *Chair* – Washington State University
- Rob Broeren – Boeing
- Chris Cebra – Veterinary Medicine
- Rick Colwell – Atmospheric & Oceanic Sciences
- Tom Wolpert – Botany & Plant Pathology

The self-study document was received on April 21, 2008. The detailed information contained within the self-study will not be reproduced here except where required for emphasis and/or illustrative purposes. In addition to the items requested by the Graduate Council in Appendix II of the Guidelines for the Review of Graduate Programs (version approved 04-06-06) our review will also address the following issues that were specifically raised within the self-study document:

1. Evaluate the current ME curriculum and identify opportunities for enhancement. (Is our proposed graduate curriculum in line with other graduate programs in Mechanical Engineering as well as in other OSU programs?)

2. Consider the impact of allowing selected undergraduate courses, including those outside of ME, to apply towards the coursework requirements for an MS or PhD in ME.

3. With the recent merger, we have an extraordinary opportunity to implement significant changes to how the graduate programs in ME and IE are administered. We would welcome suggestions from the review committee on how to best manage the complex processes involved in ways that leverage existing capabilities.
Lastly, we would welcome the committee’s input on how best to enhance our visibility in the high tech industrial base in Oregon and how to foster entrepreneurship amongst our graduate students.

The Site Visit took place May 4-5, 2008. The agenda for the visit is summarized below. All members of the Review Team were present at all the meetings. Martin Fiske, Associate Dean of the Graduate School, was also in attendance and provided clarification on policy questions.

Site Visit Agenda
Sunday, May 4, 2008
Working dinner:
Sally Francis, Dean Graduate School and Mike Unsworth, Professor Oceanic & Atmospheric Sciences
Monday, May 5, 2008
8.00 - 9.00 am Program Overview:
David Cann – Graduate Program Chair, School of Mechanical, Industrial & Manufacturing Engineering
Belinda Batten – Head, School of Mechanical, Industrial & Manufacturing Engineering
9.00 - 9.45 am Graduate Committee:
David Cann – Graduate Program Chair
Rich Peterson
Kagan Tumer
Tim Kennedy
Bill Warnes
10.00 – 10.45 am Meeting with College Dean
Ron Adams – Dean, College of Engineering
10.45 – 11.45 am Meeting with Department Faculty
1.00 – 2.00 pm Lab/Facilities Tour
Bill Warnes
David Cann
2.00 – 3.30 pm Meeting with Graduate Students
3.45 – 4.15 pm Wrap up
David Cann
Belinda Batten

During each meeting the Review Team made detailed notes and each member submitted a summary of their comments to the Review Team chair. These summaries were combined in this report. Specifically, the goal of the Review Team was to provide feedback on the areas requested in the Graduate School document and to provide specific feedback on the areas identified by the Mechanical Engineering (ME) faculty.
3.2. Inputs

3.2A Fit of the mission of the program and its relationship to the mission of the academic college, and University mission

The mission of the school of Mechanical, Industrial & Manufacturing Engineering (MIME) is consistent with that of many state universities. The School of MIME wants to engage graduate students in cutting-edge research within a collaborative environment. It also wants to ensure that these students are well positioned upon graduation for a wide variety of career options. There is a focus on the economic and societal benefit of the research and engagement. Clearly the School is achieving success in accomplishing its mission. During the Review Team meeting with the ME graduate students several indicated that among their decisions for choosing OSU was the quality of the research and the collaborative atmosphere within the School.

The mission of the ME program states an additional emphasis on international collaborations and creating a broader international visibility. There is some evidence that progress is being made in these areas. Several faculty do have research activities with colleagues overseas and these might be expanded in a broader and more formal way to include exchange opportunities for graduate students. The graduate students who had spent time in Germany as part of a collaborative research program commented very positively on their experience. Clearly there is significant potential to expand international programs and several of the graduate students indicated an interest in participating in some form of international experience.

**Recommendation 1:** Identify specific existing collaborative interactions with international institutions and develop a plan for how these could be expanded within the programmatic effort, e.g., summer exchange program, semester abroad for collaborative research, etc.

In the Review Team meeting with the Dean of the College of Engineering he articulated that the ME program is a key part of the college. The overarching goal of the college is to increase its national ranking (the ME program also wants to increase its discipline ranking). For many of the external metrics used to determine these rankings the ME faculty are making significant contributions that appear to exceed those of some of the other programs within the college. For example, the ME program has shown significant recent growth in research expenditures, a high citation impact for their published work, and a doubling of PhD enrollment. As the first two items are phase I indicators for American Association of Universities (AAU) membership and doctoral education is a phase II indicator, the ME program is clearly helping in advancing the status of the College of Engineering at OSU. Indicators for AAU membership assessment are given in Appendix A.

Research expenditures and doctoral degrees awarded are also factors used in the *U.S. News and World Report* rankings for engineering colleges. Total research expenditures have a weighting of 0.15, average expenditures per faculty member is weighted 0.10, and doctoral degrees awarded weighted 0.0625.
3.2B Quality of students

The Review Team met with a group of ME graduate students. The students who attended the meeting were articulate and many appeared to have had the opportunity to attend other schools for their graduate work. Using the scores on the Graduate Record Examination (GRE), which is one of the standard metrics for incoming graduate students the quality would seem to be consistent with that at many other similarly ranked schools. Collectively the data can be misleading because only international students are required by the Graduate School to report GRE scores. The U.S. News and World Report does factor into its rankings the Quantitative component of the GRE. Comparison with the most recently released rankings shows that the reported scores for the ME graduate applicants at OSU is about 20+ points lower than schools within the top 25 engineering programs. However, a significant effort spent in trying to increase this metric is not likely to be particularly beneficial.

As might be expected, the majority of the graduate students in ME are from overseas. It is not clear that faculty in ME have explored and availed themselves of current opportunities in China to engage with top schools and attract some of the best graduate students from that country. The Chinese government currently sponsors 5000 students each year from the top 50 Chinese universities to undertake doctoral programs overseas. The U.S. institution is typically only required to provide the cost of tuition and medical insurance. In addition the Chinese government also sponsors another 5000 exchange graduate students who spend 1 to 2 years conducting research overseas. This is a no-cost research resource. Increasing the number of Chinese students would be consistent with goals of the OSU Graduate School, which is concerned about the decline in enrollment of international graduate students.

**Recommendation 2:** The Graduate Program Chair should investigate building on existing links with institutions in China and determine whether it is possible to use current opportunities to expand the contribution of Chinese students to the ME program.

Most of the domestic graduate students in the ME program come from Oregon. It is not unusual for most of the domestic graduate students at a state institution to be from the home state. What was not given in the self-study document was the identity of the schools these students came from. This information should be available and would have been useful if reported. If most come from OSU then it would show that local recruiting efforts are working, but that there is little broader engagement with other schools in the state.

It would also be useful to know what schools non-Oregon students come from. If the five from Minnesota were from the University of Minnesota-Twin Cities that would indicate a very effective and significant “pipeline”, which could be further exploited with some very targeted recruiting. If the students come from smaller schools with weaker engineering programs then it is important to ensure that the quality of the incoming cohort of graduate students is adequately maintained. These smaller schools do offer the possibility for creating a “pipeline” because often they do not have their own doctoral
programs and hence there is no internal competition for recruiting these students. What is clear is that a broader more aggressive recruiting program is needed. The need to expand recruiting efforts beyond the Pacific Northwest is important in attracting very good students and increasing the overall quality and visibility of the ME graduate program.

**Recommendation 3:** The Graduate Program Chair needs to develop a full recruiting plan with a budget.

Overall, a comprehensive recruiting strategy is needed. Activities should include:
- Significant update of web site – it should be current and reflect what is actually happening within the program
- Establish mutual graduate student recruiting partnerships with schools in the Pacific Northwest
- Develop a list of target schools
- Advertising and promotion of ME graduate programs to target schools
- Making graduate program attractive to OSU students – this is a potential pool of students that are already familiar with OSU
- Create an environment among existing graduate students that makes them advocates for the program
- Continue with the successful and popular recruiting weekend

**Recommendation 4:** Submit a proposal to the National Science Foundation to establish a Research Experience for Undergraduates (REU) site in ME. If such a proposal is funded it will give ME faculty access to some of the best and most highly motivated undergraduates in the United States. The effectiveness of these sites in recruiting top students into graduate school has been widely documented. They also increase recruiting opportunities for domestic PhD students.

3.2C Admission selectivity
The data presented in the self-study report indicates that about 70% of applicants are rejected. This number is consistent with a number of other similar programs. It is higher than the OSU College of Engineering average (Data from: *U.S. News and World Report, America’s Best Graduate Schools 2007*). Selectivity is important in maintaining a high quality and competitive graduate program.

3.2D Level of financial support of students
While the monthly compensation for ME graduate students at OSU ranks towards the top of the identified peer institutions as shown in Table A2 of the self-study document any direct comparisons are difficult. Fees paid by the students can vary widely by institution as can the costs of tuition, which are sometimes included as part of the graduate student stipend. However, the stipends are significantly lower than those paid by agencies such as the National Science Foundation to students participating in IGERT and GK-12 programs.

A concern of some of the ME graduate students was in the inequity in funding levels between TAs and RAs and in the manner the School distributed partial TA support. As
RA funding is determined by faculty PIs based on external funding and TA funding is based on a state or university pay scale it may not be possible to pay uniform stipends. However, in as much as it is possible, efforts should be made to minimize differences in graduate student support.

In terms of TA assignments, most of the graduate students felt that the School was accommodating in balancing duties and time commitments. In some cases the background of the student was not always a good fit with the TA assignment, but this is often simply a resource problem rather than poor “matchmaking”.

3.2E Curriculum strength

An immediate observation on the graduate curriculum in ME is that it seems rigid and highly compartmentalized. Both these characteristics are not consistent with how research is actually conducted (flexible and interdisciplinary) and the needs of the student (allowing them to take courses that enhance their research skills). Requiring more graded coursework credits than the minimum required by the Graduate School seems counterproductive and may be at the heart of a number of concerns that were raised by the faculty and graduate students.

A concern expressed by the ME faculty and the Dean of the College of Engineering was the high teaching load. Although the majority of this teaching is at the undergraduate level, reducing the number of required graduate credits and letting graduate students, in concert with their thesis committee, develop a more flexible and broader set of course requirements could help reduce the faculty teaching load.

Taking as illustration the requirements for the MS degree: a minimum of 27 graded credits is required by the Graduate School, but the ME program requires 36 graded credits (see Table 1). Thus, it is well within the discretion of the ME program to reduce their number of required coursework credits or to allow students to take 1-2 undergraduate classes that would apply to their graduate program. Both faculty and graduate students alike mentioned the importance of students being able to take undergraduate classes outside of their program to support their research activities.

<table>
<thead>
<tr>
<th>Table 1. Comparison of Degree Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate School</td>
</tr>
<tr>
<td>Total Credits</td>
</tr>
<tr>
<td>Research</td>
</tr>
<tr>
<td>Seminar</td>
</tr>
<tr>
<td>Graded</td>
</tr>
</tbody>
</table>

A similar argument could be made for the PhD program.
Recommendation 5: Reduce required course credits to Graduate School minimums. Such a reduction would facilitate flexibility and allow students to take courses (including some at the undergraduate level) outside ME and outside the College of Engineering.

The Review Team believed that encouraging a high level of flexibility in selection of courses could be an incentive for some students to attend OSU.

Recommendation 6: Emphasize the option to develop flexible interdisciplinary programs of graduate study when promoting the graduate program (e.g. on the ME program web page and in the department offer letter).

Despite the rigid set of core requirements and the large number of total coursework credits required there are still specialization areas within ME that appear to be poorly served, especially for students working towards a doctoral degree. A concern expressed by several of the ME graduate students was that the number of dynamics courses offered was small and additional courses in this area were needed.

The recently introduced Graduate Communication Seminar is an important addition to the curriculum that will benefit all graduate students. Faculty involved in this seminar program are to be applauded. It clearly addresses a number of areas that are critical for students to be effective in their research programs and also for their careers whether in academe or in industry. Some of the topics that are handled in a single lecture could legitimately expand to several lectures, or even a whole quarter. There may be opportunities to obtaining funding through the National Science Foundation to expand the seminar program and to develop mechanisms for broader dissemination.

Recommendation 7: Continue providing the Graduate Communication Seminar and consider expanding it to two quarters or possibly the entire year.

Despite the Graduate Communication Seminar, which seems unique to this program, the majority of the curriculum and the general approach to graduate education are typical of many institutions. Whilst undergraduate education in engineering has made significant advances in recent years, graduate education has not changed significantly for decades. There are certainly ways to broaden a graduate education and provide the types of opportunities now routinely offered at the undergraduate level.

Recommendation 8: Provide graduate opportunities for international exchange and collaboration.

Another common characteristic of undergraduate programs that is missing from most graduate programs is the internship. In the Review Team meeting with ME graduate students several indicated that they would be interested in an internship in industry or a national laboratory. Certainly opportunities exist for graduate internships at Pacific Northwest National Laboratory (PNNL) in Richland, Washington. Providing internships
with industries in Oregon, such as HP and Intel, would be one way for greater interactions between the ME program and the industrial base in Oregon.

**Recommendation 9:** Establish graduate cooperative agreements for industry internships.

As most OSU ME graduate students go into careers in industry rather than academe the curriculum should address some of the specific needs of industry employers. Industry highly rewards verbally assertive people that make positive/negative feedback on issues, and those that present their team’s results for feedback. These are typically highly interactive discussions rather than a number of people just listening to a presenter. Schools, in general, teach students to be quiet and listen, but that is definitely not how to succeed in industry. More opportunities should be given for all graduate students to make presentations to faculty and graduate student audiences. Each presentation might be recorded so that the students can see themselves speaking. They could then discuss their presentation with faculty whose expertise is in communication. A similar, and very successful, program is in place at University of California-Irvine.

**Recommendation 10:** Increase the opportunities for graduate student presentations

**3.2F Quality of personnel and adequacy to achieve mission and goals**

The quality of the ME faculty is high. There are two current CAREER awardees, which is a very good number for this size of department. The number of Full Professors (3 out of 19) is a little low and appears to be due, in part, to recent departures and retirements. Maintaining a good balance between the ranks is important for a number of reasons. At the Full Professor level these faculty would be expected to take on leadership roles in departmental administration, mentoring of junior faculty, and leading the establishment of major center and program funding. These large programs (REU sites, IGERTs, MRSECs, ERCs, etc.) are often the reason for proportionally higher funding levels in the top ranked institutions. If the program is in a position to hire new faculty then serious consideration should be given to attracting senior faculty with national/international reputation that could lead a highly visible center/program.

It is essential for the success of the ME graduate program that future faculty hires are consistent with the “vision” for the merged school and strongly support graduate research and education. Concern was raised by several faculty over opportunities for shared governance and a common vision for the future of the School particularly with a view toward future hires.

**Recommendation 11:** The School should consider forming a faculty “vision” or “long-range planning” committee. Encouraging widespread faculty participation would help foster a sense of collaboration and shared sense of future.
3.2G Level and quality of infrastructure
The Review Team was given a tour of facilities and laboratories used by ME program faculty and students. The entire team was very impressed with the engineering shop facilities. The equipment was clearly well maintained and the quality of shop supervision was excellent. This facility is obviously a very important asset to both students and faculty.

The quality of laboratory space varies. Some of the laboratories are of a high quality. For example, the Electroceramics Research Laboratory seems to be well-used space and appropriate for the type of research that is being conducted.

The Review Team was very impressed with the new x-ray diffraction facility that was obtained through Office of Naval Research funding. The vision that the Materials Science faculty in ME expressed for the utilization and expansion of the characterization facility was also impressive. Although acquisition of major research instrumentation is very competitive, at least through federal sources, one of the biggest issues related to this equipment is adequate support for upkeep, training, and maintenance. As funds for this purpose can almost never be obtained from federal sources it is necessary to have an internal plan to cover these costs. User fees are often only sufficient for part of these costs.

3.2H Quality of organizational support
Although this issue was not covered in the self-study document and not specifically addressed by the Review Team it did appear that appropriate organizational support is provided. In terms of the ME graduate program, Professor Cann is on a 25% appointment as Associate Head of Graduate Programs. This appointment will certainly help to increase activity in areas of recruiting and visibility of the graduate program in ME. One full time administrative assistant will support Professor Cann. This type of support is critical and it is very encouraging to see the School providing this.

3.3. Productivity
3.3A Level and quality of student performance
The self-study document specifically addressed student performance in terms of graduation statistics, student awards, and student thesis topics.

None of these metrics address broader aspects of quality, particularly those aspects that would increase the visibility of the program and it’s ranking. While most students that enter the program graduate this metric is clearly one that is self-determined. The pass rate of the Qualifying Examination is 100% so it is very difficult to tell if this is due to the quality of the students or the level at which the examination is set.

Recommendation 12: Consider the role of the Qualifying Examination and whether it is being used in the most effective way.

Recommendation 13: Metrics for graduate student success should be identified and tracked.
One criterion for student performance that the Review Team found a little disappointing was the lack of student awards. Since 2004 only four awards were received, two of which were internal, one a “recognition”, and the other “second place”. Thus it seems that no significant student awards have been received. The reason for this lack of achievement is not clear, but it probably at least, in part, is due to lack of aggressive nomination procedures. It would be expected that at least one of the graduate students would have received a National Science Foundation Graduate Fellowship, a National Defense Science and Engineering Graduate (NDSEG) Fellowship, a Hertz Foundation Applied Science Graduate Fellowship, or some level of equivalent competitive award. As with CAREER awards and other levels of faculty recognition, the quality of the award nomination package is critical. Faculty should help identify outstanding students and work with them to prepare competitive nomination materials.

**Recommendation 14:** Form a Graduate Student Awards Nomination Committee.

The list of student thesis topics on p. 26 of the self-study document was interesting and showed the diversity of research conducted by faculty in the ME program. What was missing was a list of archival publications with graduate students as first authors or co-authors. The self-study document suggests that graduate students are encouraged to write papers, but that there is no formal requirement. Although it can be counterproductive to link a specific number of publications to a degree requirement it might be articulated to all graduate students that without at least one (for MS) or three (for PhD) journal articles that they would unlikely be in a strong position to graduate.

Some ME faculty expressed serious concern about an apparent competition between the goal of graduating students from the program as quickly as possible and the quality of the student’s work. In this same context, concern was raised over policy for the creation, maintenance and authority of graduate program committees. The Review Team cannot overemphasize the importance of maintaining quality in the graduate program. Although agencies such as the National Research Council and consulting companies such as the Yardley Group do consider factors such as time to degree and retention rate; the single most important contribution to a successful and nationally competitive graduate program is quality. Linking graduation with external publications in top, peer-reviewed journals might be a way of ensuring quality and providing a useful quality metric for recruiting purposes.

**Recommendation 15:** The School should clarify/develop policies regarding the formation and maintenance of graduate committees and publication requirements for graduate degrees.

**3.3B Level and quality of faculty performance**

The ME faculty have a high level of scholarly productivity. Their work is published in some of the leading journals (e.g., *Acta Materialia* and *Applied Physics Letters*) and it is highly cited. The Dean of the College of Engineering specifically commented on the productivity of the ME faculty and noted their high citation impact.
Another metric of faculty productivity is research expenditures. These reached a peak in 2006 with about $3.2 million for the ME faculty. This translates to about $180k per faculty member, which is close to that for the college average for that year reported to U.S. News and World Report. The research expenditures dropped slightly in 2007 due to the loss of some very productive faculty, but the self-study document indicates that for 2008 the level will be in excess of $3.5 million. As federal funding is increasingly competitive it is very encouraging to see that expenditures will rise in 2008 and hopefully that trend will continue.

An issue associated with total research expenditures and expenditures/faculty is the overall size of a department/school. Data generated by a national survey of electrical engineering departments by the Electrical and Computer Engineering Department Heads Association (ECEDHA) shows the effect of faculty size on expenditures per faculty (Figure 1).

Although these data are only for electrical engineering departments it is evident that similar trends exist for other engineering programs. Increasing the number of faculty enables the creation of a critical mass in a number of different areas. It also allows for more collaboration both within a department/college and between colleges.

Figure 1. National Survey of Electrical Engineering departments by ECEDHA (Electrical and Computer Engineering Department Heads Association)

The ME program currently has two NSF CAREER faculty and this is a very good indication that the program is successful in attracting high-quality, young faculty.

It would have been interesting if the self-study document had included other metrics of scholarly productivity by faculty. Although the traditional approach in academe is to define scholarship as that associated with traditional research (i.e., publications and funding) it would have been instructive to see faculty productivity defined in terms of the expanded definition of scholarship by Boyer (see: Boyer, E. L. (1997). Scholarship reconsidered: Priorities of the professoriate. San Francisco: Jossey-Bass). Under this
model faculty productivity might be closely tied to other aspects of the mission of the School of MIME and the College of Engineering. For example, ME faculty productivity should be high in terms of interdisciplinary activities (certainly in Materials Science and areas that overlap with Electrical Engineering).

A priority for the College of Engineering is increasing “innovation impact” through university spinouts and technology licensing agreements. The Boyer model of scholarship specifically considers economic and societal impact through innovation. Finally, Boyer describes the scholarship of teaching. Some of these areas are addressed in individual faculty résumés provided in the CD attached to the self-study document, but more broadly addressing these factors in the self-study document would show the broader aspects of faculty productivity.

**Recommendation 16:** Form a Faculty Awards Committee. This committee should identify outstanding faculty and help nominate them for Fellow status in their respective societies and national awards available through professional societies such as MRS and ASEE.

3.3C Viability of scholarly community within which students can interact

During the meeting with the ME graduate students several students indicated they were quite active in professional societies such as ASME. On the other hand many were not active and did not seem to have the opportunity to attend professional meetings/conferences. Active student participation at professional meetings/conferences increases program visibility. It also creates a level of raised expectations among graduate students. A comment was made during the meeting with the ME graduate students that conference participation takes away from research time. The likely problem is that there are too many required courses and students would be concerned about missing a week of classes and the effect that might have on their grade. Conference attendance is a critical mechanism for graduate students to participate in the bigger community with others and to see the larger context of their research work.

**Recommendation 17:** The School should provide travel funds on a competitive basis (maybe matched by the Graduate School) to encourage graduate (particularly doctoral) student attendance at conferences.

There would appear to be opportunities to increase the scholarly community of graduate students within ME. It is possible to form student chapters of professional societies, such as the Materials Research Society (MRS). These often provide funds to the student organization for attendance at professional meetings. The student chapters also create a framework for student lead activities such as a seminar program and field trips to local industry.

**Recommendation 18:** The School should consider forming a student organization within ME.
3.4. Outcomes

3.4A Professional viability of graduates

Clearly ME graduates from OSU are placed in a wide variety of careers (Self-study Appendix Table E). This placement suggests that the graduate program is producing students with the right skills for positions in industry, universities, and national laboratories. Tracking of graduate student placement is always difficult and the incomplete data, particularly for 2002 – 2003, is very typical for many institutions. It is becoming more and more important to be able to collect this information; alumni are the donors of the future.

**Recommendation 19:** The School should improve tracking for graduate alumni.

From the perspective of the member of the Review Team from Boeing there are key criteria that major companies look for when hiring graduate students:

1) Good team players – experience in working in small to large teams to accomplish goals
2) Communicators – experience in primarily verbal as well as written communication with peers
3) Good project management skills – can see the big picture of what is required, can create a multi-step plan to solve the problem, can define a schedule to complete each task, and follow through.
4) Good System Engineering Skills – can take high-level requirements and derive lower level specific requirements to meet program needs. This includes defining what analysis and/or testing would be required to ensure the final design does in fact meet the requirements.
5) Good technical basis – understands the basic science within their technical discipline.
6) Good numerical skill – Since all engineering today is done on a computer, it is critical to be fluent in creating simple Excel analysis to more detailed computations.

To ensure that ME program graduates continue to meet the needs of major engineering companies the curriculum should be assessed periodically with respect to the above criteria.

**Recommendation 20:** The School should consider creating a curriculum committee to periodically review programmatic needs and teaching activities.

3.4B Satisfaction of students and graduates

The Review Team met with several of the graduate students in the ME program. Overall the students seemed to be satisfied with their experience at OSU. An informal survey during the meeting showed a number of reasons for their decision to come to OSU. They
commented positively about the quality of research programs and the collaborative atmosphere within the department.

A main concern expressed by the students was that of “slash” courses. Specifically they commented that it was difficult to find appropriate and relevant “non-slash” courses. These courses also seem to be a considerable source of confusion for the students. Although a detailed analysis for this confusion could be presented, it is sufficient to summarize the analysis with one recommendation.

**Recommendation 21:** Clarify on the web and any published documents the course requirements and how students can satisfy these requirements.

The alumni survey described on page 29-30 of the self-study document gave the lowest rating to “creativity enhancement”. This is consistent with what the Review Team heard during the meeting with ME graduate students. There was interest in expanding entrepreneurship programs at the graduate level. There exists one class in the College of Engineering on this topic, ECE599 Product Innovation and Commercialization. But it is not clear if this course is offered outside of the School of Electrical Engineering and Computer Science.

Another place where entrepreneurship programs are typically offered are colleges and schools of business. There have been apparent problems working with the College of Business at OSU and it may be worth seeing if these problems can be overcome, particularly because of a current focus on entrepreneurship. Improved interactions with the College of Business would also help in making that college aware of innovative new technologies coming from ME. The interaction could benefit both colleges.

Another avenue to explore might be to work with ONAMI on developing an entrepreneurship program that could incorporate a business plan competition (i.e., give graduate students the opportunity to see how their research might be commercialized).

**Recommendation 22:** Provide access to student training in aspects of entrepreneurship either through the College of Engineering and/or Business and establish mechanisms for exposing students to ongoing entrepreneurial activities within the College.

A student comment received via e-mail after the site visit noted that the School web site needs updating. Specifically, the graduate student directory was not current and existing students in the program are not listed. Keeping the directory current serves two important needs: Firstly, it allows students to see that they are an important part of the organization. Secondly, an updated web site allows them to have visibility with outside agencies, such as potential employers. The requirement for keeping the web site updated could be assigned to the assistant to the Graduate Program Chair. The directory would only need to be updated twice a year.
**Recommendation 23:** Maintain the graduate student directory and keep School web site current.

Several students also expressed a desire to be more involved in the administrative activities of the School. Although it would not be beneficial to the student to have to spend a significant time away from their research the School should invite and encourage graduate student participation on committees. Encouraging student participation will improve the collaborative nature of the program and instill in the students a sense of community and dedication to the development of the program. For example, a graduate student could be invited to be on faculty search committees. This experience would be particularly beneficial to those doctoral students planning on a career in academe.

**Recommendation 24:** Encourage student participation on committees.

3.4C Rankings/ratings

The Dean of the College of Engineering has set a goal of making the college a top 25 engineering program. This is a laudable goal and one that is being set by many other institutions. Rather than using published metrics such as *U.S. News and World Report* rankings where OSU is ranked #86 (based on 2007 on-line publication), he has created a ranking based on “innovation impact”. In this context impact is defined as not only degrees awarded and research expenditures, but also on number of university spinouts and licenses. On these criteria alone, and once normalized for faculty size, the OSU College of Engineering does appear to fare quite well. It is worthy of note that ten spinout companies have been created. For a college the size at OSU this accomplishment is very impressive.

Whilst the shortcomings of the *U.S. News and World Report* rankings are widely known it does remain the definitive ranking for graduate programs. It is certainly the ranking that all international students use to determine the top schools in the U.S. The OSU College of Engineering will need to increase its ranking within the *U.S. News and World Report* system in order to increase national/international visibility and to attract the very best international students.

A comparison between OSU and the two schools ranked at #26 by *U.S. News and World Report* show quite a disparity in research expenditures and PhD matriculation (Table 2). In order to increase the number of doctoral students in the College, and in the ME program in particular, all the state allocated resources for graduate students could be directed only towards PhD students. When this idea was presented to the faculty it met with only very limited support.
Table 2. Comparison of OSU, the Ohio State University, and University of Florida (2007 on-line edition)

<table>
<thead>
<tr>
<th>School</th>
<th>Rank</th>
<th>PhD students/faculty</th>
<th>Research expenditures ($ million)</th>
<th>Expenditures/faculty ($ thousands)</th>
<th>PhDs granted per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio State University</td>
<td>26</td>
<td>2.8</td>
<td>106.8</td>
<td>420.6</td>
<td>96</td>
</tr>
<tr>
<td>University of Florida</td>
<td>26</td>
<td>4.2</td>
<td>92.1</td>
<td>341.1</td>
<td>145</td>
</tr>
<tr>
<td>Oregon State University</td>
<td>86</td>
<td>1.5</td>
<td>22.8</td>
<td>201.6</td>
<td>25</td>
</tr>
</tbody>
</table>

3.5. Conclusions
In conclusion, the ME program at OSU is very similar and comparable to many equivalent engineering programs at state universities. The strength of the program is in its faculty and a collective sense that the program could and should become even better. The Review Team was impressed with a number of aspects of the program and the quality of the self-study document. Without reiterating all the recommendations it is sufficient to conclude with the two overarching issues that need addressing for the program to reach its full potential: communication and visibility. Communication within the School definitely needs improving. There seems to be a disconnect between what is happening at the college level and the faculty and certainly improved communication within the School is necessary. Poor communication is at the heart of many of the concerns raised by the faculty and graduate students. Communication at all levels should be improved.

Increasing the visibility of the School to all of its constituencies will significantly enhance the ME program from increasing the pool of high quality domestic graduate students to expanding the desired interactions with industry. There are some very quick fixes that can be applied that will immediately increase program visibility: encourage more graduate students to attend national meetings/conferences and present their work, nominate more faculty and students for highly visible awards.

Additional Responses to Specific Issues Raised in Self-Study Document
Whilst the narrative presented here addresses, both directly and indirectly, the four specific issues raised by the ME program in the self-study document, the Review Team is pleased to provide some additional feedback and suggestions below.

(1) Evaluate the current ME curriculum and identify opportunities for enhancement. (Is our proposed graduate curriculum in line with other graduate programs in Mechanical Engineering as well as in other OSU programs?)
Review Team Response:
The ME program at OSU is very typical of most graduate engineering programs. Yet these programs are continually failing to engage many U.S. students. The Review Team has identified a number of approaches that could enhance the curriculum and make it more appealing to students.

(2) Consider the impact of allowing selected undergraduate courses, including those outside of ME, to apply towards the coursework requirements for an MS or PhD in ME.

Review Team Response:
The Review Team recommends that the number of required graduate courses be reduced to the Graduate School minimum requirement. This will then allow more flexibility within the curriculum and the opportunity for graduate students to take undergraduate classes outside of their major. Industry does not work in silos nor do most university faculty. Graduate students should be encouraged to gain the background and skills necessary to be most effective in their research. Taking courses that are tailored to their research and their future careers will benefit their overall research productivity and professional viability.

(3) With the recent merger, we have an extraordinary opportunity to implement significant changes to how the graduate programs in ME and IE are administered. We would welcome suggestions from the review committee on how to best manage the complex processes involved in ways that leverage existing capabilities.

Review Team Response:
In any merger it is essential to create increased sense of community and engagement. Due to near-term and long-term objectives for substantially increasing the number of faculty in MIME, the need arises for a “Vision” or long-range planning committee. Joint participation and active involvement by members of ME and IME in these activities could help to provide a sense of collaboration and a shared sense of the future. The best benefit of this merger is the larger size of the department. Ideally, once common policies are set up there is some overhead sharing that will benefit both sides. A department-focused effort to increase capital equipment across ME/IME would be one area that could create an active community of researchers across both programs. In any merger the key to success is to identify the strengths within each program and then see how to most effectively combine them. It is essential to avoid creating a sense of disenfranchisement within a group or groups of faculty.

In terms of administering the graduate programs in the merged School the recommendation is to have a common and streamlined recruiting and administrative procedure. This approach will have several benefits. Firstly, it will make communication more effective. Applicants will have one point of contact that can ensure applications are handled quickly and efficiently. As happens now students may enter in one area, but find their interests may lie elsewhere. A single administrative unit can help with these transitions and ensure that students are effectively placed. A single administrative unit can also avoid duplication of activities/resources.
Lastly, we would welcome the committee’s input on how best to enhance our visibility in the high tech industrial base in Oregon and how to foster entrepreneurship amongst our graduate students.

**Review Team Response:**
ME faculty and students expressed a desire for more interactions with industry. Mechanisms that could help facilitate this objective include:

- Streamline and/or standardize confidentiality agreements to expedite industry partnerships.
- Develop a seminar series for visitors from industry. In general, most OSU alumni would be very willing and honored to come back and talk to students.
- The Dean and Chair indicated that interactions with industry are continually expanding. These interactions should be effectively communicated to faculty and students.
- Create a department level ¼-time position to focus on both industry sponsorship and research facilities. The first goal would be to put a corporate map together of what contacts the department has and how they were made. Next, as in all good business relationships both parties must benefit, so an active effort to contact the top 10 corporations in the Pacific Northwest and ask them what research help and/or internship would benefit them.
- Create a database of faculty expertise that could be shared with industry. Faculty and graduate students could then work on short-term fixed-price contracts with companies.
Appendix A Indicators for AAU Membership Assessment

Phase I Indicators
(1) *Competitively funded federal research support:* These data are collected by the National Science Foundation. The Membership Committee has been using obligations, which are the only measures that break down federal support by agency. The committee has recently switched to using NSF research expenditure data, which are more accurate, with a correction factor to subtract the estimated proportion of university expenditures drawn from USDA. Most USDA funding is not allocated competitively, and USDA support accordingly is included as a Phase II indicator.

(2) *Membership in the National Academies (NAS, NAE, IOM):* The National Academies’ membership database maintains the current institutional affiliation of its members.

(3) *National Research Council faculty quality ratings:* These ratings are drawn from the decennial national assessment of research-doctorate programs conducted by the NRC. Though the data become dated between surveys, the committee believes that they continue to provide a valuable peer-assessment of faculty quality. The last NRC report was published in 1995 based on 1993 data; preparation for the next NRC assessment is currently underway.

(4) *Faculty arts and humanities awards, fellowships, and memberships:* For its last research doctorate assessment, NRC compiled a list of awards, fellowships, and memberships signifying faculty achievement primarily in arts and humanities fields. The Membership Committee has expanded this list and will use it as an additional assessment of the distinction of an institution’s faculty, focusing on the arts and humanities faculty. Additional appropriate awards, fellowships, and memberships will be added to this list as they are identified.

(5) *Citations:* The *U.S. University Science Indicators* citations database provides an annually updated measure of both research volume and quality and will provide a valuable complement to the first four indicators listed above.

Phase II Indicators
(1) *USDA, state, and industrial research funding:* Though these three sources of academic research support fund important, high-quality research, they will be treated as phase II indicators since they are generally not allocated through competitive, merit-review processes. Competitively funded USDA research programs that can be separately identified in reported data will be included in phase I data.

(2) *Doctoral education:* The committee will use number of Ph.D.s granted annually as well as tabulate the distribution of Ph.D.s across broad disciplinary categories (e.g., engineering but not aerospace engineering), using Department of Education IPEDS (Integrated Postsecondary Education Data System) data. These data will be treated as phase II indicators to de-emphasize the quantitative dimensions of Ph.D. programs and avoid sending an unintended signal to institutions to increase Ph.D. output at a time when many institutions are or are considering scaling back their Ph.D. programs.

(3) *Number of postdoctoral appointees:* The committee will use NSF-compiled data from institutions on postdoctoral appointees, most of whom are in the health sciences, physical sciences, and engineering. Postdoctoral education is an increasingly important component
of university research and education activities that the committee believes should be tracked in AAU membership indicators. However, because postdoctoral activity is highly correlated with university research and because self-reported postdoctoral data are less uniform than data on federally funded research, postdoctoral appointees will be treated as a phase II indicator.

(4) Undergraduate education: The committee will assess the institution’s undergraduate programs to determine that the institution is meeting its commitment to undergraduate education. Recognizing that differing institutional missions among research universities dictate different ways of providing undergraduate education, the committee will be flexible in this assessment. A number of measures have been suggested, including some that focus on input and others that look primarily at output variables. These are at this time imperfect, but may provide some guidance to the committee in making its judgments on this topic.

Source: Association of American Universities (www.aau.edu/aau/Policy)