

**ACADEMIC PROGRAM REVIEW COMMITTEE REPORT OF
THE UNIVERSITY OF WASHINGTON DEPARTMENT OF MECHANICAL ENGINEERING**

by

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The committee was charged with evaluation of the programs (both undergraduate and graduate) of the Department of Mechanical Engineering as a part of the routine, mandated 10 year evaluation cycle at the University of Washington. As a part of this review, the committee received the department's self-study document prepared by the chair and associate chairs of the department addressing the strengths, weaknesses and opportunities and providing data on important departmental metrics. Over the course of the two-day visit of the committee, the department provided the committee with the opportunity to meet with its constituents including faculty groups from different ranks, graduate and undergraduate students and staff. Based on the charge given to the committee, we addressed the following questions posed to us as detailed below. The committee was unanimously impressed with the high quality of the UW Mechanical Engineering undergraduate and graduate programs.

Overall Recommendation of Review Committee:

All four degree programs (BSME, MSME, MSE and PhD) should be continued for the next 10 years.

The ME Department has done a remarkable job relative to its peers despite significant current limitations as we discuss further below.

We framed our assessment around the four questions posed to us in our Committee's charge. Those questions are repeated below along with our responses. Our assessment draws from both the Self-Study Report provided by the Department as well as from our discussions with ME faculty, students and staff during our site visit. We included in our response some excerpts from the Self-Study Report in those areas where our own opinions and recommendations closely mirror those in the Self-Study Report.

1. Are they doing what they should be doing?

Absolutely YES they are. The BSME, MSME, MSE, and PhD programs are vibrant, growing and healthy but are also limited by the current physical facilities and resources that compromise their ability to grow. The main positive aspects of the program are:

- Very high student demand and selectivity across all degree programs
- Students matriculating in all degree programs and successfully finding employment upon graduation
- A good balance of the spread of resources between teaching and research
- Significant and continuing research collaboration with local partners and with other units on campus, service to both the University and to professional communities.
- Strong desire to enhance the reputation of the department and to increase its national ranking

2. Are they doing it well?

They have done an excellent job as evidenced by the following positive aspects:

- They have doubled the PhD output from 10 years ago (from 10/yr. to 20/yr.)
- A large majority of the faculty is active in research, with multiple graduate students pursuing their degrees as well as research faculty who are strong researchers and contribute significantly to the department's research enterprise.
- Conversion of the MS programs to fee basis has provided the department additional financial resources and flexibility to further support to the Department and its programs.
- There is strong evidence (as conveyed to us by faculty, staff and students we met) of the outstanding Department leadership and this carries over to the remarkably high morale among students, staff and faculty.
- The undergraduate program is extremely selective and consequently the student retention rate is remarkably high, and the quality of student training appears to be excellent
- The Department has consistently recruited top-notch faculty for decades, including junior faculty in the past several years that are developing well.
- The Department has increased the number of staff with their own resources to streamline the Department's support functions in the areas of pre- and post-award management and advising (though intentionally slowly). However, the department is still short-staffed compared to its peers (see related point in the next section).
- For a Mechanical Engineering department of its current size, it is not possible to excel in all areas within the discipline. Consequently, the Department has strategically focused on four major areas in the discipline. They have identified these four areas for growth and hiring of additional faculty based on the department's strengths and local advantages. These four areas include:

1. *Alternative/Renewable Energy/Fluids*

This is a strategic choice due to worldwide needs in the long term. The Department plays a leadership role in Northwest National Marine Renewable Energy Center and participating roles in the Clean Energy Institute, and NanoES.

2. *Health/Medicine*

The department has clearly leveraged the resources of the world-renowned UW School of Medicine and has developed collaborations with the medical school and Medical/Health Companies located in the Seattle area. Importantly, they have also distinguished themselves from the Department of Bioengineering by focusing on whole-body biomechanics and medical devices, robotics, prosthetics, bio-design, imaging,

manufacturing, sensing and micro-fluidics. In contrast, Bioengineering is focused largely on cellular and molecular phenomena.

3. *Dynamics/Robotics/Mechatronics/Controls*

Department has leveraged proximity to PACCAR for research in advanced vehicles, diagnostics/prognostics, reacting flows, CFD, robotics, sensors, actuators, computing and nanotechnology which also has cross-over to energy/fluids and materials research.

4. *Advanced Manufacturing/Materials*

The Department has developed strengths in additive manufacturing, advanced materials and digital manufacturing as represented by large research initiatives with funding from Ricoh, Boeing (BARC), FAA, and NSF.

- Department has been extremely successful in expanding its research enterprise by doubling its research expenditures in the last five year by focusing on important and fundable research areas and formed research partnerships with other academic departments, UW School of Medicine, and industry. This growth has been achieved despite current limitations on both physical infrastructure and facilities, by expanding their activities to various locations (nine different locations) across the UW campus and beyond.
- The Department's finances are in very good shape, and this can be attributed both to the increase in research expenditures as well as to the fee-based MS programs that provide an important revenue stream.
- The faculty members we met were unanimous in stating that their colleagues are extremely collegial and helpful to each other. They cited specific examples of colleagues mentoring others, senior faculty giving up lab space for junior faculty, etc.
- Mentoring for assistant professors appears to be strong and well structured. The resources/opportunities are provided to them in the form of: 1) priority for the courses they wish to teach; 2) opportunities for them to become more visible in their field, examples including invitations to prominent researchers as seminar speakers , hosting conferences at UW and incentives for them to travel to give seminars, serve on proposal review panels etc.; 3) priority access to the incoming graduate students; and 4) Teaching Assistantship availability for their graduate students beyond that available to senior faculty.
- Departmental emphasis in interdisciplinary research/science is considered a significant and important strength as evidenced by the interdisciplinary research topics listed above.
- The faculty members we met were also unanimous in emphasizing the opportunities for collaboration both within and outside the Department. They were also confident that their individual efforts are being recognized in such collaborations as it relates to the promotion and tenure decisions.
- We noted extremely high tenure rate and also retention rates for the T&TT faculty. We believe this is a reflection of high selectivity at the faculty hiring stage and is the right approach in the current academic landscape. The retention rate for research faculty is somewhat lower, but this is solely a function of research faculty's ability to raise research funds.
- The Department understands the value and the challenges associated with diversifying its faculty and student populations and they are tracking demographics of pipelines and doing their best to attract diverse pools of candidates. In particular, they have an admirable

increase in underrepresented minority (URM) representation in the undergraduate program.

- We applaud the Department's effort to use peer evaluation of faculty teaching. We recognize that this is a sensitive issue and must be done in a thoughtful and positive manner to encourage constructive feedback, to learn best practices and to also help set expectations about teaching effectiveness.
- We also applaud the Department's effort to maintain a first-rate machine shop and prototyping facility equipment for the UG program and research program. The access to this shop and the superb supervision within it promotes student success in the curriculum and in extra-curricular student team activities.

3. How can they make things better?

- While there appears to be very good mentoring of assistant professors, this does not appear to carry over to associate professors. The mid-career faculty members we met were less certain of the criteria for promotion to full professor, and they indicated that the department did not really have structured mentoring, other than yearly meetings and their resume reviews with the department chair. It appears that mentoring at this level is on the basis of faculty request. In addition, the Department is encouraged to consider implementation of an Individual Development Plan (IDP) career development document (as required for trainees supported by NIH grants) for junior faculty and graduate students. Such a document would be updated on a yearly basis and reviewed by the individual's mentorship committee. Note: Conrad Liles can provide the templates for documents that were developed and are currently used in the University of Washington Department of Medicine and the University of Toronto Department of Medicine (as well as the template for the NIH IDP used by NIH-funded trainees).
- Currently, the undergraduate curriculum includes many separate laboratory components for the required classes, which places considerable pressure on scheduling, space and laboratory equipment. One possible way to alleviate this pressure is to consider consolidating these labs into dedicated laboratory courses where experimental methods are taught for subjects that span the curriculum at the appropriate place in the curriculum. Doing so would reduce both the number of individual lab sections to be scheduled and likely reduce the space needed to offer them.
- There is clearly a need for increasing the staff in ME as already identified in the Self-Study Report as well as from the interviews of faculty and staff. Example areas include academic advising and post award contract/account reconciliation.
- The Engineering Innovation in Health program will need to be re-energized as funding sources and development efforts have withered away. It may also have to be refocused for success. We also recognize that a number of the student-led projects have succeeded in this area, and this bodes well for the future if and when the funding mechanism is strengthened.
- Increase in the size of the fee-based MS program will allow more departmental revenue to be generated, as there is still capacity for growth in this offering.
- Both the ME Graduate students we met and the faculty voiced concerns about the current PhD qualifying exam. It should be noted that they also voiced confidence in the forthcoming

improvements now being proposed. We realize this is a common point of discussion in many ME programs as ME expands its research into multi-disciplinary areas. We commend the department and its faculty for considering changes in the qualifying exam content as a part of the continuous improvement of the graduate program.

- The department might consider a 5 year combined BS and MS program by inviting their high achieving juniors to take part in a BS-MS program. Undergraduates we interviewed indicated that they would have participated in such a program if this were available to them. If implemented, this would also form a pipeline to the Ph.D. program in the department.
- Undergraduate students also expressed a desire for capstone design experiences that span multiple departments/engineering disciplines such as mechatronics and other interdisciplinary projects.
- We encourage the department to undertake a regular strategic planning activity involving the entire faculty to set long term goals that includes a multi-year faculty and staff hiring plan to share with the College of Engineering leadership. It was not clear that the entire faculty we met understood the larger goals included in the Self-Study. Earning their buy-in for these (and other) goals will be important for the department's success. One approach might be to prepare a 5-year ME Strategic Plan that articulates priorities and the action items needed to achieve them with target dates.
- A major bottleneck to raising the prominence of the Department is the size of the Department's faculty and degree programs. The Self-Study rightly notes that the Department is probably about half the size it needs to be in order to compete with premier public institutions nationwide and rise in the national rankings.
- Future growth of the faculty and degree programs strongly couples with the need to increase space for research and improve the quality of the department's currently occupied space. The laboratory space available for the undergraduate program clearly places a limit on the undergraduate program size, which in turn frustrates a large number of undergraduate students (and their parents) seeking entry to the ME program. In addition, this limits the impact of the Department in serving the State of Washington and employers throughout the state/nation/world.
- Furthermore, the quality of the space in the Mechanical Engineering Building places extreme limits on the both the size and quality of the research programs housed within. Many of the research topics associated with the strategic research areas above require modern laboratory infrastructure (e.g., exhaust to support fume hoods and bio-safety cabinets, wet lab space) that simply doesn't exist in the current building. Capturing the recently vacated second floor of the ME Annex space for departmental use would be a small but useful step in the right direction.
- Some faculty noted potential flight-risk of the high-performing mid-career faculty who might be lured away by some peer institutions. Two actions to mitigate this were suggested and include: 1) increasing the number of chaired and named professorships providing discretionary funds, and 2) providing seed funds for all faculty (including mid-career faculty) to pursue new lines of research.
- Regarding URM students, the department might consider setting goals relative to the associated URM rates within the appropriate national pipelines. The graduate program URM rate is likely well below the national pipeline of URM students graduating with ME UG degrees, which is one measure to consider.

4. How Should the University Assist Them?

The increase in the prominence of the College of Engineering at the University of Washington is tied to the success and prominence of its departments. In every college of Engineering, the Mechanical Engineering Department is one of most important units and as such the success and prominence of the ME Department will undoubtedly influence the college rankings in a positive way.

The prominence/ranking of the ME department is tied to both the quality and size of its programs. The high quality, high demand for the ME program is clearly indicative of the potential for this program to rise in prominence and national rankings if additional resources are provided. We therefore recommend that the University administration should:

- Support a major increase in the size of the undergraduate program.
- Support a major increase in the size of the faculty.

To achieve this growth, the Department needs a new ME building and/or major renovation of the existing ME building and facilities. A Strategic Plan prepared by the Department of Mechanical Engineering should include options for expansion and improvement of the departmental space and facilities with milestones and a timetable. We recommend that the college and upper university administration work with the department leadership collaboratively to realize this expansion which undoubtedly will raise the stature of the Department of Mechanical Engineering and the College of Engineering for many years to come.

We thank the College and University administration for the opportunity to review the Department of Mechanical Engineering programs. We appreciate the fact that the UW Department of Mechanical Engineering is successful and vibrant, with excellent potential for growth and increased academic stature.