Report for the 10-Year Review of the Electrical and Computer Engineering Graduate Program

May 1, 2019

Review Committee Members

- Michael Arnold, Professor, Materials Science and Engineering (Chair)
- Gregory Nellis, Professor, Mechanical Engineering
- Shannon Stahl, Professor, Chemistry (Graduate Faculty Executive Committee Representative)
- Paul Terry, Professor, Physics

Review Process

The committee was formed on March 9 and was charged to "analyze program quality and student learning, affirm ways that the program is working well, and implement improvements." The charge asked the committee to "focus on evaluating the quality and function of the academic programs", focusing on "academic programs and the student experience." The committee began by reviewing the Electrical and Computer Engineering (ECE) Graduate Program Self-Study, in addition to the Graduate Handbook. The committee gathered additional information by:

- Performing one-on-one interviews with at least half of the Faculty in the department;
- Meeting as a committee with the ECE Administrators including the Chair (Prof. Susan Hagness), Graduate Associate Chair (Prof. Barry Van Veen), and Operations Associate Chair (Prof. John Gubner);
- Meeting as a committee with ECE Graduate Student Services Coordinators (Hannah Roberg and Daryl Harrison);
- Meeting as a committee with ECE Graduate Students; and,
- Reviewing ECE program statistics collected and published online by the Graduate School.

The Student Services Coordinators are College of Engineering staff who coordinate with ECE Graduate Students on matters including advising, policy, and degree progression. The two Coordinators, Hannah Roberg and Daryl Harrison, serve on-campus and off-campus online Graduate Students, respectively.

The Graduate Students who were interviewed were 3 Ph.D. students in their 2nd, 3rd, and 7th years of study, encompassing international versus domestic and gender diversity. The students were selected by the ECE Department because of their leadership roles in the ECE Graduate Student Association. The ECE Department did not provide students currently enrolled in a M.S. program; however, the 3 students who were interviewed did their best to provide a broad perspective representative of all students.

After reviewing the Self-Study, Handbook, and Graduate School data, the committee generated a detailed list of questions and topics that were used to guide discussion with the Administrators, Coordinators, Faculty, and Students. A total of 24 Faculty were interviewed including the Chair and Associate Chairs. The particular faculty members who were interviewed were determined by the ECE Department. The one-on-one interviews with Faculty were conducted for 20 minutes each over the course of April 17 to April 25, depending on the committee availability. The committee met with the Chair for 30 minutes, Graduate Associate Chair for 60 minutes, Operations Associate Chair for 30 minutes, Student Services Coordinators for 30 minutes, and Students for 30 minutes, on April 18.

Data

The ECE Department offers a Ph.D. program, a Research M.S. program, and 3 course-only M.S. programs including a Professional M.S. program (on-campus); an M.S. program specifically in Signal Processing and Machine Learning (on-campus); and an M.S. program specifically in Power Engineering (online). The Ph.D., Research M.S., and Powering Engineering M.S. programs have long histories whereas the Signal Processing and Machine Learning and Professional M.S. programs are relatively new (created in 2017 and 2019, respectively).

Size. *The ECE Graduate Program is the largest Program in the Physical Sciences Division on campus* with an enrollment of 359 students, averaged over the last ten years, compared to 315 in Computer Science and 318 in Chemistry. The ECE Ph.D. Program is the 2nd largest in the Physical Sciences Division with an average enrollment of 218 Ph.D. students (2nd only to Chemistry with 306 Ph.D. students). The ECE Department is attempting to increase the size of its M.S. Programs, in part to access new potential revenue streams associated with non-pooled tuition in the Named Option M.S. Programs.

Time to Completion (M.S.). The time to degree for an M.S. in ECE is on par with the typical time to degree in the Physical Sciences Division over the last 10 years. 48.1% and 81.0% of ECE students have completed M.S. degrees in ≤ 2 and ≤ 3 years, respectively, compared to 56.0% and 85.0%, respectively, in Physical Sciences.

Time to Completion (Ph.D.). The time to degree for a Ph.D. in ECE is marginally longer than the typical time to degree in the Physical Sciences Division over the last 10 years. 34.9% of ECE Ph.D. students leave with an M.S. or no degree, compared to the 30.7% in Physical Sciences. Of the remaining fraction that do complete their Ph.D. degree, 28.8% and 74.9% of ECE students have completed their Ph.D. degrees in ≤ 5 and ≤ 7 years, respectively, compared to 35.2% and 84.5%, respectively, in Physical Sciences. The ECE data are similar to data from ECE AAU Peer Institutions (characteristic time to Ph.D. degree of 5.24 years in the UW-Madison ECE Department compared to 5.10 years for AAU Peer Institution ECE Departments, averaged over the last five years).

Career Outcomes. The career outcomes for Ph.D. graduates in ECE are comparable to the rest of the Physical Sciences Division and are generally very good, with only 15% of Ph.D. graduates

not yet employed at the time of graduation in ECE compared to 18% in the Physical Sciences. Data for M.S. graduates were unavailable.

Ph.D. Student Support. In Fall of 2018, 69% (144 of 210) of ECE Ph.D. students were supported on Research Assistantships or by Fellowships (versus 60% in the Physical Sciences Division). However, 14.2% had no or insufficient support. The remainder of students were supported by Teaching and Project Assistantships (some in ECE; others outside of ECE).

Faculty. There are currently 42 tenure-track faculty in the ECE department (15 assistant, 2 associate, 25 full). 7/42 faculty are women. 4/17 assistant and associate faculty are women, showing improved gender diversity in recent hiring.

Graduate Program Rankings. #12 nationally in Computer Engineering. #16 nationally in Electrical Engineering. (2020 rankings; College of Engineering website)

Staffing and Administration. The Associate Chair for Graduate and Online Studies (currently Prof. Barry Van Veen) provides leadership and oversight of the graduate program and oversees faculty committees pertaining to (a) student recruiting, admission, and fellowship, (b) graduate curriculum, and (c) assessment of Ph.D. progress towards degree, including the Ph.D. qualifying exam. The on-campus Student Services Coordinator provides academic and sometimes personal advising to on-campus ECE graduate students (the vast majority of the ECE graduate students) and also interfaces with prospective graduate students. Other ECE staff contribute to payroll, benefits, and communications at both undergraduate and graduate levels.

Interviews

The one-on-one meetings with faculty and discussions with administrators, staff, and students were beneficial and provided first-hand insight into the Graduate Programs beyond the data and information provided by the ECE Department Self-Study. The tenor of all the interviews was highly positive. None of the interviewees identified major flaws. When prodded, faculty identified only minor criticisms, with the most prevalent concerns related to uncertainty about the impact of the department's new admissions policy, which requires faculty to provide a five-year funding commitment to incoming students, and to TA support. Aside from these minor criticisms, the interviewees indicated they were happy with the department leadership and had the opinion that the ECE Department and its Graduate Programs are headed in the right direction. The committee concurs with this assessment.

Overall, the ECE Department's Graduate Programs are healthy; their quality is excellent; the student outcomes are excellent; and student learning goals are being met. The Department should be commended for creating, maintaining, and continuously improving an outstanding Graduate experience.

Below are summaries of particularly notable program strengths and concerns/challenges, followed by recommendations. For the most part, the concerns and challenges are of the type that

typically arise over time even in perfectly well run departments and/or because of budgeting constraints.

Program Strengths

- **Restructured Departmental Administration Resulting in Greater Commitment to Graduate Programs.** The creation of the Associate Chair for Graduate and Online Studies has been very effective in directing and coordinating faculty committees relating to ECE graduate programs. This restructuring has increased the number of faculty members involved in graduate student issues and enhanced their level of participation. The Associate Chair is viewed as strong and proactive, and his work is considered well coupled to similarly effective leadership provided by the Chair. The Associate Chair has also been an effective Department-level resource for graduate students. The restructuring of the Departmental Administration (along with other recent policy changes, see below) is evidence of the Department's commitment to a Graduate Program that ensures excellent student outcomes, meets students' learning goals, and creates a positive student experience.

- **Faculty Hiring that Promote a Better Student Experience.** The department had done an excellent job of hiring new faculty in recent years. The gender diversity among the faculty, which surpasses that of most ECE departments, is notable and should contribute to improved diversity among incoming students in the coming years and therefore a better student experience.

- **Favorable Career Outcomes for Students.** One of the most important student outcomes is job placement, and the department is performing very well in this area. Data show that the overwhelming majority (85%) of graduating Ph.D. students have lined up employment by the time of graduation. Job placement and career advancement were not worries shared by current students; on the contrary, placement and advancement opportunities were viewed optimistically. Faculty reported students are well sought after by industry and national laboratories, with graduates receiving multiple job offers with high bonuses (at least within some areas of ECE).

- **Improved Graduate Student Handbook.** The recently revised Graduate Student Handbook is rightly regarded as a significant improvement to the graduate program. It appreciably clarifies departmental organization, policies, and procedures, making them more transparent to students and ensuring that programmatic- and student learning- expectations are clearly defined. This information, including key details related to graduation benchmarks (e.g., qualifying and preliminary exams) will be of great value to the students and could even improve time to graduation. The revision of this handbook took considerable effort and is another example of the Department's commitment to a Graduate Program that ensures excellent student outcomes, meets students' learning goals, and creates a positive student experience.

- **Proactive Identification of "Orphan" Graduate Students.** Interviews with both faculty and students indicated that, in the past, graduate students who do not have advisers or funding might continue their program for years without making any real progress towards a Ph.D. The learning objectives of these "orphan" Ph.D. students were not being met without the necessary research experiences. Both students and faculty pointed to the new policy of requiring a five-year commitment at the time of admission as being a way to prevent this situation in the future. Students who "slip through the cracks" will be identified and provided alternate advisers and funding so that these students can meet their learning objectives. This should also decrease time to graduation.

- **Graduate Course Selection that Empowers Students to Meet Learning Goals.** Both faculty and students that were interviewed expressed their satisfaction with the graduate course offerings. The number of courses is felt to be sufficient to allow students to develop a course plan that prepares them for success and is interesting. The offering schedule is predictable and therefore does not cause delays in graduation. Scheduling challenges that arise are promptly addressed. Finally, the size of these courses is typically sufficiently small as to allow students access to the instructor and create a favorable learning environment. These characteristics will be challenged by the activation of the new Named Option M.S. programs; but, these observations suggest that there may be room for this expansion without negatively impacting student learning or the student experience.

- **ECE 610/611 Introductory Courses that Improve Student Outcomes.** The recent addition of required introductory courses for M.S. and Ph.D. students (ECE 610 and 611) has been a success on multiple levels. Students report the courses have improved community and cohesion among the graduate student population and therefore have improved the student experience. (The recent formation of a Graduate Student Association was cited as having a similarly important effect, providing more opportunity for graduate students to interact with a larger community.) Faculty appreciated the ECE 610 and 611 courses and their effectiveness at introducing students to research areas and groups and disseminating best practices for succeeding in graduate school. ECE 610 and 611 were also viewed by some faculty as effective means for identifying and recruiting promising M.S. students for potential future Ph.D. studies. Thus, the addition of these courses have facilitated interactions between students and faculty.

Program Concerns and Challenges

- **Insufficient Staff for Graduate Programs.** The large number of on-campus students in the Ph.D. and M.S. programs (300+ and growing) has placed an unrealistically large load on the singular staff member (the Graduate Student Services Coordinator for on-campus students) handling these student programs. The current staff member in this position has been extremely effective but has been overworked and is at risk of burnout. The department administrators and new Associate Chair for Graduate Studies have compelling ideas how to

improve the Graduate Program, student outcomes, and the student experience but lack staffing resources to execute these ideas. Overall, it is clear that administrative staff positions are insufficient for handling the workload under present and projected future conditions. Simply, the staffing is too small for a Graduate Program of this size.

- **Potential Unintended Effects of the Five-Year Funding Guarantee Policy**. A dramatic change in student recruitment policy has recently been implemented in response to the Graduate School's requirement for a five-year funding guarantee. It is too early to gauge its effects, but it could have negative impacts on the Department. Student enrollment has the potential to drop significantly unless the admission procedure is modified to take into account anticipated declinations. Although implementation of five-year funding commitments to incoming Ph.D. students was largely seen by the faculty as a necessary step to improve student experience, there was concern and uncertainty about the details of how the policy has been and will be implemented by the department. Some faculty thought the policy would result in an improvement in recruiting and not affect faculty once the shock of the change wears off. But, others expressed concern, much of which is shared by this committee, about how this change will affect the long-term health of the program. One particular concern regards how the five-year guarantee is insured; there is sentiment that asking individual faculty members to assume all of the risk is not ideal (e.g., possible summer salary loss, future recruiting restrictions) and misses the possibility of leveraging risk by making the commitment collective across the faculty. Multiple faculty members conveyed reservations about hiring research assistants sight unseen with a five-year funding commitment, which inherently carries significant risk. At least one faculty member indicated that requiring a five-year funding commitment by specific faculty members and then not making TA backup funds easily available without stigma will have deleterious consequences. The worry of the committee is that the Department's current policy could lead to fewer commitments by the faculty and therefore negatively impact Ph.D. student recruitment and the quality of the Ph.D. program as a whole (and therefore the student experience) -- if not addressed. Some faculty reported that the specific details of the policy have already resulted in faculty making fewer offers, as well as driving faculty to recruit graduate students from other departments.

- **Inequity in TA Workload (from student perspective).** Both student and faculty interviewees expressed concerns, mostly shared by the committee, regarding the level of TA appointment. First, the level of TA appointments does not correlate well with teaching workload. While the written agreement between the Department and TAs envisions times for task completion that fit within a certain appointment (e.g., 33%), graduate students regarded allotted times as insufficient to complete the tasks. This mismatch between workload and percentage appointment is a source of frustration for students, does not appear to be measured via surveys or other means, and has not been adjusted. Second, there is concern

that the level of TA appointment (typically 33% or less) is less than the levels of RA appointments and TA appointments in other departments.

- **Insufficient TA Support for Many Classes (from faculty perspective).** Interviewees very frequently expressed concerns about the need for more TA support in the department. It was noted that considerable TA support has been allocated to new "flipped" classrooms, while more traditional courses lacked adequate support to cover discussion sessions and office hours outside the classroom. As noted above, in many cases, TA workload and expectations by faculty surpassed that supported by their appointment. For example, relatively large courses (>50) are, in some cases, allocated only one shared TA, with a 1/6 or 1/12 appointment. The resulting burden on the faculty and TAs negatively impacts the educational experience of the students in these courses and the research productivity of the faculty and their groups and is therefore a drain on student outcomes both in the classroom and the research laboratory.

- **Long Term Plan for Providing Mental Health and Wellness Resources Needed.** The Graduate Associate Chair and Graduate Student Coordinator are very committed to supporting students for student wellness and mental health issues. However, there is concern that the effort required is not sustainable (e.g., could lead to burnout, or new people rotating through positions may be less well equipped). Also, students may not feel comfortable approaching these individuals (or their faculty advisors) as they may not be viewed as neutral. The College of Engineering mental health counselors are only available one day a week. The Department should consider and adopt long term plans to address these challenges because a substantial fraction of the graduate student body's experiences and learning outcomes are affected by mental health and wellness issues.

- **Uneven Awareness by Faculty of Resources for Addressing Mental Health and Wellness Issues.** Most faculty indicated that the Department was more focused on student mental health than it had been previously (as evidenced by a recent visit of a UHS staff person to a ECE department meeting meeting). However, it was clear from the faculty interviews that understanding of the resources available for supporting mental health and wellness varied substantially among faculty and research groups. This perception was echoed by the graduate students. The confidence of faculty in their own ability to address mental health challenges also varied from faculty member to faculty member.

- **Diversity.** The Department is well connected to the GERS Program in the College of Engineering, and this is viewed as a successful and valuable resource. However, the ECE Department has less diversity in its graduate student population than it would like. The committee was concerned that the move towards a new 5-year funding guarantee policy for Ph.D. students could further negatively affect Ph.D. diversity. It is often the case that students from different socioeconomic backgrounds may not look as strong on paper as more traditional students. By forcing faculty to make student selection choices based largely on

their paper record, it might adversely affect their likelihood of bringing in a diverse graduate student pool. Several faculty indicated that a stronger connection to GERS might help mitigate this effect.

Recommendations

- **Create a New Graduate-Focused Staff Position.** An additional staff position should be authorized. The new staff member would assist the Associate Chair for Graduate and Online Studies, particularly in the area of programs for on-campus students, working with existing staff members to implement new ideas for improving and assessing student outcomes and learning goals.

- **Monitor and Address Impact of the Five-Year Funding Guarantee Policy.** The impact of the new five-year funding guarantee policy should be monitored by the department to ensure it does not have a negative effect on the quality and desired quantity of the Ph.D. student pool. Likely, the policy will need to be updated to ensure the policy promotes recruitment of the best students and promotes a diverse student body.

  The department leadership and broader faculty should assess the impact of the new Ph.D. admissions policy in the near future, once data from the first year of implementation are clear. Such assessment should be continued for the foreseeable future to alleviate any negative impact this policy has on student recruitment by junior faculty, recruitment of underrepresented minorities, and other vulnerable groups. Efforts should be made to listen to and respond to concerns by faculty as the impact of this policy emerges, especially if negative effects become evident. The department leadership and faculty will be in the best position to devise effective measures to counter unintended consequences, but ideas include identifying better insurance policies to allow individual faculty to be aggressive in their recruitment of excellent students, while distributing the risk acrdoss the department. The department should fully leverage TA positions available inside and outside the department to allow for many more offers to be made than the number of positions directly available from existing faculty grants. New policies could be supported by the acquisition of good historical data summarizing sources of student funding, ratio of offers-to-acceptances, among other metrics to enable faculty to increase the number of offers beyond that allowed by the current policy. Specific policies should be implemented (1) to guarantee that junior faculty are given adequate "insurance" back-up to allow them to be aggressive in their recruiting during their probationary period and (2) to provide incentives for the the recruitment of high-quality underrepresented minority students who may not be the primary targets of recruitment.

- **Assess and Update TA Workload and Appointment Percentage.** The ECE department should carry out a TA workload assessment to quantify workload on a course-by-course basis across the entire curriculum. The department is encouraged to adjust the TA workload for each course so that it is commensurate with the percentage of TA appointment, or vice versa.

Moreover, the department should consider raising the TA appointment percentage across the board so that it matches the RA appointment level and the TA appointment levels commonly offered by other departments -- in order to create a more equitable environment. One suggestion for quantifying TA workload is to require all TAs to keep accurate timesheets over a three week period to provide a snapshot of TA workload on a course-by-course basis. These actions promise to improve the experiences of students supported by TAs.

- **Increase Number of TA Positions and TA Budget.** More TA positions and an increased TA budget are needed to improve educational outcomes and faculty productivity. At the same time, a larger TA budget would allow the department to backstop individual faculty members' five-year commitments to Ph.D. students in a way that is more natural and positive. Faculty should be encouraged to recruit aggressively with an understanding that it is expected that during some portion of their program, their graduate students will be expected to TA.

- **Expand Mental Wellness and Health Support and Awareness in a Sustainable Way.** Mental health training and advertisement of available resources (to both students and faculty) should be expanded. Inclusion of this content in 610/611 and graduate student orientation is a positive step that promises to be sustainable, but efforts should be made to ensure that more senior students, who may be more likely to encounter the need, are given and informed of these resources, as well. Possible steps could include (1) periodic emails from the Chair or Graduate Coordinator highlighting resources, (2) providing more opportunities for student networking and/or social interactions (e.g., led by the Graduate Student Association), and (3) training of faculty on issues related to mental health support for their students. Creating policies and best-practices that are sustainable and self-propagating in the long term are recommended. Regular UHS office hours with recurring advertisement to the students should be provided or another resource should be established to off-load some of the burden currently being carried by the Associate Chair and Graduate Coordinator.

Other Observations by Committee:

- **Maintaining Strength of ECE's Part of a Successful Campus-Wide Program.** The fusion plasma program in ECE is highly successful (funding of $2M/year) and highly regarded nationally. It is one leg of a campus wide effort among three departments with a national ranking of 2 – 3. This is a graduate program issue because the plasma area is very successful in attracting numerous high quality students to UW-Madison across the three departments and in providing a uniquely rich graduate student environment. ECE is at risk for losing this program because its low priority in the department's strategic plan may not result in replacements for retiring faculty.