



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

July 15, 2024

Professor Susan McCahan
Vice-Provost, Academic Programs
University of Toronto

Dear Professor McCahan,

I write in response to your request for an interim monitoring report for the 2018-2019 external review of the Department of Materials Science & Engineering and its programs, and the Faculty's administrative response to the review recommendations.

Below I address the implementation of plans regarding the recommendations contained in the [Final Assessment Report and Implementation Plan](#) (FAR/IP), as presented to the Committee on Academic Policy and Programs (AP&P) at its October 27, 2020 meeting. The then-acting department chair, Professor Jane Howe, was consulted in the creation of this report in the spring of 2024.

Note that the department and its programs will undergo an external review in 2024-2025, under its new chair, Professor Hani Naguib, at which time many of the implementation goals listed below will be reviewed and re-assessed.

- 1. The reviewers observed that undergraduate programs offered students limited access to research opportunities, few team activities, limited capstone projects, and generally low levels of pedagogical innovation.**

On May 4, 2020 the department held a retreat focussed on undergraduate education. It was the kick-off for a deep curriculum review through the summer of 2020, with the objective to bind together the varying parts of the program more effectively. A key objective of this review process was to fit the conceptual elements of the core courses of the program together more effectively.

A biweekly second year seminar series, MSE 296/297: The Materials Paradigm at a Glance, was also created over the summer of 2020 using Category Theory from Mathematics and Information Theory from Electrical Engineering as a framework for organizing the concepts taught through second year. This course will tie together concepts from other second year courses by fusing parallel content in the second-year curriculum as it unfolds week by week through the term, with the objective being to directly teach 'big picture' materials thinking (as opposed to hoping that it will have formed within the students before they graduate). Also developed during the summer of 2020 was a new fourth year capstone course.

Immediate-term goals

- Use the new MSE 296/297 seminar series as a platform for building a richer landscape of defined learning outcomes across second year such that program expectations can be more clearly defined for all relevant stakeholders.

Medium-term goals

- Because of the ongoing change in the mathematical organization of the discipline, in particular the transition from a descriptive-based science to a field making quantum mechanics-based predictions, the department will consider how it can more formally integrate robust mathematics into its teaching.
- Cultivate faculty-led pedagogical initiatives across the department; evaluate progress and recommend development steps, with each faculty member being encouraged to develop a teaching innovation plan to be reported in their annual activity report.
- At the Faculty level, leverage undergraduate research opportunity models in place in other FASE departments and institutes. Have a plan in place for summer 2021 to increase the number of opportunities and track this number through time.

Long-term goals

- Expand curricular integration initiatives and promote continuous, year-over-year course improvement and innovation.

Update:

MSE120: Materials Engineering, Processing and Application has been offered since 2020. It covers an introduction to the field of materials science and engineering following a design-led approach. The course has five practical sessions which requires students working as a team of three in the lab.

In the teaching of MSE219: Structure and Characterization of Materials, the department increased the time and content of the lab components. Second-year students have more time using the materials characterization equipment in small team settings.

Pedagogical innovation has been implemented in teaching online since 2020.

Efforts have been made to expand the capstone projects (MSE498: Capstone Project: Design of Materials Processes). As a result, there is an increased interest and participation of summer research by undergraduate students.

The department will review its undergraduate curriculum, including ways in which to increase levels of pedagogical innovation, as part the planning phase associated with the 2024-2025 external review.

- 2. The reviewers noted that the structure of the curriculum, which requires a robust list of courses in four theme areas, reduces opportunities for undergraduates to partake in other curricular opportunities in the Faculty, such as minors and certificates, and for faculty to teach graduate electives.**

MSE's recent curriculum changes allow students more flexibility in course selection by giving them the option of taking technical elective substitutes (courses that are outside the MSE list that can be requested through the undergraduate office). Most students who pursue a minor or certificate will take advantage of this opportunity as it allows them to double-count courses towards their degree and minor.

Note that MSE technical elective lists in third and fourth year are listed as specialization themes for the purpose of organizational grouping only. While there is currently no restriction as to how many courses must be completed within any given theme, this was the case in the past and could have resulted in a legacy impression during the site review.

Immediate-term goals

- Continue the work of the summer 2020 Undergraduate Task Force reviewing how to best fit together the undergraduate curriculum. This will include establishing a substantially more robust landscape of learning outcomes than have been used by the department in the past.

Medium-term goals

- Develop new computational and data analytics modules for presenting the Materials AI landscape at the undergraduate level.

Long-term goals

- Focus efforts around creating a 'de-siloed' materials curricular landscape.

Update:

A new course, CHM1449H: Machine Learning and Physics Based View on Chemical Compound Space, has been offered by Prof. von Lilienfeld.

The department will review the structure of its undergraduate curriculum during its next planning phase.

- 3. The reviewers noted a number of ways to better support undergraduate students and reduce stress as they progress through the programs, specifically through targeted retention efforts, by eliminating class rank data and by reviewing workload.**

Regarding class rank data, the department requested that its students be removed from the FASE ranking process in summer 2019. FASE has since removed this ranking for its students.

Workload surveys amongst the upper year MSE undergraduate students showed a striking imbalance in the perceived workload between second year and third year, with the second-year winter presenting the lightest of all eight terms and third year winter presenting the heaviest. As a rebalancing step, the department moved a 'heavier' core course from winter of third year down to the winter of second year and moved an elective up into its place in the spring of 2020. Further refinements to the curriculum are ongoing.

MSE is building new communication channels with students and has expanded the scope and mandate of its Undergraduate Curriculum Committee to become an Undergraduate Studies Committee which now has undergraduate representation. It has also encouraged undergraduate students to develop a formal Undergraduate Academic Advisory Board to highlight and resolve their issues with the intent of partnering with the Undergraduate Studies Committee to find solutions and ensure accountability.

Immediate-term goals

- Hire for an 'active counsellor' position to help more pro-actively create programming and develop mental wellness strategies within the department. This programming will be developed in the context of 'wide learning' as a part of the newly created MSE 296/297 seminar series in collaboration with the Troost Institute for Leadership Education in Engineering (ILead).
- At the Faculty level, incorporate lessons learned from the Decanal Task Force on Academic Workload (struck in January 2020), which is looking into academic workload and to develop strategies to help create a better balance. The Task Force's recommendations are expected at the end of the Fall term.

Medium-term goals

- Implement the newly coordinated undergraduate engagement plan through the Undergraduate Academic Advisory Board.
- Continue developing the MSE 296/297 seminar course platform and integrate with the existing MSE 298 Communications course to fostering greater adaptability and resiliency amongst undergraduate population.
- Engage with outside partners to look for new solutions and develop strategies to enable wider learning.

Long-term goals

- Continue to iterate and re-evaluate program with input from all stakeholders.

Update:

MSE is working to improve the resilience of students from the first year. A new undergraduate advisor has been hired and is effective in counseling. More “out of box” action items are in the planning phase.

All undergraduate students now benefit from a fall study break, which was introduced in September 2020 to improve student wellness.

MSE will continue to identify ways to better support undergraduate students and reduce stress as they progress through the programs during its next planning phase. In doing so, it will consider recommendations made in the [final report](#) of the Faculty’s Joint Task Force on Academic Advising & Mental Health (November 29, 2019), such as the implementation of the Student Self-Declaration of Illness pilot; elimination of student rankings from Engineering web services, creation of an Academic Workload Task Force, etc.

- 4. The reviewers found both the numbers of graduate applicants and the gender diversity of the applicants to be limited. They recommended a concerted effort to increase female student numbers in the MASc and PhD programs. They also recommended generally increasing graduate applicant numbers to ensure quality and increasing the number of graduate students per faculty member.**

The department needs to increase the annual number of graduate applicants in order to be in a position to better address the question of gender diversity. A major effort on this front is to invigorate the departmental website with rich media content that is focussed on telling more compelling stories around the leading-edge research being conducted within the unit. With better and more compelling stories told on its website (for example, properly reflecting its central role in enabling sustainability efforts and to highlight the strength of its innovation portfolio), the department will be able to attract a larger pool of students from which it will be possible to select students for a better gender balance. Likewise, the expanded graduate course offerings, and especially, the new emphasis on Materials AI is designed to entice a greater number of applicants. Increasing the number of graduate students per faculty member hinges upon increasing the amount of research funding available to each faculty member; departmental efforts towards this end are outlined in Section 8.

The department will also highlight the ground-breaking role of its first female faculty member, Ursula Franklin, in the lead up to the centenary of her birth (Fall, 2021). Prof. Franklin was at the leading edge of progressive social initiatives and the department has renamed its graduate seminar series after her to more prominently highlight her pioneering activities.

Immediate-term goals

- Model pathways to graduate school for female undergraduate students using the new seminar series MSE296 as a place for illustrating the career progression of female engineering graduate students.
- At the Faculty level, work with the Equity, Diversity, and Inclusion Action Group (EDIAG) to develop strategies towards addressing gender diversity with an emphasis on supporting student-led initiatives.

Medium-term goals

- Work towards securing more large research grants to support needed funding for new students.
- Continue outreach efforts to promote graduate school to undergraduate students.

Long-term goals

- Set targets, define metrics, encourage year-over-year improvement and accountability.

Update:

MSE alumna, Jacquelyn MacCoon, was the Commencement Speaker for the Spring Convocation Ceremony (June 20, 2023), illustrating the career progression of a female engineering graduate student.

The department will develop new goals to increase the number and diversity of graduate applicants as part of its next planning phase.

5. The reviewers encouraged efforts to reduce PhD time-to-completion, including allowing students to take the qualifying exam earlier.

The department's goal is to build easier and more accessible informational structures and to foster a culture of accountability. Over the summer of 2020 the department built a new SharePoint control platform for managing individual graduate student case files that streamlines the organizational and review process. Each graduate student now has their own SharePoint landing site through which all of their interactions with the department can be coordinated. The site is meant to be a one-stop location for all administrative activities at the graduate level and is color-coded to indicate if the student is falling behind in meeting any of their academic requirements in a timely manner. It is directly accessible to members of each student's advisory committee and can be more easily reviewed and tracked by departmental personnel. In addition, the new site facilitates the collection of statistics across the department and will help enable new accountability measures. While the department was already planning to move in this direction before the pandemic hit, it is an even more timely development given the current COVID-19 landscape.

Immediate-term goals

- Collect statistics on historical graduate times-to-completion and create a time-to-completion index for faculty members with respect to their graduate student supervision to determine how they score, in general, in terms of their graduate student completion rates. This will be part of a new process of generating individual PI accountability statistics that can be reviewed on a year over year basis.

Medium and long-term goals

- Track and review progress; update SharePoint platform as needed.

Update:

Additional efforts to decrease PhD time-to-completion will be considered by the department during its next planning phase.

6. The reviewers made recommendations to improve the graduate curriculum. They found graduate course offerings could be broadened, and they endorsed the idea of having common required core courses to ensure discipline identity.

MSE has created eight new graduate courses in the past year, nearly doubling its annual complement from nine to 17. It has also joined the FASE Artificial Intelligence emphasis by developing three new Materials AI courses, with a fourth being planned. This set of courses first covers how to frame and pose Materials AI questions and then dives deeper into the three broad Materials AI informational “flavours”: process-based, experimental-physics-based, and theoretical-physics-based.

Immediate-term goals

- Create a core graduate course based around thermodynamics that is team-taught and team-developed, to be offered as a pilot in 2021.

Medium-term goals

- The footprint of materials-related research across the University of Toronto is much broader than the activity within the MSE department. The department’s objective is to lead in education across all fronts, offering a graduate-level “introduction to materials thinking” course to non-MSE graduate students doing materials-based research.

Long-term goals

- Continue to update, grow, and develop the new graduate curriculum including creating a collaborative specialization that provides students from MSE and other participating degree programs an additional multidisciplinary experience.

Update:

MSE is considering the creation of a graduate emphasis in scanning electron microscopy and X-Ray diffraction through the instruments available at MSE's Open Centre for the Characterization of Advanced Materials (OCCAM) and its Walter Curlook Lab. This will help increase the footprint of materials-related research beyond the department.

MSE will examine its graduate curriculum and discipline identity during its next planning phase.

7. The reviewers recommended creation of formal mentoring and performance evaluation programs as well as strengthening/expanding the role of committees with active participation of faculty and students.

MSE has taken several steps to expand and strengthen its committees in the last year. It has created a Graduate Studies Committee with graduate student membership and has reconstituted its Undergraduate Curriculum Committee as an Undergraduate Studies Committee with a broader mandate that includes student membership. The Undergraduate Studies Committee will work with the newly forming Undergraduate Academic Advisory Board (also populated by undergraduate students) and similarly tackle undergraduate issues on an ongoing basis. At the executive level, the chair has engaged in ongoing consultation through an active Departmental Executive Committee that is comprised of the chair and associate chairs and meets every week with a mandate to brainstorm ideas about the future of the department. An informal Three Chairs Committee was also created, composed of the chair and the two past chairs who meet as needed to discuss broader strategic directions and how to deal with specific challenging situations.

Immediate-term goals

- The chair will meet with relevant groups across the university to learn best practices on building a formal mentoring program, leveraging existing solutions and finding ways to apply them within MSE.
- Set up new meetings to engage with faculty and review their Activity Reports; have them outline their next steps for research and teaching innovation over the coming years.
- Initiate analogous engagement with the administrative staff under the direction of the director of administration to build an administrative culture of innovation in which MSE's year-over-year target is to make its systems easier to implement.

Medium-term goals

- Maintain and encourage a departmental culture of continuous improvement in all facets of departmental activity.

Long-term goals

- Find new strategies to grow and strengthen a “new normal” of strong committee participation and involvement, with more extensive engagement by faculty.

Update:

MSE will consider performance evaluation and mentorship programs during its next planning phase. Regarding performance evaluation programs, the department will consult the Faculty’s [Guidelines for the Assessment of Effectiveness of Teaching in Tenure, Continuing Status and Promotion Decisions](#) (April 13, 2022) and its [Best Practices for Assessing Teaching Effectiveness in PTR Decisions](#) (February 14, 2023).

8. The reviewers noted that there is a sense of complacency with respect to the department’s research. They noted that there could be improvements in publishing, publicizing research, and partnering with external collaborators.

The second departmental summer retreat (July 22, 2020) was organized around research, with a focus on leveraging local strengths in order to increase the impact of the department’s research, with the department soliciting ‘moonshot materials research initiatives’ that the department could envision tackling together. The department has also created a new Associate Chair, Industrial Relations position to raise funds and create a new departmental research consortium that pools expertise within the department.

Immediate-term goals

- With active leadership from new Industrial Relations Associate Chair, build research consortium and trigger development of new Industrial Advisory Board.

Medium-term goals

- Build international relationships, in particular with its longstanding partnerships with the University of Tokyo.
- At the national level, the department will host the 2021 Canadian Materials Science Conference and the inaugural symposium on Category Theory in Materials Science and Engineering. Amongst other benefits, these events will synthesize the work of MSE’s re-framed graduate seminar series.
- Incentivize new cluster formation by providing additional graduate student support for MSE-led cluster activities, bridging these partnerships to other FASE units.

Long-term goals

- Build on opportunities that emerge from the ‘de-silofication’ initiative merged with Materials AI project work; synthesized year-over year through the department’s group seminar series.

Update:

MSE has expanded collaborations with research institutions and industries in USA, UK, Germany and Japan. MSE faculty members are working on two NSERC/NSF joint proposals. The department also started two research projects as part of the U of T/ Manchester program. PhD graduates are going to Japan and Germany as postdoc fellows. An engineer from Hitachi High Tech Japan is a trainee in MSE for a year, collaborating on the development of new materials characterization platform.

Additional efforts to improve publishing, publicizing research, and partnering with external collaborators will be considered during MSE's next planning phase.

9. The reviewers encouraged strategic planning to guide future hiring, build department cohesion and create a common sense of vision and direction.

Two academic retreats were held in the summer of 2020 to guide decision-making around research and education. The chair recognizes the need to promote faculty engagement and modify elements of departmental culture. To this end he has shortened the length of MSE faculty meetings, increased their frequency and extended them through the summer. In addition, the department has created new opportunities to develop social cohesion within the unit, starting a new 'Last Thursday of the Month' virtual socializing opportunity amongst faculty so that collaborations and ideas within the department can more naturally form.

Immediate-term goals

- The department is on track for four new hires in the Materials AI space, dramatically strengthening its footprint in this key strategic area.
- Encourage and build on new cultural and social engagement, including the creation of new spaces and opportunities for people to more naturally collaborate.
- Create a formal Industrial Advisory Board and Research Consortium for the department.

Medium-term goals

- Help faculty members develop their own initiatives and incentive cluster-based activities.
- Develop new ways to track departmental performance (new metrics) and build accountability against these into MSE's mission statement.

Long-term goals

- Formalize a culture of continuous departmental self-improvement and self-accountability; continually check where the department wants to go next.

Update:

MSE will consider holding another strategic retreat as part of a robust re-evaluation of the department's research and education activities.

Implementation of goals set out in department/institute FAR/IPs is monitored through annual meetings between the Dean and chairs/directors.

Sincerely,



Christopher Yip
Dean

cc:

David Lock, Coordinator, Academic Planning & Reviews

Emma del Junco, Coordinator, Academic Planning & Reviews

Professor Hani Naguib, Chair, Department of Materials Science & Engineering

Caroline Ziegler, FASE Governance & Programs Office