

# UTQAP Cyclical Review: Final Assessment Report and Implementation Plan

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## 1. Review Summary

<b>Programs Reviewed:</b>	Materials Engineering, BSc Materials Science & Engineering, MEng Materials Science & Engineering, MSc Materials Science & Engineering, PhD
<b>Unit Reviewed:</b>	Department of Materials Science & Engineering
<b>Commissioning Officer:</b>	Dean, Faculty of Applied Science & Engineering
<b>Reviewers (Name, Affiliation):</b>	<ol style="list-style-type: none"><li>1. Prof. Angus Rockett, Head, Metallurgical &amp; Materials Engineering, Colorado School of Mines</li><li>2. Prof. George Demopoulos, Chair, Mining &amp; Materials Engineering, McGill University</li><li>3. Prof. Amit Misra, Chair, Materials Science &amp; Engineering, University of Michigan</li><li>4. Prof. Mary Wells, Dean, College of Engineering &amp; Physical Sciences, University of Guelph</li></ol>
<b>Date of Review Visit:</b>	February 25 - 26, 2019
<b>Date Reported to AP&amp;P:</b>	October 27, 2020

## Previous UTQAP Review

**Date:** May 13 - 14, 2013

### Summary of Findings and Recommendations

#### **Strengths:**

- Many well-structured, interactive and innovative learning opportunities available to undergraduate students
- Strong, highly productive research programs
- Positive morale in the faculty complement

#### **Opportunities for Program Improvement and Enhancement:**

- Reforming undergraduate curriculum to both streamline offerings and better position courses within the programs
- Creating a core set of graduate courses and regularizing the offering of specialized graduate courses
- Better allocating space to encourage research programs of newer faculty
- Updating undergraduate laboratory spaces
- Creating a mentoring program for new faculty
- Offering equity and diversity training to search committees
- Making strategic junior faculty hires and increasing the complement of computational materials professors

## Current Review: Documentation and Consultation

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### Documentation Provided to Reviewers

- Confirmation Letter; Terms of Reference; Self-Study Report; Faculty CVs; Itinerary
- Previous External Review (May 13-14, 2013) Report; Dean's Response; Final Assessment Report and Implementation Plan
- FASE Academic Plan; Annual Report; Undergraduate and Graduate Calendars
- University of Toronto Towards 2030
- University of Toronto Quality Assurance Process

### Consultation Process

During the visit, the review team met with:

- Prof. Cristina Amon, Dean
- Prof. Jun Nogami, MSE Chair
- Vice-Dean, Undergraduate; Vice-Dean, Graduate Studies; Vice-Dean, Research
- Associate Chair, Undergraduate; Undergraduate Advisor

- Associate Chair, Graduate Studies; Graduate Program Counsellor & Administrator
- Graduate and undergraduate students
- Pre-tenure, assistant, tenured and teaching stream professors
- Department administrative staff
- Department technical staff
- Chairs and directors of cognate departments and institutes within the Faculty

## Current Review: Findings and Recommendations

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### 1. Undergraduate Program

The reviewers observed the following **strengths**:

- Objectives
  - ▶ Well-aligned with Canada's strong mineral/metal resource sector and manufacturing/industrial activity
  - ▶ Curriculum revisions and hiring in sustainable processing and extraction give graduates better preparation for employment
  - ▶ Positive to CEAB accreditation visit outcome
- Admissions requirements
  - ▶ Consistent with other similar engineering programs across Canada
- Curriculum and program delivery
  - ▶ Large number of optional minors and certificates across the Faculty offer great opportunities for the undergraduates
- Accessibility and diversity
  - ▶ Number of female students in MSE is on par with other materials departments across Canada
- Student engagement, experience and program support services
  - ▶ High levels of employment, suggesting that the educational experience, while stressful, has broad success
  - ▶ Effective undergraduate advising process that monitors students regularly and addresses problems as they arise
- Quality indicators – undergraduate students
  - ▶ Steady number of high quality applicants
  - ▶ Strong participation of students in the Professional Experience Year (PEY) option, up to 70%, with the grand majority of them (87%) completing their degree on-time within five years

The reviewers identified the following **areas of concern**:

- Objectives
  - ▶ Program does not seem to be focused on advancing beyond its current position
- Curriculum and program delivery
  - ▶ Relatively little access to research opportunities

- ▶ Deficient design emphasis with very few students taking part in a capstone final design experience
- ▶ Unclear amount of teamwork capstone/thesis project experiences
- ▶ Interdisciplinary “capstone design” project offered via MIE has limited capacity to accept MSE students, leaving out a lot of MSE students
- ▶ Four theme areas, though appropriate, do not seem to connect well with current faculty distribution
- Innovation
  - ▶ Content and mode of delivery for most courses appears to be relatively unchanged over many years
- Student engagement, experience and program support services
  - ▶ Students experience high levels of stress and workload, with little time for enrichment opportunities
  - ▶ Students who are not obviously in trouble have to be proactive to obtain personal advising
- Quality indicators – undergraduate students
  - ▶ Net decrease of the students entering second year, indicating program is not attractive for Track One or Engineering Science students
  - ▶ Data provided make it unclear what graduation rates are
  - ▶ Only ~50% of non-PEY students complete their studies on-time (4 years) and 85% after 5 years
  - ▶ Roughly 10% net loss of undergraduates through the course of their studies

The reviewers made the following **recommendations**:

- Curriculum and program delivery
  - ▶ Find more opportunities to get involved in research, mentored by MSE faculty, both during summers and the academic year
  - ▶ Consider introducing a departmental capstone design project course to replace the Thesis project course
  - ▶ Add undergraduate student representation to the Curriculum Committee for student input; current Curriculum Committee should evolve into an Academic Committee dealing with all aspects of the undergraduate program
  - ▶ Engage in more use of student data to enhance tracking of student progress and reduce enrollment losses
  - ▶ Improve teaching efficiency by optimizing offerings to avoid “oversupply” of technical complementaries as is the case in year three
  - ▶ Review the amount of teaching effort required for the minors and certificates and whether that places an undue burden on their ability to offer MSE-specific graduate courses and electives
  - ▶ Conduct regular surveys of recent graduates and peer institutions to assess best practices and lead to curriculum revisions
- Innovation
  - ▶ Pursue new teaching and learning techniques as identified in the Faculty’s Transformative Teaching and Learning initiatives

- Student engagement, experience and program support services
  - ▶ Consider eliminating providing class rank data to each student as this appeared to create a more competitive environment amongst the students
  - ▶ Consider reviewing student workloads in an effort to increase engagement in enrichment opportunities
- Quality indicators – undergraduate students
  - ▶ Review undergraduate time to graduation statistics and trends to determine if MSE graduation rates are consistent with those across the Faculty
  - ▶ Examine why MSE is not attractive for Track One students
  - ▶ Examine how non-PEY graduation rates can be improved

## 2. Graduate Program

The reviewers observed the following **strengths**:

- Accessibility and diversity
  - ▶ MEng program appears to attract significant female participation
  - ▶ Significant lack of diversity among the graduate students by comparison to the undergraduates
- Student engagement, experience and program support services
  - ▶ Advising process seems to be working well and has an appropriate process for evaluating student progress
- Quality indicators – graduate students
  - ▶ Students are successful at getting jobs in the field

The reviewers identified the following **areas of concern**:

- Admissions requirements
  - ▶ Applications are limited; most faculty recruit students using individual efforts
- Curriculum and program delivery
  - ▶ Graduate course offerings are still limited
  - ▶ Acceptable but not uniquely novel or leading program structure, faculty research, or quality enhancement to ensure the intellectual quality student experience
  - ▶ Relatively high time to completion for PhD
  - ▶ Core graduate courses have not been implemented and remain an important goal for the graduate program, providing foundational material for students entering from other disciplines and a unified identity for the graduates, and building community regardless of focus area
- Accessibility and diversity
  - ▶ Limited gender diversity, particularly for MASc and PhD, relative to undergraduates and other programs across Canada
  - ▶ No evidence of making the program more accessible
  - ▶ Structural or funding issues limit enrollment of international students
- Student engagement, experience and program support services

- ▶ Significant capacity to increase levels of doctoral student supervision from the current 2.5-3/faculty to twice that to reach other peer research intensive Universities like McGill
- ▶ Unclear faculty commitment to student mentoring
- Quality indicators – graduate students
  - ▶ PhD enrollment is low for a department this size

The reviewers made the following **recommendations**:

- Curriculum and program delivery
  - ▶ Consider introducing one or two common foundational courses that all grad students take, enhancing shared identity and uniformity of expectations
- Accessibility and diversity
  - ▶ Make a concerted effort to increase female student numbers in MASc and PhD programs
- Student engagement, experience and program support services
  - ▶ Ensure that graduate students are more involved in curriculum and departmental planning activities; add a graduate student representative on the Departmental Graduate Affairs Committee and the Departmental Curriculum Committee
  - ▶ Establish a Graduate Studies Committee with student representation; encourage them to reduce time to completion for doctoral students by one year
  - ▶ Establish a plan allows PhD students to take the QE earlier
- Quality indicators – graduate students
  - ▶ Make more use of statistics to evaluate key points for intervention to improve time to completion
  - ▶ Increase numbers of applicants to ensure higher quality

### 3. Faculty/Research

The reviewers observed the following **strengths**:

- Overall quality
  - ▶ High quality faculty with notable levels of accomplishment
- Research
  - ▶ Exceptionally large number of patents
  - ▶ Strong connections to other departments across campus
- Faculty
  - ▶ Chair is the main mentor for junior faculty
  - ▶ Reasonable faculty complement plan
  - ▶ Positive plan to hire additional faculty in process metallurgy as well as in computational materials science

The reviewers identified the following **areas of concern**:

- Research
  - ▶ Lack of interest in the external environment and the capabilities of competitors on the part of the faculty has led to a sense of complacency and lack of initiative

- ▶ Very low number of graduate students in the Department relative to the research volume, suggesting that the faculty are leaning more to bringing in students from other departments, especially in the biomaterials area
- ▶ Very little undergraduate research except limited experiences in summer sessions and senior thesis
- ▶ Recognition of research (invited talks, citations to publications, and overall level of funding) is low relative to the University of Toronto's reputation and the Department's aspirational goals
- ▶ Characterization instrumentation is limited
- Faculty
  - ▶ New interdisciplinary cross-appointed faculty with MSE, while a good idea, lacked clarity; involvement seems to be limited to participation in teaching
  - ▶ Relatively low number of graduate students per faculty member
  - ▶ Teaching efforts are still largely devoted to undergraduate courses
  - ▶ Limited progress made in hiring computational materials science and engineering faculty relative to its rapid growth and large workforce

The reviewers made the following **recommendations**:

- Research
  - ▶ Resume leadership in driving intra-Faculty collaborative efforts at the level of Research Institutes or Centres
  - ▶ FASE to address support of central research facilities and in particular the cost of operation of large materials characterization equipment like the TEM
  - ▶ Dean and VPRI to provide leadership on interdisciplinary research and centres of research excellence
  - ▶ Increase large scale research team activities in addition to individual research projects
- Faculty
  - ▶ Active participation of cross-appointed faculty in co-supervision or joint committees should be encouraged
  - ▶ Pursue plans to hire in the computational and characterization areas
  - ▶ Engage in partnership with other units for hiring in energy materials area
  - ▶ Establish formal mentoring and performance evaluation mechanisms
  - ▶ Strengthen/expand the role of committees with active participation of faculty and students
  - ▶ Ensure technical staff report to academic lab directors, not the chair
  - ▶ Ensure Department receives more credit for the activity of the split appointees, especially as these represent roughly 1/4 of the entire faculty in the Department; should include credit for graduate students advised, funds raised, service activities and courses taught
  - ▶ Strengthen the diversity of the faculty
  - ▶ Create formal mentoring and performance evaluation programs
  - ▶ Incorporate computational materials and materials and mineral processing into the department

- ▶ Develop a strategic plan to guide future hiring in strategic areas such as computational materials science

## 4. Administration

The reviewers observed the following **strengths**:

- Relationships
  - ▶ Department is functioning well; general sense of contentment among the entire MSE community
  - ▶ Department contributes extensively to FASE through collaborations, course offerings, and its own degrees
  - ▶ Students are successful in getting jobs in the materials engineering field
  - ▶ Staff (both administrative and technical) seem highly positive and excited and the morale is high; faculty seem content and collegial
  - ▶ Relationships with other FASE academic units are collaborative and appear to value the MSE Department
  - ▶ Addition of new extractive metallurgy faculty strongly adds to department's social impact
  - ▶ Applied research nature of new faculty provides opportunities for industrial support
- Organizational and financial structure
  - ▶ Excellent, engaged Department Chair is appreciated by everyone, works hard, and is dedicated to enhancing the Department's performance
  - ▶ Addition of an external relations staff member was a positive step and will be critical to improving the reputation of the Department in the broader community and developing industrial connections and support of student and faculty interactions with industry
  - ▶ Administrative staff is well organized and functions as an effective team
  - ▶ Technical staff also works well with the faculty in all areas and are to be highly commended
  - ▶ Resource allocation has been managed well
- Long-range planning and overall assessment
  - ▶ Commendable that the Faculty maintains an independent department in this area with a dedicated faculty, curriculum at all levels, and valuable degrees, especially considering the tuition cuts announced by the Province of Ontario
  - ▶ Department's strengths relate to its diversity of research areas, the positive attitude of the faculty and staff, and the willingness to work hard on the part of the students
  - ▶ Undergraduate program is strong and has an effective enrollment strategy
  - ▶ MEng graduate program has high levels of enrollment; significant fraction of those students are international and represent a financial resource to the Department
  - ▶ Program is strong and making positive changes
- International comparators
  - ▶ Compares well with other national programs



The reviewers identified the following **areas of concern**:

- Relationships
  - ▶ Students indicate that they are overworked and stressed
  - ▶ Faculty do not seem highly motivated or driven
  - ▶ Interactions with cognate Faculties seem to be primarily through pre-existing formal relationships (i.e., joint appointments)
  - ▶ General lack of team-based, large scale research targeted at problems beyond the capability of individual faculty
  - ▶ Limited evidence of FASE departments collaborating strategically to leverage each other to achieve common goals in research excellence; could change as resources become more restricted
  - ▶ Modest level of collaboration with external research groups
- Organizational and financial structure
  - ▶ Concerns about financial support of the microscopy facility going forward
- Long-range planning and overall assessment
  - ▶ Lack of unsolicited graduate applications at the PhD level, with faculty doing individual recruiting of applicants by personal contact, limiting the applicant pool
  - ▶ Significant progress has been made in reducing the additional cost burdens for Visa PhD students
- International comparators
  - ▶ Mid-level 'average' department when compared to peer institutions in North America
  - ▶ Limited partnerships in comparison to other institutions in Canada and elsewhere
  - ▶ Lower numbers of typical achievement metrics relative to peers

The reviewers made the following **recommendations**:

- Relationships
  - ▶ Ensure that the external relations staff member works with the Department to improve awareness of the faculty and their research
  - ▶ Improve upon external partnerships and relationships to enhance the profile of the department, both on a national and international level
  - ▶ Develop areas of social impact more fully
  - ▶ Highlight the strength in extractive metallurgy across campus, as there is a significant presence in other departments; advertise these faculty as a unit
  - ▶ Ensure faculty are more involved in external collaborations and national/international leadership efforts in professional societies and related activities, to raise the profile of the MSE department externally
- Organizational and financial structure
  - ▶ Use Department surplus funds to address important recommendations including support of Visa students and others, renovation of teaching facilities, support for faculty travel, etc.
  - ▶ Create more effective advertising, billing and booking for materials characterization facilities to generate significant revenues

- ▶ Make efforts to ensure smooth leadership transitions and avoid major changes in direction in the short term
- ▶ FASE/VP-Research administration to develop a plan for subsidy and centralized support of essential materials analysis facilities across campus; account for this support when new instrument purchases are authorized
- Long-range planning and overall assessment
  - ▶ Engage more with other departments in Canada to promote applications from other schools
  - ▶ Continue efforts to reduce cost burdens with Visa PhD students
  - ▶ Continue additional efforts to diversify the faculty
  - ▶ Prepare a strategic plan, led by new department chair, and involving all staff; hold a retreat within the first six months of new chair's appointment, bolstering faculty engagement in the planning process
  - ▶ Foster awareness among the faculty of their status relative to peer institutions
  - ▶ Ensure faculty are more engaged with and leading most aspects of planning
  - ▶ Implement a strategic planning process incorporating active faculty and staff involvement to build stronger departmental cohesion and a common sense of vision and direction

## 2. Administrative Response & Implementation Plan



### UNIVERSITY OF TORONTO FACULTY OF APPLIED SCIENCE & ENGINEERING

September 23, 2020

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

Dear Professor McCahan,

I write in response to your letter of February 18, 2020 regarding the February 2019 external review of the Department of Materials Science and Engineering (MSE) and its undergraduate and graduate programs.

The external review process is a valuable exercise that affords us the opportunity to take stock of the state of our academic units and of the Faculty as a whole. We appreciate the time and effort spent by the external review team – Professors George P. Demopoulos, Amit Misra, Angus Rockett and Dean Mary Wells – before, during and after their visit, and we are pleased with their positive assessment of the strength of the department. In particular, we appreciate their comments on the department’s positive atmosphere and excellent leadership, diversity of research areas and exceptionally large number of patents, strong connections to other departments across campus, and the success its graduates have in securing jobs in the materials engineering field.

This administrative response was written in consultation with Prof. Glenn Hibbard, chair of the Department of Materials Science and Engineering since 2019-2020, who submitted his unit response on September 15, 2020. The most serious deficiency identified by the review team was a sense of complacency within the department. In his response, Prof. Hibbard outlined an ambitious plan to capitalize on the changing nature of the MSE landscape within the context of the new Materials AI. In particular, he discusses the ‘silo-fication’ that has emerged in MSE and its programs over time, which is behind many of the review team’s observations. Prof. Hibbard’s innovative plan is to incorporate ideas from outside MSE as the foundation of a research and pedagogical innovation strategy towards decreasing this ‘silo-fication’.

The following responses incorporate the department’s immediate- (within six months), medium- (one to two years) and long-term (three to five years) plans to emphasize creativity and innovation across all operations (e.g., undergraduate and graduate education, research, outreach and service). I am in support of these plans, and, where appropriate, have added measures where the Faculty can assist.

**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.

- 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 student 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-silofied' materials curricular landscape.

- 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.
- 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 MSE 296 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.

### **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.

### **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.



**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.

**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.

### **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.

The next review of the Department of Materials Science and Engineering and its programs is scheduled for the 2026-2027 academic year. In the interim, the chair of the department will report to me on progress made toward the implementation of recommendations on an annual basis, and I will submit an interim report to you in the 2022-2023 academic year, midway between the 2018-2019 review and the next site visit. This review will be discussed at the October 27, 2020 AP&P meeting. I will be in attendance, along with MSE chair, Professor Glenn Hibbard.

Attached is the draft summary of the review, which has been reviewed for tone and accuracy and with requested information provided.

Thank you for the opportunity to respond to the report of the external review team. Their comments and recommendations have helped sharpen the vision and future priorities for the Department of Materials Science and Engineering.

Sincerely



Christopher Yip  
Dean

cc:

Daniella Mallinick, Director, Academic Programs, Planning and Quality Assurance  
David Lock, Coordinator, Academic Planning and Reviews  
Emma del Junco, Assistant Coordinator, Academic Planning and Reviews  
Professor Glenn Hibbard, Chair, Materials Science & Engineering  
Caroline Ziegler, Governance and Programs Officer

Attachments:

FAR/IP draft summary  
Unit administrative response

### **3. Committee on Academic Policy & Programs (AP&P) Findings**

The spokesperson for the Reading Group reported that the summary covered the full Review. The Group agreed that the Dean's administrative response fully addressed the issues identified.

Dean Christopher Yip indicated that he was pleased with the review and that an interim report would be issued by his office in 2022-23 to provide updates on departmental initiatives.

Professor Glenn Hibbard, Chair of the Department, offered comments with respect to one written ancillary comment from the Reading Group pertaining to increased connections between the Department and industry. He noted that an Associate Chair had been hired to focus specifically on industrial relations and to examine ways to capitalize on the increasing prevalence of artificial intelligence in the field and how to increase industry connections in this area.

No follow-up report was requested.

### **4. Institutional Executive Summary**

The reviewers highlighted the department's positive atmosphere and excellent leadership, and found the faculty, staff, and students to be hardworking and generally content; they noted that faculty work in diverse research areas and hold an exceptionally large number of patents, and the success that graduates have in getting jobs in the materials engineering field. The reviewers recommended that the following issues be addressed: addressing an overall sense of complacency, and emphasizing creativity and innovation across all operations; enhancing access to research opportunities, team activities, capstone projects and pedagogical innovation in the undergraduate program; addressing the restrictive structure of the undergraduate curriculum, which reduces access to other curricular opportunities such as minors or certificates; enhancing undergraduate student support and reducing student stress as they progress through the programs; making a concerted effort to increase gender diversity in the MASc and PhD programs, and generally increasing graduate applicant numbers; enhancing efforts to reduce PhD time-to-completion; improving the graduate curriculum by broadening course offerings, and establishing common required courses to ensure discipline identity; creating formal mentoring and performance evaluation programs, as well as strengthening/expanding the role of committees with active participation of faculty and students; addressing issues of complacency with respect to the department's research; and conducting strategic planning to guide future hiring, build department cohesion and create a common sense of vision and direction.

The Dean's Administrative Response describes the Faculty, unit and programs' responses to the reviewers' recommendations, including an implementation plan for any changes necessary as a result.

## **5. Monitoring and Date of Next Review**

The chair of the department will report to the Dean on progress made toward the implementation of recommendations on an annual basis, and the Dean will submit an interim report to the Vice-Provost, Academic Programs no later than the 2022-2023 academic year, midway between the 2018-2019 review and the next site visit.

The next review of the Department of Materials Science and Engineering and its programs is scheduled for the 2026-2027 academic year.

## **6. Distribution**

On June 30, 2021, the Final Assessment Report and Implementation Plan was posted to the Vice-Provost, Academic Programs website and the link provided by email to the Dean of the Faculty of Medicine, the Secretaries of AP&P, Academic Board and Governing Council, and the Ontario Universities Council on Quality Assurance. The Dean provided the link to the Chair of the Department.