UTQAP Cyclical Review: Final Assessment Report and Implementation Plan

1. Review Summary

Programs Reviewed:	Computer Engineering, BASc Electrical Engineering, BASc Electrical and Computer Engineering, MEng Electrical and Computer Engineering, MASc Electrical and Computer Engineering, PhD
Unit Reviewed:	The Edward S. Rogers Sr. Department of Electrical & Computer Engineering
Commissioning Officer:	Dean, Faculty of Applied Science & Engineering
Reviewers (Name, Affiliation):	1. Professor Ivan Fair, Professor and Chair, Electrical and Computer Engineering, University of Alberta 2. Professor Sarah Rajala, James L. and Katherine S. Melsa Dean of Engineering, Iowa State University 3. Professor T.E. (Ed) Schlesinger, Professor and Benjamin T. Rome Dean, Electrical and Computer Engineering, Whiting School of Engineering, Johns Hopkins University
Date of Review Visit:	June 18 – 19, 2018

Previous UTQAP Review

Date: May 22 – 23, 2013

Summary of Findings and Recommendations

Program Strengths

- Internationally well-recognized academic programs
- Program objectives, admissions process, and degree-level expectations favourably evaluated by the Canadian Engineering Accreditation Board (CEAB)
- High-impact, high-quality research
- Students' positive assessment of faculty members' teaching and research

Opportunities for Program Improvement and Enhancement

The reviewers recommended that the following be considered:

- Finding the appropriate balance between teaching and research workload
- Removing barriers to interdisciplinary research and longer-term, high-risk research endeavours
- Enforcing deadlines and timelines for graduate review committee meetings, impacting progress in students' doctoral studies
- Attending to variations in graduate student funding levels
- Strengthening graduate student advising
- Examining the "big jump" between the first and second year in the undergraduate program and the level of required courses in the second year

Current Review: Documentation and Consultation

Documentation Provided to Reviewers

The reviewers were provided with:

- CVs of Electrical and Computer Engineering Faculty
- FASE Academic Plan, 2017-2022
- FASE Undergraduate Calendar, 2017-2018
- Itinerary
- Review Report Template
- Self-study
- Terms of Reference

- University of Toronto Graduate Calendar, 2017-2018
- University of Toronto Quality Assurance Process (UTQAP)
- University of Toronto Towards 2030 - Synthesis
- University of Toronto Towards 2030 – View from 2012 (Progress Report)

Consultation Process

The reviewers met with:

- FASE Dean Cristina Amon
- FASE Vice-Deans of Graduate Studies, First-Year Engineering, and Research
- ECE Chair Farid Najm
- ECE Associate Chair and staff related to undergraduate studies
- ECE Associate Chair and staff related to graduate studies
- ECE Associate Chair and staff related to research
- ECE undergraduate students in the computer engineering and electrical engineering BASc programs
- ECE graduate students in the computer and electrical engineering MEng, MASc and PhD programs
- ECE administrative and technical support staff
- ECE professors (pre-tenure and tenure-stream)
- Chairs and Directors of other FASE departments, divisions and institutes, and Chair of the FAS Computer Science department
- FASE Advisory Search Committee for the Chair of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering

Current Review: Findings and Recommendations

1. Undergraduate Program

The reviewers observed the following **strengths:**

- Admissions requirements
- High demand for programs and high admission requirements
- Curriculum and program delivery
- Good curricular flexibility
- Innovation
- Impressive investments made to improve undergraduate labs, specifically robotics and energy systems
- Quality indicators – undergraduate students
- Programs attract the most highly qualified students with strong academic records

- Most students complete the program in an expected timeframe

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

- Admissions requirements
- Maintaining a high admission requirements, specifically the high GPA requirement, may exclude other well-rounded students who would excel in engineering studies
- Curriculum and program delivery
- While the reviewers understood the history of offering two degree programs, they question whether it makes sense moving forward to offer one program in electrical and computer engineering, especially given the flexibility within the undergraduate degree programs
- Last curriculum overhaul was 15 years ago
- Introduction of math and computing science courses within the department does not seem optimal
- Quality of Teaching Assistants varies largely based on the individual's initiative
- Innovation
- While improvements to some labs have been made, students still observed some ongoing equipment failures

The reviewers made the following **recommendations**:

- Admissions requirements
- If the high GPA admission standard is maintained, consider promoting program as focused on producing career researchers
- Curriculum and program delivery
- Consider feasibility of providing academic credit for students who complete a research project with a faculty member
- Advocate to the Canadian Engineering Accreditation Board (CEAB) to offer one degree program in electrical and computer engineering
- Review curriculum and consider ways to emphasize "modes of thought" meaning not just "what we teach" but also "how we teach"
- Consider benefits of students taking courses from outside the department
- Increase investment in systematic training of Teaching Assistants, for both lab and seminar instruction
- Innovation
- Enhance efforts to secure additional internship opportunities
- Quality indicators – undergraduate students
- Other than CEAB "Graduate Attributes, it is unclear how proficiency is evaluated in graduating students
- Potential impact on curriculum development due to the collection of Graduate Attributes

2. Graduate Program

The reviewers observed the following strengths:

- Student funding
- Financial support is a considerable advantage compared to many other programs in North America

The reviewers identified the following areas of concern:

- Curriculum and program delivery
- Requiring all PhD courses to be completed before the qualifying exam seems "restrictive"; courses that may assist with the dissertation may emerge as students complete thesis work
- Department practices and expectations seem to vary based on which research area the student belongs to
- Student engagement, experience and program support services
- Supervisory committee meetings are not always held annually and students would benefit from additional guidance and program structure
- Quality indicators – graduate students
- PhD time to completion seems "excessive"
- No data on graduate outcomes of master's students who do not pursue a PhD

The reviewers made the following recommendations:

- Curriculum and program delivery
- Consider relaxing the timeline for the PhD program requirements to allow students to complete courses before and after the qualifying exam; reconsider the number of required courses for the PhD
- Ensure program requirements are clearly articulated on the department website
- Innovation
- Enhance efforts to secure additional internship opportunities
- Student engagement, experience and program support services
- Ensure supervisory committee meetings are held on an annual basis
- Provide a support person, like an ombudsperson, for PhD students to raise their concerns to
- Quality indicators – graduate students
- Work towards reducing PhD time to completion to closer to 5-years to ensure international competitiveness
- Track employment and salary outcomes of MASc and MEng graduates who do not pursue a PhD; evaluate whether there is a difference in the marketplace and if the department should continue to offer both degrees
- Student funding

- Ensure funding levels are reviewed regularly to ensure they remain sufficient to cover the cost of living in Toronto

3. Faculty/Research

The reviewers observed the following **strengths**:

- Overall quality
- Considerable number of distinguished faculty members
- Research
- High level of research activity
- Researchers are strong in their individual areas of expertise

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

- Overall quality
- Reviewers were not clear what metrics were used to measure faculty performance
- Research
- Faculty research programs seem “highly individualistic”, and there is unrealized potential to create focused areas of research strength in the department
- Faculty
- Faculty members seem dismissive about the role of technology in teaching and education

The reviewers made the following **recommendations**:

- Overall quality
- If faculty engage in additional outreach activities, these should contribute to the evaluation of faculty performance
- Research
- Encourage faculty to pursue common research goals, allowing for greater research impact
- Seek buy-in among faculty to establish the department as the “go-to” for defined research areas
- Maintaining position as a leader in the field may require shifting away from individual research emphasis to a focus on combined research efforts
- Consider strategic new hires that focus on research areas and collaboration, rather than simply making “replacement” hires for faculty who retire or leave; consider ways to refresh the faculty complement and balance full professors with early career faculty
- Faculty

- Empower teaching-stream faculty to introduce innovative teaching methods, and provide these faculty with time to work on the scholarship of teaching
- Institute formal and informal faculty mentoring programs

4. Administration

The reviewers observed the following **strengths**:

- Relationships
- Clear sense of community within the department
- Chair is commended for work to affect change within NSERC, and is encouraged to continue such efforts
- Organizational and financial structure
- New space in the Myhal Centre presents many new opportunities to benefit undergraduate and graduate students, such as new learning spaces, additional support for student clubs, and enhanced use of technology
- Faculty and staff have strong confidence in leadership, and feels well supported by them and that they also have a voice
- Impressive transparency in departmental resource allocation

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

- Relationships
- Graduate students reported feeling left out of program and policy discussions and decisions
- Unclear what outreach activities are being undertaken, and materials were not provided to the reviewers on this topic
- Organizational and financial structure
- Faculty and students are concerned over increasing administrative burdens, and feel that more services could be streamlined and available online
- Long-range planning and overall assessment
- Unclear Department mission:
- As a top Department internationally, there is untapped potential (and an "obligation") to be a leader in education, student experience, and social impact
- Lack of consideration for potential future "threats" to educational costs, delivery, international competition, research funding, and opportunities, which are currently being discussed among US peer schools
- Somewhat conservative and comfortable with the traditional notion of scholarship
- Departmental "areas" may be too dominant and restrict administrative planning and research expansion

The reviewers made the following **recommendations**:

- Relationships
- Strengthen department's relationships with its graduate students by seeking regular input from them
- While the department already does a good job of celebrating faculty and staff accomplishments, it is encouraged to promote accomplishments even more to further develop the sense of community
- Establish an outreach program, leveraging the learning and successes of others, and working to form new partnerships
- Organizational and financial structure
- Long-range planning and overall assessment
- Clearly articulate a Department mission, vision and purpose that:
- Considers "calculated risks" in advancing educational delivery, research pursuits, and maximizing benefits to society
- Identifies areas where Department can become a "world leader" (such as emerging important technological developments in transportation, healthcare, energy and autonomous machines) and encourage faculty to work towards these goals
- Explores opportunities for large-scale collaborations with other U of T units, including cognate units at the Faculty
- Seizes the opportunity to become a model for other Canadian engineering departments, and consider how to respond to new online and distance programs that are entering the marketplace
- Explore further development opportunities within alumni body

2. Administrative Response & Implementation Plan

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

March 11, 2019

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

Dear Professor McCahan

I write in response to your letter of February 5, 2019 regarding the June 18-19, 2018 external review of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering 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 are extremely pleased with the reviewers' positive assessment of the strength of the department, particularly the excellent quality of its students and faculty, the flexibility of its undergraduate curriculum, and its overall sense of community.

This administrative response was written in consultation with the department chair and advisory committee, which includes faculty representation from the department's eight research groups. Below I address the issues raised by the reviewers.

1. **The reviewers emphasized the need for the department to refine its mission, and they encouraged the department to take "calculated risks" on how education and research are delivered and conducted. They noted the unit's untapped potential and opportunities for new areas of research collaboration and expansion. How does the unit plan to address these overarching recommendations and leverage its work to maximize its impact?**

The next leadership team will craft a mission statement and academic plan building on the Faculty's *Academic Plan 2017-2022* and the University of Toronto's *Towards 2030: Long-term Planning Framework*. We will create incentives for faculty members to try new teaching methods like active learning and project-based learning. We will also select new research themes and develop incentives for faculty members to work in these areas, capitalizing on the strength of collaboration to address high-impact problems.

Immediate-term goals (within six months)

- Hold a teaching workshop for ECE faculty members to discuss the topic of active and project-based learning. Invite ECE faculty members who have been using these innovative teaching methods to give presentations and help run the workshop.

OFFICE OF THE DEAN, 44 St. George Street, Toronto, ON M5S 2E4 Canada
Tel: +1 416 978-3131 • Fax: +1 416 978-4859 • dean.engineering@ecf.utoronto.ca • www.engineering.utoronto.ca

Medium-term goals (within one to two years)

- Develop pilot programs to include active and project-based learning in a number of ECE courses, spanning the four years of the program.
- Hold an ECE research retreat to identify new research areas in which the department should establish a focus and should create incentives for faculty members to work and collaborate. Encourage collaboration by targeting areas that require expertise from a wide variety of ECE research areas.
- Develop incentive programs for research collaboration in the identified areas, including faculty from other departments if applicable.

Long-term goals (within three to five years)

- Assess courses that have incorporated active and project-based learning to examine the success and impact of these curricular changes.
- Assess the results of the research incentive programs developed earlier, by the extent of collaboration and grant funds that have been raised.

2. The reviewers observed the lengthy time-to-completion for PhD students. How does the department plan to address this and the need for supervisory committee meetings, which students clearly want?

The average time-to-completion in the ECE department's PhD program is approximately five years, indicating that some students must be taking longer than that to complete their degree requirements. We acknowledge that we can support these students to move more quickly towards their graduate study goals and have been working to address this issue over the last several years. The department began developing a software system (GRID) for tracking student performance about four years ago. The system will help students maintain good progress towards their goals by functioning as a central hub where faculty members, students and the graduate office staff can communicate, submit material for review, make assessments, schedule supervisory committee meetings, etc. The system will also help the graduate office ensure compliance with the requirement of having an annual supervisory committee meeting for all PhD students, by providing reminders for everyone involved and raising flags when deadlines are missed. Perhaps because of the ambitious goals of the system, repeated deployments of prototypes of this system have fallen short of expectations and generated new requests for additional features or for revised interfaces. The latest iteration is slated for deployment in April 2019. In the meantime, an alternative system (PhD Project Tracker) has recently become available from SGS that may serve the goals equally well, although it is too early to tell.

Immediate-term goals (within six months)

- Deploy the latest prototype of the GRID system and assess the success of this tool by surveying stakeholders, including students, faculty members and admin staff.

Medium-term goals (within one to two years)

- Assess the newly introduced SGS system and compare it to the GRID system, considering features, usability and flexibility. Arrive at a recommendation to either adopt the SGS system or the GRID system.
- Deploy the software for use by all graduate students and supervisors in ECE, and embark on a full year deployment cycle where incoming new students would use this system at the start of their graduate studies.
- At the end of two years, assess the utility of this system, with possible suggestions for improvements, if needed.

Long-term goals (within three to five years)

- In the longer term, the system will have been in use by virtually every student in the cohort for the duration of their graduate studies. Assess the impact of this tool on the time-to-completion.

3. How does the department plan to clarify expectations for faculty performance?

We regret that the reviewers did not receive a full description of the department's expectations for faculty performance. It may be that the faculty members with whom they met were not well informed about this. In response, we will improve our communications with faculty members to ensure everyone understands these expectations.

Immediate-term goals (within six months)

- Hold a meeting for ECE faculty members to discuss the expectations and metrics for faculty performance, covering tenure review, PTR and promotion.

Medium-term goals (within one to two years)

- Develop and disseminate communications material (e.g., on the department's internal website) to keep faculty members informed on this issue.
- Incorporate discussions on these expectations into the chair's regular mentoring meetings with junior faculty.

Long-term goals (within three to five years)

- Survey ECE faculty members to assess progress and to determine if improvements in communicating faculty performance expectations are needed.

4. How does the department plan to refresh its faculty complement and balance full professors with junior faculty?

The reviewers recommend considering ways of incentivizing retirements to encourage regeneration of the faculty complement, and to hire strategically in terms of research areas and collaborations. Even though the university expects most faculty members to become full professors, we do appreciate the issue of the demographics of the faculty complement. While policy regarding retirement is set by the university and Faculty, not by

the department, there may be ways in which the department may be able to help refresh the complement and balance of full professors with junior faculty.

Immediate-term goals (within six months)

- Discuss, across the department, emerging hiring needs in certain areas where we do not have enough faculty expertise.

Medium-term goals (within one to two years)

- Work with the Dean's office to develop long-term plans for hiring the required talent, focusing on hiring junior colleagues.
- Implement the hiring plan over two consecutive years.

Long-term goals (within three to five years)

- Reassess the issue of demographics and consider the need for renewed hiring efforts.

5. The reviewers made a number of recommendations regarding the undergraduate curriculum and encouraged engaging in a review that emphasizes "modes of thought" rather than "information transfer."

We believe this issue relates to methods of teaching innovation that include active learning and project-based learning, as opposed to traditional lecturing. The purpose is to help today's students learn more effectively in the classrooms, thereby overcoming the reported lack of student motivation and engagement.

Immediate-term goals (within six months)

- Hold a teaching workshop for ECE faculty members to discuss the topic of active and project-based learning. Invite ECE faculty members who have been using these innovative teaching methods to give presentations and help run the workshop.

Medium-term goals (within one to two years)

- Develop pilot programs to include active and project-based learning in a number of ECE courses, spanning the four years of the program.

Long-term goals (within three to five years)

- Assess courses that have incorporated active and project-based learning to examine the success and impact of these curricular changes.

6. The reviewers inquired as to whether it still makes sense to offer both the MASc and MEng programs, given the programs' flexibility. They recommended tracking employment and salary outcomes to help in this determination.

The MASc is a research degree that includes a thesis, almost always with publications. The MEng is not intended to be a research degree, instead it emphasizes applications over research. It is course-based and does not require a thesis. There are variations, whereby a

student can do an MEng project (either with a faculty member or in the local industry) in lieu of some course work, but these are usually the exception. MEng students can take some of the introductory courses available in the research stream, but they do not take the more advanced research courses. Instead, the department has developed a number of courses that are "application focused" rather than "research focused," and are often developed in collaboration with and taught by industry colleagues.

We do not believe it is advisable to merge or cease to offer either of these two degrees. It would negatively affect MASc students who need to hone their research skills in preparation for undertaking the PhD, and it would not serve industry-based MEng students who pursue advanced studies in lucrative employment sectors. Nevertheless, it would be useful to survey ECE graduates and track their employment and starting salaries as this information might suggest good ways to improve both degrees.

Immediate-term goals (within six months)

- Establish a working group with membership from faculty, alumni and students to discuss and recommend the best ways in which we can reach out to graduates from ECE's masters programs to track their employment outcomes and salaries.

Medium-term goals (within one to two years)

- Work with the engineering career centre and engineering advancement office to implement the working group's recommendations on reaching out to our master's graduates to track their employment outcomes and salaries.
- Based on the above, conduct surveys over two consecutive years to collect data on the employment and economic outcomes of our graduates. Analyze the data and implement corrections or extensions for the process if required.

Long-term goals (within three to five years)

- After multiple years of surveys, use the data to assess whether modifications to the structure of the masters' programs are required.

The next review of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering and its programs is scheduled for the 2022-2023 academic year. In the interim, 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 a report to you in the 2020-2021 academic year, midway between the June 2018 review and the next site visit.

This review will be discussed at the April 2, 2019 AP&P meeting. Professor Julie Audet, Vice-Dean Graduate Studies, will attend on behalf of the Dean's office, and Professor Ravi Adve, Associate Chair, Undergraduate, will attend on behalf of the department.

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 Edward S. Rogers Sr. Department of Electrical and Computer Engineering.

Sincerely

Cristina Amon
Dean

cc: Justine Garrett, Coordinator, Academic Planning and Reviews
Daniella Mallinick, Director, Academic Programs, Planning and Quality Assurance
Farid Najm, Professor and Chair, The Edward S. Rogers Sr. Department of Electrical & Computer Engineering
Caroline Ziegler, Faculty Governance & Programs Officer

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

At its meeting on April 2, 2019, the Committee on Academic Policy and Programs (AP&P) concluded that there were no issues to be drawn to the attention of the Agenda Committee but requested a follow up report in one year on recommended changes within the research culture to a more cooperative model, suggestions that the department identify areas of priority in which it will provide leadership at an international level, and reform of the undergraduate programs.

4. Institutional Executive Summary

The reviewers praised the high quality of students, their strong academic records, and the flexibility of the undergraduate curriculum. The reviewers complimented the faculty members' high level of research activity and strong individual areas of expertise. Overall, the reviewers were impressed by the sense of community throughout the department. The reviewers recommended that the following issues be addressed: refining the department's mission and taking "calculated risks" on how education and research are delivered and conducted; exploring untapped potential opportunities for new areas of research collaboration and expansion; addressing lengthy time-to-completion for PhD students and the need for supervisory committee meetings, which students clearly want; clarifying expectations for faculty performance; refreshing faculty complement and balancing full professors with junior faculty; engaging in a review of the undergraduate curriculum that emphasizes "modes of thought" rather than "information transfer"; and considering whether it still makes sense to offer both the MASc and MEng programs, given the programs' flexibility, and tracking employment and salary outcomes to help in this determination. 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 next review of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering and its programs is scheduled for the 2022-23 academic year. In the interim, 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 a report to you in the 2020-2021 academic year, midway between the June 2018 review and the next site visit.

6. Distribution

On May 17, 2019, 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 Applied Science & Engineering, 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.