Prospectus for the Creation of an Institute for *Engineering Education*

(Draft Nov 28, 2016)

The Faculty of Applied Science and Engineering (FASE) proposes the creation of an Institute for Engineering Education as an Extra-Departmental Unit A (EDU:A). The proposed Institute would offer academic advantages by:

- strengthening cross-departmental and collaborative teaching,
- facilitating the instruction of trans-disciplinary competencies,
- supporting research on related instruction and practice,
- helping the FASE to become a leading innovator in educational practice, and
- bolstering the FASE's ability to flourish long term within a rapidly shifting landscape.

Further, the Institute would address an administrative challenge that makes the status quo no longer viable.

In the fall of 2016, the Dean established a working group to explore options and consult widely so as to synthesize the input and make recommendations. This prospectus was created to guide this consultation process; the ideas put forward should not be considered as decided or fixed and additional issues and opportunities are emerging as we proceed. For example, useful suggestions have been received regarding the name of the Institute and thus the working name "Institute for Engineering Education" is given only as a placeholder.

The input and ideas generated through the consultation process will be documented in a report that will include a recommendation as to whether to seek approval for creating the Institute through the Faculty's and University's governance processes.

Academic Rationale

The Institute would leverage an existing academic foundation across a range of divisions, units and committees within the FASE, including the Engineering Communication Program, the Institute for Leadership in Engineering Education, the First-Year Office, the Collaborative Program in Engineering Education, the Cross-Disciplinary Programs Office, and the Engineering Design Education Group, among others. These units, in collaboration with the core administrative units[1], work to foster a comprehensive engineering education. By incorporating the 12 CEAB Graduate Attributes and making strong connections between the essential scientific foundation of engineering work, engineering discipline-specific expertise, and the trans-disciplinary professional competencies that "amplify" technical strengths, this collaboration enables our students to have greater positive impact after graduation and enjoy more successful careers. Further integrating this cooperation would promote and stimulate

[1] The core administrative units in FASE are: the Department of Chemical Engineering & Applied Chemistry, the Department of Civil Engineering, The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, the Department of Materials Science & Engineering, the Department of Mechanical & Industrial Engineering, the Division of Engineering Science, the University of Toronto Institute for Aerospace Studies, and the Institute of Biomaterials & Biomedical Engineering.

instructional collaborations to further enhance the value that the component units already bring. The Faculty has already made a commitment to "Further integrate professional competencies, such as global fluency, entrepreneurship, leadership and communication into undergraduate and graduate curricula"[2].

Globally, there are many examples of academic units that were created to promote evolution in the teaching and practice of engineering. Over 30 Engineering Education departments, institutes and programs exist across the United States and internationally[3]. Further, 15 national engineering education societies exist along with 10 journals and almost 40 regular conferences and meetings. The American Society for Engineering Education, for example, was founded in 1893 and has a global membership of over 12,000[4]. Programs and departments of medical education also exist at Canadian universities and internationally, further illustrating the value that professional disciplines see in creating academic structures to promote education related research and practice. This said, creation of this Institute would be groundbreaking in Canada and it would have its own distinct identity that builds on a direction already begun in the FASE and the University. Thus, by formalizing existing *ad hoc* relationships across the FASE, this Institute would bring a Canadian perspective to this field, building on the University of Toronto's culture of excellence and preeminent global position.

The Institute would include and support several existing areas, including:

- **First-Year Curriculum**: the FASE's first-year program has evolved immensely over the last 10 to 15 years, and now supports the education of approximately 1,200 students. The first-year boasts a complex complement of teaching teams that support foundational learning through cross-disciplinary collaboration in teaching, assessment, and research, and the introduction of new pedagogical techniques, tools, and approaches.
- **Cross-disciplinary Design Teaching**: Since a 2003 initiative, the FASE has incorporated instruction of design throughout the undergraduate curriculum. A major step was the introduction of the cornerstone design courses for all first-year students. This instruction of design has now evolved into "design spines" in each program that provide learning from this initial cornerstone course to the capstone courses in fourth year. In 2014, a multidisciplinary capstone course was introduced to further enrich the design related instruction available. The Engineering Design Education Group currently works to harmonize design teaching across the nine undergraduate programs.
- **Engineering Communication**: The Engineering Communication Program (ECP), since its inception in 1995, has grown to provide integrated communication instruction that responds to the changing needs of engineering programs and CEAB requirements. ECP collaborates with faculty in each of the core administrative units through standalone communication courses, communication and design courses, assignment and rubric design, and support for the FASE's growing number of multilingual students. ECP also engages in research on teaching and learning (often in collaboration with engineering faculty) in areas including digital learning objects, transfer of course concepts, rubric validation and TA training.

[2] FASE Academic plan 2011-16 Chapter 4: Educating Engineers, Item 2 (page 17)
[3] http://engineeringeducationlist.pbworks.com/w/page/27610307/Engineering%20Education%20Departments%20and%20Programs%20(Graduate) (accessed Nov28 2016)
[4] https://www.asee.org/about-us/the-organization (accessed Nov28 2016)

- **Engineering Leadership:** Teaching and learning of leadership in the FASE has also evolved since its introduction over a decade ago. Through the Institute for Leadership in Engineering Education (ILead), 17 undergraduate and graduate course sections are now offered reaching over 500 students a year. These courses are supplemented by rich co-curricular offerings, and leadership learning opportunities integrated into core technical and design courses, that reach several thousand students per year.

In this collaborative space, the proposed Institute would serve to:

- **Strengthen cross-departmental teaching and learning**, by serving as a resource for the instruction and assessment of the current CEAB graduate attributes, including teamwork, professionalism, ethics, and life-long learning, and thus meet a demand that cuts across traditional engineering disciplines. The Institute would also serve as a resource to support the incorporation of future changes in accreditation requirements and more generally help the FASE proactively navigate the emerging pressures to transform post-secondary education.

- **Create an academic community of faculty and students pursuing research** that can help shape the evolution of engineering education and practice, by exploring topics such as instructional design, learning technologies, assessment methods, and engineering culture (building on the existing graduate Collaborative Program in Engineering Education). By establishing a critical mass of research- and teaching-stream faculty, and students, working in this area, the Institute would:
    - provide a unique environment to share best practices, teaching strategies and research in engineering education,
    - lend weight to guiding and facilitating the evolution of engineering education, Faculty-wide and beyond,
    - help generate new knowledge that will support the evolution of these emerging trans-disciplinary fields and their practice beyond education, and
    - support the development of new teaching methodologies and innovative educational technologies.

  For example, the disciplines of engineering and education are currently converging within the field of digital learning and education technologies. Here, the global market is growing by 24% annually and it is predicted to reach $465B by 2020[5]. Through the research and practice enabled by the Institute, the FASE and UofT would have much to offer in terms of innovation to this shift in the educational landscape.

- **Provide an academic home to support the development of new cross-disciplinary academic instruction and programs** facilitating the reshaping and evolution of academic curricula. In so doing, the Institute would facilitate collaboration across the FASE, enabling engineering teaching and research that builds on the strengths, yet transcends the domain, of any one discipline. The Institute could, for example, facilitate Faculty-wide curricular integration of cross cutting themes such as sustainability, globalization and entrepreneurship. The Institute could also facilitate launching of certificates and minors related to new cross-cutting themes. Similarly, the Institute might help support lifelong learning by creating and delivering courses in partnership with the School of Continuing Studies. All these initiatives could help the Institute and the FASE build a strong niche in technology enhanced and web based instruction.

[5] http://www.marketsandmarkets.com/PressReleases/smart-digital-education.asp (accessed Nov 28,2016)

- **Support delivery of UofT's Strategic Mandate Agreement with the new provincial Ministry of Advanced Education and Skills Development** by further leveraging and building the FASE's strengths in the areas of technology enhanced learning, entrepreneurship, experiential learning, research and graduate education. For example, the Institute could help integrate learning opportunities into curricular and co-curricular activities that enable and amplify the development and refinement of competencies through work internships, research, entrepreneurial design project experiences, and other experiential learning opportunities.
- **Enhance the visibility of the FASE's activities in engineering education**, both internally and externally.
    - Internally, it would provide opportunity for collaboration, research and dissemination of knowledge to further guide and promote the evolution of engineering education across the Faculty.
    - Externally, both within Canada and globally, it would promote the interest, expertise, and leadership of the FASE in engineering education.

Ultimately, the envisioned Institute would further raise the stature of the FASE and support our University's priority for innovation in education. It would grow to become a Canadian hub for pedagogical work in engineering education, and eventually, a global leader in this emerging area.

<u>Administrative Considerations</u>

As an EDU:A, the Institute would serve as a home for faculty involved in cross-disciplinary teaching and engineering education-related research. These full or joint appointments would include five ECP teaching-stream faculty and two teaching-stream faculty in Engineering Science, as well as three recent hires in the First Year and ILead programs. Most of these colleagues are currently not appointed to proper administrative units (e.g. a department or an EDU:A). Regardless of the outcome of this consultation, this administrative challenge must be addressed and, in this regard, the status quo is no longer viable. Creation of the Institute as an EDU:A would remedy this administrative challenge.

This cohort of 10 core faculty would be supplemented with the cross-appointment of research- and teaching-stream faculty from within the FASE who are interested in promoting intersections in areas outside their primary discipline. It should be emphasized that the Institute would not be solely for teaching-stream faculty and that teaching-stream faculty who are currently fully appointed to existing academic units would be invited, but not required, to seek cross-appointment in the Institute.

Externally, faculty at OISE have indicated interest in cross-appointments and increased involvement of the FASE in the integration of engineering in education of future kindergarten to grade 12 teachers through their Masters of Teaching program. Further, adjunct appointments of "engineers in residence" from companies and government is envisioned to help contextualize the instruction of trans-disciplinary competencies within the FASE.

The Institute would also provide a structure and mechanism for the full or joint appointment of future teaching- and research-stream faculty whose expertise transcends our existing departments and institutes. Thus, given the pattern of recent cross-disciplinary hires, the size of the Institute's faculty contingent might grow modestly over the next five to 10 years. An essential goal would be sustaining a critical mass of colleagues with shared expertise and interests to foster a vibrant community and avoid colleagues working in isolation.

The Institute would focus its undergraduate instruction on non-technical cross-departmental and cross-program teaching. As is currently the case, much of this instruction would be through collaborative and team teaching to promote strong ties with the Faculty's technical foundation. Although the Institute may eventually support some minors, it would not host a dedicated undergraduate program. A second key goal would be sustaining and growing partnerships for collaborative instruction with colleagues in the existing core units.

The Institute might seek to host a graduate PhD program in engineering education to complement the existing Engineering Education Collaborative Program, allowing engineering students to be accepted into the program from beyond the current member programs in CIV, CHE, and MIE. Hosting a graduate program would also facilitate the appointment of Institute faculty to SGS.

An interim director would be appointed to oversee the launch of the EDU. A committee would be struck to appoint a director under the *Policy on Appointment of Academic Administrator*s for a five-year term, renewable once. The Institute and its programs would undergo an external review every five years.

Working Group's Process

Over the upcoming months, the working group will:

1. Consult deeply and broadly on the creation of the Institute, incorporating suggestions and clearly articulating the nature and outcome of that consultation
2. Describe the intended scope of activity of the proposed Institute and provide an academic argument for its creation
3. Clearly describe the academic focus of the Institute, including program delivery, research focus, and other activity or programming
4. List the faculty who may be actively engaged in the proposed Institute
5. Articulate the duties of the Institute director, including policies and administrative operations
6. Describe expectations relative to the periodic review of the Institute

This process will be executed in three overlapping phases

1. Consultation Phase: November 2016 - January 2017
2. Documentation Phase: January 2017 - March 2017
3. Governance Approval Phase (if recommended): March 2017 - June 2017

Your input and ideas are requested and welcomed. Please speak with or email any of the working group members or email Caroline Ziegler at caroline@ecf.utoronto.ca.

- Greg Evans, Professor, Department of Chemical Engineering and Applied Chemistry (Working Group Chair)
- Kamran Behdinan, Professor, Department of Mechanical and Industrial Engineering
- Jason Foster, Associate Professor, Teaching Stream, Division of Engineering Science
- Sean Hum, Associate Professor, The Edward S. Rogers Sr. Department of Electrical and Computer Engineering
- Dawn Kilkenny, Assistant Professor, Teaching Stream and Associate Director, Undergraduate Programs, Institute of Biomaterials and Biomedical Engineering
- Brenda McCabe, Associate Professor, Department of Civil Engineering

- Elizabeth Smyth, Professor, Department of Curriculum, Teaching and Learning, Ontario Institute for Studies in Education and Vice-Dean, Programs, School of Graduate Studies
- Micah Stickel, Associate Professor, Teaching Stream, The Edward S. Rogers Sr. Department of Electrical and Computer Engineering and Chair First Year
- Deborah Tihanyi, Associate Professor, Teaching Stream and Director, Engineering Communication Program

The Working Group is also soliciting input from individuals and presenting this proposal for discussion at some departmental meetings. A short survey will be circulated in December to further facilitate providing input.

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