UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3395

MEMORANDUM

To: Executive Committee of Faculty Council

From: Dr. Micah Stickel
Chair, First Year

Date: September 13, 2013 for October 18, 2013 Faculty Council Meeting

Re: **Engineering at UTM – A Proposed 2+3 Degree Pathway**

REPORT CLASSIFICATION

For discussion.

EXECUTIVE SUMMARY

This report describes a new degree pathway for students within the Faculty of Applied Science and Engineering (FASE), that will enable them to gain additional experience and qualifications through a partnership with the University of Toronto Mississauga (UTM). This proposed pathway is not a new program, instead it will allow FASE students to graduate with a UTM minor or major in addition to their engineering degree (BASc).

Students who follow this degree pathway will be admitted and registered as FASE students throughout their undergraduate studies. They will spend the first two years of their engineering program at UTM, completing the 10 half-course TrackOne first-year curriculum, along with 10 UTM half-courses of their choice. Provided they satisfy the relevant engineering promotion regulations, they will then join the engineering department of their choice to complete the final three years of their degree program.

The primary advantage of such a new degree pathway is that it will provide potential FASE students with a wider variety of educational options. For example, the Faculty will now be able to offer potential applicants an Engineering Chemistry program, which augments the traditional degree in Chemical Engineering with a stronger focus on fundamental chemistry. Such programs have been quite successful at other Canadian engineering schools. Other minor or major options, such as Commerce and Management, and Biology and Life Sciences, coincide with UTM's program strengths. It is planned that the proposed degree pathway will start with a pilot cohort of 50 students in the fall of 2015. It is anticipated that the steady-state cohort will consist of about 100 students.

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

BACKGROUND

In May of 2011, the Faculty (FASE) and the University of Toronto Mississauga (UTM) struck a joint task force to investigate the potential for collaborative programs at both the graduate and undergraduate levels. This task force consisted of:

- Tarek Abdelrahman, Professor of Electrical and Computer Engineering
- Konstatin Khanin, Chair of Mathematics and Computing Sciences, UTM
- Ulli Krull, Vice Principal Research, UTM/Professor, Chemical & Physical Sciences
- Susan McCahan, Chair, First Year, Faculty of Applied Sciences & Engineering
- Mihkel Tombak, Chair of Management, UTM
- Ron Venter, Emeritus Professor, Mechanical and Industrial Engineering

The final task force report was submitted on November 3, 2011 and was discussed by Chairs and Directors at the November 10, 2011 meeting. Updates on the development of this program were also discussed at the January 20, 2012, June 1, 2012, February 19, 2013 and September 6, 2013 Chairs and Directors meetings.

The specific assignments of the Task Force were to:

1. Identify potential new engineering programs, at the graduate or undergraduate level, that could be introduced at UTM and that would build upon complementary strengths and potential synergies between Arts and Science at UTM and the Faculty of Engineering.
2. Determine if there are any areas where duplication of offerings between FASE and UTM could be mutually advantageous.

3. Identify already available and newly required resources needed for the new programs, including human resources, equipment and space.

4. Recommend a timeline for the start of any programs.

The work of the Task Force culminated in three concrete proposals:

1. At the Undergraduate Level; A 2+3 model
2. At the Undergraduate Level; A “Management Sciences Engineering” Program
3. At the Graduate Level; Offering of M.Eng Relevant Courses

The purpose of this report to is to propose the implementation of a 2+3 model undergraduate engineering degree pathway in partnership with UTM. It is the intent of the Faculty to consider implementation of the other two Task Force proposals at a later date, once the undergraduate 2+3 model has been successfully realized.

A detailed rationale for 2+3 model collaboration between FASE and UTM can be found in the Task Force Report, but this can be summarized by the following advantages:

1. *Access to Relevant Complementary Studies*
   A partnership with UTM enables the faculty to offer potential applicants a degree path with a more diverse set of options. These options are currently not available to our students due to the difficulty in gaining access to the relevant courses at the St. George campus. At the undergraduate level, this would allow a student to work towards a BASc degree, while fulfilling the requirements for a UTM minor (4 Full Course Equivalents, (FCEs)), or a UTM major (6 to 8 FCEs). The minors or majors would likely align with UTM's strengths, such as Commerce and Management, Mathematical and Computational Sciences, Biology & Life Sciences, Chemistry & Physical Sciences, Language Studies, and Communication, Culture & Information Technology.

2. *Ability to Offer a Pathway for an Engineering Chemistry Major*
   For a number of years the Department of Chemical Engineering & Applied Chemistry within the FASE, has been exploring the idea of providing students with an Engineering degree which has a stronger focus on fundamental chemistry. The proposed Engineering at UTM pathway would enable students to graduate in five years with a Chemical Engineering degree along with a Chemistry Major. Students with such a dually accredited degree are highly sought after both in industry and academia. Currently U of T has no such opportunity that can compete with comparable programs at other Canadian engineering schools.

3. *Geographical Positioning for the Faculty*
   By establishing a presence in the western region of the Greater Toronto Area (GTA), the Faculty could potentially achieve:
   a. An expansion of the applicant pool, and subsequent quality, given the geographical advantage of the UTM site for students currently living in the western GTA,
   b. The development of additional opportunities for Engineering students to participate in PEY placements at industrial partners located in the western GTA, and
   c. An amelioration of competition from other universities by the presence of the Faculty in the western GTA.

4. *Strategic Expansion at UTM*
   As part of its 5-year strategic plan, UTM has significant interest in continuing to expand its undergraduate and graduate programming. Over the past 10 years the student population has doubled, while entry grade standards for admission at UTM have been maintained at a high level, with these being generally equivalent to those of Arts and Science at the St. George campus.

   As well, there is a positive track record for cross-divisional joint ventures and a willingness on the part of UTM to form strategic partnerships with other faculties and divisions to advance new initiatives. The Mississauga Academy of Medicine is the most recent example of a highly successful UTM cross-divisional collaboration.

STRUCTURE

The proposed Engineering at UTM degree pathway would follow a 2+3 model. This model is conceptually aligned with the types of opportunities offered by some of the best engineering schools in the USA; a mix of introductory courses in Engineering and Arts and Science for the first 2 years. Then, a clear focus in an engineering program for the next 3 years. Engineering schools at California Institute of Technology, Columbia, and Rensselaer Polytechnic Institute all offer some combined program with liberal arts partner colleges. An overview of the proposed 2+3 model is:

- The Faculty would be responsible for the admissions of all students into the Engineering at UTM program.
- The first 2 years would be at UTM with the subsequent 3 years in a FASE program stream.
- The 2-year academic content at UTM would include the courses presently in the General First Year Engineering (TrackOne) program.
- Complementing the General First Year Engineering courses would be UTM Arts and Science courses.
- At the end of the first 2 years of study at UTM there would be entry to the second-year curriculum of one of the Engineering programs at the St. George campus, with the additional advantage of completion of a minor or major in the final 3 years in an Arts and Science program.
- Students would not be allowed to transfer to the Engineering program at the St. George campus after only one year at UTM.
- The standard promotion regulations within the Faculty would apply to students following this degree pathway.
- Students would be entering the second-year of their Engineering program with an additional year of maturity, and will have had more time to develop their career aspirations.
- Students would graduate in 5 years (6 with PEY) with a BASc degree along with notation of completion of a minor or major in a UTM program.
- An alternative option for a student at the end of the first 2 years would be to transfer from the engineering cohort to another UTM program.

PROCESS AND CONSULTATION

Since the Task Force report, the development of this degree pathway has been done in collaboration with:

- Cheryl Regehr, Vice-Provost, Academic Programs, Office of the Vice-President and Provost
- Jane Harrison, Director, Academic Programs and Policy, Office of the Vice-President and Provost
- Susan McCahan, Vice Dean Undergraduate, Faculty of Applied Sciences & Engineering
- Ulli Krull, Vice Principal Research, University of Toronto Mississauga, Professor, Department of Chemical and Physical Sciences

- Kelly Hannah-Moffat, Professor and Vice-Dean: Undergraduate, University of Toronto Mississauga
- Peter M. Macdonald, Professor and Chair, Department of Chemical and Physical Sciences, University of Toronto Mississauga
- Konstantin Khanin, Professor and Chair, Department of Mathematical and Computational Sciences, University of Toronto Mississauga
- Graeme Norval, Senior Lecturer and Associate Chair and Undergraduate Coordinator, Department of Chemical Engineering & Applied Chemistry, Faculty of Applied Sciences & Engineering
- Tim Bender, Assistant Professor, Department of Chemical Engineering & Applied Chemistry, Faculty of Applied Sciences & Engineering
- Barbara McCann, Registrar, Faculty of Applied Sciences & Engineering
- Diane Crocker, Registrar and Director of Enrolment Management, University of Toronto Mississauga
- Paul Donoghue, Chief Administrative Officer, University of Toronto Mississauga
- Tom Nault, Associate Registrar, Admissions & Director of Academic Scheduling, Faculty of Applied Sciences & Engineering
- Phil Poulos, Director, Engineering Computing Facility, Faculty of Applied Sciences & Engineering

We have also recently surveyed over 700 of our current FASE undergraduate students who lived in the western GTA region. The response rate was quite high, at 39%, with a total of 273 survey respondents. A summary of the relevant results are:

***Demographics*:**

- 273 respondents; 39% response rate
  - Current students with home addresses in the Halton and Peel Regions
  - Broad representation across years of study, engineering programs
  - 64% of respondents from Mississauga
  - 15% of respondents from Brampton
  - 10% of respondents from Oakville
  - Approximately 60% of respondents still live at home and commute to campus
  - Most students, 47% spend between 1 – 2 hours commuting each day

***Survey Findings*:**

- 60% of respondents indicated that having more time to earn a major or minor in another discipline would have appealed to them “considerably” or “a great deal”
- 58% of respondents indicated that studying engineering closer to home would have appealed to them “a great deal” or “considerably”
- 61% said that they ‘definitely’ or ‘probably’ would have chosen to complete their degree at UTM, if given the option.
- 41% indicated that an additional year to complete a major/minor would not discourage them, while 38% said that this would discourage them
- The interest in additional disciplines was:
  - 47% - Commerce, Management and Economics

- 16% - Biological and Life Sciences
- 15% - Mathematical and Computational Sciences
- 14% - Arts, Humanities, and Social Sciences
- 5% - Communication, Culture and Informational Technology
- 3% - Chemical and Physical Sciences

DEGREE PATHWAY STRUCTURE

A more detailed description of the proposed degree pathway is:

First Two Years

Students are admitted to the Faculty of Applied Science and Engineering and complete their first two years at the UTM campus. During these two years, students complete the General First-Year Program (TrackOne) and 5 FCEs of UTM courses that they would use to complete their minor or major. A potential curriculum might be:

Term	Course 1	Course 2	Course 3	Course 4	Course 5	Seminars
1F	Calculus A	Mechanics	UTM Course	UTM Course	UTM Course	-
1S	Calculus B	Materials/ Chemistry	UTM Course	UTM Course	UTM Course	
2F	Computer Fundamentals	Dynamics	ESP I	UTM Course	UTM Course	Engineering Ethics
2S	Linear Algebra	Electrical Fundamentals	ESP II	UTM Course	UTM Course	Intro to Engineering

Final Three Years

Upon satisfying the promotion regulations in their first and second year, students will join the second-year of the Core 8 engineering program of their choice at the St. George Campus. In these years, they will complete the requirements for their BASc as well as their UTM minor or major (in some cases it may be possible to complete the UTM minor in the first 2 years). Most of the Core 8 programs have at least 5 half-course electives (4 CS/HSS and 1 Free Elective), so most students should be able to complete a UTM major within the 5 total years. It is also quite possible that a student would be able to complete this major with 4.5 years. This is due to the fact that UTM offers a large number of courses in the summer, which would provide students with additional flexibility in fulfilling the requirements for a major.

Admissions

Student would be admitted to this pathway by the Faculty under the supervision of the Chair, First Year. The admissions requirements would be set at a level that is the same as the General First-Year (TrackOne) standards. This cohort of students would be eligible for scholarships according to our general engineering scholarship strategy. It is hoped that a specific scholarship pool will be also established by UTM.

Initially, a cohort of 50 students would be selected for the pilot year, with a steady-state class of 100 students. The targets for the St. George General First-Year (TrackOne) program would most likely be correspondingly reduced, such that the net entry into our second-year programs would remain unchanged from current practice.

Promotion Regulations
Students would have to satisfy the promotion regulations for both their Engineering and UTM subsets of courses. Specific regulations pertaining to strong performance in one subset and weak performance in the other subset will have to be developed. These will be established through consultation with the Faculty's Examinations Committee and the UTM Registrar's office.

Students would not participate directly in the T-Program, but instead would have to adjust their schedules to make up the required engineering course(s) at the next available opportunity. However, students would be eligible to take T-Program courses at the St. George Campus in the summer term (May-June) if required.

Teaching Resources
In the first two years, all courses will be taught at UTM and students will not normally need to attend any classes at the St. George Campus. Some of the core engineering courses will be taught within existing UTM course offering, while other courses will need to be created.

Course Equivalencies and New Course Requirements
Relative to the current course offerings at UTM, the following course equivalencies are proposed:

TrackOne Course (FASE)	**UTM Course Equivalency**
APS104H1S: Introduction to Materials and Chemistry	*No Comparable UTM Course – New Course Required*
APS105H1F: Computer Fundamentals	CSC108H1F: Intro to Computer Programming
APS111H1F: Engineering Strategies and Practice I	*No Comparable UTM Course – New Course Required*
APS112H1S: Engineering Strategies and Practice II	
CIV100H1F: Mechanics	*No Comparable UTM Course – New Course Required*
ECE110H1S: Electrical Fundamentals	*No Comparable UTM Course – New Course Required*
MAT188H1F: Linear Algebra	MAT233H1X: Linear Algebra I (Offered Fall, Winter, Summer)
MAT196H1F: Calculus A	MAT135H1Y: Calculus
MAT197H1F: Calculus B	
MIE100H1S: Dynamics	PHY136H1F: Introductory Physics I

For the course equivalencies that are approved, they will enable the Engineering at UTM cohort of students to join those courses and be taught by existing UTM faculty. The courses which require the creation of a new course would be taught by either newly hired faculty or instructors or by existing FASE faculty members, on a volunteer basis.

Coordination and Student Support
Both UTM and FASE will need to provide the Engineering at UTM cohort with the appropriate administrative (registrarial), academic (curricular), and counseling support.

One potential model for this support structure, would be for FASE to hire a new Teaching-Stream Faculty member who would have residence at UTM. This position would be

responsible for teaching into the program (e.g., CIV100: Mechanics, ECE110: Electrical Fundamentals, and/or APS111/112: Engineering Strategies and Practice), as well as providing the necessary administrative coordination. The registrarial support could be incorporated into the UTM Registrar's office with support from FASE's First Year Office. The administrative and registrarial support positions would work closely with the Chair, First-Year to ensure continuity of experience and standards between the two pathways.

Skule Spirit at UTM

An engineering student common room has also been established as part of this summer's major renovation of the physics labs at UTM. Joint and individual orientation programs will be developed to provide the UTM cohort of students with a unique identity that is part of the larger Engineering Society.

Financial Structure

Students following this pathway would pay engineering tuition throughout their undergraduate studies. The business model that this pathway will follow will be negotiated between the Dean of the FASE and the Vice-Principal Academic and Dean for UTM. The implementation of the Engineering at UTM degree pathway is entirely dependent on the results of this negotiation.

Timeline

This pathway will begin in September 2015 with a pilot cohort of 50 students. In order to begin at this time, recruitment efforts need to be put in place starting in March 2014. As further details of the pathway are developed through consultation with relevant Standing Committees, including the Admissions, Examinations, and Undergraduate Curriculum Committees, updates will be put before council at the appropriate time.

APPENDIX A
POSSIBLE ENGINEERING AT UTM MINOR/MAJOR OPTIONS

The Engineering at UTM pathway will provide an increased variety of curricular options that are available to FASE students following this pathway. In addition to their BASc degree, this pathway will facilitate minors or majors in areas such as: Economics, Sciences (such as Chemistry or Biology), Environmental Management, Mathematics and Computational Sciences, and Humanities and Complementary Studies (such as Political Science, Psychology, Sociology, History, Language, etc.)

Complementary Studies & Humanities and Social Science Courses

As a starting point, Complementary Studies (CS) courses are courses which are neither engineering design, nor engineering science, not mathematics nor natural science. Humanities and Social Sciences (HSS) courses are a subset of CS courses, and refer to materials which engages the thought processes of the humanities. History, art, music, religion studies count as HSS. Playing an instrument, learning a language, economics are CS courses. The FASE has a list of acceptable courses for both categories, available at: http://uoft.me/electives. Generally, FASE students have 2 HSS and 2 CS elective slots in their curriculum.

Rules for Course Eligibility for UTM Minors and Majors

Relevant FASE rules regarding the counting of core and elective courses that students take as part of their BASc degree are:

1) Students can use their HSS and CS and Free elective courses (if they have any) for the purposes of counting courses both for the FASE degree and a minor or major.

2) Students can use 1 Full Course Equivalent (FCE, 1 FCE = 2 HCE) of their core course requirements to count towards a minor or major.

The implications of the rules are as follows:

- Students can complete a minor in the Humanities – through use of 4 HSS courses, plus 2 half credits of design/thesis, and 1 FCE in addition to their program.
- Students can complete a minor in the broader CS programs through use of 2 CS courses, plus 2 half credits of design/thesis, and 2 FCE in addition to their program.
- Students can complete a minor in mathematics or the sciences, through use of any 1 FCE of their courses, and 3 FCE in addition to their program.

The expectation is that Engineering at UTM students would take 10 Engineering (TrackOne) Half-Course-Equivalents (HCEs), which would leave 10 HCEs, or 5 FCEs, available for completion of a minor, or the partial fulfillment of a major. A minor typically requires 4 FCEs, while a major generally requires 8 FCEs. Some general examples of these options are described below. Given that there is such a variety of options available to students following this pathway, these examples are for illustrative purposes only.

Economics

Economics Minor (4 FCEs)

Year 1 UTM	Select initial TrackOne Courses
	Select ECO100Y (1 FCE)
	Select other Electives as required
Year 2 UTM	Complete TrackOne Courses
	Select ECO200Y/204Y/206Y (1 FCE)
	Select other Electives
Years 3-5 FASE	Complete FASE Degree courses
	Select one ECO300 or ECO400 level (1 FCE)
	Complementary Studies courses

NB - MAT133Y/134Y/135Y/137Y (1 FCE) Requirement by TrackOne math courses

Economics Major (8 FCEs)

Year 1 UTM	Select initial TrackOne Courses
	Select ECO100Y (1 FCE)
	Select other Electives as required
Year 2 UTM	Complete TrackOne Courses
	Select ECO200Y/204Y/206Y (1 FCE)
	Select ECO202Y/208Y/209Y (1 FCE)
	Select other Electives
Years 3-5 FASE	Complete FASE Degree courses
	Select ECO220Y/227Y (1 FCE)
	Select two ECO300 or ECO400 level (2 FCEs)
	Select STA256H/257H (0.5 HCE)
	Complementary Studies courses (1 FCE)

NB - MAT133Y/134Y/135Y/137Y (1 FCE) Requirement by TrackOne math courses

Chemistry

Chemistry Minor		Chemistry Major	
Year 1 UTM	Select initial TrackOne Courses	Year 1 UTM	Select initial TrackOne Courses
	Select CHM120H		Select CHM120H
	Select other Electives as required		Select other Electives as required
Year 2 UTM	Complete TrackOne Courses	Year 2 UTM	Complete TrackOne Courses
	Select 2 FCE of CHM and/or JCP credits		Select CHM211H, CHM231H, CHM242, CHM243, JCP221H
Years 3-5 FASE	Complete FASE Degree courses	Years 3-5 FASE	Complete FASE Degree courses
	Select one FCE of CHM or JCP 300/400 Complementary Studies courses		Select CHM371H/391H/393H Select three FCE CHM or JCP courses Select other Electives as required
NB - MAT133Y/134Y/135Y/137Y Requirement by TrackOne math courses		NB - MAT133Y/134Y/135Y/137Y Requirement by TrackOne math courses	

Humanities/Complementary Studies

Humanities Minor		Humanities Minor	
Year 1 UTM	Select initial TrackOne Courses	Year 1 UTM	Select initial TrackOne Courses
	Select 100 level Humanities course		Select 100 level Humanities courses
	Select other Electives as required		Select other Electives as required
Year 2 UTM	Complete TrackOne Courses	Year 2 UTM	Complete TrackOne Courses
	Select 200 level Humanities courses		Select 200 level Humanities courses
	Select other Electives as required		Select other Electives as required
Years 3-5 FASE	Complete FASE Degree courses	Years 3-5 FASE	Complete FASE Degree courses
	Select 300 level Humanities course		Select 300 and 400 level Humanities courses

A complementary studies minor/major track would be very similar. The Humanities/Complementary Studies minor/major options include, for example, Environmental Management, Political Science, Geography, History, Psychology, Sociology, South Asian Studies, and Languages.