



**FOR INFORMATION AND FEEDBACK**

**PUBLIC**

**OPEN SESSION**

**TO:** Planning and Budget Committee

**SPONSOR:** Cheryl Regehr, Vice-President & Provost  
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**PRESENTER:** As above  
**CONTACT INFO:**

**DATE:** December 12, 2017 for January 10, 2017

**AGENDA ITEM:** 3a

**ITEM IDENTIFICATION:**

Faculty of Applied Science and Engineering, Academic Plan, 2017-2022

**JURISDICTIONAL INFORMATION:**

Divisional academic plans are considered by the Committee and the Academic Board for information and feedback. Prior to approval by the Provost and presentation to the Committee, it is expected that the relevant divisional Council would endorse the academic plan in principle. (*Planning & Budget Committee, Terms of Reference, Section 4.1*)

**GOVERNANCE PATH:**

1. **Planning and Budget Committee (January 10, 2018)** – for information and feedback
2. Academic Board (January 25, 2018) – for information and feedback

**PREVIOUS ACTION TAKEN:**

The Academic Plan was endorsed in principle by the Faculty of Applied Science and Engineering Faculty Council on December 12, 2017.

**HIGHLIGHTS:**

The Faculty of Applied Science and Engineering Academic Plan was developed over the past 24 months. The process began with the development of a self-study and the Provostial review of the Faculty in January/February 2017.

To facilitate the creation of the Academic Plan, representatives from across the Faculty, in conjunction with academic and administrative leaders, developed a 2017-2022 Academic Planning Framework, which was posted online for reference and input throughout the process, as were draft chapters as they were developed. Extensive consultations occurred through several

means. This included special meetings with Chairs and Directors, Dean’s Town Halls, meetings through the Vice-Deans and their committees (research, undergraduate, graduate) and updates to the U of T Engineering community through their newsletter and website. The plan was discussed at Faculty Council on October 23.

The Academic Plan focuses on *Transformative Teaching and Learning; Student Experience; Innovative Research and Entrepreneurship; Influence, Collaboration and Partnerships; and Organization and Strategic Resources.*

The plan was considered by the Provost’s Advisory Group on November 8, 2017.

**FINANCIAL IMPLICATIONS:**

The resource implications of the Divisional Academic Plan are as detailed in the plan.

**RECOMMENDATION:**

This item is *for information and feedback only.*

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**DOCUMENTATION PROVIDED:**

- Faculty of Applied Science and Engineering, Academic Plan, 2017-2022



**UNIVERSITY OF TORONTO,  
FACULTY OF APPLIED SCIENCE & ENGINEERING**

# **ACADEMIC PLAN 2017–2022**



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

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## STATEMENT OF ACKNOWLEDGEMENT OF TRADITIONAL LAND

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people and we are grateful to have the opportunity to work on this land.



# EXECUTIVE SUMMARY

The Faculty of Applied Science & Engineering's *2017 – 2022 Academic Plan* was developed through a highly consultative strategic planning process with our community of stakeholders. This plan articulates and affirms U of T Engineering's priorities, setting out the five-year measurable goals that we will pursue with dedication and commitment. This plan provides the structure for both administrative and academic units to enhance the contributions to our Faculty and to our broader community. It allows us to measure, assess and adjust initiatives within U of T Engineering and beyond, while maintaining support for our overall mission: to lead in transformative teaching and learning, ensure an outstanding student experience and advance impactful research through creativity, multidisciplinary collaboration and innovation. In addition, in each area of the Faculty, we will continue to focus on our culture of excellence, diversity and globalization.

We believe academic planning is an ongoing process and every year we assess our progress and achievements to ensure we reach our stated goals and create new opportunities as they arise. Our *2017 – 2022 Academic Plan* is a living document and as a Faculty we work

extensively throughout the academic year, with our standing committees, undergraduate and graduate societies, working groups and task forces to ensure we continue evaluating, improving and creating. Each fall, we also publish the *Update to the Academic Plan*, which reports our progress not only to the Faculty, but also to the U of T community. In the next five years we will continue with this annual reporting, with the aspiration to engage our Faculty in ongoing and open discussions about the progress towards our goals.

The Faculty has created a number of strategic initiatives over the past five years to address the recommendations stemming from our 2010 self-study and external review, and respond to feedback from consultations that occur throughout each academic year. The *Overview* of our academic plan outlines the key initiatives that allowed us to assess challenges and create opportunities within the Faculty and provides the context of this Academic Plan.

From January 31 to February 2, 2017, the Faculty of Applied Science & Engineering was the subject of an external review. In preparation for the review, and to lay the groundwork for our next academic plan, we prepared a self-study — a comprehensive and critical overview of the Faculty in accordance with the *Guidelines on Divisional Academic Planning*. The self-study, in addition to the *Terms of Reference*, provided a framework for the external review. Also guiding our academic planning process was the University of Toronto's *Three Priorities*, and *Towards 2030: The View from 2012*. The external reviewers' final report spoke to the outstanding faculty and student body, and our worldwide reputation for excellence in education and research. While acknowledging these strengths in our Faculty, we have translated the recommendations from the report into new goals and opportunities for this next phase of academic planning.

To facilitate the creation of the *2017 – 2022 Academic Plan*, representatives from across the Faculty, in conjunction with academic and administrative leaders, developed the *2017 – 2022 Academic Planning Framework*. Initiating the process in early 2016, we created the framework from an extensive body of work — the self-study, external review, working and focus groups, ongoing evaluation and extensive consultations. With thoughtful consideration we identified where we were, and now, together as a Faculty, where we want to go. The *2017 – 2022 Academic Plan* which follows is the culmination of this work.

The Faculty of Applied Science & Engineering is dedicated to *Transformative Teaching & Learning*. We will continue to strengthen our highly regarded undergraduate and graduate programs and will strive to provide outstanding learning experiences. Our goal is to ensure a wealth of opportunities that are multidisciplinary, collaborative and internationally focused. We will graduate the U of T 21<sup>st</sup> Century Engineer, the global engineering leader of tomorrow. The Faculty will continue developing innovative programs, such as the new Engineering Science Major in Machine Intelligence. We will also work with our departments and institutes through the *University of Toronto Quality Assurance Process* and the Canadian Engineering Accreditation Board to ensure high-quality educational programs and strong graduating students' competencies.

We will continue to provide rigorous foundational learning in engineering principles and we will enrich students' learning experiences by integrating professional competencies such as multidisciplinary design, communication, business, entrepreneurship, leadership and global engineering into the curricula. We will also promote and support opportunities for students

to engage in meaningful international experiences, research and Professional Experience Year (PEY) internships so they can use their technical knowledge in other settings — gaining experience in the workplace, research laboratory or abroad. Our goal is to ensure our students have outstanding technical and professional competencies, in addition to strong multicultural fluency — attributes needed in today’s complex and quickly evolving world.

To meet the goals of our *2017 – 2022 Academic Plan*, we must continue to attract the brightest students and faculty, both here in Canada and from around the world. We must also continue our efforts to improve gender diversity within our Faculty, and enrich the socio-economic, ethnic and cultural diversity within U of T Engineering, especially underrepresented groups. We look forward to receiving the recommendations from the *Eagles’ Longhouse: Engineering Indigenous Initiatives Steering Committee*, which will guide us in our outreach, recruitment and programming efforts. We will work to leverage this diversity, ensure that our curricula and learning are inclusive to all students, faculty and staff and foster an environment in which each member of our community can excel, contribute and benefit from each other’s perspectives. With the opening of the Centre for Engineering Innovation & Entrepreneurship (CEIE), we will enter a new era for technology and learning, and we will continue to improve our infrastructure to support innovative teaching. We will work towards balancing our undergraduate to graduate student ratio, reducing time-to-completion for our research-stream graduate students, and further integrating active learning pedagogies into curriculum delivery to encourage life-long learning and knowledge creation.

*Student Experience* and *Transformative Teaching and Learning* work together, inside and outside of the classroom, to support student learning and the development of global engineering leaders. U of T Engineering is dedicated to supporting faculty-student engagement and a vibrant student community. We strive to not only create an outstanding educational environment, but also extensive opportunities to engage in co-curricular activities and Faculty research.

Actions in the *2017 – 2022 Academic Plan* include strengthening the connection and community of students, including MEng students and our student commuters, many of whom travel long distances to reach our campus. We will also continue to support our student clubs, and their transition into the new CEIE space, when it opens in 2018. Out of the two decanal task forces on Academic Advising and Mental Health, we have committed to improve the quality and delivery of academic advising and also create resources and initiatives that support good mental health and well-being.

The U of T Engineering research community is defined by its commitment to generating transformative knowledge, research excellence and global impact. To support these goals, we worked extensively through our Faculty’s Research Committee and academic planning focus groups to solidify our four main research themes. Our faculty members’ research touches upon one or more of the themes: *Data Analytics and Intelligent Systems*, *Advanced Materials and Manufacturing*, *Sustainability*, and *Engineering and Human Health*. We will leverage our strengths to develop a compelling research vision with the mandate to enhance our impact by leading research benefiting the Province, Canada and global society through creativity, multidisciplinary collaboration, entrepreneurship and innovation.

Our *Influence, Collaborations and Partnerships* include relationships across Engineering and other U of T Faculties, and also linkages with our diverse city and internationally through our student body and global research. The priorities for the next five years include inspiring education and learning in science, technology, engineering and math for K-12 and also strengthening the connection with our more than 50,000 alumni. We will continue our leading role in pre-university outreach programming within Canada and work towards enhancing our presence as an influential thought-leader within the K-12 engineering curriculum. We will also foster new cross-disciplinary collaborations and create strategic partnerships with key institutions and industry partners.

Driven by academic and research priorities, our *Organization and Strategic Resources* support all aspects of the Faculty's mission. Our goals include diversity in our faculty and staff complement, infrastructure and IT renewal, new advancement priorities, strong fiscal management and utilizing our communications to inform, celebrate and connect our U of T Engineering community.

The *2017 – 2022 Academic Plan* was developed through the dedication and efforts of faculty, graduate and undergraduate students, staff, alumni and our University of Toronto partners. In the next five years, we will continue our commitment to a culture of excellence, diversity and globalization. To remain the #1 engineering school in Canada, and one of the best in the world, we will measure and evaluate our progress towards our goals, throughout the year, each year. Together, we will work to strengthen our Faculty and continue our pursuit of excellence, but also remain adaptable to creating new opportunities for our students and faculty.





# CHAPTER 1

## OVERVIEW

Founded in 1873, the Faculty of Applied Science & Engineering at the University of Toronto is Canada's #1 engineering school and one of the best in the world. The Faculty is a leader in multidisciplinary collaborative research, and innovative teaching and learning. The University of Toronto is one of the top ten publicly funded universities worldwide, and our Faculty is a vital component of its diverse and vibrant community.

At the time of the Faculty's *2011 – 2016 Academic Plan*, the University had launched its long-term strategic initiative *Towards 2030*: [www.towards2030.utoronto.ca](http://www.towards2030.utoronto.ca). In September 2011, the University started to assess its progress with respect to the *Towards 2030* goals and examine new and continuing challenges and opportunities for the future. The broader University of Toronto community engaged in an extensive consultation process resulting in the publication of *Towards 2030: The View from 2012*. In addition, in October 2015 President Gertler articulated the Three Priorities for the University of Toronto:

- Leverage our urban location(s) more fully, for the mutual benefit of University and City;
- Strengthen and deepen key international partnerships by means of a well-defined strategic focus; and,
- Re-imagine and reinvent undergraduate education.

▲ Maker spaces allow engineering students to bring their creativity to life, whether they are designing a prototype for a new business idea or a vehicle that will compete internationally. Published in May 2017, the Faculty's *Maker Space Report* will ensure students have the space and facilities they need to innovate.

The University of Toronto's *Three Priorities*, and *Towards 2030: The View from 2012*, have continued to inspire and guide us in the development of our *2017 – 2022 Academic Plan*.

Starting in early 2016, we initiated our Faculty self-study as the precursor of the academic planning process to:

- Facilitate cross-Faculty discussions for our academic priorities for the next five years;
- Ensure a cohesive strategy across all units;
- Surface our most important foci and consider how these will evolve to new levels of excellence across the Faculty; and,
- Galvanize us as a community dedicated to the highest standards of research, transformative teaching and learning, and an outstanding student experience.

The Faculty's planning process is directed through the University's *Guidelines on Divisional Academic Planning*. In addition, the *Policy for Approval and Review of Academic Programs and Units* and the *University of Toronto Quality Assurance Process (UTQAP)* support the cyclic review process to monitor the academic standards of undergraduate and graduate programs, and to ensure ongoing enhancements. For U of T Engineering, the Canadian Engineering Accreditation Board (CEAB) is responsible for accrediting all engineering undergraduate programs, and we will undertake a CEAB audit in the fall of 2018.

While international rankings are only one measure of excellence, they do highlight our reputation as one of the top engineering schools in the world. As a Faculty, we also realize that these highly publicized rankings influence faculty and students in their decision to come to U of T Engineering.

Remaining cognisant that we are one of the preeminent engineering schools in the global rankings influences the approach we take in setting our academic priorities. Therefore, excellence in engineering education and teaching, multidisciplinary collaborative research, a diverse student body that excels professionally and personally, committed faculty and staff, and engaged alumni are all priorities in our plan.

Since we published our *2011 – 2016 Academic Plan*, we have assessed our progress and achievements to ensure we reach our stated goals and create new opportunities as they arise. Each fall, we publish the *Update to the Academic Plan*, which reports our progress to the Faculty, and the U of T community. Over the past five years, as part of this ongoing assessment, the Faculty has created a number of strategic initiatives, which have allowed us to prepare for the *2017 – 2022 Academic Plan*.

The *Decanal Task Force on Mental Health* was created in July 2015 to examine the existing mental health support systems for the Faculty's students. Within the task force we conducted an assessment of the Faculty's current performance and initiatives in relation to each of the strategic priorities within the University of Toronto's *Student Mental Health Strategy and Framework* (released in October 2014). Our final report was published in January 2017.

The *Dean's Task Force on Academic Advising* was struck in the fall of 2015, and identified the need to review student counselling as an action item within the strategic theme of

*Student Experience.* The task force reviewed academic and student advising and made key recommendations for our future direction. The final report was issued in August 2016.

The *Core Curriculum Review Task Force* was created in 2013 as a decanal task force to formally review the content and delivery of the Faculty of Applied Science & Engineering first-year (core) curriculum for the Core 8 and TrackOne (Undeclared) programs from the perspective of students, faculty and external evaluators. It compared these offerings to best practices and recommended changes to meet the evolving foundational education needs of our programs. The final report was published in December 2014.

The Faculty-level *Engineering Strategies and Practice I and II Review Committee* was created in the fall of 2016 to review the cornerstone sequence of Engineering Strategies and Practice I and II within the Core 8 and TrackOne (Undeclared) programs. This review was in response to one of the recommendations of the *Core Curriculum Review Task Force*. The final report was issued in June 2017.

Published in May 2017, the *Faculty of Applied Science & Engineering Maker Space Report* identifies what equipment and facilities are available, and what we need to complement existing resources, including supervision and safety.

This report was key to our strategy development supporting design courses and other student activities.

The *Bibliometrics Working Group Report* was published in March 2017. This working group was established to determine how bibliometrics could effectively be deployed within the Faculty to assess research excellence.

The *U of T Robotics Strategic Planning Committee: Final Report* was completed in July 2017. This report was a collaborative effort between U of T Engineering, the Department of Computer Science and UTM. The committee was tasked to strengthen U of T as the best robotics school in Canada and make it top five in the world.

Recommendations of the *Eagles' Longhouse: Engineering Indigenous Initiatives Steering Committee* and the *Information Security & Protection of Digital Assets Steering Committee* are both expected early in 2018.

The Faculty of Applied Science & Engineering's *Annual Report of Performance Indicators* was first published in 2009, and tracks progress towards the goals laid out in the Faculty's Academic Plan. Each publication is a data-rich, systematic examination of our educational programs, research and co-curricular initiatives. A breadth of information is provided, including detail on admissions, enrolment, research funding, awards, world rankings, advancement, communications, resources, diversity, international initiatives and cross-faculty education and experiential learning. Through concrete metrics and statistics, the Annual Report provides a comprehensive picture of Faculty initiatives and program development over the past year, in addition to a comparison of progress over the past ten years.

**U of T ENGINEERING IS COMMITTED TO DEVELOPING THE NEXT GENERATION OF MAKERS, INNOVATORS, AND ENGINEERING LEADERS, AND TO ENSURING THAT THE REQUIRED FACILITIES EXIST TO DO SO.**

As part of the larger U of T academic planning and accountability process, the *Faculty of Applied Science & Engineering Self-Study* is a broad-based and reflective report that allows for a critical analysis of the Faculty and our strengths and challenges. The Self-Study was published in January 2017 and reports on the status of, and progress within the Faculty and identifies future opportunities.

In 2017, our Vice-Dean, Research established four Faculty *Academic Planning Research Focus Groups*. These groups, with representatives from every department and institute, formed our academic plan research themes, each with important and emerging sub-themes. Areas of expertise across the Faculty, in addition to the goals in the University of Toronto's *Strategic Research Plan*, were brought together to set our focus for the next five years.

From January 31 to February 2, 2017, the Faculty's external reviewers, commissioned by the Provost, met with University and Faculty leadership, faculty members, students, staff and alumni. The external reviewers' final report spoke to the outstanding faculty and student body, and our worldwide reputation for excellence in education and research. The report also provided thoughtful and comprehensive recommendations, which have been incorporated into our academic plan goals and actions.

To facilitate the creation of our *2017 – 2022 Academic Plan*, stakeholders from across the Faculty, in conjunction with academic and administrative leaders, first developed the *2017 – 2022 Academic Planning Framework*. Initiating the process in early 2016, we created the framework from a comprehensive body of work — the self-study, external review, working and focus groups, ongoing evaluation and extensive consultations. The Faculty's academic planning process has relied heavily on our U of T Engineering community through assessment, consultation, analysis and planning. From this framework, we worked together to complete the plan. The *2017 – 2022 Academic Plan* is a result of broad and iterative consultations with the Faculty's leadership, Chairs and Directors of academic units, Associate Chairs and Directors and standing committees of Faculty Council, Faculty Council members, faculty members, undergraduate and graduate students, staff, alumni and University of Toronto stakeholders.

Our plan sets our academic priorities and administrative direction within the University's strategic context for the next five years and aims to achieve our goals for new levels of excellence in research and transformative teaching and learning. We are dedicated to academic excellence, impactful research, global outreach and visibility, student, staff and faculty diversity and inclusivity, enriching student experiences, and strengthening our collaborative partnerships, both locally and internationally.

The *2017 – 2022 Academic Plan* will be presented to U of T Engineering's Faculty Council on December 12, 2017.



# CHAPTER 2

## TRANSFORMATIVE TEACHING AND LEARNING

The Faculty of Applied Science & Engineering offers nine fully accredited undergraduate programs — with students obtaining either a Bachelor of Applied Science (BASC) or Bachelor of Applied Science in Engineering Science. In first year, students can choose between three entry points: Core Programs (Core 8), TrackOne (Undeclared) or Engineering Science. Our programs are highly competitive, and they attract some of the brightest students — from here in Canada and around the world.

For those pursuing graduate studies, our Faculty offers two research degrees, the Master of Applied Science (MASc) and the Doctor of Philosophy (PhD). These research-stream programs provide unparalleled opportunities to work alongside with our world-renowned faculty members. U of T Engineering also offers a Master of Health Science (MHSc) and a Master of Engineering (MEng) professional degree, which can be customized through thirteen technical specializations. These include Sustainable Engineering, Forensic Engineering, Robotics and Mechatronics, as well as an Emphasis in Analytics that starts in January 2018. Professional students may also pursue an MEng in Biomedical Engineering or Cities Engineering and Management.

▲ Professor Jason Bazylak (middle) teaches Engineering Strategies & Practice and serves as the Dean's Advisor on Indigenous Initiatives as co-chair of the Eagles' Longhouse. Bazylak is one of six Hart Teaching Innovation Professors.

The U of T 21<sup>st</sup> Century Engineer not only needs a strong technical foundation, but also a breadth of professional competencies in areas including leadership, entrepreneurship, communication and business. Therefore we have proactively created several options for students, to complement their academic programs in high demand areas of interest. These include the emphasis in Entrepreneurship, Leadership, Innovation and Technology in Engineering (ELITE) for MEng students, a choice of eight undergraduate minors including Engineering Business, and nine undergraduate engineering certificates including Global Engineering, Communication, Entrepreneurship and Engineering Business.

**WHETHER OUR GRADUATES ARE DESTINED FOR A CAREER IN ACADEMIA, INDUSTRY OR THE PUBLIC SECTOR, WE STRIVE TO PROVIDE AN OUTSTANDING LEARNING EXPERIENCE, ONE THAT OFFERS DIVERSE AND GLOBAL PERSPECTIVE, AND IS RICH WITH OPPORTUNITIES THAT ARE MULTIDISCIPLINARY AND COLLABORATIVE.**

Inspiring and nurturing the U of T 21<sup>st</sup> Century Engineer continues to be our goal.

For admissions, in the 2015 cycle we started a three-year pilot for our Broad Based Admissions (BBA) process, which considers high school performance in the context of non-academic factors. Marks alone do not provide a

complete picture of a students' potential and the BBA allows our Admissions Committee the opportunity to learn more about each candidate's strengths and interests, including their ability to articulate their thoughts and ideas, dedication to learning and overall excellence. In this next phase of academic planning, we will complete the pilot review and implement a permanent BBA system to fully integrate the process into all admissions decisions. To further enhance our admissions tools, we will also implement a new *Admissions Portal*, which will be used by the Admissions Committee and staff to assess domestic and international applicants and will provide better dashboard information and analytics to aid with the decision process.

Our admission and recruitment strategy for the Faculty also focuses on enhancing gender diversity and working towards increasing representation from Indigenous, Black and other communities. Part of this approach is to continue to adapt and improve our recruitment and admissions process to reduce the barriers for students that take alternative pathways into engineering. Supporting us in this goal will be the recommendations of the *Eagles' Longhouse: Engineering Indigenous Initiatives Steering Committee*, which will issue its final report in 2018.

U of T Engineering is dedicated to transformative teaching and learning, and creating and implementing initiatives that speak to our culture of excellence and legacy of innovation in curricula and course delivery. In support of this mission, the Faculty works with the Office of the Vice-Provost, Academic Programs who oversees quality assurance under the *Policy for Approval and Review of Academic Programs and Units*, and more specifically under the *University of Toronto Quality Assurance Process (UTQAP)*. In the context of quality assurance, the Faculty, and the University of Toronto, "is committed to being an internationally significant research university, with undergraduate, graduate, and professional programs of excellent quality"<sup>1</sup>. The bachelor degree programs in the Faculty of Applied Science & Engineering are also accredited by the Canadian Engineering Accreditation Board (CEAB). Our Faculty will undergo a CEAB audit in the fall of 2018, which will provide us an opportunity to further review

<sup>1</sup> University of Toronto Quality Assurance Process (UTQAP), September 21, 2012.

and refine our academic programs to ensure they continue to meet the high standards required for engineering licensure and professional mobility, and develop within our graduates the full complement of engineering attributes that prepare them to take leading roles in addressing the world's major challenges.

Our *2017 – 2022 Academic Plan* is the culmination of years of preparation and groundwork within our U of T Engineering community. The goals and actions we have chosen to pursue over the next five years arise from many sources. In addition to consultations for the self-study and external review, ongoing Dean's Town Halls and working groups, the decanal *Core Curriculum Review Task Force* formally reviewed the content and delivery of the Faculty of Applied Science & Engineering first-year (core) curriculum for the Core 8 and TrackOne (Undeclared) programs from the perspective of students, faculty and external evaluators. As a result of the recommendations, we appointed an *Engineering Strategies and Practice I and II Review Committee* to review the sequence of cornerstone courses Engineering Strategies and Practice I and II within the Core 8 and TrackOne (Undeclared) programs. Recommendations from both these initiatives will continue to be implemented, ensuring we continue to meet the evolving rigorous foundational education needs of our programs.

The Faculty remains committed to innovation in education, and ensuring we develop best practices in new technologies and methods. Within the *2017 – 2022 Academic Plan*, we will expand or implement several programs and initiatives. These include the *Technology Enhanced Active Learning (TEAL) Fellows Program*, created in 2017, and the *Hart Teaching Innovation Professorships*, which support innovation in engineering education and Indigenous outreach. We will continue our successful *Engineering Instructional Innovation Program*, which aims to foster curriculum innovation through strategic investments to improve teaching pedagogies and the student experience. We will also establish a new extra-departmental unit, the Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTE2P). This institute will focus on three themes: (1) investigating the application of successful practices from other domains to engineering education; (2) cross-disciplinary competencies; and (3) guiding and supporting innovation in pedagogy.

During our external review, and during the consultations for the self-study, reducing the average time-to-completion for PhD students was recommended by many of our stakeholders. Over the last several years, trends for the average PhD time-to-completion have been affected by the practice in many academic units of promoting fast-tracking and direct-entry into the PhD program, as well as the dedication of supervisors and students to keep with regular committee meetings. Therefore, with the goal to account properly time-to-completion, we will be assessing the impact of fast-tracking and direct-entry. In addition, we will encourage stricter monitoring of compliance for a mandatory annual supervisory committee meeting, so student progress can be assessed, and remediation measures implemented, if required.

An important role of the Faculty is to educate and prepare the next generation of research leaders. A central aspect of research is to design studies and analyze data to draw conclusions. Therefore we will have a goal of improved access to statistical expertise for complex studies, which may also help to decrease time-to-completion and allow for better use of time and resources. During the self-study consultations, graduate students

noted the desire for additional resources to design experiments. Therefore, we will work on integrating statistical consulting with library resources and writing support.

*Transformative Teaching and Learning* focuses on the academic curriculum, while *Student Experience*, the next chapter in the *2017 – 2022 Academic Plan*, looks to student engagement and fulfillment, both in the classroom, for academic advising and mental health, to outside the classroom for co-curricular interests, such as student clubs, and providing for meaningful international exchanges and experiences. *Transformative Teaching and Learning* articulates our education and curriculum-based goals and actions, especially related to innovative teaching, technology and the infrastructure in support of such pursuits.

## GOALS

Over the next five years, the following goals will drive us to establish U of T Engineering as a leader in pedagogical development and teaching innovation in undergraduate and graduate education. We will be dedicated to excellence in engineering education and course delivery, and multidisciplinary collaborative opportunities that will create the U of T 21<sup>st</sup> Century Engineer — an engineer who will work towards addressing the world’s most pressing challenges, and have the competencies to create technological change for the betterment of society.

1. Establish U of T Engineering as a global leader in pedagogical development and teaching innovation in engineering education.
2. Continue to develop rich opportunities for experiential learning and professional development for undergraduate and graduate students, including interdisciplinary fluency and working effectively and collaboratively across cultures.
3. Further integrate active learning pedagogies into curriculum delivery to encourage life-long learning and knowledge creation.
4. Prepare students with the technical and transdisciplinary competencies necessary for them to identify, learn, and apply these along with engineering practices to resolve global challenges, create new technologies and contribute to the prosperity of society.
5. Leverage the Centre for Engineering Innovation & Entrepreneurship’s state-of-the-art facilities, as well as instructional technology tools, to further enrich our students in the active learning experience in engineering design and prototyping, and collaborative, multidisciplinary learning.
6. Attract diverse, outstanding students from a wide range of backgrounds; and leverage all types of diversity to promote inclusivity and create opportunities to experience working collaboratively across cultures.
7. Ensure U of T Engineering remains a leader in the promotion and support of research training for graduate and undergraduate students.





# CHAPTER 3

## STUDENT EXPERIENCE

Our undergraduate and graduate students come from diverse backgrounds and have a wide range of academic and personal interests. Both inside and outside the classroom, U of T Engineering is dedicated to supporting faculty-student engagement and a vibrant student community to ensure a dynamic educational environment and extensive opportunities to engage in co-curricular activities and research.

Beyond standard supports and infrastructure, we are dedicated to providing a comprehensive and quality experience — one that not only speaks to the diversity and international outlook of our students, but also keeps with our culture and pursuit of excellence.

Academic planning is an ongoing process and we have received input from our undergraduate and graduate students through many channels. This includes consultations for the Faculty's self-study and external review, Dean's Town Halls, and recommendations from decanal task forces and working groups. In this cycle of academic planning we worked to ensure we reached all stakeholders, including meeting with postdoctoral fellows, and engaging in more robust MEng student consultations.

Complementing the academic goals and plans in *Transformative Teaching and Learning*, our five-year plan will strengthen our undergraduate and graduate programming to ensure an

▲ A Professional Experience Year (PEY) intern uses a virtual reality headset to validate the performance of a new graphics card at Advanced Micro Devices (AMD). Each year, over 700 engineering undergraduates and 325 employers participate in PEY, the largest paid internship of its kind in Canada.

enriching *Student Experience*. There are many initiatives within *Student Experience*, including enhancing entrepreneurship, providing more experiential learning opportunities (both locally and abroad), and integrating multidisciplinary collaborations into student activities. To ensure students succeed, academically, personally and professionally, we have created new and improved programs and support systems for academic advising, mental wellness and healthy lifestyles. In addition, with the Centre for Engineering Innovation & Entrepreneurship, our students will have dedicated student-club space for co-curricular activities, new design studios, prototyping and fabrication facilities.

## **THE QUALITY OF THE *STUDENT EXPERIENCE* IS IMPORTANT FOR OUR UNDERGRADUATE AND GRADUATE STUDENTS WHILE THEY ARE HERE IN OUR FACULTY, BUT IT ALSO HAS A LASTING IMPACT WHEN THEY BECOME ENGINEERING ALUMNI.**

Engagement inside and outside the classroom broadens each student's perspective, contributes to the development of the attributes expected of engineering graduates, and ultimately allows them to better manage and succeed in today's complex global environment. Academic

credentials are no longer sufficient; equally important are work experience, a network of colleagues and friends, and a co-curricular record that demonstrates the development of professional and personal competencies in areas such as communications, professionalism, project management, finances, leadership, teamwork and problem solving. Therefore, our focus over the next five years supports the personal, professional, and technical development of engineering students, enriching and enhancing their opportunities for a lifetime of success.

Through the self-study and external review consultations, it was recommended to provide more certainty to graduate students regarding their funding. While the Faculty communicates minimum guaranteed stipend levels on our website, we will endeavour to accelerate the assignment of teaching assistantships in each department and institute in order to provide this information to students in a timelier manner. These steps are articulated in our implementation plan.

In this chapter, we outline the goals to support both our undergraduate and graduate students to ensure that the experience they have here at U of T Engineering is not only dynamic and memorable, but also prepares them to succeed professionally and personally in our broader community. We are dedicated to graduating the U of T 21<sup>st</sup> Century Engineer.

### **GOALS**

Taking a comprehensive view of the student educational experience as encompassing curricular, co-curricular, and extra-curricular components, we will offer unparalleled opportunities to our students to develop the attributes expected of a U of T 21<sup>st</sup> Century Engineer. This includes a broad range of competencies and skills such as leadership, communications, business, entrepreneurship, professionalism, fostering inclusivity and equity, and with a global perspective and commitment to ethics and integrity. We are also dedicated to providing a student experience that will stay with our graduates forever. This includes the passion for life-long learning, a diverse network of fellow alumni and friends, and continued pursuit of their co-curricular and

extra-curricular interests. The following goals will guide the Faculty's initiatives to enrich the student experience and provide support to students during their studies.

1. Create a Centre for Engineering Student Success — a “one stop” point of access for information, resources, and assistance.
2. Encourage all undergraduate students to participate in a significant co-curricular experience and enhance programs to further undergraduate professional development: increase the number and diversity of PEY internships, summer research internships and international experiences.
3. Improve the quality, accessibility, and delivery of academic advising services.
4. Leverage and create resources, and develop policies and procedures to support mental wellness, assist students in need and promote healthy lifestyles.
5. Build on the pilot professional development program for graduate students (i.e. professional development for PhD students) and promote industrial interactions.
6. Encourage participation in, and support the activities of, co- and extra-curricular student activities, such as the competitive student design teams and other student clubs and groups.
7. Ensure that infrastructure (space and IT) supports are in place to facilitate collaboration and innovation within student teams and clubs.
8. Support deeper engagement and community amongst graduate and undergraduate students, in addition to enhanced faculty-student interaction across undergraduate and graduate programs.
9. Equip students, staff and faculty with the competencies necessary to navigate cross-cultural communications and interactions, thereby creating an enriching inclusive environment where everyone will excel and flourish.



# CHAPTER 4

## INNOVATIVE RESEARCH AND ENTREPRENEURSHIP

The Faculty of Applied Science & Engineering is a vibrant research community and is defined by creativity, multidisciplinary collaboration, innovation and entrepreneurship. U of T Engineering is an integral part of the University of Toronto's success as the #1 university in Canada and among the world's best. Our Faculty is committed to generating transformative knowledge, research excellence and global impact.

Initiatives in the Faculty are interdisciplinary by design, connecting our engineering researchers with each other, with faculty across the University of Toronto, and externally. A community of outstanding graduate and undergraduate students, research associates, postdoctoral fellows, laboratory technicians and staff, support and facilitate our research mandate. Our faculty members have continued growing provincial and federal research funding received, in addition to increasing the amount of financial support secured from industry partners and endowments. U of T Engineering is home to 90 research chairs, a growth of 30% over the past five years. We have embarked on major research initiatives both nationally and internationally, created spinoff companies, expanded our collaborations with industry and government, and advanced our culture of innovation and entrepreneurship through our startup incubators.

▲ Professor Angela Schoellig (left) and her students test drones in the Dynamic Systems Lab at U of T's Institute for Aerospace Studies. In 2017, she was named one of MIT's Innovators Under 35 and awarded a Sloan Teaching Fellowship to advance her research on autonomous aerial vehicles.

Paramount to our Faculty's mission of multidisciplinary collaborative research, the Research Committee, one of Faculty Council's Standing Committees, acts as an advisory body to support our culture of excellence and advance innovation. Each department and institute has an appointed Associate Chair or Associate Director, respectively, and they consult with each other and their constituent department on research matters pertaining to strategic planning, and support implementation of the goals and actions in the Academic Plan. Members of the committee coordinate research, entrepreneurship and innovation activities within the Faculty, in addition to supporting and strengthening relationships with other Faculties, external institutions and industry. To further support our external engagement, we have created two new positions; a Director of Foundation & Corporate Partnerships and a Director of Corporate, Government & International Partnerships. Both roles are focused on building strategic partnerships to drive technology development, leverage government research funding programs and maximize our impact globally.

Within the Faculty, our researchers develop and create innovative technologies and solutions for the most pressing health challenges; ensure the sustainability of our urban environment; provide novel solutions for advanced

manufacturing; and look beyond our world to aircraft flight and space exploration. The themes of each department and institute are noted in **Table 1**.

**OUR DEPARTMENTS AND INSTITUTES, EACH WITH THEIR UNIQUE INDIVIDUAL STRENGTHS PROVIDE AN EXCEPTIONAL ENVIRONMENT TO SUPPORT CUTTING-EDGE RESEARCH, NURTURE LEADERSHIP AND PROMOTE MULTIDISCIPLINARY TRAINING.**

Our achievement in fostering multidisciplinary and collaborative research activities is illustrated through our 26 centres and institutes, 11 of which were created in the past five years. These include the Institute for Water Innovation, Centre for Healthcare Engineering and the University of Toronto Transportation Research Institute. Cross-Faculty initiatives are a result of strategies to nurture innovation and new partnerships. The Translational Biology & Engineering Program of the Ted Rogers Centre for Heart Research and Medicine by Design are two such initiatives launched in U of T Engineering in 2015 that build on the expertise from several U of T Faculties along with research hospitals and other partners. Looking externally, our centres and institutes also collaborate with more than 300 industry partners, from startups to global multinationals.

Through our self-study, external review, numerous task forces, working groups and consultations, we actively sought new opportunities to refine our Academic Plan. From this ongoing work, and to solidify our *2017 – 2022 Academic Plan*, we created a research steering committee overseeing four focus groups. These focus groups had the mandate to discuss the corresponding four main themes to represent our cross-Faculty research foci. From these themes, we have structured corresponding sub-themes, which are detailed below. Our research themes align with the University of Toronto's goals and priorities, allow for the expansion of research funding and infrastructure, create an environment for innovation and entrepreneurship, and support and strengthen local and international partnerships. During the self-study consultations, it was noted that despite the great success we have had in securing research funding, there are untapped opportunities to significantly grow sponsored research funding. Accordingly, we have developed specific goals and actions in the academic plan to seize this potential.

**Table 1: Areas of Research Expertise by Department/Institute**

<b>Department of Chemical Engineering &amp; Applied Chemistry</b>	<ul style="list-style-type: none"> <li>• Biomolecular and biomedical engineering</li> <li>• Bioprocess engineering</li> <li>• Chemical and materials process engineering</li> <li>• Environmental science and engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Informatics</li> <li>• Pulp and paper</li> <li>• Surface and interface engineering</li> <li>• Sustainable energy</li> </ul>
<b>Department of Civil Engineering</b>	<ul style="list-style-type: none"> <li>• Structural engineering</li> <li>• Transportation engineering and planning</li> <li>• Environmental engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Building engineering</li> <li>• Mining and geomechanics</li> </ul>
<b>The Edward S. Rogers Sr. Department of Electrical &amp; Computer Engineering</b>	<ul style="list-style-type: none"> <li>• Biomedical engineering</li> <li>• Communications</li> <li>• Computer engineering</li> <li>• Electromagnetics</li> </ul>	<ul style="list-style-type: none"> <li>• Electronics</li> <li>• Energy systems</li> <li>• Systems control</li> <li>• Photonics</li> </ul>
<b>Department of Materials Science &amp; Engineering</b>	<ul style="list-style-type: none"> <li>• Advanced coating technologies and ceramics</li> <li>• Biomaterials and biotechnology</li> <li>• Metals and alloys, composites, polymers and hybrid materials</li> <li>• Computational materials engineering</li> <li>• Electronic materials and systems</li> </ul>	<ul style="list-style-type: none"> <li>• Electrochemical energy conversion and storage devices, systems and technologies</li> <li>• Materials fracture and failure</li> <li>• Materials processing and modelling</li> <li>• Advanced manufacturing</li> <li>• Nanomaterials and nanotechnology</li> </ul>
<b>Department of Mechanical &amp; Industrial Engineering</b>	<ul style="list-style-type: none"> <li>• Advanced manufacturing and materials engineering</li> <li>• Applied mechanics and design</li> <li>• Biomedical engineering</li> <li>• Energy and environmental engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Human factors and ergonomics</li> <li>• Information engineering</li> <li>• Operations research</li> <li>• Robotics, mechatronics and instrumentation</li> <li>• Thermal and fluid sciences engineering</li> </ul>
<b>Institute of Biomaterials &amp; Biomedical Engineering</b>	<ul style="list-style-type: none"> <li>• Neural, sensory systems and rehabilitation</li> <li>• Engineering in a clinical setting</li> </ul>	<ul style="list-style-type: none"> <li>• Biomaterials, tissue engineering and regenerative medicine</li> <li>• Nanotechnology, molecular imaging and systems biology</li> </ul>
<b>University of Toronto Institute for Aerospace Studies</b>	<ul style="list-style-type: none"> <li>• Aerodynamics, fluid dynamics and propulsion</li> <li>• Aircraft flight; structures, design and optimization</li> </ul>	<ul style="list-style-type: none"> <li>• Space systems engineering</li> <li>• Engineering physics</li> </ul>

Each department and institute will have research corresponding to one or more of the four themes. The interdisciplinary nature of our research bridges these themes, thereby enabling us to more effectively address today's complex challenges, enhance our Faculty's achievements and scientific and socioeconomic impact. The research themes also support our internationally

recognized Research Chairs and allow our undergraduate and graduate students to gain research competencies. The four research foci will serve as platforms to further strengthen external partnerships, and increase our capacity to create opportunities to draw donor support that will further enable research initiatives.

## **DATA ANALYTICS AND INTELLIGENT SYSTEMS**

Our world is more connected today than ever before due to the central role that data plays in all major fields of physical and life sciences, and in technology. Over the years, we have learned how to efficiently sense, store, and communicate more data, and how to draw “intelligence” from it as to create autonomous systems such as self-driving cars, to improve human health through personalized medicine, and to better our lives through smart connected systems. Our research in this area can be divided into four sub-themes:

### **AUTONOMOUS SYSTEMS AND ROBOTICS**

Our research in autonomous systems and robotics focuses on developing and integrating systems that will have an enormous impact on our daily lives through such applications as self-driving cars, unmanned aerial and mobile vehicles, robotic surgery, assistive and rehabilitation robots and devices, smart homes and appliances, and advanced manufacturing. Our researchers are also working on developing new actuator, control, artificial intelligence, and sensory technologies, which will enable individual and teams of autonomous systems and robots, from the nano to the macro size scale, to do things never before possible.

### **INTELLIGENT WELLNESS TECHNOLOGIES**

Intelligent Wellness Technologies are meant to improve the wellbeing of humans by adopting the leading-edge technologies and sciences. Specific topics include personalized medicine, digital medicine, wearable monitoring devices, health-care analytics, and predictive health-care delivery.

### **SMART CONNECTED SYSTEMS**

Our research in smart connected systems addresses the design of intelligent distributed systems in which interconnectivity plays a crucial role. These systems typically involve gathering, dissemination and storage of large volumes of sensor data, extraction of intelligence via analytics and machine learning, and support a wide gamut of smart applications. Examples include smart grids, smart homes, intelligent transportation, “Internet of Things” and intelligent manufacturing. These ultimately lead to the design of smart cities where overarching socio-economic challenges such as energy efficiency, air quality and carbon footprint are addressed.

### **ENABLING TECHNOLOGIES FOR INTELLIGENT SYSTEMS**

Computing systems are “learning” to “think”, “see”, “hear”, “read”, “write”, and in general to interact with the physical world in ways that we typically associate only with humans and high intelligence. In part, regular and exponential advances in semiconductor technologies enabled the emergence of these intelligent systems over the past four to five decades. Our plan moving forward is to work on enabling technologies for intelligent systems, including but not limited to technologies for data sensing, storage, communications, security and privacy, analytics and management, optical communication and networks, distributed systems, and hardware/software co-design.

## ADVANCED MATERIALS AND MANUFACTURING

Our Faculty is strategically located in Southern Ontario, which is a major manufacturing hub in Canada. Therefore, the main objective of this theme is to leverage U of T Engineering's knowledge and expertise in advanced materials and manufacturing and our partnerships with the Canadian manufacturing industry. The goal is to scale up advanced materials and manufacturing technologies and develop innovative manufacturing practices for the 21<sup>st</sup> century. The mission is to expedite the research and development of advanced materials and manufacturing technologies by creating multidisciplinary, multi-departmental networks focused on sharing knowledge, ideas and resources. Operating under the University of Toronto strategic priority area, our Faculty will strive for global leadership in advanced materials and manufacturing by translating lab-based technologies into commercial, scaled-up processes, and contributing to education and the training of High Qualified Personnel (HQP) in the materials and manufacturing sector. The strategic area of Advanced Materials and Manufacturing will take shape through three sub-themes:

### MANUFACTURING OF ADVANCED MATERIALS

This sub-theme covers the complete range of knowledge involving the processing, structure, properties, performance, and design of advanced materials. In particular, it focuses on the development of an innovative and new class of materials with unique properties and far-reaching applications in the key sector of materials and manufacturing, which includes structural, electronic, surface, energy, bio and green materials. New emphasis in this theme will be given to super macromolecules materials, materials for wearable technologies, and electrical and autonomous cars. The development of cost-effective high-performance materials could potentially result in a large number of applications that are innovative, multi-functional, sustainable, and environmentally benign.

### ADVANCED MANUFACTURING PROCESSES AND SYSTEMS

These are knowledge- and capital-intensive techniques and facilities employed to manufacture classes of materials and structures in a novel, more efficient or more effective manner. Examples are additive manufacturing, rapid prototyping, digital manufacturing, subtractive manufacturing, rapid manufacturing, and bio printing. In order to achieve optimal performance for these processes, precise placement of materials in space is required. Advanced manufacturing systems are applicable to many processes and materials, and add further knowledge intensity to organize or control a set or series of manufacturing processes.

### MANUFACTURING PLANNING AND MANAGEMENT

In addition to research in physical materials and processes, this sub-theme will focus on the representation of knowledge in advanced manufacturing processes, materials and products. Such representations will support automated reasoning and analysis techniques, leading to better predictive and diagnostic models. This knowledge-based approach will enable the integration of data and knowledge from physics-based models of processes and materials including optimization modules, artificial intelligence, neural networks, design of experiments (DOE) and design for manufacturability (DFM), to engineering and control systems used in making decisions about design and production within the enterprise.



## SUSTAINABILITY

Engineers have long been aware of — and have strived to reduce — the impact of activities on the biosphere, lithosphere, hydrosphere, and atmosphere. Achieving a sustainable future and mitigating the adverse effects of climate change require the responsible use and protection of our natural and built environments through the development of clean technologies. The three sub-themes of Water, Air, Soil, Sustainable Energy, and Built Environment are included in this over-arching research theme; these frequently intersect and are inter- and cross-disciplinary research subsets:

### WATER, AIR, SOIL

This sub-theme includes research related to drinking water, municipal wastewater, industrial water, surface and ground water supplies, storm water management and low impact development, water reuse, water accessibility and security, water footprints, air quality, air pollution monitoring and control, carbon management, capturing and repurposing CO<sub>2</sub>, minimizing air emissions from urban centres and industrial operations, municipal solid waste reduction and management, industrial solid waste reduction, and soil remediation.

### SUSTAINABLE ENERGY

The Faculty's research strengths include energy distribution systems and renewable energy, particularly in the areas of solar, fuel cells, hydrogen production, bio-fuels, and wind, electrochemical energy conversion, and energy storage. We also have foci in energy recovery, and in sustainable use of energy in aerospace, industrial processes, green information technology, grid management, and energy transportation.

### BUILT ENVIRONMENT

Our interdisciplinary approach to research provides an excellent position to address the increasingly complex issues associated with built environments, including resilient infrastructure, transportation systems, structural engineering, energy efficient and healthy buildings, sustainable materials, sustainable industrial processes, product life cycle, advanced recycling, reducing carbon footprint, and clean technologies for mitigating climate change.

## ENGINEERING AND HUMAN HEALTH

Technology is re-wiring all of society and the time is ripe for intensifying engineering impact in addressing health challenges. Health research has experienced exponential growth due in part to technological advances, with engineering playing an integral role in leading and advancing these technologies. The Faculty of Applied Science & Engineering has particular strength in the areas of aging, neural engineering, human factors, medical robotics, pain management, regenerative medicine, and natural and urban environments. The broad research in this theme can be divided into three general categories:

### BIOENGINEERING

Bioengineering is the integration of engineering principles with medicine and biology. This subtheme includes clinical engineering, rehabilitation engineering, tissue engineering, stem cell engineering, neural engineering, synthetic biology, endogenous regeneration, biomaterials, therapeutics materials, nutraceuticals, electrotherapeutics,

electromagnetic therapy, and mechanobiology. Bioengineers in our Faculty are working towards diagnostics to detect diseases easier and earlier using optical detection systems, image analysis of diseased tissues and anatomy, hardware/software development, communications and signal processing, machine learning, medical imaging, and mobile devices. Our bioengineers are also working towards therapies to treat diseases including wound-healing materials, organ-specific targeted stimulation, robotic surgery, electromagnetics, using electricity to stimulate organisms, and nanomaterials.

### **HEALTH TECHNOLOGY**

Technological advances are critical to driving new biological discovery. Engineers are at the forefront of developing technology that interfaces with biology including medical and assistive robots, robotic surgery, wireless diagnostics, wearable or disposable diagnostics, medical electronic devices and implantables, point of care molecular diagnostics, optical diagnostics, image analysis of disease tissues and anatomy, sensing and medical imaging, mobile health technology. Our Faculty is also looking for ways to improve how technology interfaces with humans including developing healthy infrastructure related to the maintenance of the water, air, food and transportation system; the design of healthy buildings; the supply of water and air; and the communication of smart cities (e.g. wireless diagnostics, coordination, scheduling).

### **PUBLIC HEALTH**

Engineers in the Faculty of Applied Science & Engineering use wide-ranging design principles to impact public health at multiple scales: smart healthy cities and communities; sensors and analytics for public health; healthy aging; neural aging; impact of urban environments on aging; advanced care solutions; pain management; remote health monitoring; impact of air pollution on human health and climate; role of transportation, industrial plants and cities in pollutant emissions; technologies to monitor and reduce human exposure to pollution; healthy infrastructure for clean and safe water, air, food, nutrition, energy and transportation; indoor air quality; health in remote areas; health in Indigenous communities; impact of genomic, epigenetic and exposomic factors on health; machine learning and intelligent health technologies; and all-connected health systems.

## **GOALS**

The following goals will drive our Faculty's research activities over the next five years. We will continue to develop a compelling research vision with the mandate to enhance our impact by leading research benefiting the Province, Canada and global society through creativity, multidisciplinary collaboration and innovation.

## **RESEARCH EXCELLENCE**

1. Increase our support of transformative cross-disciplinary collaborative research that inspires innovation.
2. Continue fostering multidisciplinary collaborative research and education so it becomes an integral part of our culture.

3. Lead impactful multi-institutional research collaborations in strategic areas that will address local and global needs, in addition to create new technologies that will act as an engine of prosperity and economic development.
4. Create a vibrant research ecosystem, which is nurturing, collaborative and inclusive, with centres/institutes focusing on impactful priority areas.
5. Expand our mentorship programs for early-career researchers.
6. Increase our reputation and visibility, and be recognized for excellence and the impact of our contributions.

## INTERNATIONAL OUTREACH

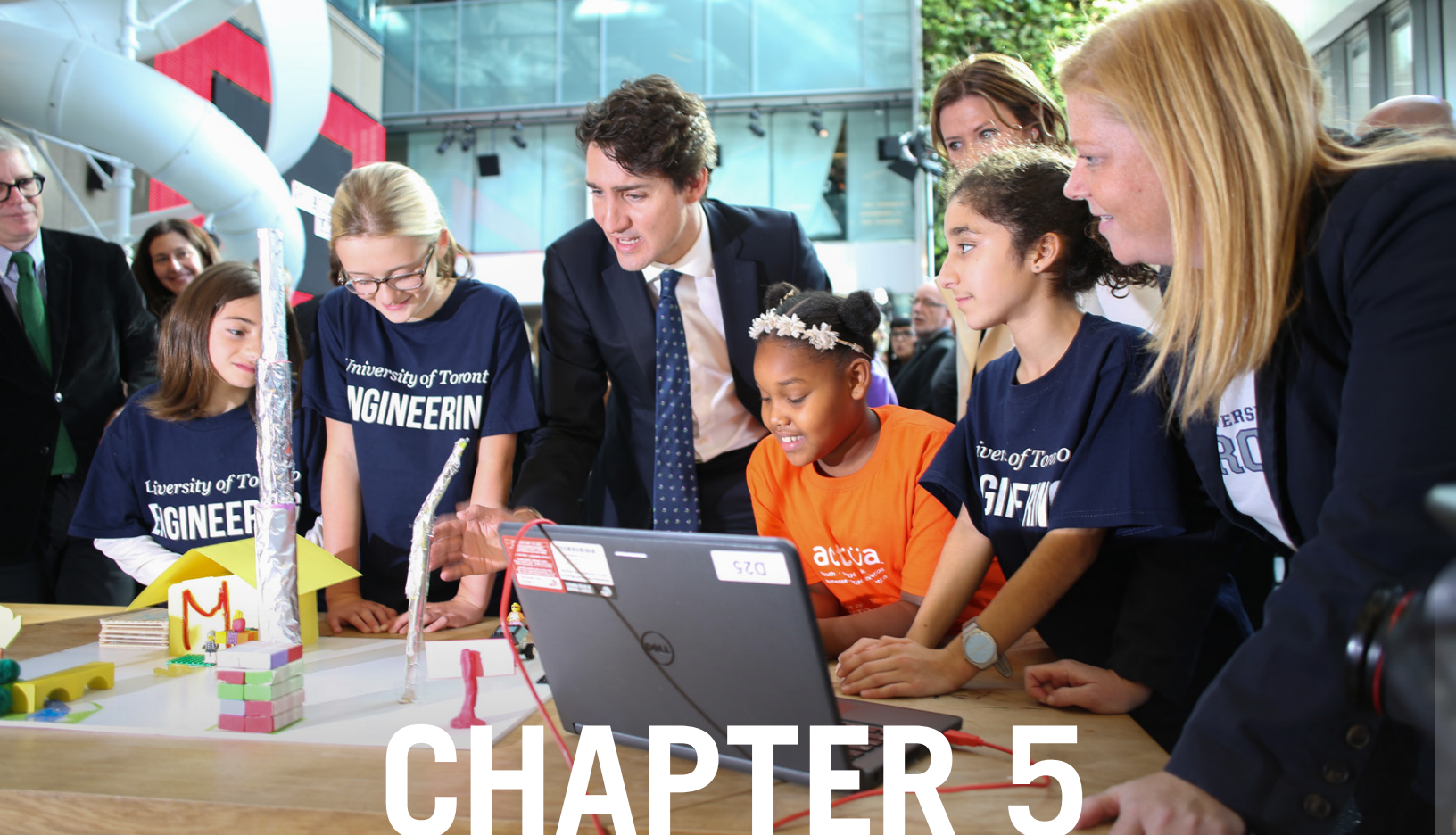
7. Enhance our impact through international institutional and industry research cooperation that address global challenges.
8. Increase our leadership and participation in internationally significant and impactful projects.
9. Develop/expand faculty and research student international mobility programs (e.g. *Named Opportunities* for Visiting Professors) and HQP international exchange capacity to educate and prepare the next generation global leaders.

## INDUSTRY AND ENTREPRENEURSHIP

10. Strengthen our research impact via the translation of basic discovery to application through increased industry partnerships and support for entrepreneurship initiatives.

## INFRASTRUCTURE AND SPACE

11. Create a forward-looking plan for our research space and infrastructure renewal, both quality and quantity.
12. Devise and implement a sustainable model for research support and for the operation of major research infrastructure in the Faculty of Applied Science & Engineering.



# CHAPTER 5

## INFLUENCE, COLLABORATION AND PARTNERSHIPS

Since its beginnings in 1873, with the creation of the School of Practical Science, then as a Faculty in 1906, the Faculty of Applied Science & Engineering has had deep roots within the University of Toronto and our diverse and dynamic city. One of the oldest engineering schools in Canada, it is home to undergraduate and graduate students seeking strong academic and research opportunities within the Faculty and University, connections with our alumni, and interactions with the external world, through international experiences, Professional Experience Year internships, and community involvement. Our faculty members are leaders in engineering education and research, both here in Canada and internationally. Many of the Faculty's 50,000+ alumni are actively involved as mentors, volunteers and generous donors towards our philanthropic initiatives.

▲ Prime Minister Justin Trudeau meets with elementary school students who spent the day designing the neighbourhood of the future at a workshop held by U of T Engineering Outreach. The project was part of an announcement by Waterfront Toronto and Sidewalk Labs to design a new community on Toronto's Eastern Waterfront.

Locally, we are dedicated to our pre-university outreach programs, to inspire all young women and men to explore a career in engineering. Our outreach initiatives also include leadership camps, to nurture future engineers and leaders, and work with K-12 educators to enhance the presence of engineering thinking in the elementary and high school curriculum.

## **THE STRENGTH OF OUR U of T ENGINEERING COMMUNITY, AND OUR MULTIDISCIPLINARY COLLABORATIVE APPROACH, ALLOWS US TO WORK WITH SOME OF THE MOST INNOVATIVE COMPANIES, PEER INSTITUTIONS, AND LEADERS IN EDUCATION AND RESEARCH.**

In *Innovative Research and Entrepreneurship*, we detailed our research-focused industrial partnership goals that will further develop and strengthen these collaborations. Partnerships are essential in creating outstanding opportunities for knowledge exchange between the Faculty and industry, student internships and multidisciplinary initiatives.

*Influence, Collaboration and Partnerships* articulates our goals and actions in relation to how we connect with each other at the Faculty and University, and also how we interact externally with our broader community. How effectively we connect with others has an important impact within the Faculty on our ability to attract the brightest students and faculty members, and also externally in addressing complex engineering challenges and creating new technologies for global prosperity.

U of T Engineering is dedicated to connecting with others outside the Faculty through many outreach initiatives to:

- Educate and inspire pre-university students to pursue careers in engineering;
- Foster enhanced education in science, technology, engineering and math (STEM);
- Develop strong partnerships with other Faculties, and between the City and the University;
- Employ engineering students as instructors in our outreach programs, providing them with first-hand experiences as engineering educators;
- Support the recruitment of prospective undergraduate and graduate students;
- Connect prospective students with current students to facilitate their decision process;
- Encourage engagement of alumni and volunteers within our vibrant U of T Engineering community;
- Continue to develop meaningful relationships with donors, and expand the network of philanthropic supporters;
- Support faculty and staff participating in government and funding agency panels and committees, professional academic or administrative organizations and groups;

- Better society through all our initiatives, with emphasis on those from the Centre for Global Engineering, the Food & Nutrition Security Engineering Initiative and the Institute for Water Innovation.

U of T Engineering supports extensive multidisciplinary **collaboration** and **partnerships**, with the goal to connect, facilitate, create and innovate. These include:

- Relationships with over 300 industry partners, representing all engineering disciplines;
- Offering of cross-Faculty undergraduate minors and certificates;
- Offering of collaborative graduate specializations such as Engineering Education with the Ontario Institute for Studies in Education, Psychology and Engineering with the Faculty of Arts & Science, and Biomedical Engineering with the Faculties of Medicine, Arts & Science, and Dentistry;
- Integration with other divisions through our cutting-edge research, such as Medicine by Design with the Faculties of Medicine, Pharmacy, Arts & Science and the Translational Biology Engineering Program with the Faculties of Medicine and Dentistry;
- Fostering student and faculty mobility, through exchanges and research with Canadian universities and international institutions;
- Nurturing essential professional competencies such as leadership and entrepreneurship through the Institute for Leadership Education in Engineering, Start@UTIAS Entrepreneurship Program and The Entrepreneurship Hatchery;
- Through extensive consultation and collaboration with the Faculty of Arts & Science, creation of the *Interdivisional Teaching Agreement* — which has allowed us to work in partnership for excellence in teaching and pedagogy, and improve access to courses to better the student experience;
- Working with industry partners, such as Google and AMD, and Canadian organizations, such as Actua, to create and deliver effective outreach programming to local and remote communities.

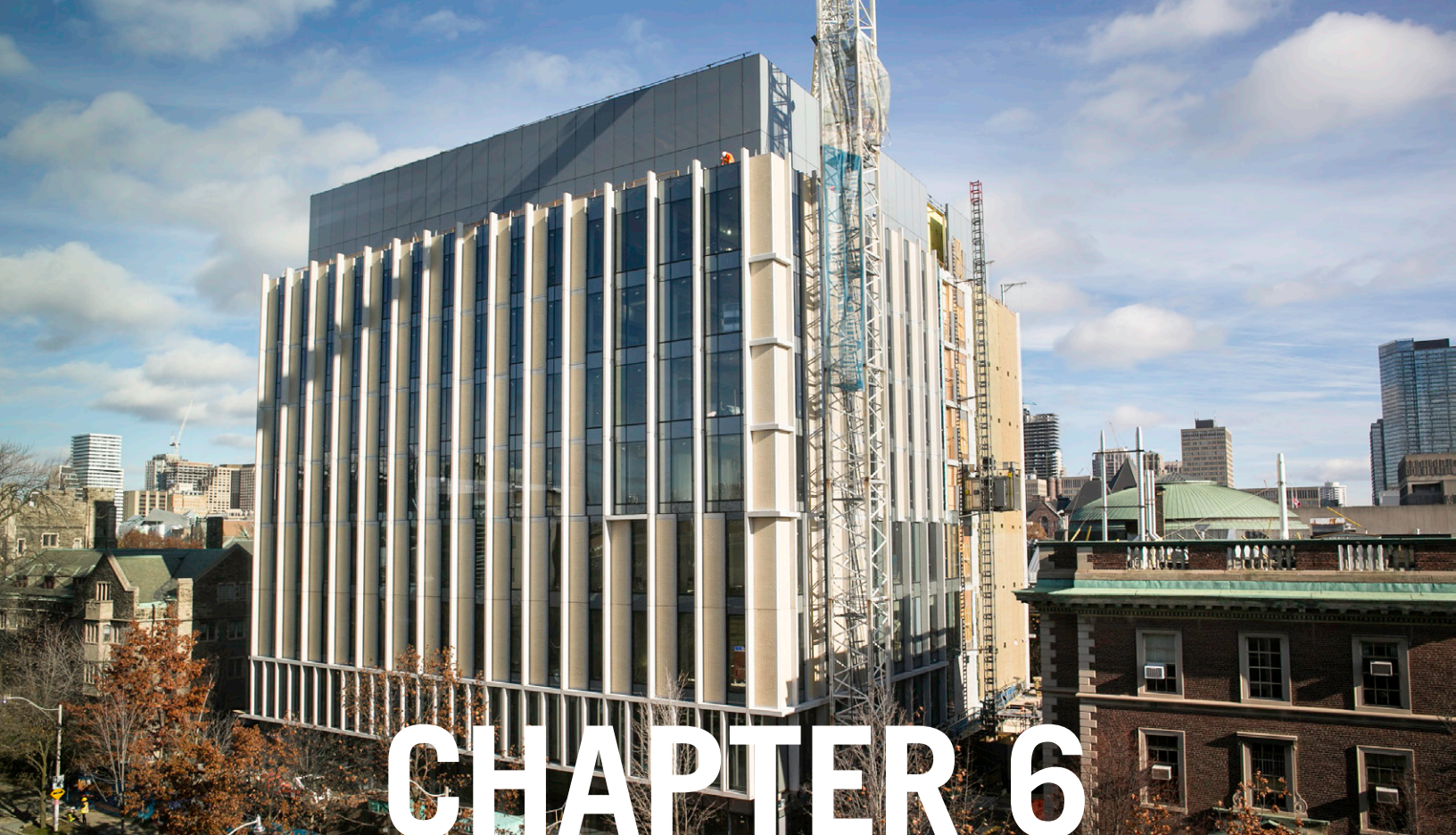
Outreach activities, collaborations, and partnerships allow U of T Engineering opportunities to **influence**, in a measureable and impactful way. The Faculty influences with commitment to:

- Create new technologies that will act as an engine of prosperity and economic development;
- Generate transformative knowledge, research excellence and global impact;
- Educate the next generation of global engineers who will be influential leaders in their chosen careers and in society;
- Promote excellence in the engineering profession and public understanding of engineering and its impact on society.

## GOALS

To strengthen collaborations and create impactful partnerships, we have set the following goals to direct our Faculty's efforts in these areas for the next five years.

1. Inspire and influence education and learning in science, technology, engineering and math (STEM) for K-12, while enhancing the student experience for undergraduate and graduate students.
2. Create connections within our community to enrich the City and the University.
3. Strengthen the relationship with alumni and increase interactions between alumni and current students.
4. Foster a stronger sense of community with alumni and donors who volunteer and provide philanthropic support to the Faculty.
5. Continue nurturing cross-disciplinary collaborations with other University of Toronto Faculties.
6. Develop strategic partnerships with key institutions and industry (local, national and international).
7. Increase the Faculty's impact through advocacy to and support from government agencies and industry; contribute to shaping the Canadian and global research agenda by influencing federal and provincial R&D priorities.
8. Raise the profile of the Faculty by actively participating in and providing leadership to professional societies, editorial boards and external research committees.
9. Provide outstanding leadership and influence for excellence in education.
10. Monitor and measure the impact of the Faculty's outreach, collaboration and partnerships.



# CHAPTER 6

## ORGANIZATION AND STRATEGIC RESOURCES

Our ability to achieve the important and ambitious goals we have set out in our Academic Plan is enabled by our Faculty's organization and resource allocation. Our philosophy is to effectively and strategically use our key resources to advance our innovation in research, support faculty and staff, and create an extraordinary learning environment for our students.

The self-study consultations, external review, decanal task forces, working groups, and other ongoing initiatives have allowed us to develop our organizational priorities for the next five years. Particular studies relevant to resources allocation include the Faculty's *Strategic Facility Plan*, *Report on Information Security & Protection of Digital Assets* and the *Faculty of Applied Science & Engineering Maker Space Report*.

U of T Engineering attracts top scholars whose research and teaching inform and shape our Faculty's goals. Our faculty members synergistically combine teaching, research and service. Teaching activities share leading-edge knowledge and inspire future generations of engineering leaders. While at the same time, our research endeavours attract funding, strengthen our Faculty's collaborations and outreach, enhance student education, and allow the Faculty to address the most pressing global issues of our time.

▲ When it opens in 2018, the Centre for Engineering Innovation & Entrepreneurship will provide a new home to several multidisciplinary research hubs as well as technology-enhanced classrooms, prototyping facilities and dedicated space for student clubs and teams.



In 2009 our *Divisional Space Review* confirmed that the Faculty's space no longer met our needs as a world-class engineering research and education institution. In 2018 the Faculty will open the Centre for Engineering Innovation & Entrepreneurship (CEIE). The CEIE will create a stimulating ecosystem to facilitate and celebrate multidisciplinary collaboration to the fullest. Here, students, researchers, alumni, industry partners and staff will work together to foster and accelerate technology innovation and entrepreneurship. Within the CEIE, there will be multidisciplinary research hubs to bring together innovative teams across the Faculty and our broader community. Many of our space concerns will be addressed within the nine floors of the building, which will also include new prototyping and fabrication facilities for students and faculty entrepreneurs. There will be a state-of-the-art 500-seat auditorium, dedicated student club space to enhance co-curricular experiences, eight design studios and five Technology Enhanced Active Learning (TEAL) rooms to enable dynamic group learning.

While the CEIE is a significant component in our strategy to alleviate our urgent space issues, we also continue to improve our existing facilities and infrastructure. In the past five years, we have invested more than \$200M in major cross-Faculty renovations and upgrades, including those in the Wallberg, Lassonde Mining and Sandford Fleming Buildings. In the implementation of the academic plan, we include actions to continue revitalizing and redesigning our historic spaces. One of our key goals is to continue creating new infrastructure, and improving the utilization and flexibility of space to support research, educational and co-curricular initiatives.

## **OPPORTUNITIES FOR LEADERSHIP IN ENGINEERING ADVANCEMENT**

While we continue to be strategic and prudent in managing our resources, advancement remains a critical part of ensuring we can support both our research, academic and capital priorities. In Chapter 4 we outlined our research foci that will allow us to further strengthen external partnerships, and increase our capacity to create opportunities to draw donor support. From the research themes, we have selected three main priorities for advancement, which are outlined below.

### **SUSTAINABILITY**

From renewable energy generation, energy storage, electric vehicles, emissions reduction, capture and storage to air quality and livable cities, U of T Engineering researchers are leaders in ensuring the ongoing health of our planet. With over 35% of our faculty working in some capacity in these areas, we have the critical mass of research excellence to create opportunities for global change. Coupled with both industrial and public sector awareness and drive, our Faculty is in an outstanding position to continue leading and creating new *Sustainability* initiatives.

### **WATER**

Canadians find themselves in a paradigm of plenty when it comes to water resources, but U of T Engineering researchers recognize that in a global context, water scarcity rather than abundance is the norm. With that in mind, our researchers tackle challenges related to municipal water reuse, industrial water remediation, drinking/irrigation water accessibility and water resource accounting and resilience. Our faculty members travel from South America to Europe to Asia to address research questions that arise from the global need for freshwater resources and are an indispensable asset to the global water community. As these water-related issues become increasingly intertwined, our researchers are finding that complementarities in our expertise represent a pathway towards the next generation of breakthroughs.

## ROBOTICS

Southern Ontario is a region already established as a leader in automotive and healthcare R&D. U of T Engineering has strong connections with these two sectors and continues to actively create new research collaborations and partnerships. Led by researchers in U of T Engineering and in the Department of Computer Science, we also have strengths in artificial intelligence. Our cohort of researchers have the expertise to create a comprehensive robotics ecosystem within the University. From autonomous vehicles to personal and assistive robotics to next-generation surgical tools, we are developing systems that incorporate computer vision, electromechanical control theory, mechanical design and application-specific considerations.

## FINANCIAL RESOURCES

Strategic increases in revenues together with responsible fiscal management have allowed us to invest in our pursuit of excellence in research, innovation, education and the student experience. This approach, coupled with the Faculty's budget model we developed in 2009, has also enabled us to strengthen our financial position, infrastructure capacity, and increase unencumbered operating contingency reserves.

Even in light of declining overall government support, U of T Engineering has enjoyed double-digit revenue growth over the past several years through enrolment expansions, research intensification, and an increase in funding and industry partnerships. Such growth has given the Faculty greater capacity towards sponsoring new initiatives, and the expansion of existing ones.

We are proud of the success we have enjoyed with the development and adoption of our hybrid *Responsibility Centered Management Based Budget Model*, and going forward we will continue with our prudent budgeting and fiscal management in support of our academic priorities and investments for the future. U of T Engineering must ensure the continued creative use of finite resources while prioritizing the quality of teaching, student experience, and research. Our faculty and students are creative and driven, often seeking to do things that have never been done before. Rigorous financial management through education and working within our budgeting framework will aid in these efforts.

## COMMUNICATIONS

Our strategic communications team aims to create and facilitate meaningful communication among all our stakeholders and advance our Faculty's academic mission. We work in partnership with over 30 communicators across the Faculty, who comprise the Engineering Communications Network, and with colleagues across the University of Toronto. We strive to establish new standards of excellence in higher education for creative, strategic communications and in support of the institution's vision of global leadership in university communications.

Our goal is to create innovative strategies and high-quality content that inspires action while advancing the reputation and visibility of U of T Engineering among all stakeholders. We will:

- Reinforce our message of diversity and inclusivity;
- Build the profile of U of T Engineering in strategic priority areas with key global audiences, including students, leaders, influencers, policymakers, peer institutions, alumni and donors;
- Enhance our communications capacity in support of our academic mission;

- Utilize our communications network and Intranet to facilitate knowledge exchange in our U of T Engineering community and to share best practices in support of excellence in teaching, learning, research and administration.

## HUMAN RESOURCES

Championing the Faculty's priorities are our dedicated administrative and technical staff. Supporting every facet of our operations, our staff maintain our culture of excellence and provide a stable and efficient environment for our students and faculty members to thrive. No matter what their function is, the Faculty's staff members are committed to outstanding service and supporting the U of T Engineering community.

Our professoriate stands at 261 faculty members, and among these members 21.1% are women, up from 9.8% in 2006. Diversity is a core value of U of T Engineering, and we believe that diversity deepens the creative process, enriches the learning experience and brings different perspectives to better solve global challenges. Our goal over the next five years will be to continue our efforts to improve diversity in our faculty complement. This includes gender diversity, and other groups that are underrepresented in the Faculty, particularly Indigenous and Black academic staff.

## INFORMATION TECHNOLOGY

In 2017, we established a steering committee on Information Security & the Protection of Digital Assets. Under the scope of this initiative is the Faculty's IT plan. This report will be published in 2018 and will include recommendations on Information Security, professional development in the use of new technology and setting a base level of IT support across the Faculty.

## GOALS

Strategic use of our resources will allow us to support the Faculty's academic priorities over the next five years.

1. Expand opportunities for staff development to address the evolving needs of our Faculty, to provide appropriate tools to increase effectiveness and to create innovative approaches for staff advancement.
2. Emphasize diversity and cross-disciplinary strategic research themes when recruiting faculty, and become a magnet for world-class talent.
3. Continue to enhance teaching and design facilities, improve laboratory and research space and provide co-curricular space for undergraduate and graduate students.
4. Strengthen our network of faculty, staff, students and alumni for the betterment of the Faculty and our broader community.
5. Continue to increase the quality of our communications and key messaging, and increase the Faculty's visibility to target audiences.
6. Create a base level of IT services across the Faculty and enhance professional development for staff and faculty in the use of new technologies.
7. Ensure operating budgets, capital plans, and fundraising, continue to align with our academic mission and priorities, and invest strategically for the future.



## OUR COMMITMENT

U of T Engineering's *2017 – 2022 Academic Plan* has been brought together through the efforts of our outstanding community of students, faculty, staff, alumni and other key stakeholders. With our five-year goals established, we will concentrate on the actions related to these goals, as detailed in our implementation plan. We will also establish timelines and metrics, by which we will measure our progress. We will accomplish our initiatives, together, as a Faculty, through our philosophy of collaboration, inclusivity, dedication and commitment.

Over the next five years, the Faculty of Applied Science & Engineering will be focused on pursuing and reaching the goals articulated in the *2017 – 2022 Academic Plan*. Although we have outlined our goals and implementation plan, we know that the academic plan is a living document. Each year we will continue to monitor and refine our current actions, while setting new ones to capture emerging priorities. By concentrating on educating the U of T 21<sup>st</sup> Century Engineer, and advancing our innovative research, we will continue to collaborate on multidisciplinary and diversity initiatives that will allow us to not only address global challenges but create new technologies for local and global prosperity.



## ADDITIONAL RESOURCES

1. 2017 Self Study:  
[www.uoft.me/selfstudy2017](http://www.uoft.me/selfstudy2017)
2. 2017 – 2022 Academic Planning Framework:  
[www.uoft.me/academicplanningframework](http://www.uoft.me/academicplanningframework)
3. Towards 2030:  
[www.towards2030.utoronto.ca/synth.html](http://www.towards2030.utoronto.ca/synth.html)
4. Three Priorities:  
[www.threepriorities.utoronto.ca](http://www.threepriorities.utoronto.ca)
5. Policy for Approval and Review of Academic Programs and Units:  
[www.uoft.me/gcacademicprograms](http://www.uoft.me/gcacademicprograms)
6. Guidelines on Divisional Academic Planning:  
[www.uoft.me/guidelinesacadplanning](http://www.uoft.me/guidelinesacadplanning)
7. University of Toronto Quality Assurance Process (UTQAP):  
[www.uoft.me/utqap](http://www.uoft.me/utqap)
8. 2017 Annual Report of Performance Indicators:  
[www.uoft.me/AR2017](http://www.uoft.me/AR2017)



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FACULTY OF APPLIED SCIENCE & ENGINEERING

**OFFICE OF THE DEAN**

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