December 2023

Faculty Self-Study for External Review

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

DEFY GRAVITY

Contents

Glossary

AER	Aerospace Science and Engineering
BASc	Bachelor of Applied Science
BME	Biomedical Engineering
CARTE	Centre for Analytical and Artificial Intelligence Engineering
CEAB	Canadian Engineering Accreditation Board
CFI	Canada Foundation for Innovation
CGEN	Centre for Global Engineering
CGPSS	Canadian Graduate and Professional Student Survey
ChemE	Chemical Engineering and Applied Chemistry
CIHR	Canadian Institute of Health Research
CivMin	Civil and Mineral Engineering
COMP	Computer Engineering
CRC	Canada Research Chair
CRD	NSERC - Collaborative Research and Development
CREATE	NSERC – Collaborative Research and Training Experience
CTSI	Centre for Teaching Support and Innovation
DEEP	DaVinci Engineering Enrichment Program
DSF	Dean's Strategic Fund
DUA	Division of University Advancement
ECC	Engineering Career Centre
ECE	Electrical and Computer Engineering
ECP	Engineering Communication Program
EDU	Extra-Departmental Unit
EGEC	Engineering Graduate Education Committee
ELEC	Electrical Engineering
ELITE	Entrepreneurship, Leadership, Innovation and Technology in Engineering
Eng Sci	Engineering Science
Eng Soc	Engineering Society (undergraduate student government)
ERA	Early Researcher Award
ESIP	Engineering Summer Internship Program
ESP	Engineering Strategies and Practice
ESRRO	Engineering Student Recruitment and Retention Office
FTE	Full-Time Equivalent
gradSERU	Graduate Student Experience in the Research University
GSU	Graduate Student Union
IBET	Indigenous and Black Engineering and Technology PhD Project
ICT	Information and Communication Technology
IDEA	Indigenous Design & Engineering Academy
IEEE	Institute of Electrical and Electronics Engineers
Troost ILEAD	Troost Institute for Leadership Education in Engineering
IND	Industrial Engineering

IPO	Innovation & Partnerships Office
ISI	Institutional Strategic Initiatives
ISTEP	Institute for Studies in Transdisciplinary Engineering Education and Practice
JTF	Joint Task Force on Academic Advising and Mental Health
MASc	Master of Applied Science
MB	Mining Building
MEC	Mechanical Engineering
MEng	Master of Engineering
MHSc	Master of Health Science
MIE	Mechanical and Industrial Engineering
MIN	Mineral Engineering
MSE	Materials Science and Engineering
NAE	National Academy of Engineering
NASM	Net Assignable Square Metres
NSERC	Natural Sciences and Engineering Research Council
NSSE	National Survey of Student Engagement
OAC	Ontario Academic Credit
OGS	Ontario Graduate Scholarship
ORF-RE	Ontario Research Fund – Research Excellence
Peng	Professional Engineer
PEO	Professional Engineers Ontario
PERA	Professional Expense Reimbursement Allowance
PEY Co-op	Professional Experience Year Co-op
PhD	Doctor of Philosophy
PPIT	Prospective Professors in Training
RA	Research Assistant
RC	Research Committee
SGS	School of Graduate Studies
SSHRC	Social Sciences and Humanities Research Council of Canada
SSWG	Self-Study Working Group
TA	Teaching Assistant
TATP	Teaching Assistants' Training Program
TEAL	Technology Enhanced Active Learning
THE	Times Higher Education
U of T	University of Toronto
UCC	Undergraduate Curriculum Committee
UnERD	Undergraduate Engineering Research Day
UTIAS	University of Toronto Institute for Aerospace Studies
UTQAP	University of Toronto Quality Assurance Process
WISE	Women in Science and Engineering

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1.0 Executive Summary

Over the last six years, the Faculty of Applied Science & Engineering has strengthened its position as Canada's premier engineering school. We have achieved many of the goals set out in our *Academic Plan 2017–2022*.

Our research impact continues to grow, with a larger cohort of graduate students and the launch of new partnerships and institutes that engage in multidisciplinary collaboration to address some of the most complex challenges we face. Our researchers are routinely recognized for their excellence with national and international awards.

We have strengthened our educational programs, guided by our belief in holistic engineering education. We expanded pathways for students to complement their technical skills with rich experiences that enable them to develop abilities in entrepreneurship, communication, leadership and global perspectives. The diversity of our student body continues to grow, and we are committed to creating an environment where every member of our community can thrive.

Our administrative systems remain strong and we are making changes to further improve our finances and delivery of services such as IT. We have also invested in our physical infrastructure, with upgrades to a number of facilities across our campus, most notably the creation of the Myhal Centre for Engineering Innovation and Entrepreneurship, which opened in 2018.

This self-study serves as a guide for the Faculty's 2023 external review and will inform the development of our next Academic Plan. It was created in accordance with the *Provostial Guidelines for Review of Academic Programs and Units* and the review's *Terms of Reference* and is the result of a comprehensive and iterative consultation process that included faculty members, staff, students, external partners and alumni.

1.1 Undergraduate Education (Chapter 3)

Our innovative undergraduate programming, along with targeted outreach, recruitment, communications and marketing, attracts talented and diverse students from across Canada and around the world. The most recent academic cycle saw both the highest number of overall applications in our history, as well as the highest number of applications from domestic students.

By enhancing the diversity of our student body, we enrich both the student experience and the engineering profession as a whole. Ten years ago, the proportion of women across our undergraduate student body was around 25%; it has been above 38% for the last three academic cycles. More than a quarter of our students come from outside of Canada. Our broad-based admissions process enables us to select students who excel not only academically, but also in communication, leadership, problem solving, entrepreneurship and other key engineering competencies.

Our innovative educational and co-curricular programs provide rich opportunities for experiential learning and multidisciplinary collaboration. We have integrated engineering design across all years of study, from first-year Engineering Strategies and Practice and Praxis courses to fourth-year capstone design courses. More than three quarters of eligible students choose to complete 12- to 16-month Professional Experience Year (PEY) Co-op placements after their third year, working for firms ranging from local startups to large multinational companies to the public sector. Three out of every four students pursue multidisciplinary minors and

certificates in topics ranging from Artificial Intelligence to Music Performance.

Our Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTEP) consolidates and expands many co-curricular programs that embody our holistic approach to engineering education. These include the Engineering Communication Program (ECP), the Troost Institute for Leadership Education in Engineering (Troost ILead) and the Engineering Business minor.

1.2 Graduate Education (Chapter 4)

Our research- and professional-stream graduate programs attract highly qualified students from around the world, and prepare them to be global leaders in research, academia, industry or government. Our graduate cohort has grown significantly over the past six years, with PhD enrolment increasing by more than a third since the time of the last self-study. This has increased our research capacity and impact. Strong demand for our professional stream Master of Engineering (MEng) program, particularly among international students, has resulted in a nearly 50% increase over the last six years. We continue to enhance and expand our MEng offerings, and we are creating innovative strategies in continuing education for life-long learning, including bespoke microcredentialing courses.

Demand for our research-stream programs remains very high among international students, and they currently comprise more than a quarter of our MASc students and nearly half of PhD students. We have expanded our efforts to recruit more domestic students into these programs through cross-Canada graduate studies fairs and our annual Faculty-wide Graduate Research Days event. We have increased the number of students who enter PhD programs by fast-tracking MASc students or admitting bachelor's degree students directly, thereby reducing their overall time in graduate school.

We have enriched the options available to our graduate students with programs such as the Collaborative Specialization in Engineering Education, the PhD in Clinical Engineering, the MEng in Cities Engineering and Management and the MEng in Biomedical Engineering. We have also created new courses and new areas of emphasis for MEng students. Through programs such as Prospective Professors in Training (PPIT), Opportunities for PhDs: Transitions, Industry Options, Networking and Skills (OPTIONS) and Troost ILead's courses and workshops, we support our graduate students in developing professional competencies and preparing for their future careers. The creation of the Graduate Engineering Council of Students (GECoS) has enhanced the pathways for graduate students to engage directly with the Faculty and work with us to improve the overall graduate experience.

1.3 Research (Chapter 5)

Research produced within U of T Engineering addresses critical global challenges, from developing new sources of clean energy to ensuring that the power of AI is used in a responsible and ethical way. We bring new technologies to market, but we also bring new knowledge and insights to bear on the development of public policy, from industrial strategies to the prioritization of new areas of research. Our rich suite of more than 400 partners includes startups, established multinational industry leaders, governments at all levels, community organizations, NGOs and even multilateral organizations such as the UN.

In 2021–2022, the most recent year for which complete data are available, our research operating funding per faculty member was $440,000, up more than 20% over the past six years. Total federal Tri-Council research funding (NSERC, CIHR and SSHRC) has remained steady

over the period, but total funding from industry has more than doubled from $8.5 million to $19.9 million.

Facilitating cross-disciplinary collaboration continues to be a priority. U of T Engineering is home to more than 30 multidisciplinary research centres and institutes that bring together expertise from our Faculty and partners in industry and academia. Over the past several years, many of these institutes have evolved to become University-wide Institutional Strategic Initiatives (ISIs). Examples include the Mobility Network, which evolved from the University of Toronto Transportation Research Institute, and the Robotics Institute. Many other ISIs are headed by U of T Engineering professors, including the Climate Positive Energy Institute, AGE-WELL and PRiME.

International recognition of our research excellence has enhanced our ability to attract even more talent to our programs. In 2022–2023, our faculty members earned 13.7 % of the major national and international honours and awards given to Canadian engineering professors, despite comprising only 5.5% of the nation's engineering faculty. We are home to 89 research chairs, including Canada Research Chairs, NSERC Industrial Research Chairs, endowed chairs, U of T Distinguished Professorships, and University Professorships.

We provide a suite of programs to help our researchers translate their innovations from the laboratory to the marketplace or clinic, including The Entrepreneurship Hatchery, our in-house startup accelerator, as well as collaborative training programs. Over the past five years, our faculty members have accounted for 70% of all invention disclosures at the University of Toronto and have launched 24 spin-off companies.

1.4 Organizational Structure, Resources and Infrastructure (Chapters 6 & 7)

We continue to maintain a balanced budget while advancing our Faculty's priorities. We have hired 30 new professors since the time of the last self-study, many of whom work at the intersection of more than one field and hold cross-disciplinary appointments. We have increased the proportion of female faculty members from 16.9 % to 21.9 % over the last ten years. More than 400 staff members support our Faculty with expertise in financial management, information technology, writing and communications, fundraising, human resources and classroom laboratory support and other fields. We continue to provide rich professional development opportunities for both faculty and staff.

The completion of the Myhal Centre for Engineering Innovation & Entrepreneurship in 2018 added significant new space to support both research and education across our Faculty. The new building includes Technology Enhanced Active Learning (TEAL) classrooms, a state-of-the-art fabrication facility and a 500-seat auditorium with stadium-style video. It provides new offices for the Centre for Global Engineering, The Entrepreneurship Hatchery and the Institute for Water Innovation, as well as dedicated space for student clubs and teams, from design-oriented groups such as the Human-Powered Vehicles Development Team to the Skule™ Orchestra. It also contains the Stewart Blusson Visualization Facility, which enables the visualization of research data that cannot be accomplished in any other way. Together, these resources set a new standard for engineering education and research by providing flexible spaces for cross-disciplinary collaboration, experiential learning and entrepreneurship.

1.5 Information Technology (Chapter 8)

The need for excellent IT infrastructure and service has evolved considerably over the last five years. Our ability to enable advanced research and teaching activities, offer robust and reliable

service to our community, manage critical data securely, and support a shift toward a more distributed workforce is inextricably tied to IT. In 2019, the Faculty Information Technology Office was established to lead U of T Engineering's strategic planning around IT, and provide centralized service in support of academic and administrative success.

Collaboration is core to delivering integrated, scalable IT solutions that meet local needs while aligning with broader institutional mandates. As reliance on IT continues to grow, so too do the risks that threaten our systems. Coordinating a more structured approach to IT and offering continuous training opportunities to faculty and staff will be central to mitigating risk as we look to the future.

1.6 Relationships, Contributions and Influence (Chapter 9)

We enrich our educational programs and research through collaborations with other faculties at U of T and with industry partners, alumni, and international peer institutions. These partnerships take many forms, including research collaborations, joint educational programs, and exchanges. Companies from across Canada and around the world hire our students for year-long internships, and work with them to solve industrial challenges through our University of Toronto Institute for Multidisciplinary Design and Innovation or through fourth-year capstone courses.

Student mobility at the undergraduate and graduate levels helps build global fluency, a key competency in an increasingly borderless world. We have grown the number of our undergraduate students who are hired on PEY Co-op internships outside Canada. We have also developed new and strengthened existing strategic international partnerships, which enrich the experience of our students and present new opportunities for cross-cultural exchange.

To enhance and formalize our network of more than 400 industry partners, we have expanded the Industry Partnerships Office with a number of new roles. We also continue to strengthen our vibrant, global network of engineering alumni and leverage opportunities for them to engage with our Faculty through teaching courses, guest lectures, mentorship of student startups, participating in career fairs and panels and philanthropic support.

1.7 Diversity, Inclusion and Professionalism (Chapter 10)

Diversity deepens the engineering creative process and enriches the student experience by exposing all of us to new perspectives. We are committed to enhancing diversity in all its forms across our Faculty. More than a quarter of incoming undergraduates and nearly half of our graduate students come from outside of Canada. We are part of a broad national coalition that aims to increase the proportion of women to 30% of all newly licensed engineers by 2030, and our recent success in increasing the number of women in our undergraduate and graduate programs will help advance this goal.

The creation of the Office of Diversity, Inclusion and Professionalism has accelerated our progress in creating an environment where all members of our community can thrive, regardless of their background. We have created resources to raise the level of cultural competency of all our faculty, staff and students with respect to groups that have traditionally been underrepresented in engineering, such as Indigenous individuals, Black individuals and members of the 2SLGBTQ+ community. Targeted outreach and support for professional development activities enables us to engage with these communities and increase their representation among our students, faculty and staff members. Examples range from pre-university programs such as Blueprint and the Indigenous Design and Engineering Academy

(IDEA) to graduate-level programs, such as the IBET Momentum Fellowships.

1.8 Conclusion

Since the time of the last self-study, we have expanded and diversified our faculty, staff and students, enriching both our pool of talent and student experience. We have leveraged investments from governments, industry and other partners, alumni and friends to build world-leading infrastructure, and we have enhanced programs that develop the next generation of makers, entrepreneurs and global leaders.

However, challenges exist for our Faculty and uncertainty remains with respect to the provincial tuition framework for next year. At this time, for the fourth consecutive year, domestic tuition fees remain frozen (i.e., 0% increase) for 2023–2024. While revenues have plateaued with domestic tuition continuing to be frozen, expenses are increasing, with inflation remaining high and payroll expenses continuing to grow at a rate of 4–5% (or more) per year.

Identifying potential new revenue streams, to supplement our traditional income sources, will be essential to ensure our financial sustainability. Despite facing the challenges of a global pandemic, economic headwinds, and a challenging research funding environment, U of T Engineering has continued to forge ahead, building its leadership position in education, research, and community engagement. We have strengthened our position as Canada's premier engineering school, but opportunities remain to continue to enhance the impact of our research and educational programs. We will continue to seek out the best students and faculty the world has to offer and provide opportunities for them to develop competencies that enable them to address society's most complex and pressing challenges.

2.0 Introduction and Context

2.1 Overview of Faculty of Applied Science & Engineering

Our Faculty traces its roots back 150 years to the Ontario School of Practical Sciences, which was founded in 1873 and established its physical presence in 1878. In 1900, it became the Faculty of Applied Science & Engineering, and in 1906 it joined the University of Toronto. Over the past century and a half, we have grown to be an international leader in engineering education and research.

We have a rich and diverse community that extends across Canada and around the world, which includes over 5,500 undergraduate students, nearly 3,000 graduate students, more than 300 faculty and more than 50,000 alumni.

In addition to the strong technical foundations that our programs provide, our students are provided with a myriad of opportunities to develop expertise and experience in entrepreneurship and communication. We enable them to develop the global perspectives they need to become the next generation of engineering leaders. Our internationally recognized faculty members collaborate across disciplines to address key global challenges, from new ways to generate and store energy to leveraging machine learning to diagnose and treat human diseases. Our solutions improve the quality of life not just here in Toronto, but for communities around the world.

2.2 Progress Towards the Faculty's Academic Priorities

2.2.1 Academic Plan 2017 – 2022: Significant Developmental Milestones

The Faculty of Applied Science & Engineering's *Academic Plan, 2017–2022* was approved on December 12, 2017, setting out our academic and administrative directions for the next five years.

It aimed to strengthen our research-intensive culture, academic rigour, global reputation and visibility, enrolment, excellence in students — experiences inside and outside the classroom, funding models and our internal and external collaboration, outreach, and influence.

The following sections describe the progress our Faculty has made toward the priorities described in the *Academic Plan*.

2.2.1.1 Culture of Excellence

U of T Engineering remains the premier engineering school in Canada across several international rankings (**Table 2-2**). We attract committed educators and leading researchers who demonstrate excellence in interdisciplinary research and contribute to our intellectual and cultural diversity. We have hired 30 new faculty members since 2016 and increased the proportion of women professors to 21.9%. Many of our professors hold budgetary appointments in more than one academic area and conduct interdisciplinary research in fields that include smart buildings and cities, advanced cancer diagnostics, and sustainable resource extraction.

In 2022-2023, our faculty members earned 13.7% of the major national and international honours and awards given to Canadian engineering professors, while accounting for only 5.5% per cent of the nation's engineering faculty. These recognitions range from early-career to

lifetime achievement awards. We continue to strengthen the supports available to our faculty to enable them to perform at their best in education and research.

2.2.1.2 Positioning

The achievements of our students, faculty and alumni are a source of pride for our Faculty. In the past year alone, our students took the top spot in the AutoDrive Challenge, an international autonomous vehicle competition, and launched Canada's first experimental hybrid rocket. We leverage strategic communications initiatives to share our stories with key audiences and raise our visibility across both print and digital media.

By raising the quality of our storytelling and engaging in proactive media outreach, we have grown our impressions in print, broadcast, and online media to more than one billion per year. More than half of the more than 4,500 media stories about our Faculty published in the last year appeared in international outlets. We engaged more than 52,000 followers across our social media platforms in 2022–2023 and increased our total impressions — the number of potential interactions with all U of T Engineering-related content — to more than 9 billion.

2.2.1.3 Educating Future Engineers & Student Experience

We have made gains in many important areas over the past several years. These include raising the overall number of applications to our undergraduate programs, increasing the proportion of women in both our undergraduate and graduate cohorts, and significantly growing our graduate student numbers, especially the proportion of MEng students.

From first-year courses such as Engineering Strategies & Practice and Praxis, to fourth-year capstone design courses, we ensure that opportunities for experiential learning are integrated across the curriculum. We have also increased the number of third-year students who participate in the Professional Experience Year Co-op Program (PEY Co-op) from 66% in 2016 to 78% today.

We continue to enrich our undergraduate and graduate students' experiences by creating new cross-disciplinary programs and expanding our suite of minors and certificates, with two new certificates launching in Fall 2023. We have also worked to create new pathways for students to gain global experiences, whether through exchanges, including participating in International Doctoral Clusters, international PEY Co-op placements or virtual collaborations such as our International Virtual Engineering Student Teams (InVEST) initiative. Through curricular and co-curricular activities, including those offered by our Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTEP), we are preparing future engineering leaders to lead, collaborate in multidisciplinary teams and launch new business ventures.

2.2.1.4 Research Foci

We have grown our suite of multidisciplinary research centres and institutes that bring together researchers from across our Faculty and beyond to address critical challenges such as building more sustainable cities, catalyzing advanced manufacturing and harnessing AI in thoughtful ways.

Our total research funding (infrastructure + operating) has increased from $75.5 million in 2016 to $109.7 million today. Our research operating funding per faculty member is now $440,000 per year, an increase of more than 30% over 2016. Our Faculty is home to 89 research chairs

including Canada Research Chairs, endowed chairs, NSERC Industrial Research Chairs, U of T Distinguished Professors, and University Professors.

We secured investments from federal and provincial governments, resulting in significant upgrades to a number of our research facilities, including our Structural Testing Facility, and BioZone. Our most recent building, the Myhal Centre for Engineering Innovation & Entrepreneurship, contains collaborative research space for projects in robotics and global engineering, a state-of-the-art makerspace, design and fabrication space for our student teams, a world-class data visualization studio, and Fujitsu's first Co-Creation Research Centre to be housed outside of Japan.

2.2.1.5 Outreach, Collaboration & Influence

We have strengthened our engagement with institutional partners around the world and formalized a number of agreements with them regarding research collaboration, student exchanges, and joint programs where students from peer institutions complete the final year of their undergraduate degrees at U of T Engineering and gain conditional acceptance into our MEng programs. We have also participated in major funding agency work (e.g., NSERC, Mitacs), and on panels and advisory boards focused on enhancing opportunities for international experience in undergraduate education.

Our Faculty has played a leading role in growing U of T's suite of Institutional Strategic Initiatives, such as the Climate Positive Energy Initiative, the Robotics Institute, the Mobility Network, AGE-WELL and PRiME (Precision Medicine). These programs bring together researchers from multiple disciplines and faculties within U of T as well as external partners in hospitals, companies, and research organizations.

We continue to strengthen relationships with our global network of more than 50,000 alumni, hosting many events for alumni chapters in Toronto and in strategic locations around the world, such as Calgary, Hong Kong, and Silicon Valley. Last year we raised more than $20 million in philanthropic support, and the year before that we raised more than $35 million. Our advancement team has been instrumental in coordinating the celebrations around the 150th anniversary of our Faculty that we celebrated throughout 2023, including a gala event featuring Col. Chris Hadfield as the keynote speaker. The event also marked the beginning of the Faculty's new fundraising campaign, a part of the University of Toronto-wide Defy Gravity campaign. Defy Gravity has twin goals of inspiring 225,000 alumni to get involved, while encouraging them to contribute their time and talent to the University one million times collectively, as well as raising $4 billion in support for the University's highest priorities.

U of T Engineering has enhanced its network of more than 400 industry collaborators and has developed new ways for students to be exposed to industry. These include projects brought forward by industry clients in first-year design courses and capstone courses, and through our Faculty's University of Toronto Institute for Multidisciplinary Design & Innovation.

2.2.1.6 Resource Allocation

We continue to advance our priorities by investing in infrastructure and launching new initiatives, while maintaining a balanced budget. Total revenue has increased from $192.1 million in 2015–2016 to $247.1 million today. While total costs have risen, the net revenue for 2022–2023 is also the highest on record at $127.5 million.

Since its inception in 2011, the Dean's Strategic Fund (DSF) has been a powerful catalyst for innovation, providing more than $50 million in seed funding for projects and collaborations that have a broad impact across the U of T Engineering. With projects focused on engineering education, research, entrepreneurship and facilities, DSF-funded initiatives advance our position as one of the world's leading engineering schools. Many have gone on to become self-sustaining, permanent additions to U of T Engineering — from internationally recognized research institutes to upgraded laboratories and enhanced manufacturing facilities.

One of our most significant infrastructure investments in recent years is the Myhal Centre for Engineering Innovation & Entrepreneurship, which opened in 2018. This leading-edge facility is a vibrant hub for engineering education and research, providing an open, collaborative space to bring together our vibrant community.

2.2.2 Looking Ahead

We operate in a competitive global environment for research and engineering talent, including faculty members and graduate and undergraduate students. Although we are the leading engineering school in Canada, we must continue to distinguish ourselves on the global stage by building on our unique strengths and continuing our unwavering pursuit of excellence.

While we have made progress in diversifying our undergraduate and graduate student populations, we have more work to do before our community reflects the diversity of the societies we serve. This is especially true at the faculty level, and with respect to other traditionally underrepresented groups in engineering, including Black, Indigenous and 2SLGBTQ+ individuals. We will build upon our current trajectory and continue to reach out to these groups.

We have significantly increased the size of our graduate student population, especially in terms of enrolment in the MEng program. Total MEng enrolment has nearly doubled in the past ten years, but PhD enrolment has also increased by 50% over that time. We will continue our recruitment efforts, especially among domestic students, and encourage MASc students to fast-track into PhD programs. We will also strengthen our support to graduates who wish to market their expertise to industry, government, and academia.

Our research has become more diverse as we create multidisciplinary research centres and institutes that facilitate collaboration across our Faculty and beyond. The excellence of our research is well recognized at the national and international levels, and we are leaders within the University in terms of patents and invention disclosures. Going forward, we will leverage our global network of industry collaborators and alumni to accelerate the translation of our innovations into industrial or clinical application. This includes leveraging traditional technology transfer and strengthening our support for entrepreneurship, including our in-house startup incubators and commercialization fellowships. We will also guide our researchers to leverage funding programs that are geared toward startups, and to participate in the wider entrepreneurship ecosystem across U of T and the Toronto region. In addition to innovative technologies, our researchers are known for playing key roles in informing decision making and public policies within industry and all levels of government.

We are well positioned to take advantage of emerging global opportunities in multidisciplinary engineering research and education and will continue to strengthen our relationships with other faculties within U of T, our peer institutions around the world, industry partners, regulatory bodies, governments, and our 50,000-strong alumni network.

2.3 Consultation and Preparation for the Self-Study

This self-study of the Faculty of Applied Science & Engineering has been prepared as part of the University of Toronto's process for reviewing its academic programs and units. Our previous external review was conducted in 2016, and the feedback we received from that consultation and review process contributed to the establishment of our strategic goals for the next five years, as described in the *Academic Plan, 2017–2022*.

This document represents an intense seven-month process that began in March of 2023 with the creation of a Self-Study Working Group (SSWG), established by Dean Christopher Yip and co-chaired by Professor Heather MacLean, Vice-Dean, Strategic and Nefeteria Wickham, Director, Office of the Dean. The SSWG was directed to determine the focus and structure of the self-study, gather feedback from the Faculty's diverse stakeholders, and begin a reflective discussion on progress we have made toward our *Academic Plan* goals over the last five years.

The self-study highlights major initiatives undertaken in the Faculty and comments briefly on the achievements and challenges we faced through those initiatives. Through this reflection, the document implicitly addresses recommendations from the last review (**Appendix A**).

The various chapters in this document address the *Terms of Reference* and guidelines presented by the Office of the Vice-Provost, Academic Programs in terms of the quality, size and scope of undergraduate and graduate academic activities and the student experience; the Faculty's research activities; organizational and financial structure; physical, research and programming infrastructure; external relationships; and student and faculty diversity.

The SSWG, in conjunction with key staff, developed preliminary position statements on topics within the self-study that formed the foundation for more extensive consultations held with a wide range of stakeholders between March and August 2023. The consultations were well received; on-line surveys had modest response rates and in-person events were modestly attended outside of the staff consultation.

The following groups were engaged in the consultation process:

- **Undergraduate Students** – through an in-person consultation with student leaders (who represent and consult with their constituents) and an on-line survey
- **Graduate Students** – through three separate in-person consultations with MASc, MEng and PhD students
- **Staff** – through an in-person consultation with Shared Services staff and an on-line survey
- **Faculty** – through on-line surveys
- **Research & Industry** – through the Office of the Vice-Dean Research consulting with the Research Committee and Chairs and Directors to discuss research priorities, challenges, opportunities, and funding successes. The office also communicated via email with stakeholders on the operations of various institutes and funding successes.
- **Alumni** – through online consultations with alumni and donors who have sufficient knowledge of the Faculty to engage in meaningful dialogue
- **Industry Partnerships** through on-line interviews with each partner consisting of 7-10 questions

Content and feedback were also provided by the Faculty's Dean, Vice and Associate Deans and administrative unit heads. The final draft of the self-study was made available on a public

website for all of the U of T Engineering community (e.g., faculty, students, and staff).

Through the iterative data collection, drafting and review process, our Faculty produced this comprehensive overview of where our academic programs, research, organizational and financial structure, infrastructure, and diversity goals currently stand. We demonstrate how these have strategically progressed and, where possible, have identified our strengths as well as our challenges, and will use this analysis to inform our upcoming academic planning.

2.4 Consistency of the Academic Plan with the University of Toronto's Long-Range Plan

Our *Academic Plan, 2017–2022* was approved by Faculty Council in December 2017 after nearly two years of consultation and planning. It set out a comprehensive strategy to strengthen our vision "to be a leader among the world's very best schools of engineering in our discovery, creation and transfer of knowledge and technology through teaching and research." It includes concrete and measurable goals in seven key areas: positioning; culture of excellence; educating future engineers; student experience; research foci; outreach, collaboration and influence; and resource allocation.

To demonstrate accountability and transparency in our progress, the Faculty produces two reports annually:

- **By the Numbers:** A robust, data-rich report that systematically charts key performance indicators over the previous 10-year period on admissions, enrolment, research funding, awards, world rankings, advancement, communications, resources, diversity, international initiatives and cross-faculty education and experiential learning. This report has been produced annually since 2009.
- **Impact Report:** A visually engaging report that highlights key metrics and the Faculty's best stories relating to global impact, education, research, outreach, partnership and philanthropy. This report has been produced annually since 2020.

When our next Academic Plan comes to fruition, we plan to report directly on progress against stated goals — a practice that was instituted during the *Academic Plan, 2011-2016*.

As one of the largest faculties within the University of Toronto, we are committed to strengthening the University's standing as one of the finest research and educational institutions in the world, and closely align our strategic planning to support and advance University-wide goals.

Specifically, the following sections demonstrate close alignment between the Academic Plan and the University's priorities and strategic directions as outlined in two key institutional plans:

- *Towards 2030: A Long-Term Planning Framework for the University of Toronto* (2008) and *Towards 2030: The View from 2012* (2012) — established the University's mission and identity as a globally-ranked research powerhouse, and a leader in both graduate and research-intensive undergraduate education. These reports set out broad goals in areas such as student experience, recruitment, enrolment, research strength and resources to enable the University to enhance its global standing and impact.
- President Meric Gertler's *Three Priorities: A Discussion Paper* (2015) reaffirmed the findings and directions of the *Towards 2030* reports, while proposing three new foci to enable the University to advance its identity and mission in the face of emerging challenges and opportunities.

More recently, the University of Toronto released its *International Strategic Plan, 2022–2027*. Developed by the Office of the Vice-President, International in close partnership with all of the University's divisions, the *International Strategic Plan, 2022–2027* aims to deepen, diversify and enhance U of T's international engagement through ten strategic objectives across three key dimensions: Global Learning, Global Reach and Global Impact. This plan will be an important framework for alignment as we look ahead to our next Academic Plan.

2.4.1 Towards 2030 and the Academic Plan

We developed the *Academic Plan, 2017–2022* for the Faculty of Applied Science & Engineering in the context of the first *Towards 2030* document, which became the planning framework for faculties and divisions across the University. Its key themes are charted below to demonstrate alignment between *Towards 2030* and the *Academic Plan*.

Themes	***Towards 2030***	***Academic Plan***
The University's Distinctive Role	Established the core identity of U of T as a research-intensive institution with academically rigorous educational offerings and excellent faculty, staff and students. While emphasizing the significance of research, it affirmed the importance of all faculty members, including top researchers, teaching students at all levels. It also said that within any division, all programs must be excellent and most must be nationally pre-eminent and internationally competitive.	From recruiting top students and faculty and growing research funding, to innovating educational offerings and enhancing student experience, our goals and achievements clearly strengthen the University's identity as an internationally recognized research powerhouse that is committed to excellence in both graduate and undergraduate education.
Enrolment and Institutional Balance	Affirmed that the University should capitalize on its unique strengths in research by focusing on graduate and professional programs. At the same time, it said the University should capitalize on its research strengths to enrich undergraduate education.	We set and exceeded our goals to grow engineering graduate student enrolment. We committed to 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 Recruitment and Experience	Identified student recruitment as a pressing issue that required immediate attention. In particular, it said further discussion was needed around enhancing non-academic admission criteria for undergraduate programs to recruit	We committed to attracting and retaining outstanding students from a wide range of backgrounds and to increasing diversity. Notably, we implemented a Broad-Based Admissions process, which considers

	well-rounded students and students from traditionally under-represented groups. It advocated increasing the number of Canadian students from outside the Greater Toronto Area and the number of international students. It also sought to improve the student experience by increasing participatory learning opportunities, advancing the use of information technology and promoting co-curricular activities.	high school performance alongside non-academic factors. We committed to supporting student learning and the development of global engineering leaders, striving to not only create an outstanding educational environment, but also extensive opportunities to engage in co-curricular activities, work-integrated learning and research. With the opening of the Myhal Centre for Engineering Innovation & Entrepreneurship, we entered a new era for technology and learning, as well as nurturing innovative teaching methods.
Capital Plans	Committed to redeveloping and enhancing its three campuses to strengthen students' academic and co-curricular experiences. It said government funding, philanthropic support and partnerships with the private sector should be pursued to improve the campus environment.	We prioritized improving instructional, laboratory and co-curricular space to facilitate innovative teaching methods, enhance experiential learning and student activities, support research and strengthen the overall student experience.
Resources and Advancement	Noted that the University's excellent international standing was remarkable given its extremely constrained resources. In light of these financial pressures, *Towards 2030* articulated the importance of reducing gaps in per-student funding with peer U.S. universities, and between Ontario universities and schools in the rest of Canada. It advocated for more investments by the federal government in research and student aid programs. It acknowledged that tuition fees would remain an important source of revenue and committed to maintaining accessibility. It also said industry partnerships should be considered in light of implications for academic freedom, reputational risk, social responsibility and collective	We articulated a number of goals to secure a strong resource base to achieve our ambitious research and education objectives. We committed to fostering new cross-disciplinary collaborations and creating strategic partnerships with key institutions and industry partners. We also set several goals around infrastructure and IT renewal, advancement priorities and strong fiscal management.

	agreements, and committed to enhancing institutional processes for knowledge translation and commercialization.	

2.4.2 Three Priorities and the Academic Plan

President Gertler's *Three Priorities* discussion paper, published in 2015, affirms the goals of *Towards 2030* and seeks to advance the University within that framework. The three priorities represent refinements of the *Towards 2030* goals rather than new directions, and continue to spark energetic discussion across the University.

Themes	***Three Priorities***	***Academic Plan***
Leveraging the University's urban location more fully	A focus on urban research and teaching, local outreach and partnership, and strengthening the built environment.	Our *Academic Plan* supports these priorities in its commitments to excellence in research and education, enhancing the student experience, weaving experiential learning and global perspectives into all aspects of our curricular and co-curricular programs, and strengthening our local and international relationships and partnerships. Notably, the opening of the Myhal Centre for Engineering Innovation & Entrepreneurship in 2018 advanced all three priority areas — the building was designed to foster collaboration between researchers, students, industry partners and alumni. Housed within the Myhal Centre is the Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTEP), which also launched within the span of the last academic plan. ISTEP brings together people and programs from across our Faculty — and beyond — to support the development of engineering pedagogies among faculty, and to foster professionalism, effective communication, leadership, global fluency and lifelong learning among our students.
Strengthening and deepening key international partnerships	Key themes include student recruitment, improved student mobility, U of T's presence and profile internationally, and coordination across the University.	
Re-imagining and re-inventing undergraduate education	Calls for more research-based and experiential learning opportunities, as well as more global learning opportunities.	

2.4.3 Conclusion

The Faculty's *Academic Plan* clearly aligns with and strengthens the University's broad, long-term goals. These goals include enhancing the University's standing as a research powerhouse and a leader in graduate and research-intensive undergraduate education. As the University refines its goals, our dedication to excellence in engineering education and research, our focus on collaboration and innovation, and our commitment to preparing the next generation of engineering leaders position us as a key partner in strengthening U of T's standing as one of the world's great universities.

2.5 World Recognition by Rankings

Rankings of world universities are published annually by a number of bodies, including the Times Higher Education (THE)–Elsevier World University Ranking for Engineering and Information Technology, the QS World University Rankings for Engineering and Information Technology (QS), and the National Taiwan University (NTU) Performance Ranking of Engineering Papers.

Our Faculty consistently places as the top Canadian engineering school in international rankings. **Table 2-1** shows our current rankings compared with other engineering schools in the U15 group of research-intensive Canadian universities.

Table 2-1 Canadian U15 Universities across 2022–2023 World Rankings in Engineering

THE *(U15 in Top 100)*	QS *(U15 in Top 200)*	NTU *(U15 in Top 200)*
U Toronto (27)	U Toronto (27)	U Waterloo (105)
UBC (49)	UBC (33)	U Toronto (120)
U Waterloo (69)	U Waterloo (37)	U Alberta (113)
McGill U (76)	McGill U (41)	UBC (127)
U Alberta (115)	U Alberta (93)	
Western U (192)	U Montréal (119)	
	Queen's U (169)	

Among North American public universities U of T Engineering ranks in the top 10 in two of the three rankings (**Table 2-2**).

In 2021, our faculty members comprised only 5.4%per cent of Canada's tenured and tenure-stream engineering professors, yet they earned 15.9% per cent of the major national and international awards and honours given to that group, including fellowship in the Canadian Academy of Engineering, the Royal Society of Canada and the National Academy of Inventors.

Rankings provide insight into disciplinary trends and comparative quantification, and are influential in recruiting students and top scholars. However, with their varying methodologies and data sets, they provide only partial and limited information; for example, our strengths in biomedical research, health care and regenerative medicine are not captured in the engineering rankings. Although our position in the rankings and as the premier engineering school in Canada remains strong, we acknowledge that the international landscape is evolving dramatically. This is especially true in the rise of universities in Asia, fueled by rapid growth and large investments, particularly in engineering.

Table 2-2 Summary of University of Toronto Engineering Performance in World Rankings, 2022-2023

(See Figure 5.1 from *By the Numbers 2023*)

Ranking Organization	Release Date	Canada	North American Public	World
QS World University Ranking for Engineering and Technology	**March 2023**	1	8	27
QS World University Ranking by Subject	March 2023			
– Chemical Engineering		1	7	23
– Civil & Structural Engineering		1	6	19
– Computer Science & Information Systems		1	2	12
– Electrical & Electronic Engineering		1	5	18
– Materials Science		1	10	41
– Mechanical, Aeronautical & Manufacturing Engineering		1	11	38
– Mineral & Mining Engineering		5	7	21
Times Higher Education (THE) – Elsevier World University Ranking for Engineering & Technology	**October 2022**	1	6	27
Academic Ranking of World Universities (ARWU) for Engineering Subjects	**July 2022**			
– Aerospace Engineering		1	7	19
– Biomedical Engineering		1	4	21
– Chemical Engineering		4	21	137
– Civil Engineering		3	10	42
– Computer Science and Engineering		1	3	15
– Electrical & Electronic Engineering		2	13	50
– Materials Science & Engineering		2	14	68
– Mechanical Engineering		3	16	84
– Mining & Mineral Engineering		2	4	29
National Taiwan University (NTU) Performance Ranking of Scientific Papers for World Universities	**August 2022**	1	6	69
NTU Performance Ranking by Subject	August 2022			
– Chemical Engineering		4	14	147
– Civil Engineering		3	8	62
– Computer Science		4	8	86
– Electrical Engineering		4	9	79
– Materials Science		1	9	82
– Mechanical Engineering		2	5	60

3.0 Academic Programs: Undergraduate Education

The Faculty of Applied Science & Engineering at the University of Toronto is Canada's leading teaching and research-intensive engineering school, with a calibre of undergraduate programs that are commensurate with the quality of the diverse student body we attract from around the world.

This section highlights the current state of our undergraduate programs and admissions. The supporting data stem from our own records, as well as a thorough self-study consultation process which included focus groups, surveys, course evaluations and data from National Survey of Student Engagement (NSSE), a poll for first- and senior-year students that is conducted every three years by the Indiana University Bloomington. The NSSE data in this chapter compares U of T Engineering students to those at peer engineering institutions, which include 22 Ontario universities, the U15 groups of research-intensive Canadian universities, and select U.S. institutions chosen as comparators by U of T. (Note that U.S. comparators are chosen on a university-wide basis and do not necessarily reflect comparable engineering programs in the U.S.)[1]

3.1 Overview of Programs and Governance Structure

U of T Engineering students pursue either a Bachelor of Applied Science (BASc) or a Bachelor of Applied Science in Engineering Science (BASc Engineering Science). Students interested in the BASc can enroll in any of the Core 8 programs or the General First Year (**Section 3.1.1**), while students pursuing the BASc Engineering Science can choose from one of eight majors (**Section 3.1.2**) offered through the Division of Engineering Science.

The Vice-Dean, Undergraduate oversee all aspects of undergraduate education, including academic programming, student support and overall student experience. Over the past few years, several new roles have been added to the portfolio to further expand these efforts. Examples include the Associate Director, Student Experience & Teaching Development as well as a new learning strategist, a mental health programs officer, and an undergraduate research and international experience coordinator. Support for offices such as Engineering Outreach and the Engineering Career Centre have also been expanded.

The Vice-Dean, First Year coordinates and oversees all Year 1 programming with the support of the Director, First Year Curriculum. Second- through fourth-year programming is supported at the department or division level under the direction of each unit's Associate Chair, Undergraduate Studies. All four years of the Engineering Science program are coordinated through the division, with overall support from the division's director.

3.1.1 Core 8 Track One First Year Programs

Our Core 8 programs and the departments (**Figure 3-1**) in which they are offered are: chemical (Department of Chemical Engineering & Applied Chemistry, ChemE), civil and mineral (Department of Civil & Mineral Engineering, CivMin), electrical and computer (The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, ECE), mechanical and industrial (Department of Mechanical & Industrial Engineering, MIE), and materials (Department of

[1] Standard error values for NSSE scores give 95% confidence intervals ranging from ± 0.5 to ± 1.5, therefore only differences greater than these are considered statistically significant.

Materials Science & Engineering, MSE).

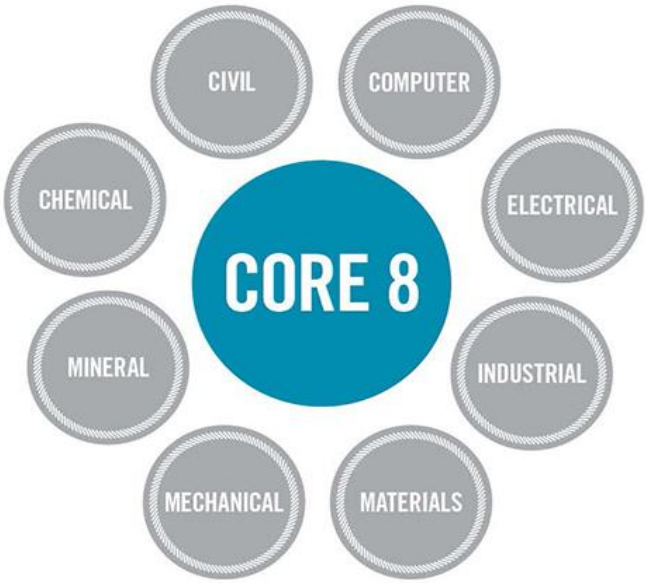


Figure 3-1 Core 8 Programs

Students who are not ready to select a discipline can complete a general first year in the TrackOne program (TrackOne students comprised 18% of incoming 2022-2023 undergraduates, a number that has been consistent for the past decade). TrackOne students with a sessional average of 60% or higher in both the fall and winter terms are guaranteed their first program choice for second year.

Students in any Core 8 program can request a transfer into any other Core 8 program at the end of first year. This transfer is guaranteed for students whose sessional average is 80% or above in both the fall and winter terms. For students who do not meet this requirement, the granting of their transfer request depends on the availability of space in their desired program. In recent years, space has been become more limited in several Core 8 programs, including computer engineering and mechanical and industrial engineering.

Students in any of the Core 8 programs may also pursue Engineering minors or certificates in select cross-disciplinary areas, or minors in programs offered by the Faculty of Arts & Science. There has been a strong increase in student engagement in our many minors and certificates which have been designed to offer flexibility in curriculum and align with changing student interests.

As a result of the First Year/Core 8 curriculum review in 2013, a common fall term was recommended by the committee in 2015 and implemented across all first-year programs in 2020/21. This specific curriculum change has made student transfer between programs more efficient. Additionally, because of the official Interdivisional Teaching (IDT) agreement within the university, Engineering works in close collaboration with the Department of Mathematics (Faculty of Arts & Science) to develop curriculum situated within the context of engineering applications and problems.

3.1.2 Engineering Science

Engineering Science is a unique program where the curriculum is distinguished by its focus on deriving results from first principles, and thus includes a strong focus on mathematics, science and foundational engineering principles and models. Over the last decade, approximately 49 % of Engineering Science graduates continued their engineering education with post-graduate studies at U of T and other top-ranked institutions around the world, while approximately 40 % directly entered the workforce. The remaining 11 % of graduating Engineering Science students were undecided as to their future at the time of program completion. Many students in these programs also express interest in pursuing entrepreneurship and start-up activities, often spun out of successful Capstone design projects.

Engineering Science is structured on two years of foundation curriculum, followed by a two-year specialization in one of eight majors (previously called options). These majors, and their respective founding year, are the following:

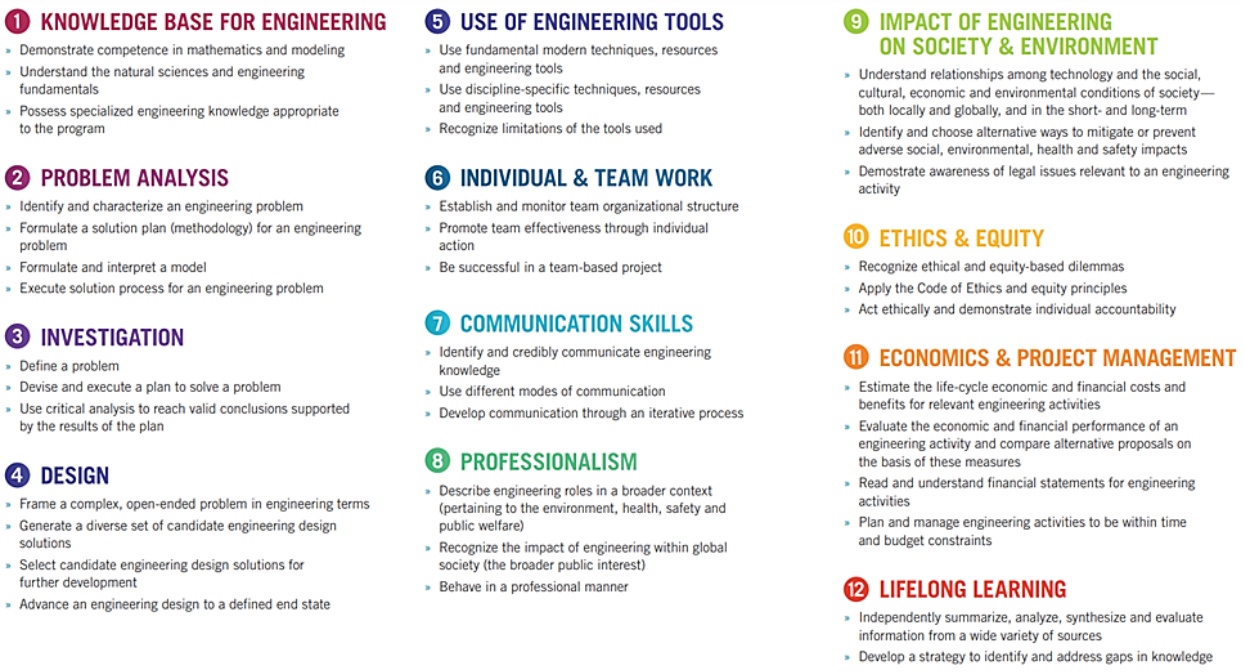
- Aerospace (1963)
- Biomedical Systems (2012)
- Electrical and Computer (2009, previously offered as two separate majors)
- Energy Systems (2009)
- Engineering Mathematics, Statistics and Finance (2010)
- Engineering Physics (1961)
- Machine Intelligence (2017)
- Robotics Engineering (2015)

These majors can be initiated within one of the committees of Faculty Council and are often finalized and approved in less than two years. This enables our Engineering Science program to quickly adapt to meet the needs of the marketplace, as well as demand for certain specializations among our undergraduate students.

3.1.3 Accreditation and External Reviews

The Faculty's nine undergraduate programs (Core 8 plus Engineering Science) are evaluated for accreditation by the Canadian Engineering Accreditation Board (CEAB) on a six-year cycle. CEAB is part of the Washington Accord which facilitates the recognition of licensure between various engineering groups around the world. The Washington Accord is intended to expedite a portion of the application for licensure reviews among the signature countries. Graduation from the Faculty therefore provides students with the education necessary to apply for professional licensure (PEng) after four years of accumulated experience anywhere in Canada in accordance with individual provincial and territorial policies.

The criteria set out by CEAB are designed to ensure that each graduate has a minimum foundation in mathematics and natural sciences, a broad preparation in engineering sciences and engineering design, and exposure to non-technical subjects (complementary studies) that complement the technical aspects of the curriculum, along with a requirement for an outcome-based assessment of 12 graduate attributes identified by the CEAB.



Canadian engineering schools, including U of T, must implement and employ processes to demonstrate that program outcomes are being assessed in the context of these attributes, and that the results of such assessments are applied to the further development of programs. All nine of our Faculty's undergraduate programs are fully accredited and the next review visit is scheduled for the 2025-2026 academic year.

Another method of ensuring quality education is the provincial requirement for institutions to implement periodic external reviews of their academic programs and the units in which they reside. This is achieved through the implementation of institution-specific quality assurance processes, such as the University of Toronto Quality Assurance Process (UTQAP), whereby each of the Faculty's departments, divisions and institutes and their undergraduate and/or graduate programs undergo an external review on a five-year cycle.

In addition to reviewing each unit's programs, external reviewers consider the scope, quality and relevance of its research, internal and external relationships, organizational and financial structure, long-range planning challenges, and international comparators. As a measure of the university's commitment to quality assurance, review reports are taken forward to university governance and are summarized for the Ontario Universities Council on Quality Assurance.

3.1.4 Academic Approvals: Governance

The development of academic degrees is governed by the University of Toronto Quality Assurance Process (UTQAP) through the office of the Vice-Provost, Academic Programs. Proposals are approved by both the Faculty's and university's governance committees, and at the provincial level.

Our Faculty Council has overall responsibility for curriculum change within degree programs, which are normally initiated and developed by the department, institute or division and reviewed by their respective curriculum committees. Faculty-wide changes, such as new minors

or changes to the first-year curriculum, are generally initiated through the Faculty's Cross-Disciplinary Programs Office, the First Year Curriculum Committee, or a relevant task force or working group.

All curriculum changes are approved by Faculty Council through its Undergraduate Curriculum Committee, a standing committee with faculty representatives from each program and representatives of the undergraduate student body. When considering changes or new programs, the committee will analyze the implications for CEAB accreditation. Major program modifications, such as the introduction of new minors or Engineering Science majors, are also approved by Faculty Council and reported to university governance for information.

3.1.5 Student Governance: Engineering Society

Undergraduate student governance in the Faculty of Applied Science & Engineering is overseen by the Engineering Society, or EngSoc. EngSoc represents all full- and part-time undergraduate engineering students and is comprised of elected student volunteers. It is governed by a constitution and bylaws that can be changed only by resolution of EngSoc's Board of Directors; such changes must be approved at an annual general meeting at which all undergraduate engineering students may vote.

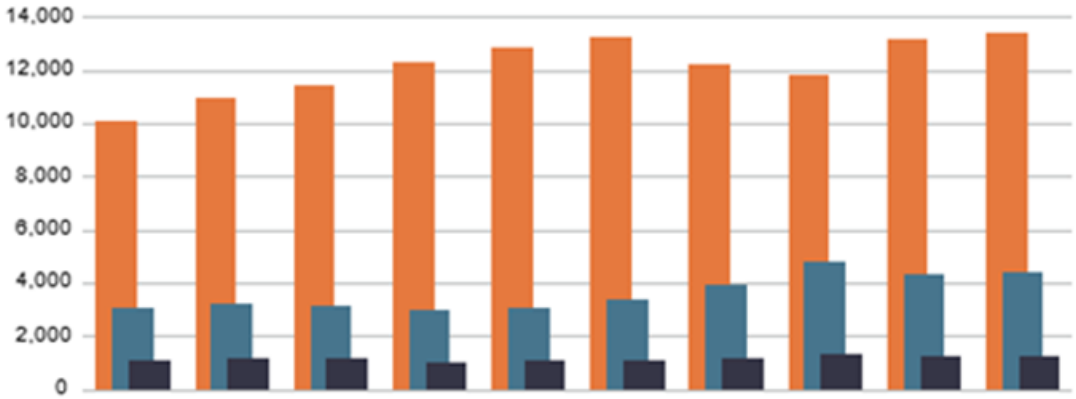
EngSoc engages in academic advocacy, allocates funding to groups and initiatives in the engineering community, and provides a wide variety of services and events to students. Student representation on Faculty Council includes one undergraduate student elected annually from each year of each program by the student body, the President of the Engineering Society, and one other representative of the Engineering Society, the Vice-President, Academic.

3.2 Quality, Diversity and Selectivity of Students

Our Faculty received more than 13,000 applications for the 2022-2023 academic year, approximately 11 times more than the number of places available. Applications to our programs have increased by 44 % since 2012, and applications from international students have increased by 75 % during that time (**Figure 3-2**).

The 2022 entering class was one of the most accomplished and diverse in our history. The incoming average of Ontario students was 96 %, the highest on record and up from 91.7 % in 2013 (**Figure 3-3**). Retention between first and second year (within two years) has remained steady with an average retention rate of 93.6 % from 2013 to 2020.

An important focus in the last decade has been diversification of the undergraduate population. The proportion of female-identifying students entering Engineering rose from 25.5 % in 2013 to over 40 % in 2016. With the exception of the COVID-pandemic affected years (2020 and 2021), this cohort has been consistently maintained at approximately 40 %. A similar effect was observed for the international cohort of first year students. A dip to 26 or 27 % observed between 2016 and 2018 was reversed through recruitment strategies to peak at 35.7 %. However, the global effects of the COVID-pandemic resulted in a drop in the total international first year cohort to 28.9 % (2022). This was largely a consequence of challenges in obtaining study permits for many of the international students offered admission during 2021-2022. For more information, see **Appendix C, Chapter 1: Undergraduate Studies**.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Applications	10,095	10,989	11,418	12,298	12,880	13,272	12,263	11,807	13,188	13,454
Offers	3,042	3,205	3,126	2,983	3,109	3,380	3,937	4,806	4,298	4,448
Registrations	1,106	1,192	1,205	1,005	1,065	1,062	1,202	1,359	1,259	1,265
Selectivity	0.30	0.29	0.27	0.24	0.24	0.25	0.32	0.41	0.33	0.33
Yield	0.36	0.37	0.39	0.34	0.34	0.31	0.31	0.28	0.29	0.28

Figure 3-2 Applications, Offers, Registrations, Selectivity and Yield of First-Year Undergraduates, 2013 to 2022

(See Figure 1.1a from *By the Numbers 2023*)

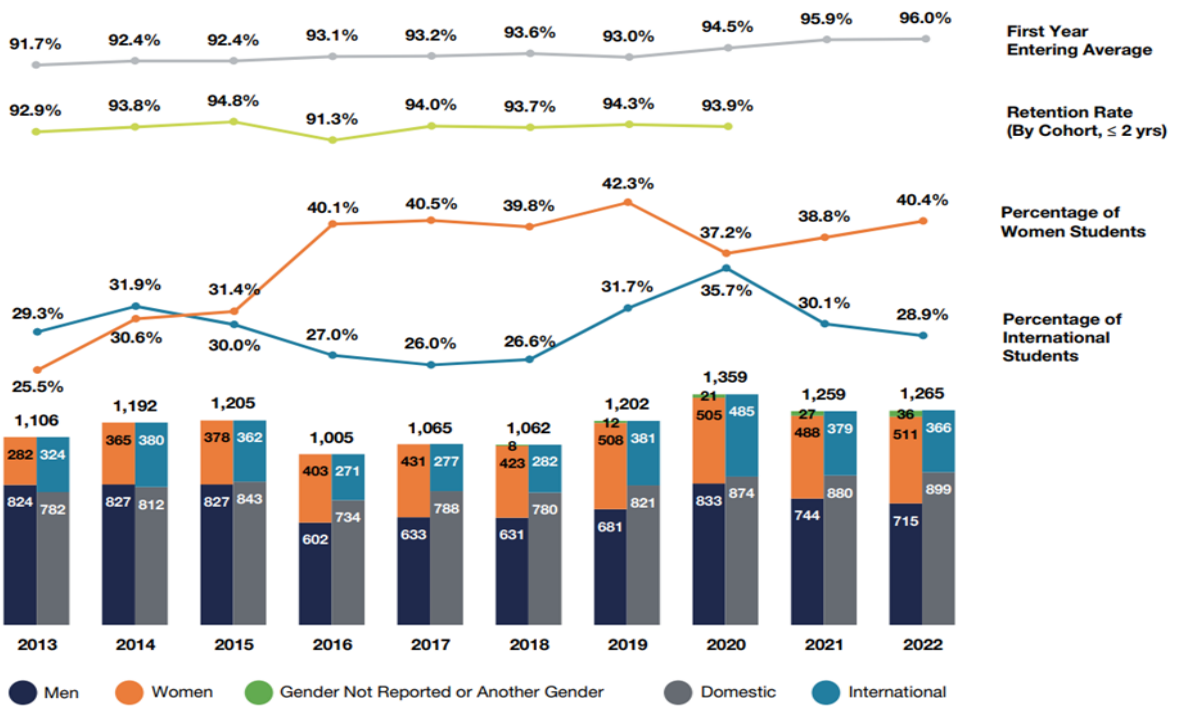


Figure 3-3 Ontario Secondary School Averages of Incoming First-Year Undergraduates and Retention Rate Between First and Second Year (within 2 years), 2013 to 2022

(See Figures 1.2a and 1.2b from *By the Numbers 2023*)

3.2.1 Recruitment and Enrolment Strategies

The Engineering Student Recruitment and Retention Office (ESRRO) and the Engineering Outreach Office work in tandem to promote engineering studies among pre-university students and encourage the best and brightest to choose U of T Engineering.

3.2.1.1 Outreach

The Engineering Outreach Office promotes awareness of the role of engineers within society and inspires talented students in grades 3 to 12 to consider the engineering profession as a way of making a positive impact on the world. Each year, programs delivered through the Engineering Outreach Office engage more than 9,000 pre-university students from the Greater Toronto Area and across Canada. These include the Da Vinci Engineering Enrichment Program (DEEP) Summer Academy for high school students, Jr. DEEP and Girls' Jr. DEEP summer day camps and Saturday programs for students in grades 3 to 8, and ENGage, a collaboration with U of T's Chapter of the National Society of Black Engineers that highlights black role models, encourages STEM literacy, and promotes academic and social growth.

Launched in 2020, Blueprint is an academic enrichment program designed for highly motivated Black students currently in Grades 10 and 11 who are interested in careers in Science, Technology Engineering and Math with a strong interest in Engineering. The Indigenous Design & Engineering Academy (IDEA) programs are designed for Indigenous secondary students who are interested in learning more about STEM. The IDEA-LIT (Leader in Training) program is grounded in Indigenous Land-based learning and Indigenous Knowledge and will demonstrate to students that Indigenous knowledge is STEM.

These programs also provide important opportunities to the undergraduate and graduate students who co-create and deliver them to develop key competencies in project management, communication and engineering education.

The Engineering Outreach Office also shares with elementary and high school teachers strategies for incorporating STEM topics into the classroom. Discovery is a program founded, implemented, and delivered by post-secondary students with a vested interest in mentoring the next generation of STEM leaders.

Recruitment

The primary objective of the Engineering Student Recruitment & Retention Office (ESRRO) is to attract top domestic and international students in pursuing an education at Canada's top engineering school and one of the best in the world. ESRRO's activities serve to raise the faculty's profile and works to recruit and retain students into the faculty's undergraduate engineering programs. These initiatives include campus tours and events, school visits, information session, applicant events, as well as digital livestream and workshops. ESRRO's stakeholders include prospective students and their families, teachers, guidance counsellors, current students, faculty, and staff. In 2021, the Engineering Recruitment and Retention Office became part of the Registrar's Office, which allows for better integration between recruitment and admissions activities in support of Faculty goals and diversification efforts.

All activities conducted by ESRRO support the Faculty's Academic Plan, specifically maintaining and enhancing a culture of excellence, increasing diversity, and optimizing our ability to increase gender parity and country-of-origin diversity within our student population. To achieve

these goals, ESRRO works to identify and recruit top students from around the world by promoting the excellence and uniqueness of our engineering programs and provide applicants with the support and services they need to successfully transition throughout the various recruitment stages.

The global pandemic had posed many challenges to the day-to-day operations of ESRRO. Specifically, travel restrictions and social distancing measures put in place prohibited the recruitment team from offering in-person services, on-campus events, and school visits between March 2020 to August 2022. At the same time, the global pandemic led to new approaches in student recruitment that we had traditionally not explored. The team optimized tools within the digital space such as: virtual tours, virtual event platforms and digital media. With no restrictions by travel budgets and borders, students around the world could interact and engage directly with the recruitment team through one-on-one meetings, application workshops, virtual events, and sessions where we could host panels with current engineering students, alumni, and faculty. These initiatives allowed ESRRO the opportunity to recruit and engage with prospective applicants from regions where we historically were not able to have a physical presence.

Today, ESRRO engages with applicants via both in-person and virtual channels. This has allowed us to further expand our reach in attracting some of the best and brightest students around the globe to our undergraduate engineering programs.

Our Faculty remains committed to increasing the diversity of our incoming students and the engineering profession as a whole. To learn more about our efforts in this area, see **Chapter 10**.

3.2.2 Broad-Based Admissions

U of T Engineering recognizes that grades alone do not reflect a student's ability or their potential for success in a professional program. All applicants are required to complete an Online Student Profile (OSP) as part of their application to our programs. On the OSP, applicants are asked to indicate their involvement in extra-curricular activities and reflect on the attributes they have developed through their involvement. Applicants are also asked to complete a Personal Profile, comprised of two brief video responses and a timed-written response to evaluate communication skills, logical thinking and engagement with the program. A group of trained alumni volunteers are recruited annually to assess Personal Profiles.

3.3 Academic and Co-Curricular Programming, Cross-Disciplinary Initiatives and Experiential Learning

Our Faculty employs a holistic approach to engineering education that integrates technical competencies with training in design, teamwork, communication, leadership and entrepreneurial skills. We have enhanced our programming by integrating engineering design courses across the curriculum (**Section 3.3.1**), developing cross-disciplinary programs (**Section 3.3.2**), strengthening communication training (**Section 3.3.3**), and enriching our co-curricular programming (**Section 3.3.4**).

Data from NSSE2020 indicate that our efforts have been successful in enabling students to engage in high-impact practices: 80 % of our first-year students and 98 % of senior-year students report having participated in research with faculty, service-learning, international study, or an internship or field experience, capstone or learning community (**Figure 3-4**). These percentages are higher than the U of T average, as well those for comparable institutions in Ontario, peers in the U15 group of research-intensive universities in Canada, and U.S. peers.

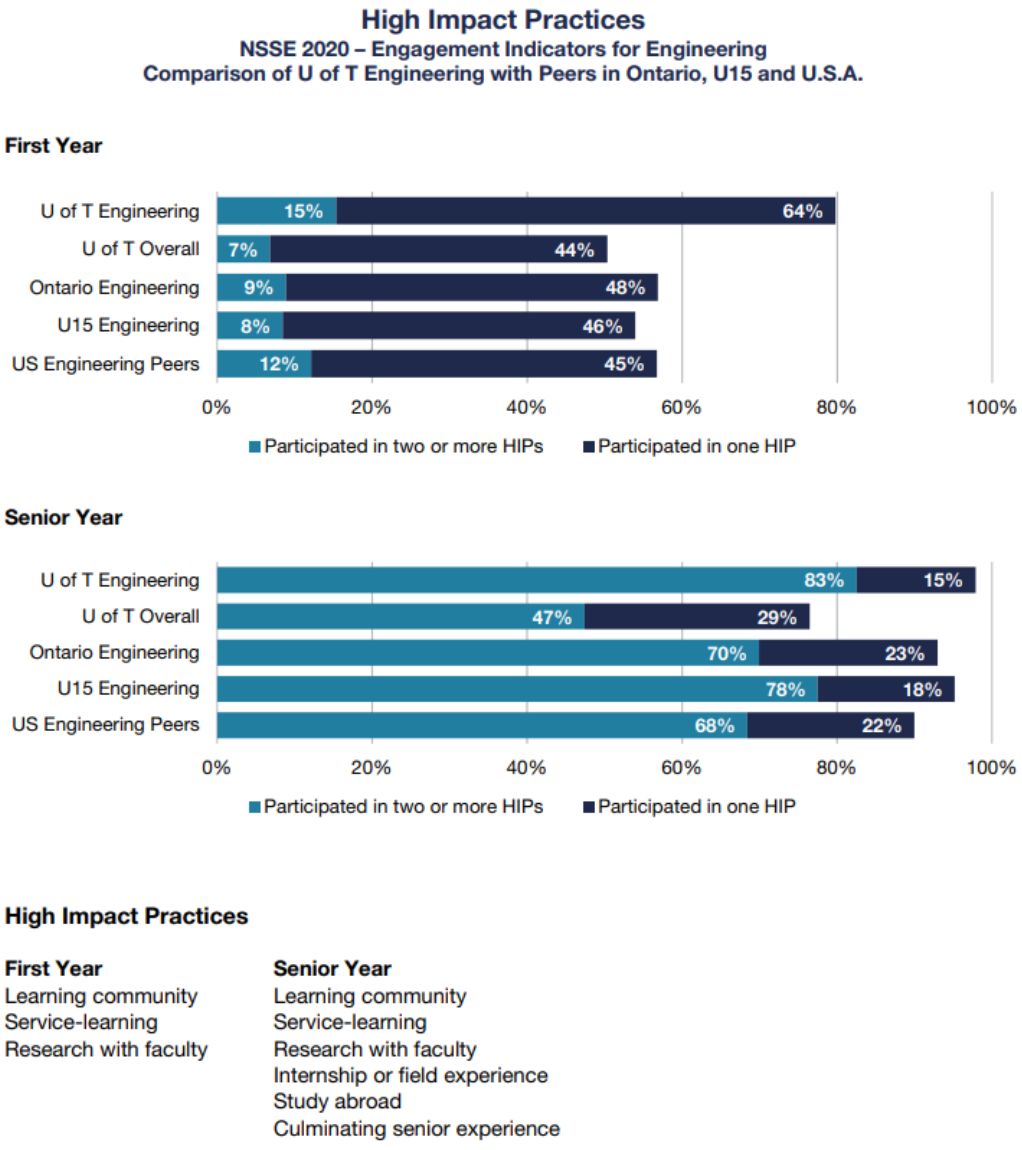


Figure 3-4 High-Impact Practices: NSSE2020

3.3.1 Design Across the Curriculum

We are committed to providing rigorous foundational learning in engineering principles and further enhancing our high-quality educational programs. One of our goals is to ensure that students can gain practical engineering design experience by working on a specific design challenge or project, often for an external client. Key courses in every year of study act as "design spines" and provide a framework into which students can integrate the skills they learn in more theoretical courses.

The design spine begins in first year with Engineering Strategies & Practice for our Core 8 and TrackOne programs, and Praxis in Engineering Science. These courses introduce students to

engineering design processes and include a culminating project. All students must complete a capstone course in their fourth year that includes a design project for an external client or take either the Multidisciplinary Capstone Project (MCP) or international capstone course offered by the Department of Mechanical & Industrial Engineering.

Engineering Strategies & Practice (ESP)

ESP is a two-term course sequence designed for first-year students in the Core 8 and TrackOne programs. In their first term (ESPI), students are introduced to the design process, work through a common team-based conceptual design project, and learn to identify social, human, regulatory, and environmental factors that affect their success. In the second term (ESPII), student teams (of 5 to 6 students) undertake a unique design project provided by a local community-based client.

As an example, in the fall of 2022, ESPI focused on teaching the design process through a conceptual redesign of the U of T Sidney Smith Building façade. In the winter 2023, 169 teams in ESPII addressed an array of problems including "Designing a Smartphone Integrated Light Device for Advanced Wound Management", "Regulation Needed for the Safety of Lithium-ion Batteries and Their Chargers", and "Benchtop Testing of Actuators for Robotic Prosthetic Legs and Exoskeletons". Through these experiences, students develop communication, teamwork, project management and design skills.

ESP is delivered by a cross-disciplinary teaching staff of multiple engineering professors, including faculty with design expertise in collaboration with faculty affiliated with the Engineering Communication Program (ECP) at ISTEP (**Section 3.3.3**).

Praxis I, II and III

Designed for first-year students in the Engineering Science program, Praxis I and II develop students' engineering identity and build upon their competencies in design, communication, teamwork and professional practice.

Praxis I, delivered in the fall term, provides a strong focus on personal and leadership development within an engineering design context. Students learn a variety of design strategies and viewpoints from within the established engineering disciplines and begin to articulate their own position through contributions to the Praxis Learning Community. In Praxis II, delivered during the winter term, students engage with communities in the Greater Toronto Area (GTA) to identify design opportunities. Each design team collaborates with their community to frame the opportunity as an engineering design challenge, which the class subsequently works to address. For example, in 2023, student groups worked to address a single challenge to 'effect a verified and validated sustainable improvement in the lived experience of a community'. Samples communities included the Toronto Fire Services, the Ukrainian Museum of Canada, the Toronto Zoo, and *A Greener Future*.

Praxis I and II are co-taught by Engineering Science faculty members with expertise in engineering design in collaboration with faculty with expertise in communication and teamwork from ISTEP (**Section 3.2.3** Students expressed strong enthusiasm for these course experiences during self-study consultations.

In 2021, we launched Praxis III, a second-year course for Engineering Science students that builds on the success of Praxis I and II. Praxis III expands these learning opportunities while

introducing a global element. Projects were carried out in partnership with peer institutions and organizations from around the world, in countries including Nigeria, Ghana, Thailand, Uganda and South Africa. Student research of each community includes a focused lens on local culture and practices, ensuring designs appropriately meet the needs of the client.

Capstone Design Courses

All students complete a team-based capstone design course in their fourth year. Most of these courses involve challenges proposed by industry partners or external organizations, although some allow students to pursue more entrepreneurial, self-identified projects. Professors and mentors provide guidance, while students supply ideas, insights and design solutions, helping them develop competencies in engineering design and enabling them to better understand how the profession impacts society.

As an alternative to their disciplinary capstone course, students may choose to participate in APS 490 Multidisciplinary Capstone Project (MCP). Offered through the Faculty's University of Toronto Institute for Multidisciplinary Design & Innovation (UT-IMDI), this course enables students to work in multidisciplinary teams on projects proposed by industry partners such as Defence Research & Development Canada, Bombardier Aerospace, and Sunnybrook Health Sciences Centre. During our self-study consultations, students expressed enthusiasm for the MCP course and said they would like it expanded. We are looking into pathways to expand the number of clients and available projects as well as the number of supervisors as these are the key limitations on further expansion of the course.

Second- and Third-Year Design Elements

We have strengthened design elements in the second and third years of our Core 8 programs:

- Mechanical Engineering introduced MIE243 Mechanical Engineering Design in second year and enhanced the design components of the third-year course, MIE301 Kinematics and Dynamics of Machines
- Industrial Engineering includes MIE240 Human Factors Engineering and MIE350 Design and Analysis of Information Systems
- Civil Engineering offers CIV312 Steel and Timber Design and CIV340 Municipal Engineering
- Materials Engineering introduced MSE 397 Materials Manufacturing and Design II
- Chemical Engineering offers CHE324: Process Design and CHE334: Team Strategies for Engineering Design
- Electrical and Computer Engineering offers ECE295 Hardware Design and Communication, and ECE297 Software Design and Communication.

3.3.2 Multidisciplinary Minors and Certificates

Undergraduate minors and certificates are administrated by the Faculty's Cross-Disciplinary Programs Office, led by an Associate Dean. They allow students to customize their degree programs to develop competencies in particular areas of interest, while interacting and collaborating with students from disciplines outside their own.

Minors and certificates are created to address evolving student and industry interests. Current options include the following:

Minors:

- Advanced Manufacturing (2017)
- Artificial Intelligence Engineering (2018)
- Bioengineering (2006)
- Engineering Business (2011)
- Environmental Engineering (2009)
- Global Leadership (2023)
- Music Performance (2018)
- Nanoengineering (2015)
- Robotics & Mechatronics (2011)
- Sustainable Energy (2009)

Certificates:

- Artificial Intelligence Engineering (2018)
- Communication (2015)
- Engineering Business (2011)
- Engineering Leadership (2014)
- Entrepreneurship, Innovation & Small Business (2010)
- Forensic Engineering (2017)
- Global Engineering (2010)
- Justice, Equity, Diversity & Inclusion in Engineering (2023)
- Mineral Resources (2012)
- Music Technology (2018)
- Nuclear Engineering (2013)
- Public Health & Engineering (2022)
- Public Policy & Engineering (2023)
- Renewable Resources Engineering (2014)

Students must complete six half courses to earn a minor, and three half courses for a certificate. In June 2023, over 76% of graduating undergraduate students completed an engineering minor (**Figure 3-5**) or certificate, with 54% completing a minor and 39% completing a certificate. The number of students completing more than one minor or certificate has grown from 4% ten years ago to more than 32% today. The Engineering Business minor and certificate are particularly popular, with almost one half of students completing one or the other.

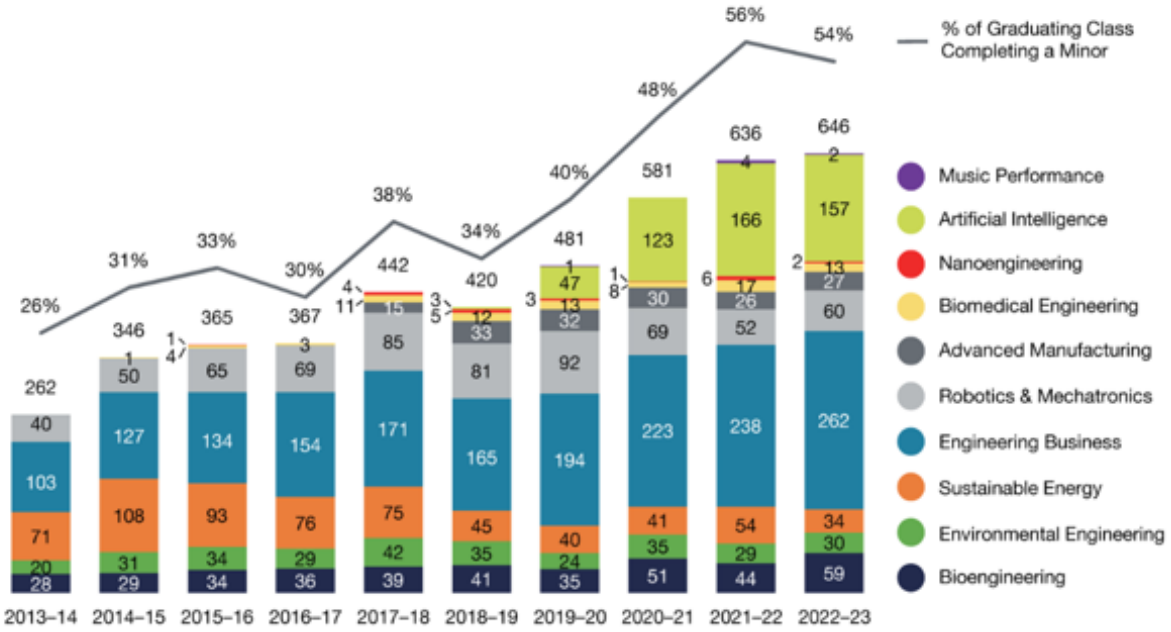


Figure 3-5 Number of Students and Percentage of Graduating Class Completing an Engineering Minor, 2013-2013 to 2022-2023

(See Figure 1.11a from *By the Numbers 2023*)

In addition to minors offered by the Faculty, students can pursue an Arts & Science minor, provided they complete associated course requirements within specific disciplines. Economics is the most commonly pursued Arts & Science minor; others include History, Political Science, Anthropology, English, Psychology, Philosophy, Fine Art, Cinema Studies and Linguistics.

In our self-study consultations, students said they felt positive about minors and certificates and expressed a desire for greater awareness of the opportunities available to them. However, some noted a need for more flexibility in their schedules to accommodate the minor/certificate courses, which is a challenge given the number of mandatory courses required by our degree programs and difficulty finding common open time slots across degree programs in which to schedule minor/certificate core courses.

Our goal is to continue to enhance the selection of minors and certificates offered. Newly launched topics starting in September 2023 include a tri-campus Global Leadership minor, and certificates in Public Policy & Engineering and JEDI (Justice, Equity, Diversity & Inclusivity). Topics currently under development include electric vehicles and human factors, and psychology engineering.

3.3.3 Instruction of Transdisciplinary Competencies

3.3.3.1 The Institute for Studies of Transdisciplinary Engineering Education and Practice (ISTEP)

Established in 2018, ISTEP is U of T Engineering's newest academic department. Across its 20 faculty members, ISTEP's vision is to provide expertise, holistic and enriching engineering

education, and related research through five themes: leadership, communication, socio-technical thinking, business & entrepreneurship, and learning for life. ISTEP aspires to enable U of T Engineering to graduate students who can leverage their technical depth with enabling breadth, to amplify their positive impact after graduation and better tackle the world's increasingly complex technical challenges.

ISTEP contributes to undergraduate teaching by providing curricular and co-curricular learning experiences. ISTEP is currently providing a foundation in communication and team-skills to all engineering undergraduate students through co-design and co-instruction in courses across each of the programs' curricula. This integrated co-instruction model benefits students by promoting learning of these competencies within the technical context of each of U of T Engineering's disciplines — which relies on collaboration of the faculty and leadership across all the departments. ISTEP faculty also teach core and elective courses related to leadership, communication, socio-technical thinking, and business & entrepreneurship. In addition, ISTEP faculty and staff offer co-curricular learning opportunities that enhance the whole student learning experience. ISTEP is thereby guiding and supporting learning related to the CEAB's graduate attributes 7 – 12. (**Section 3.1.3**).

The transdisciplinary breadth in human relations, perspectives and values enabled through this holistic approach to teaching is becoming a distinguishing feature of graduates from U of T Engineering. However, more remains to be done. The instruction of business reaches roughly half of our undergraduate students, through elective courses, certificates, and minors (**Section 3.3.2**); far fewer learn about entrepreneurship. Similarly, instruction of leadership is mostly through elective courses, with some instruction to all students through infusion lectures. The amount of targeted instruction of sociotechnical thinking varies across the Faculty's undergraduate programs so that graduates do not have a common foundation.

Learning for life involves promotion of the metacognitive skills needed to support lifelong learning and the knowledge transfer skills students need to integrate knowledge across their many curricular, co-curricular, internships, and other learning experiences. While these goals are implicit within most undergraduate instruction across the Faculty, much more remains to be done to make learning for life more direct and comprehensive, to better prepare students for the ongoing evolution from a knowledge-based to a learning-based economy, in which individuals and organizations who can learn more effectively will be more successful.

3.3.3.2 Engineering Communication Education

The Engineering Communication Program (ECP) — which is part of ISTEP — provides integrated communication instruction across the undergraduate curriculum through partnerships with Engineering departments. ECP collaborates with engineering faculty to deliver communication and design courses, and helps to build communication instruction into the technical curriculum by supporting assignment design, providing targeted communication instruction to students, and helping with assessment practices. ECP is embedded into the first-year design courses, ESP and Praxis (**Section 3.3.1**), and in second through fourth years tailors its programs to the core curricular needs of each undergraduate program.

This integration serves as ECP's pedagogical foundation for teaching communication to engineers, opening many possibilities for engaging in discipline-specific practices. ECP is among the few programs of its kind in North America, and consists of seven full-time teaching stream faculty, and more than 30 sessional lecturers each year. In addition to teaching, ECP faculty conduct research on topics such as engineering communication pedagogy and practice, the role

of humanities in STEM, professional identity development, and assessment practices in engineering education, leading to articles and books such as Robert Irish's *Writing in Engineering: A Brief Guide (2016)*. They also contribute to multiple academic societies in the field, with Alan Chong currently serving as President of IEEE's Professional Communication Society.

ECP also offers several Humanities and Social Science (HSS) elective courses which explore the intersection of humanities and science, technology, engineering, and math (STEM) topics. Taking three of these electives allows students to receive a Certificate in Communication, recognizing the students who go well beyond the core engineering communication requirements.

In addition to its curricular work, it also provides co-curricular support through a tutoring centre, which provides students with one-on-one support from a writing/communication specialist, and holding multiple workshops throughout the year. Furthermore, it administers an English language diagnostic to all incoming first-year students, and uses the results to target delivery of professional language development over the course of the program.

3.3.3.3 Engineering Leadership Education

The Troost Institute for Leadership Education in Engineering (Troost ILead) is one of the units housed within ISTEP. It enables students to develop and practice leadership competencies through courses, industry connections, and co-curricular activities. These courses include: TEP343 - Engineering Leadership, TEP442 - Cognitive and Psychological Foundations of Effective Leadership and TEP447 -The Art of Ethical & Equitable Decision Making in Engineering. Examples of co-curricular programs include:

- **Clubs Suite** — This program offers multiple supports to students participating in student clubs and organizations. This includes an asynchronous toolkit on the student learning platform, Quercus. The toolkit provides resources on topics such as “Burnout & Wellbeing”, “Equity, Diversity, Inclusion & Leadership”, “Leadership Transition & Succession”, and “Vision, Mission & Values”. In addition to the toolkit, club leaders have the opportunity to participate in two cohort-based, intensive fellowship programs: the Summer Fellowship and Winter Fellowship programs. The Summer Fellowship engages students in designing and implementing a change project for their respective organizations with the help of Project Coaches (alumni from industry). The Winter Fellowship program guides executive-level student leaders in the development and implementation of transition and succession plans.

- **Leadership Labs** — This series of workshops covers topics ranging from project management to team conflict, emotional intelligence and workplace readiness. All U of T Engineering students of any level of study can join these drop-in sessions.

- **Summer Fellowship** — This program brings together student leaders who are driven to improve their club or organization, as well as themselves as leaders. Each cohort comprises 10 to 15 fellows who take part in leadership workshops and peer-learning meetings over the summer to build key skills such as team management, conflict resolution, problem solving and more.

- **Leadership Inside Out** — This highly experiential summer program encourages self-awareness and teamwork skill development by exploring various sites across Toronto.

This program has been incredibly valuable for students seeking leadership learning, to build their social network and community, and to explore the city.

- **Teamwork Support** — Through the Effective Hybrid Teaming Handbook and Teamwork Advisor sessions, students have access to teamwork support. Teamwork Advisor sessions are closely aligned with the first-year design courses that involve a required team process; however, these resources are accessible to any student requiring additional support when working within a team.

- **Fireside Chats** — Throughout the year, industry leaders and change agents are invited to campus for fireside chats. This provides students the opportunity to get "up close and personal" with the guest speaker, learn more about their leadership journey, and be inspired for their own leadership learning trajectory.

- **The Clarke Prize Environmental Design Challenge** — Through innovative problem solving and technological stewardship, this program prepares undergraduate engineering students to propose creative solutions to intricate environmental challenges. In this two-day intensive learning experience, students evolve their leadership development and communication strategies. Participants engage in a cumulative design challenge pitch and proposal before a panel of judges with a top prize of $10,000.

- **The Difference Maker Award:** This program encourages students who have a proven track record of leadership and influence and a high commitment to their community to reflect on their leadership journey, articulate their vision for the future, and plan for how they will implement change for a better world. This program annually awards a student with a $50,000 prize.

3.3.3.4 Engineering Business and Entrepreneurship Education

ISTEP administers several programs and opportunities designed to enhance and inspire business acumen in our engineering undergraduates:

- **Engineering Business Minor** — The Faculty's most popular minor (**Section 3.3.2**) is a collaborative effort between U of T Engineering and the Rotman School of Management. It is designed specifically for engineering students interested in learning more about the business dimension of engineering — from finance and economics to management and leadership. Courses cover wealth production and creation, accounting, research and development, management, economics and entrepreneurship, all within a global context.

- **Certificate in Entrepreneurship, Innovation & Small Business** — This certificate prepares engineering students to lead in complex and changing business environments by developing their entrepreneurial talents. Students take an economics course as well as two rigorous courses: TEP 234H1 - Entrepreneurship & Small Business and TEP 432H1 - Entrepreneurship & Business Management.

Engineering Business Futures — This co-curricular program allows engineering students to develop a holistic view of business education through a speakers series, engineering business-case competitions and dynamic networking events

3.3.4 Co-curricular Programming

Over the last several years, our Faculty has significantly expanded the number of co-curricular programs we offer to help students develop key engineering competencies, such as leadership and entrepreneurship (Section 3.3.4.1).

3.3.4.1 Entrepreneurship Hatchery

In addition to ISTEP's curricular and co-curricular offerings around engineering business and entrepreneurship is The Entrepreneurship Hatchery.

Situated within the Myhal Centre for Engineering Innovation & Entrepreneurship, the Hatchery is part of U of T's larger ecosystem of start-up incubators across our three campuses. It offers several programs designed to nurture an entrepreneurial mindset in our students and equip them with the skills and experience needed to succeed as entrepreneurs within multidisciplinary teams.

Over the last ten years, the Hatchery has attracted a significant mindshare, with more than 2,400 individuals in 1,200 teams applying. Ventures successfully launched through the Hatchery include Pheedloop, Kepler Communications and Trexo Robotics.

The Hatchery offers a wide range of co-curricular programming directed toward undergraduates, graduate students and alumni. Below are offerings specifically for undergraduate students:

The NEST — A rigorous summer program that provides opportunities for start-ups to define their purpose, with the support of a unique advisory board and access to the Hatchery's resources.

- **Share Your Problems —** A crowdsourcing tool that harvests "problem" ideas from investors, industry and individuals from around the world. These challenges are then shared with students in Hatchery Idea Markets and Build-A-Team.
- **Idea Markets —** These weekly sessions allow founders to discuss problems, debate ideas and foster relationships to find collaborative solutions.
- **Build-A-Team Matching Tool —** A tool for founders looking for co-founders, or for start-ups to connect with the talent they need to strengthen their teams.
- **Hatchery Social —** Students have the opportunity to focus on the creation of software tools for use by non-profits.

After participating in any Hatchery programs, based on the merit and with the endorsement of their advisory board, the start-up reaches the Go-To-Market stage. Here, students have an opportunity to strengthen their advisory board, obtain the required professional services a start-up needs, secure early-stage seed funding and the connections for follow-on investment to scale their start-up companies.

At this stage, start-up founders have the opportunity to hire their first employees, leveraging U of T's work-study program. During this journey, founders and start-ups are guided using our own Formative Experiential Entrepreneurial Learning (FEEL™) methodology for

entrepreneurial human capital and venture formation.

3.4 Quality of Teaching and Student Assessment

U of T Engineering monitors research and development in engineering pedagogy in order to be creative and innovative in our delivery of educational content (**Section 3.4.1**). Tools such as internal course evaluations and data from the National Survey on Student Engagement (NSSE) allow us to measure our performance in this area, and the internal and external awards we receive recognize and encourage our excellence in engineering education (**Section 3.4.2**).

3.4.1 Teaching Methods, Philosophy and Professional Development

Our faculty members typically teach two or three undergraduate courses each year. While many of our classes are delivered in the traditional lecture-style format, we are leveraging technology to further engage students. “Inverted classrooms” allow students to watch recorded lectures online prior to class, reserving classroom time for reinforcing concepts through collaborative work with peers on assignments and problem sets. The inverted classroom approach is enhanced by Technology Enhanced Active Learning (TEAL) classrooms. TEAL classrooms in the Sandford Fleming informed the design of modern teaching spaces in the Myhal Centre for Engineering Innovation & Entrepreneurship. The Myhal Centre also includes a state-of-the-art light fabrication facility and rooms designed for group project work (**Chapter 7**). During the pandemic the University expanded on the inverted classroom approach with a system allowing instructors to record PPT automatically, resulting in more regularly recorded lectures and an increased availability in general for students.

Design courses such as Engineering Strategies & Practice (ESP) and Praxis (**Section 3.3.1**) combine large lectures (approximately 1,000 students in ESP and 300 students in Praxis) with tutorials of around 25 students, and like capstone courses, they require a significant amount of work by teams of approximately five students. These course formats provide key opportunities for students to develop competencies in teamwork, life-long learning and multidisciplinary collaboration.

Related teaching resources for faculty members include the following:

- **Teaching Methods & Resources Committee** — One of the Faculty’s eight standing committees, this group promotes improvements to teaching methods, hosts regular educational workshops, and advises on the delivery of our undergraduate academic programs. The committee has recently developed Faculty guidelines that describe and guide the assessment of teaching effectiveness during promotion and is re-evaluating the process of course and Teaching Assistant Evaluations by undergraduate students.
- **Education Technology Office (ETO)** – This resource inspires, supports, and empowers the Faculty in the thoughtful use of educational technologies. The ETO collaboratively works with the U of T Engineering community on idea generation, course planning, course building with multiple digital learning modalities, and teaching with technology. The office organizes and runs the bi-annual EdTech Workshop, a one-day series of workshops that showcases best practices for innovating teaching and learning, presented by some of the university's leaders in education technology.
- **Engineering Education Research** - Many U of T Engineering faculty regularly participate in and present at engineering education focussed conferences such as the annual conferences hosted by the American Society for Engineering Education and the Canadian Engineering Education Association (CEEA). The excellence of their teaching

and education research has been acknowledged through best paper and presentation awards; some have also been recognised as CEEA Fellows and 3M National Teaching Fellows. The 18 PhD stream students in the Collaborative Specialization in Engineering Education (**Section 8.1.2**) are also pursuing engineering education research on a wide range of related topics. This research is enabled and supported by two Senior Research Associates and numerous (roughly 20 per year) undergraduate work-study, summer and thesis students. The findings from this and other research is shared internally with faculty, students, and staff through the monthly meetings of the Engineering Education Research Roundtable (E^2R^2).

In addition to these Faculty resources, our instructors can access the U of T Centre for Teaching Support and Innovation (CTSI), which provides workshops, demonstrations of educational technology and other research to support teaching development.

The university-wide Teaching Assistants' Training Program (TATP) aims to enhance the teaching competencies of TAs and improve the effectiveness of grading and tutorials. Workshops, short courses, and two certificate programs are also offered to assist graduate students with various aspects of teaching. The Faculty offers a full-day, in-person workshop for first-time teaching assistants to complete their mandatory paid training. This training is also open to returning TAs who want to upskill.

The training is a collaborative effort among the Vice-Dean, Graduate, the Vice-Dean, Undergraduate, ISTEP, and the First Year Office. The training covers topics such as protecting student privacy, equity, diversity and inclusion in the classroom, and student wellness. Developed by the Faculty, the Supporting Student Mental Health and Equity, Diversity, and Inclusion online modules are unique and not offered by the Centre for Teaching Support & Innovation. Additional information regarding Teaching Assistant training and support is provided in **Chapter 4**.

3.4.2 Recognition and Evaluation of Teaching

Student feedback is critical to our efforts to continuously improve engineering education. The students involved in our self-study consultations expressed general satisfaction with the quality and effectiveness of our faculty members.

We conduct detailed evaluations of our undergraduate courses and instructors by means of a confidential, standardized survey administered during the last two weeks of each course. Beginning in 2011, our Faculty's Teaching Methods & Resources Committee worked in close consultation with the university's Centre for Teaching Support and Innovation (CTSI) to develop a new framework for the survey that characterizes the effectiveness of the learning experience from the student's perspective. This evaluation process was implemented in fall 2013 to ensure that courses align with the teaching and learning goals identified by the university, Faculty, department and course, and provide actionable feedback for improvement.

A sample evaluation form is provided in **Appendix D.** The first six statements are standard across U of T and are designed to evaluate institutional priorities. The next seven are standard across U of T Engineering and reflect our Faculty's priorities. The remaining questions are at the discretion of the instructor. Questions are scored on a scale of 1 to 5. The scores are averaged and communicated to the instructor, the departmental chair, and the Vice-Dean, Undergraduate. The comment section is returned only to the course instructor, who may use it for TA feedback and mentoring, or to obtain further student insight. The Institutional

Composite Mean (the average response for the first six statements) for the Faculty is consistently 3.7-3.8 out of 5 over the past several years.

The University's Centre for Teaching Support and Innovation published *Cascaded Course Evaluation Framework: Validation Study of the Institutional Composite Mean (ICM)* and a related document: *University of Toronto Course Evaluation Interpretation Guidelines for Academic Administrators* in 2018. These documents provide guidance on the reliability of the evaluations relative to the response rate and course size. The Faculty's Teaching Methods & Resources Committee monitors the evaluation process, with a focus on the variable response rates.

The Faculty recognizes outstanding teaching by its instructors with three annual awards: the Early Career Teaching Award, the Faculty Teaching Award, and the Sustained Excellence in Teaching Award. Instructors have also received recognition through University of Toronto Teaching Awards, provincial and national awards. Recent examples include:

- Ontario Confederation of University Faculty Associations Teaching Award to Micah Stickel (ECE) in 2022
- Engineers Canada Medal for Distinction in Engineering Education, from Engineers Canada to Professor William Cluett (ChemE) in 2021
- Sandford Fleming Foundation's Wighton Fellowship to Professor Ariel Chan (ChemE) in 2022
- University of Toronto President's Teaching Award to Micah Stickel (ECE) in 2020 and to Steven Thorpe (MSE) in 2023
- University of Toronto Early Career Teaching Award to Elham Marzi (ISTEP) in 2022
- University of Toronto Global Educator Award to Amy Bilton (MIE) in 2023

Student-Faculty Ratios

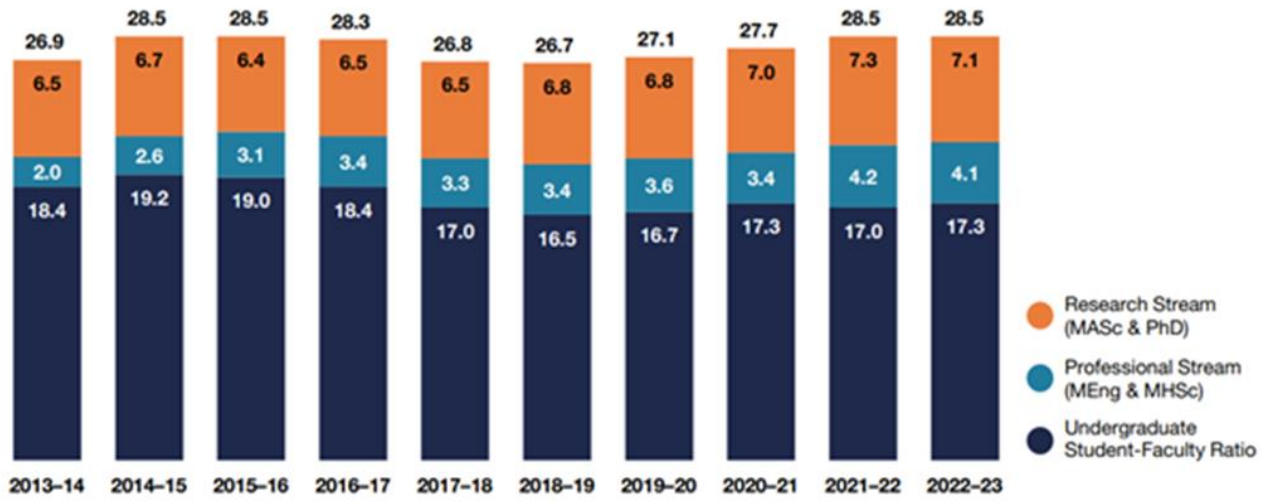


Figure 3-6 Undergraduate and Graduate Students per Faculty Member, 2013-2014 to 2022-2023

(See Figure 2.3a from *By the Numbers*)

Undergraduate student-to-faculty ratios have remained relatively constant over the last five years (**Figure 3-6**). The undergraduate ratios range from 13.6 to 20.2 in individual departments and include tenure- and teaching-stream faculty. They do not include professors from Arts & Science or other Faculties, who instruct many of our courses.

3.4.3 Academic Integrity

U of T students, faculty and staff must abide by the Code of Behaviour on Academic Matters. Teaching students to recognize and avoid academic dishonesty in all forms is part of our commitment to developing a strong culture of ethics within the engineering profession. For example, the first-year Orientation to Engineering (**Section 3.5.1**) course includes a tutorial that presents students with six scenarios that place the Code in context. Our instructors use Turnitin.com and Measure of Software Similarity (MOSS) to detect plagiarism in written papers and software, respectively. Instructors can report incidents of suspected plagiarism to the Dean's designate for academic offences through the online Academic Offense Tracking Tool. A first offence typically results in a mark of zero for a given assignment, while any additional offenses can result in an incomplete mark for an entire course, an academic suspension of up to one year, or expulsion from the program.

3.5 Student Services, Retention and Graduation

Ensuring the success of students in our programs is a high priority for our Faculty. We recognize that the transition from secondary school to first-year engineering is particularly challenging for many students. As such, support begins in the summer before students start their studies, continuing through the fall and winter terms (**Section 3.5.1**). Students can access a full range of academic advising and career development services (**Section 3.5.2**), as well as programming through Troost ILead (**Section 3.3.3.3**) and the Engineering Communications Program (**Section 3.3.3.2**) that help them develop self-awareness and team, communication and leadership skills. Other supports for students include access to the U of T Library system, the largest of its kind in Canada (**Appendix E: Library Report**).

For the 2020–2021 cohort, our first- to second-year retention rate was 93.9 %. The rate has been approximately 94 % since the 2018–2019 cohort.

3.5.1 First Year Students

During the summer before their studies begin, all incoming students can access our First Year Foundations programs, a suite of online tools, workshops and other programs:

- **Academic Orientation** — In-person sessions in June (which are also offered as online videos to students who cannot attend in person) that provide advice on selecting courses, paying or deferring fees, obtaining a student card, and helping students get prepared for the beginning of term in September.

- **Summer Academy** – a flexible, six-week, online offering that provides in-depth review and contextualization of core high-school-level math, coding and physics for those who want to refresh their fundamental knowledge while simultaneously learning how to navigate U of T's learning management system. This program was developed during the restricted COVID pandemic environment as a free resource to guide first year student transition to university learning and curriculum. Given that teaching and learning has resumed in-person, the program is now offered at a cost-recovery fee for students

interested in discipline review prior to the start of first year.

- **Success 101** — A series of full-day workshops provided several times throughout the summer. Through interactions with professors, teaching assistants, upper-year students and their peers, incoming undergraduates can address their most pressing concerns and receive tips on everything from time management to note taking, effective communication and residence life.

- **Engineering Study Skills Sessions** – Offered in person throughout the summer to help students learn tips and strategies to help them transition to university learning effectively in fall.

- **APS 162 Calculus for Engineers and APS164 Introductory Chemistry from a Materials Perspective**—For-credit online courses offered over the summer. Students may enrol in one of these courses to lighten their fall or winter term course load, or they can elect to enrol in an elective course.

- **E-Buddy Program** – For incoming first year international students that provides support from upper year mentors who are also international students. The program offers community meet-ups during the summer, and informal programming, workshops and events to for continued community building amongst international students throughout the year.

Once classes begin, students may choose to attend Guided Engineering Academic Review Sessions (GEARS) to work on problem sets and share study strategies. These informal sessions are held throughout the year and are led by upper year students who have previously taken these courses. Each term on the Study Day prior to the exam period, the First Year Office holds “Exam Jam”, a day-long event offering instructor-led course review sessions, lunch, and access to therapy dogs.

APS100 Orientation to Engineering, first offered in Fall 2015, is designed to help students entering our Core 8 and TrackOne programs with the transition to first-year engineering studies. Weekly one-hour lectures, supplemented by weekly one-hour interactive tutorials led by upper-year TAs, allow for discussion of key topics such as good study habits, time management, application of mathematics in engineering, identity as an engineer, engineering ethics, and equity, diversity & inclusion in the engineering community.

The Transition Program (T-Program) helps first-year students who fall behind in the fall session to proceed to second year on schedule by re-distributing their course load. If eligible, students in the T-Program can repeat up to three fall courses in the winter term, deferring winter term courses to the summer session. These students also meet with advisors from the First Year Office to identify and address the challenges encountered.

Our Faculty continues to host an annual First-Year Instructors Day for professors and teaching staff who work with incoming students (launched in 2013). The goals of this workshop are to develop a strong sense of community among first-year instructors and to make them aware of the supports available to first-year students.

3.5.2 Academic Advising and Other Student Supports

Every first-year student is assigned a primary academic advisor. Each advisor in the First Year

Office focuses on a specific student cohort (i.e., TrackOne, International, Core8) in addition to offering expertise in other areas of student support including Student Success & Transition, Access & Inclusion, and International Learning & Experience. Further to this, the Division of Engineering Science has dedicated advisors available for their students in Years 1 & 2; one advisor is dedicated to domestic students while the other is dedicated to international students. Academic advising for upper-year students is provided by the academic advisor attached to the unit offering the student's program of study.

During the summer, incoming students undertake the Diagnostic of English Learning Needs Assessment (DELNA). This assessment has been a joint initiative of the First Year Office and ISTEP, with provision of support mechanisms for those students identified to require professional language development support throughout the programs. This is an important resource for guiding our international cohort into our First-Year environment. Similarly, a Math Diagnostic Test (MDT) is written by all incoming students in September. This assessment provides students with an appreciation of their existing mathematical skill level. Students looking for additional math support because of their test outcomes, or throughout the academic year, are encouraged to attend GEARS sessions led by upper year engineering students and/or the Math Learning Centre available through the Faculty of Arts & Science (Math Department).

The Decanal Task Force on Mental Health (2015) examined existing mental health supports for Engineering students by reviewing and assessing the Faculty's performances and initiatives in relation to the strategic priorities identified in the University's recently launched Mental Health Framework. The 12 recommendations in the final report focused on 4 key areas: Education, Training Awareness and Anti-Stigma; Inclusive Curriculum & Pedagogy; Mental Health Services & Programs; and Policies & Procedures. These recommendations have led to a dedicated webpage for Mental Health and Wellness at the Faculty, the development of a Critical Incident Protocol, and required Syllabus Statements on Mental Health and on Academic Accommodations.

The Dean's Task Force on Academic Advising (2015) recognized the importance of student-support staff, especially academic advisors, as important resources for our students. Its final report outlined 10 recommendations that focused on the language around advising, resources for advisors and the further professionalization of academic advising within U of T Engineering. Specific actions from these recommendations include the creation of the Advising Portal to book appointments online, more consistency in terms the of the role and responsibilities of academic advisors and offering professional development on advising-related competencies. One notable result of this task force was the creation of a Learning Strategist role within the Faculty.

The Learning Strategist fosters academic skill development (including time management, procrastination, exam preparation, and more) through one-on-one and group-based appointments sessions, delivering synchronous workshops and developing asynchronous resources, as well additional partnership and programming efforts. As demand for Learning Strategist appointments remains high at the Faculty, a key effort includes the development of the engSuccess academic peer mentorship program to scale up and reach more students.

In 2019, a Joint Task Force on Academic Advising and Mental Health (JTF) was formed, to make recommendations with regards to academic advising and student mental health and wellness at the Faculty. The Task Force consisted of undergraduate students, graduate students, faculty and staff, and put forward 17 recommendations in the final report. Various initiatives have been undertaken to action these recommendations, including removal of student rankings in the Portal, successfully piloting the Self-Declaration of Illness program, and the creation of a

Decanal Task Force on Academic Workload which led to establishing a Fall Study Break for undergraduate students.

The work of JTF also led to dedicated On-Location supports being established at the Faculty, in partnership with the Division of Student Life, including a Health and Wellness Counsellor and an Accessibility Advisor. Additionally, new staff roles were created to advance student wellness, including a First Year Advisor, Intercultural Learning & Experience (focusing on better supporting international students), as well as a Mental Health Programs Officer role within the Faculty.

The Mental Health Programs Officer works to foster a culture of care at the Faculty, and has developed and delivered opportunities for student, staff and faculty to receive training on mental health. The Mental Health Programs Officer has also led the development of funding opportunities to advance student-led mental health initiatives, as well as the co-creation of the Skule Mental Wellness Bursary (in partnership with the Engineering Society) to expand access to mental health and wellness supports for students in need of financial aid. They also offer resource navigation and referral appointments to ensure that students are connected to support in a timely manner and provide guidance to academic advisors and faculty members to better support student mental wellness.

The Engineering Career Centre (ECC) provides students and alumni within two years of graduation with career advising services and access to job postings, employer recruitment events and career fairs, and administers the flagship Professional Experience Year Co-op Program (**Section 3.7.2.1**). Other sources of career advice include the Alumni Mentorship Program, which connects third- and fourth-year students with U of T Engineering alumni in their chosen field, and the You're Next Career Network, a multi-disciplinary, student-run team that provides career development programs such as career fairs and a startup career expo.

3.5.3 Final-Year Academic Achievement

Over the course of the last decade, U of T Engineering awards roughly ~ 1,000 degrees across all programs per year. A decrease in degrees awarded was observed during the pandemic; however, this trend appears to be reversing from a low of 945 in 2021-2022 to 975 in 2022-2023 Figure 3-7). Interestingly, the pandemic experience did not affect the percentage of students graduating with honours or high honours.

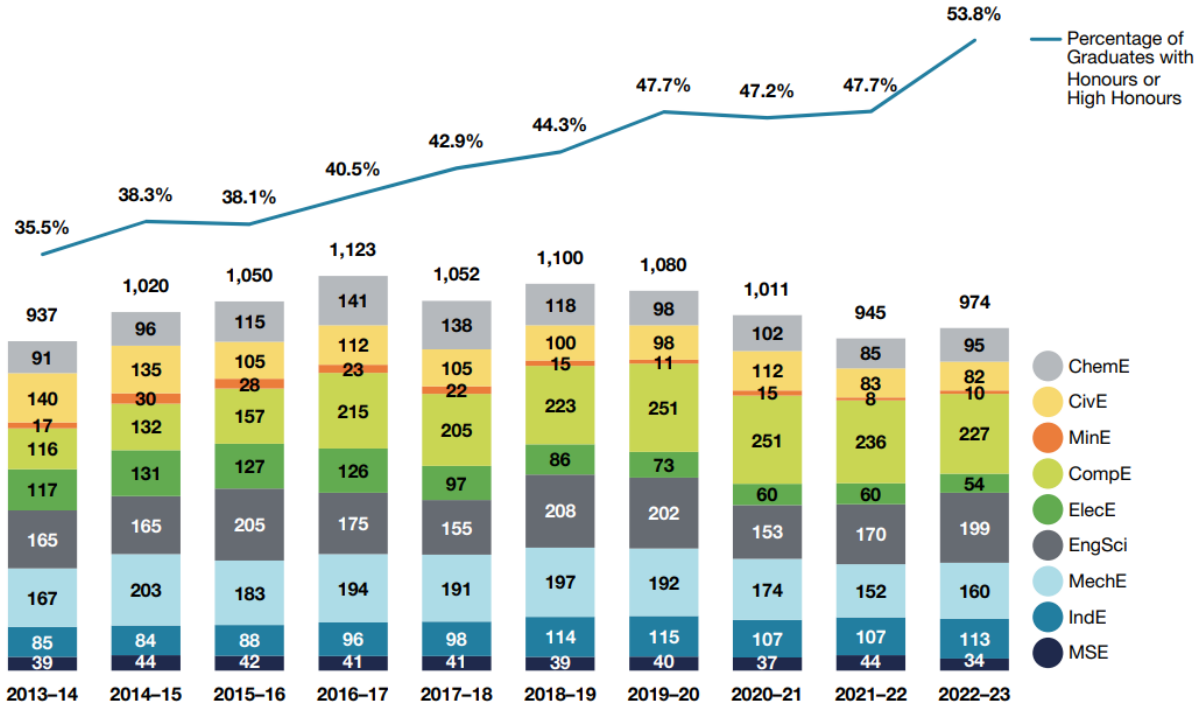


Figure 3-7 Undergraduate Degrees Awarded by Program and Percentage of Graduates with Honours or High Honours, 2013-2014 to 2022-2023

(See Figures 1.10a and 1.10b from *By the Number*)

We recognize high achievement among our graduates through the granting of Honours, which denotes a cumulative average of higher than 79.5 % across second, third and fourth years and a weighted sessional fourth-year average of 74.5 % or higher. The proportion of students graduating with Honours has grown from 28.9 % to 39 % over the last 10 years. In June 2015, we created the designation of High Honours for students with a cumulative average of 87.5 % or higher and a weighted sessional fourth-year average of 82.5 % or higher.

3.6 Student Funding

Our Faculty is committed to upholding the University of Toronto's Student Access Guarantee, which holds that no domestic student should be unable to begin or continue their studies due to a lack of financial resources. While students are expected to first seek government aid through the Ontario Student Assistance Program (OSAP), we offer a wide range of student aid options, including scholarships, bursaries and other awards based on merit and need. Our financial aid officer helps students prepare personal budgets, learn about funding sources (including University of Toronto Advance Planning for Students) and manage appeals through the OSAP process.

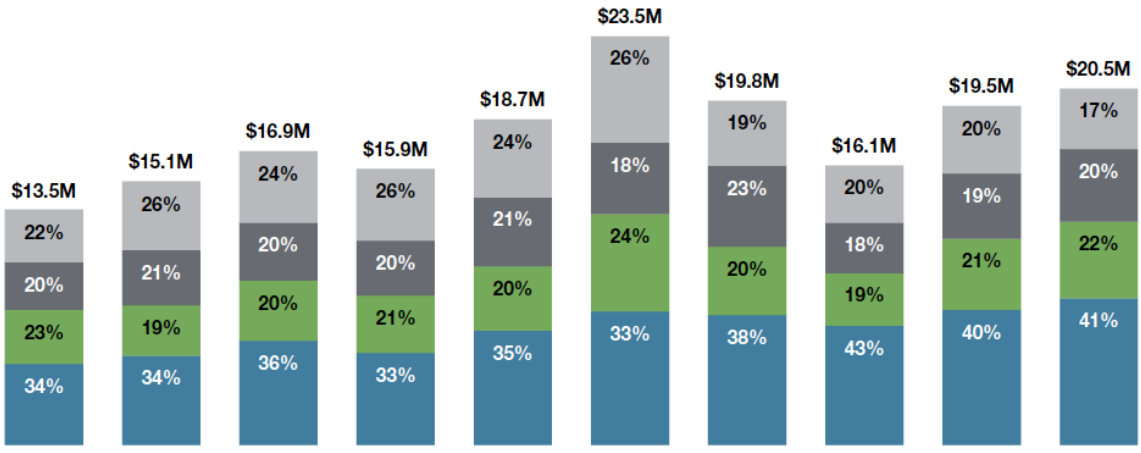
Scholarships and awards are typically geared toward students who demonstrate a high level of academic achievement in a particular discipline and/or strong leadership through co-curricular activities. To help students qualify for these awards, we have created the online ePortfolio tool,

which students can use to create a comprehensive picture of their accomplishments that goes beyond academics. More than 2,400 students have completed a profile since ePortfolio's inception in 2007.

To support the Faculty's efforts towards creating pathways for underrepresented populations within engineering, a number of renewable admission scholarships have been developed. In 2018, the Faculty established the U of T Engineering Entrance Scholarship for Indigenous Students, which covers the cost of domestic tuition – up to three scholarships are awarded each year. In 2022, a similar award, the U of T Engineering Entrance Scholarship for Black-identified students was developed with a renewable value of $10,000 per year, up to 10 students are given this award on admission each year.

Although international students are not eligible for financial aid programs, the University of Toronto Engineering International Scholar Awards provide renewable scholarships to incoming students from around the world. Awarded on the basis of academic achievement and extra-curricular involvement, over $5.8M in funding has been awarded since the award was developed in 2020.

The Faculty distributed $20.5M in financial aid and scholarships in 2022-2023 (Figure 3-8), including $9.2M in merit-based scholarships and awards received by students across all years and programs, and a further $11.2M in bursaries and grants.



	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Year 4	$3,020,566	$3,927,699	$4,111,034	$4,118,175	$4,476,023	$6,107,158	$3,747,289	$3,279,486	$3,881,711	$3,477,377
Year 3	$2,736,962	$3,179,061	$3,313,704	$3,162,741	$3,957,287	$4,113,240	$4,650,015	$2,902,371	$3,734,750	$4,168,102
Year 2	$3,104,276	$2,889,446	$3,455,534	$3,291,995	$3,698,548	$5,600,443	$3,932,700	$3,035,347	$4,091,688	$4,409,353
Year 1	$4,656,660	$5,138,198	$6,004,130	$5,302,289	$6,574,230	$7,670,098	$7,460,093	$6,842,268	$7,763,485	$8,418,668
Total	$13,518,464	$15,134,405	$16,884,402	$15,875,200	$18,706,088	$23,490,939	$19,790,097	$16,059,472	$19,471,634	$20,473,500

Figure 3-8 Total Value of Need-Based Undergraduate Financial Assistance and Percentage Distributed by Year of Study, 2013-2014 to 2022-2023

3.7 Learning Environment and Student Experience

U of T Engineering is committed to providing a rich learning environment inside and outside the classroom. This includes ensuring that our physical space is commensurate with our position as Canada's leading engineering school (Section 3.7.1) and providing experiences such as work-

integrated learning opportunities and research placements that enable students to develop key competencies in engineering design, communication and project management (Section 3.7.2).

3.7.1 Space and Facilities

Our Faculty is located on a historic campus in the heart of Canada's largest city. Though our campus and its location provide many benefits, a number of our buildings were built between 60-100 years ago. This creates unique challenges that have been addressed through renewal projects.

The most significant change to our campus in recent years has been the Myhal Centre for Engineering Innovation & Entrepreneurship, which was completed in 2018. This facility has significantly expanded and enhanced space available for multidisciplinary collaboration, innovation and entrepreneurship within our Faculty.

The Faculty has a number of Technology Enhanced Active Learning (TEAL) rooms, which facilitate non-traditional approaches to teaching and learning. It also has a state-of-the-art fabrication facility where students can use 3D printers and other equipment to build or test prototypes. Since the time of the last self-study, we have added additional staff to the fabrication facility to expand its capabilities and help meet students demands. Many rooms in the Myhal Centre can be booked by students for collaboration on group projects, and the first floor houses a 500-seat auditorium with a stadium-style video wall. The Myhal Centre provides numerous spaces for students to study, as well as design/meeting rooms where they can collaborate on projects, whether for their academic courses or as part of their co-curricular activities, as well as space for entrepreneurship programs such as The Hatchery (Section 3.3.4.1). The lower atrium of the Myhal Centre includes dedicated space for student clubs and teams, including teams that design and build their own vehicles. This space is well-used, but by necessity can only support a small number of the more than 100 clubs and design teams across the Faculty.

Other examples of recently created or upgraded a number of classrooms and laboratory facilities across the Faculty include:

- An upgrade to the undergraduate computer facility in the Mechanical Engineering building.
- Renovation to the undergraduate teaching laboratory wet lab on the third floor of the Lassonde Mining Building.
- Renovations to the Engineering and Computer Science Library that increased the amount of study space available for students, including new group study rooms.
- Additional seating installed throughout the Bahen Centre and the Wallberg Building to provide space for more than 150 students to study, collaborate or socialize between classes.
- Physical and organizational upgrades to the student machine shop in the Mechanical Engineering Building that increases its opening hours and makes the space accessible to more students from across the Faculty.
- Upgrades to staff and student accommodations at the Gull Lake facility where the Department of Civil And Mineral Engineering's annual Survey Camp is held.

3.7.2 Student Experience Beyond the Classroom

Providing students with rich experiential learning opportunities helps them develop global fluency and communication, teamwork and leadership abilities. These experiences enrich their perspectives and strengthen their relationships with our Faculty, the engineering profession, and the communities we serve. Whether through internships, exchanges, student clubs, design teams, or community service, our students engage with society to address key technical and social challenges. To encourage and support our students' participation in undergraduate research and international exchanges, we created the position of Undergraduate Research and International Experience Coordinator in 2022.

3.7.2.1 Professional Experience Year Co-op Program (PEY Co-op)

U of T Engineering's Professional Experience Year Co-op Program (PEY Co-op) is the largest paid work-integrated learning program of its kind in Canada. Since 1979, the program has enabled undergraduate students to work for leading companies in Canada and around the world. During their work terms, students become full-time employees and receive a competitive salary comparable to other engineering positions in the industry. The average annual salary for engineering PEY Co-op students in 2022 was $56,000, with numerous individual salaries ranging over $100,000.

The 2016 Self-Study indicated a degree of student dissatisfaction, particularly among first- and second-year students, with the service levels and support provided by the Engineering Career Centre (ECC). In 2017, a detailed review of the organizational and service structure of the ECC was undertaken. A comprehensive stakeholder consultation was conducted, leading to the design and execution of a new service model and competency-based preparatory program. This program aimed to make students highly competitive and better prepared.

In the summer of 2019, the Student Development & Career Programming (SDCP) unit was created to develop an integrative and dynamic workplace preparatory program for students in their first and second years of study. Additional staff were hired in the SDCP unit with funding from the Dean's Strategic Fund to design, develop and launch this new program initiative.

The goal of this new program was to offer a multi-faceted service model to students earlier in their academic program, increasing student engagement and capacity before recruitment cycles. Based on stakeholder discussions and feedback, elements of both industry-based skill standards and the Graduate Attributes (**Section 3.1.3**) were incorporated. The program specifically focused on communication, professionalism, individual & teamwork, intercultural fluency, and career exploration skills.

During the height of the pandemic in 2020, ECC launched a new PEY Co-op format. In their first and second years of study, students complete foundational programming designed to enhance awareness of different industries, develop their job search strategy, build and maintain their professional brand, prepare for workplace dynamics, and understand the support resources available to them as they complete the PEY Co-op recruitment cycles and work terms. This new co-op format has been met with burgeoning interest: since its launch, over 90% of undergraduate engineering students have chosen the co-op option.

Through this program, U of T Engineering students apply their academic knowledge in real-world environments, developing into well-rounded and skilled professionals. With the new

program format, students engage in employment preparatory modules, selecting a four-month work term after second year and a 12- to 16-month work term after third year. Unlike the previous model that offered access to a co-op job board in Year 3, students can now join the PEY Co-op program starting in first year.

This early engagement provides momentum for students to be better prepared for the competitive co-op process. Despite turbulent market conditions from 2020 to the present, engineering co-op student success is on the rise. Out of the 1,076 students seeking a PEY Co-op work term opportunity in 2023, 1,017 secured a 12- to 16-month work term, resulting in an employment success rate of over 90% (**Figure 3-9**).

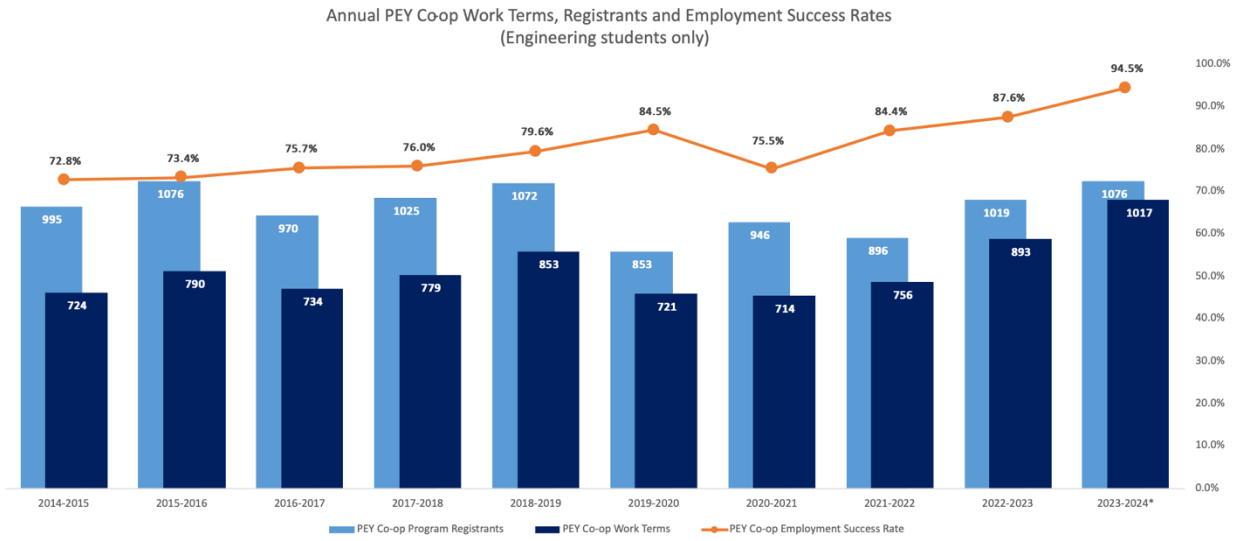


Figure 3-9 Annual PEY Co-op Work Terms, Registrants, and Employment Success Rates from 2014-2015 to 2023-2024 Co-op Years

** Numbers for the 2023-2024 Co-op years are subject to change through September 30, 2023.*

Each year, more than 3,500 PEY Co-op jobs are available, representing over 400 employers worldwide. These include small start-ups as well as large multinational corporations such as Honda, IBM and Proctor & Gamble. Additionally, the ECC played a role in launching a University-wide collaboration known as the Tri-campus Co-op Partnership (TCP). The TCP creates efficient avenues for employers to provide co-op opportunities to students across all three U of T campuses, expanding students' access to a wide range of market opportunities.

This programming will set students up to not only secure exciting work term opportunities but also make the most of their work term experiences. The PEY Co-op Program offers professional support to both employers and students to ensure positions are a good fit for everyone.

The ECC is housed within a new space called the Experiential Learning Commons (ELC), located at 255 Beverley Street. This innovative hub, spanning 1,279.54 Net Assignable Square Metres (NASM) on the third and fourth floors of the Theory Condominium Complex is the result of collaboration among three distinct but intersecting units at U of T.

The ELC aspires to enrich experiential learning and career development opportunities, foster meaningful student-industry connections, and establish efficient pathways for employers to engage with the University community. In addition to housing the ECC and its PEY Co-op Program, the ELC is home to the Office of Experiential Learning & Outreach Support (ELOS), including its Arts & Science Internship Program (ASIP), and Student Life's Career Exploration & Education Employer Recruitment & Engagement (ERE) Team.

Activities hosted within the ELC encompass student programming, employer engagements, and administrative services to support experiential learning priorities. This dynamic space is poised to redefine student-industry partnerships, serving as a hub for research and experiential education at U of T.

Since 2020, there has been a notable expansion in co-op opportunities for students. The ECC's commitment to supporting University students in their participation in the PEY Co-op program has fostered the establishment of co-op and internship programs at both the St. George and UTM campuses.

The Arts and Science Internship Program (ASIP) and the UTM Co-op and Internship Program have flourished due to the ECC's backing, particularly within program areas like Computer Science, Pharmacology, Toxicology, and Mathematics. This burgeoning landscape of programs paved the way for a collaborative tri-campus co-op partnership — an alliance that unites co-op and internship initiatives, broadening the industry prospects for students while streamlining employer relationship management.

U of T Engineering's ongoing commitment to foster interdisciplinary collaboration has enhanced co-op programs by providing students and employers with a broader range of opportunities, diverse experiences and valuable support services.

Looking ahead to further invest in career programming, the ECC will work closely with the Vice-Dean Graduate office to advance the development of internship programming for graduate students, collaborate with the Office of Advancement to offer career services to alumni, and build the capacity for a full-time recruitment function catering to graduating students and alumni, fostering deeper connections with industry partners.

Undergraduate Research

Engineering undergraduates across all years can engage in research experiences. In 2023, 220 undergraduates participated in summer research opportunities within the Faculty, and a further 65 completed summer research internships at other institutions around the world (**Figure 3-10**). COVID-19 had a severe impact on research opportunities as research activity was restricted on campus.

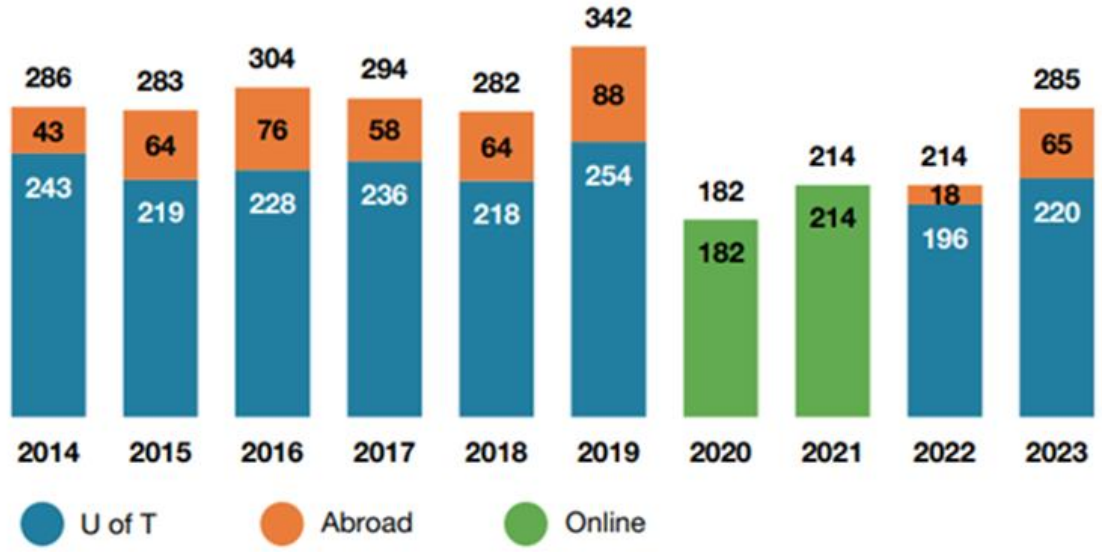


Figure 3-9 Undergraduate Participation in Summer Research Opportunities, 2014 to 2023

(See Figure 1.6a from *By the Numbers 2023*)

Most U of T Engineering faculty members offer summer research placements, typically administered at the departmental or divisional level. Other more structured programs, such as the Engineering Science Research Opportunities Program (ESROP), provide first- and second-year Engineering Science students with opportunities to work with faculty members in their area of interest. During these summer placements, students are mentored by graduate students, faculty members and industry partners, and contribute to leading-edge research projects in areas such as sustainability, robotics and bioengineering.

Each August, these students present their findings at the Undergraduate Engineering Research Day (UnERD). In 2022, UnERD celebrated its 15th anniversary including close to 100 poster and podium presentations, with the winners given the opportunity to have their work published in the student-focused *STEM Fellowship Journal*. In summer 2023, there were 148 student presenters (representing 141 presentations) at UnERD, validating a strong increase in student research experiences.

The Faculty-wide Undergraduate Student Research Program (USRP) was launched in 2019. USRP represents a community of students engaging in summer research. Participants meet weekly between May and August where sessions promote the support and development of 'success skills' that enhance the research experience. In addition to connecting as a student community, participants interact with experts from across the Faculty to discuss topics such as Research Ethics, Safety in the Research Environment, Academic Referencing, Scientific Abstract Preparation, and Research Presentations. In Sumer 2023, ~ 100 students participating in different research projects across the various departments attended at least some of the scheduled sessions.

Through U of T's Centre for International Experience (CIE), we offer research programs at a number of leading institutions worldwide, including the National University of Singapore, Hong Kong University of Science & Technology, and the University of Stuttgart. Beginning in 2015, the

Summer Research Abroad course has allowed students in some programs to receive degree credit for such exchanges. The Exceptional Opportunities Award, available to Engineering Science students, helps cover some of the costs associated with overseas placements. The CIE also provides scholarships and awards.

3.7.2.2 International Student Exchanges

The participation of our students in international exchanges has historically been low (**Table 3-1**), due in part to the need for courses at other institutions to count toward Canadian Engineering Accreditation Board (CEAB) requirements, and some limited flexibility given the high number of mandatory courses in engineering programs. A recent decision by the CEAB to exempt students participating in an international exchange will give more opportunity for Canadian Engineering students to go abroad on exchange. It is hoped that this, alongside better efforts on the part of the Faculty to increase awareness around international opportunities, will increase the number of undergraduate students participating in international exchanges. We plan to track uptake of this expanded opportunity over the next few years as this exemption is only in place until 2027 with an effort to demonstrate interest and participation to convince CEAB to make this a permanent change. A more complete tracking of participation by undergraduates in international activities is warranted to get a more fulsome picture of how our students are engaging in a global context.

Table 3-1 International Exchanges, 2011-2012 to 2021-2022

Exchange Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Total Student Exchanges	35	59	61	94	89	88	73	89	109	15	19

3.7.2.3 Interaction with the Profession

Across all years of study, our students have many opportunities to meet and interact with practicing engineers and learn more about the standards of the profession.

Some examples include:

- **Instructors and guest lectures** — Several courses, including CME 368 Engineering Economics and Decision Making and MIN330H1S-Mining Environmental Management, are taught by practicing engineers who bring their disciplinary expertise and professional experience into the classroom. Other courses involve industry professionals as guest lecturers. This includes the first-year Orientation to Engineering course that uses guest speakers to help students in the Core 8 and TrackOne programs successfully transition into the engineering academic environment and learn about the engineering profession.

- **Design projects** — Many fourth-year culminating activities including departmental capstone courses, theses and design projects involve industry partners as project advisors and clients.

- **Clubs and the Engineering Society** — Student chapters of many professional

engineering organizations, such as the Institute of Electrical and Electronics Engineers (IEEE) and the American Society of Mechanical Engineers (ASME), are active on campus. Students are also represented through the Engineering Society to Professional Engineers Ontario, the Ontario Society of Professional Engineers, and Engineers Canada.

- **Career fairs** — Whether organized through the Engineering Career Centre or the student-run You're Next Career Network, a number of annual events connect students and new graduates with seasoned professionals to help jump-start their careers.

- **Alumni Mentorship Program** — This program fosters valuable relationships between engineering alumni and students in their third and fourth years, including those on work terms through the PEY Co-op Program At a kick-off event and several structured sessions throughout the year, students can meet experienced professionals and seek advice to help navigate important career decisions.

3.7.2.4 Clubs, Conferences and Competitions

Our students can choose from more than 100 engineering clubs and teams, and hundreds more across the university; a complete list is available in **Appendix C, Chapter 3, Figure 3.8.**

Some of these organizations are focused on design competitions in which students test their abilities against those of students from other institutions around the world. Others focus on cultural pursuits, including the Skule™ Orchestra and the Muslim Students Association. Still others are service groups dedicated to improving the lives of others, such as the U of T Chapter of Engineers Without Borders or the Engineers In Action (EIA) - University of Toronto Student Chapter, which designs and constructs footbridges for communities isolated by geographic obstacles.

The Faculty supports student clubs and teams by providing space and direct funding. The Centralized Process for Student Initiative Funding (CPSIF) enables student groups to apply for support from multiple sources — including the departments and institutes, alumni and Dean's Office, Engineering Society and You're Next Career Network — with a single application. Since switching to a one-cycle process in 2016, CPSIF has allocated $355,000 - $375,000 annually towards funding on average 90 student groups each year.

Recent notable accomplishments from Engineering clubs and teams include:

- Since 2018, aUToronto, U of T's self-driving car team, has put in a consistently strong showing at the SAE AutoDrive Challenge, with five first-place finishes over the first five years of the competition. The intercollegiate competition tasks participating teams with developing and demonstrating a fully autonomous-driving passenger vehicle at the end of the second series.

- In August 2022, a team of students from the Rocketry Division of the University of Toronto Aerospace Team launched Canada's first-ever experimental hybrid rocket. The successful flight of their vehicle — dubbed *Defiance* — earned them first place in the Advanced Flight category of Launch Canada, a new industry-partnered intercollegiate rocket competition.

- In March 2022, four students from U of T Engineering took the top spot in the category

of Senior Design at the 2022 Canadian Engineering Competition, designing a prototype device for storage of mechanical energy from a wind farm in only eight hours.

- For the 2023 season, the University of Toronto Formula Racing Team made the transition to building and racing an electric vehicle for the first time. The shift led to one of the team's best seasons ever: at its on-track debut at the New Hampshire Motor Speedway as a part of the Formula Hybrid + Electric Competition, the vehicle placed first in the overall competition. The team also had strong performance at the Formula Student Czech Republic event, finishing sixth overall.

- The University of Toronto Supermileage Team attended the Shell Ecomarathon Americas 2023 regional competition at the Indianapolis Motor Speedway, and the prototype team was able to finish in 1st place for fastest technical inspection of the vehicle.

Attending and hosting conferences allows our students to build professional networks, meet future collaborators, and develop leadership competencies. In 2013, a group of students revitalized the Women in Science and Engineering (WISE) National Conference, which has been hosted annually by the U of T chapter ever since. In the past two years, through the annual WISE National Conference, and additional networking and mentorship events, WISE has reached 3500 post-secondary students, as well as conducted outreach to an additional 1500 high school students.

We also host student chapters of professional organizations, including the Institute of Electrical and Electronics Engineers (IEEE), the Canadian Society for Chemical Engineering (CSChE), the Canadian Society for Mechanical Engineering (CSME) and many others. These student chapters regularly send delegations to national and international conferences, and host student programs when such conferences are located in the Greater Toronto Area.

3.8 Social Impact and Global Competencies

Today's engineers address a wide range of technological, economic, social, educational and environmental challenges that transcend national borders. Our Faculty recognizes the need for students to acquire global perspectives and experiences that enhance their cross-cultural fluency. Through curricular and co-curricular programming, we ensure that our undergraduates can develop competencies that will allow them to have a positive impact on people around the world.

In our engineering design courses, including ESP, Praxis and capstone (**Section 3.3.1**), students regularly develop solutions to challenges brought forward by community organizations.

The Centre for Global Engineering (CGEN) (**Section 9.2.3**) offers courses to help students develop global fluency by teaching them about models of international development, diffusion of technological innovation, and global trends in sustainable development. All CGEN courses count toward the undergraduate certificate in global engineering. The Faculty is also participating in the Minor in Global Leadership, which is U of T's first tri-campus, interdivisional, multidisciplinary undergraduate program and will be offering the capstone course for this minor.

Since 2014, CGEN has sponsored 36 capstone design projects on four continents. The clients for those projects are typically NGOs or private firms with a mandate for social impact in the Global

South or Indigenous communities in Canada. The projects emerge from consultations we hold with the organizations, in which we identify technical challenges they are facing which they may not have the time or resources, to address. Each year, teams of between four and five students from across all engineering disciplines engage in those capstones under the supervision of CGEN-affiliated faculty member.

Each year, the Engineering Outreach Office (**Section 3.2.1.1**) reaches more than 9,000 students in grades 3 to 11 across the Greater Toronto Area and beyond, with programs that improve public understanding of engineering and inspire future talent in science, technology, engineering and math (STEM). Of equal importance is the opportunity they provide for our students to act as ambassadors for the profession and develop competencies in communication, youth education and project management.

While U of T Engineering has been successful at recruiting and admitting strong cohorts of first-year students each year, the class size has increased since 2020. There has been both planned growth, to support increased interest in STEM programs within Ontario and also more unpredictable yields as a result of COVID-era uncertainties. Welcoming more students to U of T Engineering can help address funding concerns, but poses challenges around scheduling, space (both in terms of teaching spaces and study spaces) and the resources required to support them (e.g., instructors, TAs and staff). Our TrackOne program was designed for first-year students who are uncertain about which specific area of engineering they are drawn to and offers them a year to explore and decide (**Section 3.1.1**). While this general first year is an attractive option to many students, it poses significant challenges to departments who need to find space to admit an unknown number of TrackOne students into second year of their programs each year — particularly if departments may not have selected these students on their own but are left with little choice (i.e., TrackOne students must move into another program in second year). Further, we are now seeing a trend that roughly 75% of the class has a strong intention to choose ECE or MIE from their first day (as measured through data collected in APS191 Introduction to Engineering, a required course for TrackOne students), which defeats the purpose of the program being a 'sandbox' to explore. We see this as an opportunity to revisit TrackOne as a pathway into U of T Engineering; elimination would allow departments to exercise more control over logistics at the onset of student entry.

At the height of the global pandemic, all teaching and support activities pivoted to online offerings. While classes and resources have resumed fully as in-person activities, students have indicated an interest in continuing to engage with online offerings. This presents an interesting opportunity to examine hybrid programming and potentially offer online sections or summer courses.

Student recruitment activities also pivoted online when travel was not permitted during the pandemic (**Section 3.2.1.1**). This allowed our recruitment team to engage with prospective students from regions where our recruitment officers do not typically travel. Since resuming travel, we continue to offer virtual touchpoints but see an opportunity to explore other digital points of engagement with a broader range of communities across Canada and around the world.

Engineering design is a critical part of the U of T Engineering student experience and is woven into every year of study starting with our first-year ESP and Praxis courses (**Section 3.3.1**). Students see the value in being able to work with real clients to design real solutions. However, recruiting new clients and supervisors are a key limitation of expanding these kinds of experiential learning opportunities.

Our students also feel positively about engineering minors and certificates, with 76% of our students graduating with at least one (**Section 3.3.2**). U of T Engineering is uniquely positioned to offer cross-disciplinary programs at the intersection of many areas that leverage University-wide strengths and areas of expertise (e.g., our new certificate in Public Policy & Engineering is the result of a collaboration between U of T Engineering and U of T's Munk School of Global Affairs and Public Policy). However, it was noted from our student consultations that flexibility in student schedules to accommodate courses tied to a minor or certificate is a limiting factor. As we look to enhance the selection of minors and certificates offered, we will also need to examine access.

The world is evolving quickly due to Artificial Intelligence (AI) and Machine Learning, which presents a host of interesting challenges and opportunities for U of T Engineering. As noted in the University of Toronto's recently issued FAQ on the use of ChatGPT and Generative AI in the classroom, this latest generation of tools will impact teaching and learning in many ways. ChatGPT, simulations and digital twin technology have already changed the trajectory of many industries, and these skills will be important for our students upon graduation. The Faculty and University is committed to supporting instructors as they adapt their pedagogy in response to emerging technologies.

The Faculty is also deeply committed to providing excellent service to our undergraduates to support their success throughout their time at U of T Engineering. To this end, we have created several new roles in recent years (e.g., Mental Health Officer, Learning Strategist, first-year advisor roles with a focus on international students, on-site accessibility expertise) and expanded dedicated offices and offerings to better serve students and their evolving needs (e.g., Engineering Career Centre, First Year Office). However, many of these services and support staff are physically scattered across our engineering buildings, making access and awareness a challenge for students. Further, demand for advising around learning strategy and accessibility has increased — due in part to the impacts of the COVID-19 pandemic. Another change we have observed in our undergraduate population is that roughly half of our first-year class commutes to campus each day instead of living on campus. While we want to be able to optimize our course offerings to make the most of a commuter student's time while on campus, this can pose some complex logistical challenges in terms of both space and scheduling. Commuter students also contend with workload balance in a way that students living on campus do not. We will need to examine ways we can better support and engage students who commute.

Another key priority for the Faculty and University is to ensure our students have ample opportunity to gain experience working and/or studying in another country. The participation of engineering students in international exchanges has historically been low (**Section 3.7.2.2**), due in part to the need for courses at other institutions to count toward Canadian Engineering Accreditation Board (CEAB) requirements, and some limited flexibility given the high number of mandatory courses in engineering programs. A recent decision by the CEAB to exempt students participating in an international exchange will give more opportunity for Canadian engineering students to go abroad on exchange. It is hoped that this, alongside the addition of the Undergraduate Research and International Experience Coordinator position spearheading efforts to increase awareness around international opportunities, will increase the number of undergraduate students participating in international exchanges.

3.9 Key Challenges and Opportunities

While U of T Engineering has been successful at recruiting and admitting strong cohorts of first-year students each year, the class size has increased since 2020. There has been both planned

growth, to support increased interest in STEM programs within Ontario and also more unpredictable yields as a result of COVID-era uncertainties. Welcoming more students to U of T Engineering can help address funding concerns, but poses challenges around scheduling, space (both in terms of teaching spaces and study spaces) and the resources required to support them (e.g., instructors, TAs and staff). Our TrackOne program was designed for first-year students who are uncertain about which specific area of engineering they are drawn to, and offers them a year to explore and decide (**Section 3.1.1**). While this general first year is an attractive option to many students, it poses significant challenges to departments who need to find space to admit an unknown number of TrackOne students into second year of their programs each year — particularly if departments may not have selected these students on their own but are left with little choice (i.e., TrackOne students must move into another program in second year). Further, we are now seeing a trend that roughly 75% of the class has a strong intention to choose ECE or MIE from their first day (as measured through data collected in APS191 Introduction to Engineering, a required course for TrackOne students), which defeats the purpose of the program being a 'sandbox' to explore. We see this as an opportunity to revisit TrackOne as a pathway into U of T Engineering; elimination would allow departments to exercise more control over logistics at the onset of student entry.

At the height of the global pandemic, all teaching and support activities pivoted to online offerings. While classes and resources have resumed fully as in-person activities, students have indicated an interest in continuing to engage with online offerings. This presents an interesting opportunity to examine hybrid programming and potentially offer online sections or summer courses.

Student recruitment activities also pivoted online when travel was not permitted during the pandemic (**Section 3.2.1.1**). This allowed our recruitment team to engage with prospective students from regions where our recruitment officers do not typically travel. Since resuming travel, we continue to offer virtual touchpoints but see an opportunity to explore other digital points of engagement with a broader range of communities across Canada and around the world.

Engineering design is a critical part of the U of T Engineering student experience, and is woven into every year of study starting with our first-year ESP and Praxis courses (**Section 3.3.1**). Students see the value in being able to work with real clients to design real solutions. However, recruiting new clients and supervisors is a key limitation of expanding these kinds of experiential learning opportunities.

Our students also feel positively about engineering minors and certificates, with 76% of our students graduating with at least one (**Section 3.3.2**). U of T Engineering is uniquely positioned to offer cross-disciplinary programs at the intersection of many areas that leverage University-wide strengths and areas of expertise (e.g., our new certificate in Public Policy & Engineering is the result of a collaboration between U of T Engineering and U of T's Munk School of Global Affairs and Public Policy). However, it was noted from our student consultations that flexibility in student schedules to accommodate courses tied to a minor or certificate is a limiting factor. As we look to enhance the selection of minors and certificates offered, we will also need to examine access.

The world is evolving quickly due to Artificial Intelligence (AI) and Machine Learning, which presents a host of interesting challenges and opportunities for U of T Engineering. As noted in the University of Toronto's recently issued FAQ on the use of ChatGPT and Generative AI in the classroom, this latest generation of tools will impact teaching and learning in many ways.

ChatGPT, simulations and digital twin technology have already changed the trajectory of many industries, and these skills will be important for our students upon graduation. The Faculty and University is committed to supporting instructors as they adapt their pedagogy in response to emerging technologies.

The Faculty is also deeply committed to providing excellent service to our undergraduates to support their success throughout their time at U of T Engineering. To this end, we have created several new roles in recent years (e.g., Mental Health Officer, Learning Strategist, first-year advisor roles with a focus on international students, and on-site accessibility expertise) and expanded dedicated offices and offerings to better serve students and their evolving needs (e.g., Engineering Career Centre and First Year Office). However, many of these services and support staff are physically scattered across our engineering buildings, making access and awareness a challenge for students. Further, demand for advising around learning strategy and accessibility has increased — due in part to the impacts of the COVID-19 pandemic. Another change we have observed in our undergraduate population is that roughly half of our first-year class commutes to campus each day instead of living on campus. While we want to be able to optimize our course offerings to make the most of a commuter student's time while on campus, this can pose some complex logistical challenges in terms of both space and scheduling. Commuter students also contend with workload balance in a way that students living on campus do not. We will need to examine ways we can better support and engage students who commute.

Another key priority for the Faculty and University is to ensure our students have ample opportunity to gain experience working and/or studying in another country. The participation of engineering students in international exchanges has historically been low (**Section 3.7.2.2**), due in part to the need for courses at other institutions to count toward Canadian Engineering Accreditation Board (CEAB) requirements, and some limited flexibility given the high number of mandatory courses in engineering programs. A recent decision by the CEAB to exempt students participating in an international exchange will give more opportunity for Canadian engineering students to go abroad on exchange. It is hoped that this, alongside the addition of the Undergraduate Research and International Experience Coordinator position spearheading efforts to increase awareness around international opportunities, will increase the number of undergraduate students participating in international exchanges.

4.0 Academic Programs: Graduate Education

As a research-intensive institution, U of T Engineering supports its graduate programs and students through numerous teaching, research and academic services.

The experience of our graduate students has been evaluated in numerous ways. In 2 016, 2019, and 2022, U of T participated in the Canadian Graduate and Professional Student Survey (CGPSS), a third-party graduate student survey that solicits student opinion on the quality of graduate supervision in MASc and PhD programs, the quality of graduate courses, and more generally, the overall impression of graduate programs and the student experience. Six hundred and ninety U of T Engineering graduate students responded to the 2022 survey, a response rate of approximately 23 %.

In addition, every two years, the U of T's School of Graduate Studies (SGS) sponsors the Graduate Student Experience in the Research University (gradSERU) survey which focuses on campus climate, research experience, financial support, educational experience and the experience of international students. The most recent data available is from a survey that was administered from February to April 2021; results from the May 2023 version are still pending. 568 U of T Engineering graduate students from research-stream and professional programs responded to the 2021 survey which is about 19.8%.

Through consultations and other vehicles (e.g., Joint Task Force on Mental Health in 2019), U of T Engineering engaged with the graduate student body as this self-study was being developed. Additionally, surveys were launched to monitor the impact of the pandemic on our students, as well as to assist in the development of our career support resources. In-person meetings were held with groups of research- and professional-stream graduate students. We surveyed current research-stream (MASc, PhD) and professional-stream (MEng) students, and analyzed graduate student feedback that was collected during recent department and institute external reviews. (see last section 4. 8 for responses to surveys).

The results of the gradSERU and CGPSS and additional consultations are referenced throughout this chapter.

4.1 Overview of Programs and Governance Structure

U of T Engineering offers two graduate program streams. The doctoral or research stream. includes Master of Applied Science (MASc) and Doctor of Philosophy (PhD) students. The professional stream includes the Master of Engineering (MEng) and Master of Engineering in Cities Engineering and Management (MEng CEM) programs. As of the Winter term 2023, these streams combined constitute nearly 3,000 graduate students. The degree requirements for these programs are outlined in **Appendix F**.

The home of a graduate program resides at the department or institute level, and is referred to as a graduate unit. At the University of Toronto, the administration of graduate programs and students is shared between graduate units within Faculties and the School of Graduate Studies (SGS).

For instance, SGS is responsible for registrar services, student services, financial aid services, scholarships administration, policy development, governance and standing committees, graduate appeals and non-standard admissions. Faculty-level initiatives also enhance programs across all graduate units. Governance processes related to new initiatives and academic change

occur at the graduate unit, Faculty and university levels.

The size of the U of T Engineering graduate student population has increased by 26.3 % from September 2016 to September 2022; the two most recent years saw the highest numbers in the Faculty's history. Graduate students now represent 37% of all of our students in the Faculty, compared with 32.9% in 2016–17.

The Faculty reached the highest percentage of women graduate students (32.2%) of its history in the most recent year (up from 26.1 % in 2016-17). Pathways have been created to improve the access of Black and Indigenous students to graduate studies. (See section 4.3.2) In addition, better means to quantify the numbers of students in underrepresented groups are now in place at the University in the form of new enrolment dashboards from the School of Graduate Studies (SGS).

The combined size of our seven PhD programs has increased continuously, from a headcount of 877 in 2016-17 to 1,259 in 2022-23 while the size of our MASc programs has seen more stable enrolment since 2018-19. The majority of our MASc and PhD students are domestic students but we have seen a steady increase in the proportion of international students in our PhD program since 2016 (from 32.7% to 46.0%). We have developed opportunities for research stream students to train within multidisciplinary research teams by launching or joining new collaborative specializations with other faculties (**See section 4.1.1**). Opportunities and funding for research-stream students to participate in industrial internships have been created.

Interest in our professional programs has grown in a sustained manner. MEng enrollment has more than doubled over the last 10 years and the MEng headcount went from 880 in 2016-17 to 1,198 in 2022-23. The increase was particularly pronounced among international students, despite the impact of the pandemic on international admissions (e.g., deferral due to travel restrictions and delays in getting visas). The number and proportion of international students in our MEng programs reached a historical high during the most recent year: 58.8% of all MEng students are now international students. We are strengthening and customizing our supports for international students in terms of career and immigration advising and written language support. We have also evolved our programming for professional-stream students by expanding course offerings and introducing new emphases and areas of study and added the new position of Engineering Graduate Affairs Officer to support students.

4.1.1 Research Degree Programs (MASc and PhD)

Our Faculty offers two research-stream graduate programs, the Master of Applied Science (MASc) and Doctor of Philosophy (PhD) degrees in the graduate units, which are housed within seven of our departments and divisions:

- The Institute of Biomedical Engineering (BME)
- The Department of Chemical Engineering & Applied Chemistry (ChemE)
- The Department Civil and Mineral Engineering (CivMin)
- The Edward S. Rogers Sr. Department of Electrical & Computer Engineering (ECE)
- The Department of Mechanical & Industrial Engineering (MIE)
- The Department of Materials Science & Engineering (MSE)
- The University of Toronto Institute for Aerospace Studies (UTIAS)

Course requirements for research-stream students vary by graduate unit. (Lists of MASc and

PhD course requirements and curriculum areas for each graduate unit are presented in Appendix F). MASc students are required to take between three and five half courses (i.e., term-long courses); PhD students with a master's degree must take between two and five courses; PhD students who enter directly from an undergraduate degree, or fast-track from the MASc (Section 4.2.2), must take between six and nine courses. Some graduate units have additional requirements, for example, attending a particular seminar series. All MASc and PhD students are required to complete a supervised research project leading to a thesis for Ethics in Graduate Research: In addition to their required coursework, all research-stream graduate students must attend a graduate ethics seminar, ideally within their first term of study. The seminar introduces students to philosophical and practical ethics through lecture and case studies, and exposes them to the university's policies on research misconduct and expected codes of conduct in the research environment.

The 2021 gradSERU survey probed the satisfaction of graduate students in terms of their understanding of ethical standards and conflict of interest in research. While 85% of the respondents agreed that their program provided them with sufficient information about what constitutes plagiarism and what are the ethical standards in research and professional practice, only a median of 63% of respondents agreed that they were informed about common practices for determining authorships of research papers and avoiding conflicts of interest. This may represent an opportunity for the Faculty to strengthen education in these areas.

TEP5500: Research Methods and Project Execution

This ISTEP course supports early-stage MASc and PhD students to develop strategies and tools to complete their thesis research project. Students learn project management skills, acquire strategies to identify and articulate a research hypothesis, set research goals, plan their research approach, and practice communicating their research. A first version of this course has been offered since 2015 in the Department of Chemical Engineering & Applied Chemistry and recently expanded to a faculty-wide offering by ISTEP.

Content from the Research Methods and Project Execution course has also been posted publicly as a resource for both current and future students, whether or not they enroll in TEP5500.

Flexible-Time PhD: Students who are employed full-time and meet the admission requirements can choose a flex-time PhD. This program is designed for highly motivated students, usually in R&D roles, to pursue a PhD on a topic closely related to their employment. This specialty degree is a partnership between a student, employer and supervising professor, and provides an avenue for knowledge creation and exchange between industry and the university. Over the past six years, MSE and CivMin have now established flex-time PhD options, joining MIE and ChemE

Graduate Collaborative Specializations: Graduate students registered in any of our degree programs may choose to concurrently complete a graduate collaborative specialization (CS). The collaborative programs bring together students and faculty from different disciplines, within and beyond engineering, around an area of common interest.

U of T Engineering currently hosts five collaborative specializations:

- Psychology, Psychiatry and Engineering
- Neuromodulation
- Robotics

- Engineering Education
- Biomedical Engineering

The first three have all been created since 2017. The first was initially psychology and engineering and has now been expanded to include psychiatry. The CS in Engineering Education has also been expanded since its creation.

In the 2022 CGPSS survey, over 80 % of research-stream students rated their overall experience at the U of T as good, very good or excellent. A similar number of students responded positively about specific aspects of their programs: the intellectual quality of faculty and fellow students, the quality of graduate-level teaching, and the quality of academic advising and guidance. Seventy-six per cent of doctoral respondents and 79% of research masters respondents indicated that they would recommend U of T to someone considering their program.

4.1.2 Professional Degree Programs (MEng and MEng CEM)

U of T Engineering offers a course-based professional Master of Engineering (MEng) degree through each of its seven departments and institutes (**Section 4.1.1**). Civil Engineering also offers a specialized MEng program in Cities Engineering and Management (MEng CEM). ISTEP does not currently offer graduate programs but is responsible for administering and offering graduate-level courses in the areas of leadership, entrepreneurship, engineering education, etc. Some of these courses can count towards the MEng program requirements as part of the Emphasis in Entrepreneurship, Leadership, Innovation and Technology in Engineering (ELITE) (**See section 4.1.2.5**).

The 2022 CGPSS survey indicated that 80 % of professional-stream students rated their overall experience at U of T as good, very good, or excellent. Ninety-five % rated the intellectual quality of the faculty as at least very good. Eighty-eight per cent rated the quality of graduate level teaching as at least good. Seventy-four % of respondents indicated that they would recommend U of T to someone considering their program. In our self-study consultations, some students noted a lack of academic support for MEng students, and a desire for stronger connections to their departments or institutes. Each department has dedicated graduate administrative staff to advise MEng students.

4.1.2.1 Standard MEng Programs

The MEng programs offered in seven graduate units — all but BME's MEng and CivMin's MEng CEM, which are discussed below — are broad programs that offer students a wide variety of choice in terms of course selection. These programs are designed for students who, in one year of full-time study, two years of extended full-time study, or three years of part-time study, can gain technical expertise and develop professional competencies, which will enhance their career prospects.

The MEng curriculum typically requires that students take at least six technical courses and up to four professional development courses. All programs offer MEng students the option of completing a project with a professor, usually in lieu of three courses although this may be lower for some units (UTIAS, CivMin).

In recent years, many of the graduate units have introduced new technical courses tailored to MEng students, as well as curricular paths known as emphases (**Section 4.1.2.5**), which allow

students to focus their studies on a particular topic. Completion of emphasis requirements, typically four to six courses, earns the student a transcript notation.

Some emphases are offered specifically within a graduate unit while other emphases are offered centrally by the Faculty (Section 4.1.2.6) and are referred to 'Faculty-wide' emphases. Currently, the most popular faculty-wide emphasis is that in Analytics which was launched in 2018. The number of new courses added in the lists of core and electives for students to earn the emphasis in Analytics has expanded significantly averaging half a dozen new courses a year, including many courses in machine learning, deep learning and artificial intelligence which reflect U of T Engineering's success in recruiting new faculty in this area.

The number of students pursuing professional master's degrees (MEng and MEng CEM) has increased dramatically since 2016, with 1,198 students in 2022-23, up from 837 students in 2016 (Figure 4.4). International students account for a large part of the growth, comprising 58.8% %of professional master's students, up from 43.4% in 2016–17. %With this increased enrolment, professional master's students now make up 68.7 % of all U of T Engineering master's students, and 39.8 % of all U of T Engineering graduate students (Figure 4-5).

4.1.2.2 MEng in Biomedical Engineering

The MEng program in biomedical engineering offered by BME is different than the broad MEng programs offered by the six other graduate units. This program is offered on a full-time, extended full-time or part-time basis, and focuses on the design and commercialization of biomedical devices. It is ideal for students planning to move directly into the biomedical device industry. Courses cover biomedical engineering technology, biomedical sciences, and commercialization and entrepreneurship. In the final term, students take on an applied design challenge via a four-month internship at an industry partner, academic lab, or hospital. The program enrolled about 10 students in the fall 2016 term when it was first offered; in 2022-23 it has reached a steady state of 50 students across the Full-Time, Extended Full-Time and Part-Time options of the program.

4.1.2.3 MEng in Cities Engineering and Management

The MEng in Cities Engineering and Management (MEng CEM) offered by CivMin was launched in 2013 in response to a growing need for professionals with both technical expertise and a fundamental understanding of the complex and cross-disciplinary issues facing cities. This program enables students to gain a comprehensive understanding of the interaction between the systems and services of a city and its ability to generate prosperity. It also allows them to acquire the analytical and management competencies necessary to assess the environmental, economic, political, and social risks and impacts of policy change related to a city's critical infrastructure. The enrolment in this program has averaged a steady state of about 10 students.

The MEng CEM program consists of 10 courses and an integrated practicum and these requirements can be completed over one year full-time, or two years as an extended full-time option. Specialization areas for the program include transportation systems, cyber security, urban structures, sustainable energy systems, operations research, environmental issues for healthy cities, resilience of critical infrastructure, and communication networks.

4.1.2.4 MEng Emphases and Projects

Single-unit Emphases: Emphases are MEng specializations that enable students to

customize their degrees by focusing on courses in a particular area. The approach varies by graduate unit; for example, ECE and CivMin offer a suite of emphases that map curricular pathways for students, including Building Science (CivMin), Environmental Engineering (CivMin), Photonics (ECE), and Identity, Privacy and Security (ECE). ChemE is launching a new emphasis in Environmental Engineering Consulting (effective Sept 2023). MSE and BME do not currently offer single-unit emphases.

Faculty-wide, multidisciplinary Emphases: A number of emphases have been developed in the past few years to bring together students from different graduate units and disciplines. The emphasis with the highest total number of students in the Faculty's history is that in Entrepreneurship, Leadership, Innovation and Technology in Engineering (ELITE) (**Section 4.1.2.5**); since 2017, 629 students have completed the ELITE emphasis. However, the latest emphasis in Analytics is catching up. Since its launch in 2018, 505 students have completed this emphasis. In addition to ELITE, the following multidisciplinary emphases are available to MEng students:

- Advanced Manufacturing (UTIAS, ChemE, MIE, MSE)
- Advanced Soft Materials (ChemE, MSE, MIE)
- Advanced Water Technologies (ChemE, CivMin, MSE)
- Aerial Robotics (UTIAS)
- Analytics (ChemE, CivMin, ECE, MSE, MIE)
- Biomanufacturing (ChemE, MSE, MIE)
- ELITE (offered in all units)
- Engineering & Globalization (offer in all units)
- Forensic Engineering (BME, ChemE, CivMin, MSE, MIE)
- Identity, Privacy and Security (ECE)
- Robotics (UTIAS, ECE, MIE)
- Sustainable Energy (UTIAS, ChemE, CivMin, ECE, MIE, MSE)
- Waterpower (CivMin, MIE)

New multidisciplinary emphases are in development, building on this successful model. For instance, the Emphasis in Environmental Consulting will be offered in ChemE in Sept 2023.

MEng Projects: As mentioned in **Section 4.1.3**, MEng students may pursue a project in lieu of courses. In our self-study consultations, some MEng students stated their desire to pursue such a project, but were unable to find one, while a few others expressed concerns with both the quality of their project and of the supervision. Under the leadership of UT-IMDI, the Faculty introduced multidisciplinary MEng projects to bring together MEng students from at least two different disciplines to work together on projects sourced from industry and academia. Student interest in these projects has been strong and there is a system in place to provide streamlined support from Mitacs scholarships.

Some units have faced some challenges in providing MEng projects to interested students, in particular a mismatch between demand and supply for projects in particular fields, with some students unable to find project supervisors and some professors unable to find students to work on a MEng project.

4.1.2.5 Emphasis in Entrepreneurship, Leadership, Innovation, and Technology in Engineering (ELITE)

Consultations with our industry partners emphasized that engineers require not only technical expertise, but professional competencies that enable them to become leaders, team-builders and innovators. To provide students with expanded opportunities to develop these competencies, the Faculty offers an emphasis in Entrepreneurship, Leadership, Innovation, and Technology in Engineering (ELITE). ELITE courses are offered Faculty-wide, primarily for MEng students. (Research-stream graduate students are also welcome to take ELITE courses, though graduate units restrict the number of the courses they can count toward their program requirements.)

ELITE courses are offered in four categories: leadership, entrepreneurship and innovation, finance and management, and engineering and society. In 2020, the administration of the leadership courses was transferred to ISTEP. These courses are now identified with the TEP prefix. The other ELITE courses retained the APS prefix. They are taught by a mixture of professors and industry experts, with different courses offered each term, including summer, to accommodate student schedules. Courses with the highest enrolment (such as APS1001: Project Management) are taught in multiple terms, and a subset of them were taught on-line, either entirely or partially, even before the COVID19 pandemic.

Total enrolment in the ELITE courses initially grew dramatically with the MEng. However, in the last five years enrolment in these courses has, on average, decreased (with currently a median enrolment of 20) as additional emphases and courses were developed (e.g., Analytics). In 2016-2017, we offered 39 sections with a total enrolment of 900 students; this has increased to 79 sections and 2,034 students in 2022-2023.

Students who successfully complete four ELITE courses are issued a transcript notation ion on their graduate degree. Since Fall 2020, over 550 students have attained the ELITE emphasis. The Faculty developed an agreement with Canadian Association of Certified Management Consultants (CMC) that certain courses such as APS1049 are credited towards the CMC designation. The majority of these courses are taught by working professionals hired as sessional lecturers. Teaching evaluations reports for these courses suggests that the level of satisfaction with the ELITE courses is high and that the students understand the importance of these courses to their future career plans.

4.1.2.6 Emphasis in Analytics

Descriptive, predictive or prescriptive analytics include topics such as: statistics, data mining, machine learning, optimization, data storage, and large-scale computing. Analytics is a rapidly growing field and career opportunities in applying analytics methodologies exist in many sectors, including technology, energy, healthcare, transportation, logistics, manufacturing, marketing, public policy, and sports.

In recent years, U of T has established several institutes focused on data analytics and AI, including the Vector Institute, the Data Sciences Institute and the Centre for Analytics and Artificial Intelligence Engineering (CARTE). Students are well aware of this field and are asking how to learn about these methods.

Before the creation of this emphasis, courses on analytics methods and application areas were spread throughout different departments. Creating this emphasis made it easier for MEng students to pursue a more coherent course of study in analytics. Additionally, given the growing

demand of students with analytics training, the emphasis provides our students with a formal notation of their training.

This emphasis was named “Analytics” since it covers a broader range of topics than machine learning (i.e., deep learning or artificial intelligence). It draws upon existing courses offered by the graduate units in the five departments listed above, plus some ELITE courses. The emphasis introduces students to these methods, and as the Faculty continues to build expertise and interest in this area, the lists of core and elective courses has grown. On average about a half a dozen new courses have been added each year since 2018.

4.1.3 Academic Approvals: Faculty Council and Engineering Graduate Education Committee

The development of graduate degree programs is governed through the Office of the Vice-Provost, Academic Programs, with Faculty leadership provided by the Vice-Dean, Graduate Studies. Proposals for new programs and major program changes usually originate in graduate units and must be approved by Faculty and university governance committees.

Faculty-level governance of graduate education is provided by the Engineering Graduate Education Committee (EGEC), a standing committee of Faculty Council, with faculty representation from each graduate unit, graduate administrative staff, alumni, and graduate students elected by GECoS (see section 4.7). EGEC has delegated authority from Faculty Council to approve minor and major curriculum changes and minor program changes. Major program changes are reviewed by EGEC with a report and recommendations brought to Faculty Council for approval. EGEC advises and reports on major graduate education and research issues, including admission regulations and requirements arising from regular meetings of the graduate chairs committee, external reviews of graduate departments, and concerns referred to it by members of the committee or by the Speaker of Faculty Council. It also advises Faculty Council on any matters related to governance of the graduate programs of the Faculty.

The School of Graduate Studies (SGS) is a university-wide body that oversees graduate education and research to ensure consistency and high standards across the Faculties and divisions and to promote best practices. SGS provides expertise to individual graduate units on a variety of administrative matters related to admission offers, student registration, and non-standard program requests, and oversees national and provincial scholarship competitions. The SGS leadership also works with Vice-Deans Graduate from across the university on initiatives that affect graduate students university-wide, and to promote best practices in graduate education.

4.2 Graduate Admissions, Enrolment and Funding

Admission to graduate programs within our Faculty is competitive, particularly in the doctoral stream, although recruiting domestic PhD students has been, and will continue to be, a challenge. In line with Faculty policy, since 2016 we have increased our graduate enrolment in the MEng and PhD programs by 36.1 % and 43.0 % respectively.

While student funding overall has not kept pace with inflation, particularly in an expensive city like Toronto, significant efforts have been made to increase levels of student support. At present, the trend in PhD student support is for all the units in the Faculty to have stipends, exclusive of tuition and fee support, of $25,000 or more by academic year 2024-2025. This is a substantive increase from 2021-2022 when the stipends ranged from $17,500 to$19,000.

4.2.1 Applications and Admissions to Graduate Studies Programs

Figures 4-1, 4-2 and 4-3 illustrate the number of applications, offers and registrations for domestic and international MASc, PhD and MEng students, respectively. For all our programs, the total number of applications from domestic students has remained relatively constant, between 1500 and 2000, since 2017. The number of applications from international students to the MASc and PhD programs has similarly remained steady until 2021-22 (with a lower number in the last academic year on record i.e., 2022-23), but the number of applications from international students to the MEng program has continuously increased from 1,531 in 2017-18 (1,292 in 2016-17) to 2,682 in 2022-23. This increase in international MEng applications constitutes the majority of the increase in total applications to our Faculty.

U of T Engineering guarantees funding for all research-stream graduate students (Section 4.2.5). This funding is provided through a combination of supervisor-provided research assistantships, fellowships provided by the graduate units, and internal and external scholarships. In turn, universities in Ontario, including U of T, receive provincial government funding to support the cost of delivering graduate education for each domestic graduate student (subject to quotas). However, the government does not provide such funding for international students (except, since 2018, for a very limited number of funding-eligible international PhD positions, across the University). To compensate for this lack of government funding, the university has historically charged international students higher tuition to offset the cost of graduate program delivery, but as tuition is part of the guaranteed funding provided to students, the net effect is that international students cost much more to support.

In 2018, the university modified this policy for PhD students, so that tuition charged to international students was aligned with tuition charged to domestic students. The tuition differential for international MASc students remained high. Partially as a consequence, the number of accepted offers (registrations) for international PhD students increased from 70 in 2017-18 (72 in 2016-17) to 118 in 2022-23. As expected, the corresponding number of registrations for international MASc students decreased from 68 in 2017-18 to 51 in 2022-23 The international MASc application numbers remained relatively stable since 2017-18, until the last year on record which saw a significant decrease similar to levels observed a decade ago.

The funding formula and limits on the number of government funding-eligible student positions demand that we recruit a balance of domestic and international MEng, MASc and PhD students, which has proven to be a challenge. Interest in the MASc program has remained flat, as domestic students have increasingly chosen to pursue the MEng instead. Nevertheless, we receive between 500 and 600 domestic MASc applications annually and extend offers to about 40 % of applicants, with an acceptance rate of over 80%.

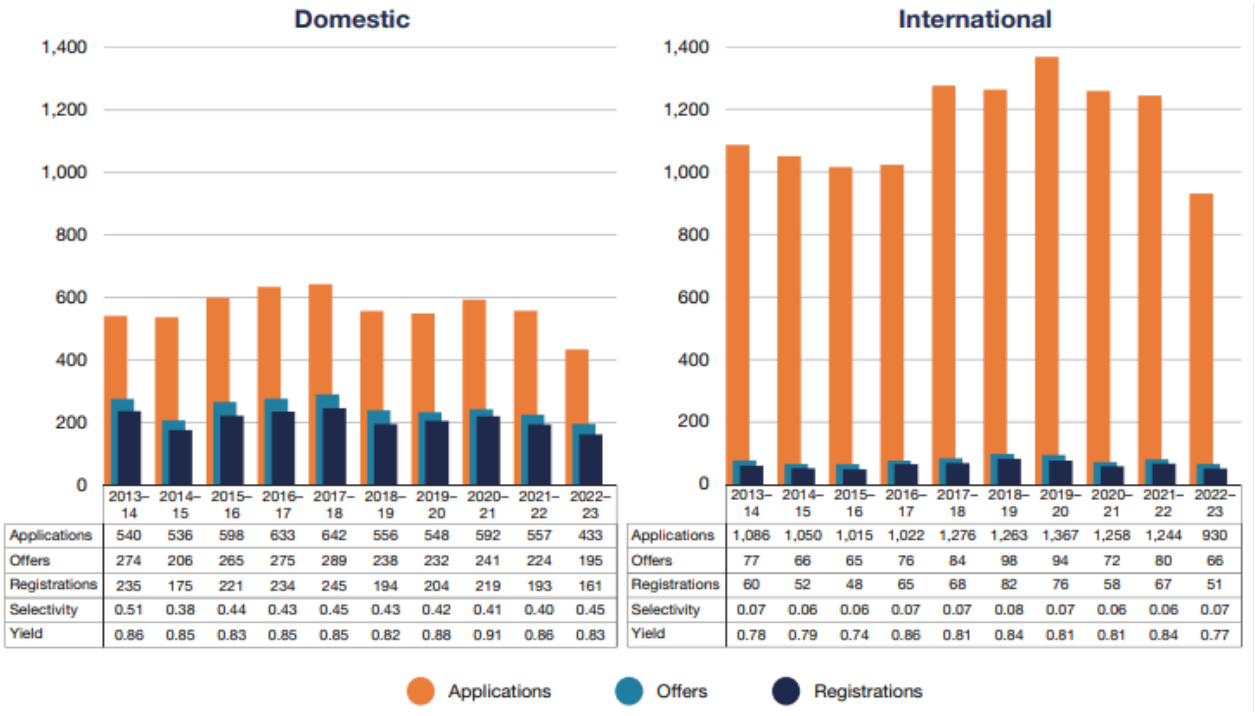
Recruiting domestic PhD students has been more challenging. There is a limited population of domestic students with research-based Master's degrees wishing to enter the PhD program, although the number of students who have been admitted directly from a bachelor's degree has more than doubled since 2017-18, in spite of the higher requirements for this type of admission reserved for outstanding candidates. Between September 2022 and June 2023, we received approximately 223 applications for direct-entry PhD students and offered admission to more than half of those. One reason for this high rate is that many students only apply when they have informally been assured of an offer. In addition, a large part of our domestic PhD cohort comes students who fast-track, that is, transfer into a PhD from the MASc program.

The total MEng application and admission data (Figure 4.3) showed a strong growth since

2017-18, but concentrated in the international cohort. Interest from domestic students has remained approximately steady since 2017-18, from 784 applications to 841 in 2022-23 (although 2022-23 was considerably lower than the previous year 2021-22 with 1041 applications, and preliminary data from 2023 indicate a possible return to higher levels). International applications to the MEng program have increased sharply since 2017, from 1,531 applications to 2,682 in 2022-23. Preliminary data from 2023 indicate a levelling of this increase, with 2,254 applications to the MEng program from international students by June 30, approximately the same pace as in 2022. These increases have allowed us to enlarge the MEng student body from 899 in 2017-2018 (**Section 4.2.4**), to 1,198 in 2022-23. Several graduate units are now no longer growing enrolment, but rather are being more selective in choosing top students from an increasing pool of applicants.

The number of female graduate students has been increasing steadily, from 27.5% in 2017-18 to 32.2% of the total graduate student population in 2022-23, which is the highest in the history of the Faculty. This trend mirrors the number of degrees awarded by gender which was 25.0% for women in 2017-18 compared with 33.0% in 2022-23. The number of women entering undergraduate engineering programs has also increased (**Chapter 10**), and there is optimism that a robust pipeline of female graduate students will develop and continue to increase this ratio.

The 2021 gradSERU survey revealed that 83% of students felt that the climate for female students in their program is at least as good as it is for male students while 96% of students agreed that the climate for male students is at least as good as it is for female students. The difference in these percentages suggests that the experience for female students is good but that there are still improvements needed to reach equity.

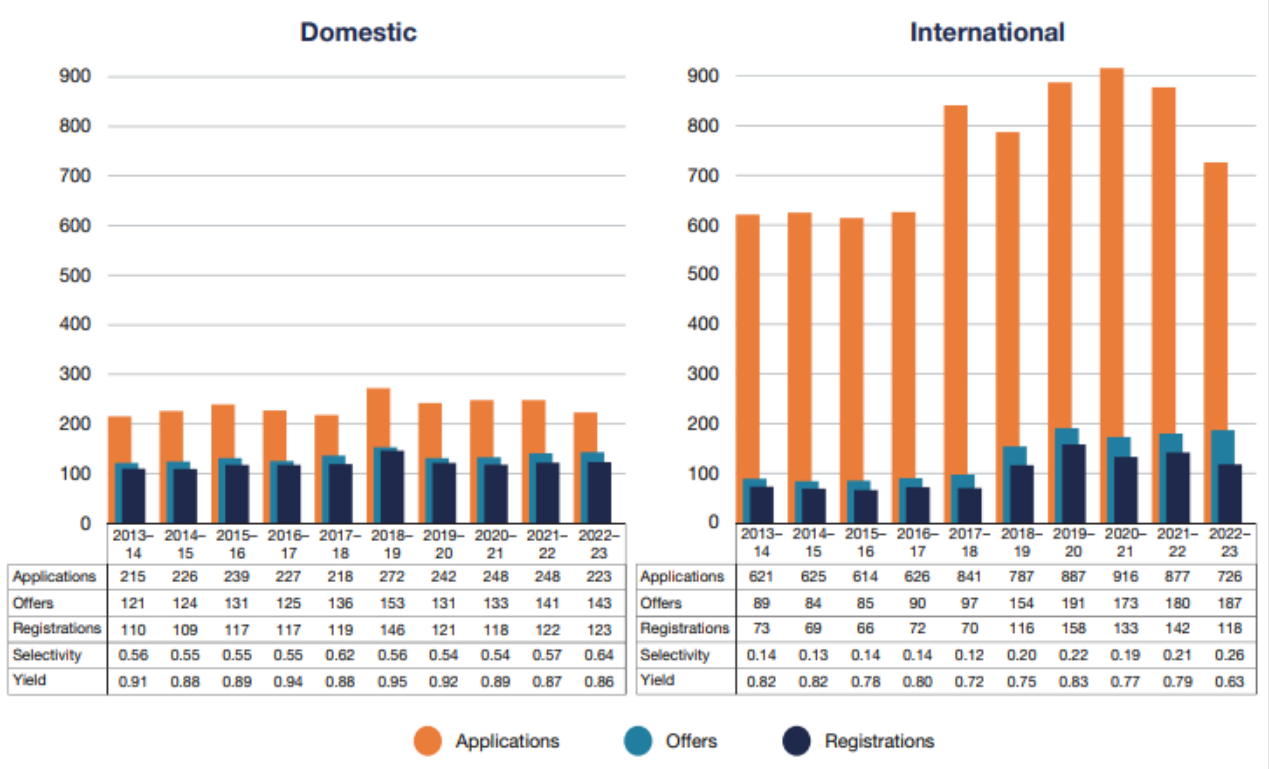


	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Applications	540	536	598	633	642	556	548	592	557	433
Offers	274	206	265	275	289	238	232	241	224	195
Registrations	235	175	221	234	245	194	204	219	193	161
Selectivity	0.51	0.38	0.44	0.43	0.45	0.43	0.42	0.41	0.40	0.45
Yield	0.86	0.85	0.83	0.85	0.85	0.82	0.88	0.91	0.86	0.83

	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Applications	1,086	1,050	1,015	1,022	1,276	1,263	1,367	1,258	1,244	930
Offers	77	66	65	76	84	98	94	72	80	66
Registrations	60	52	48	65	68	82	76	58	67	51
Selectivity	0.07	0.06	0.06	0.07	0.07	0.08	0.07	0.06	0.06	0.07
Yield	0.78	0.79	0.74	0.86	0.81	0.84	0.81	0.81	0.84	0.77

Figure 4-1 MASc Applications and Admissions Data

(See Figure 2.1a from *By the Numbers 2023*)

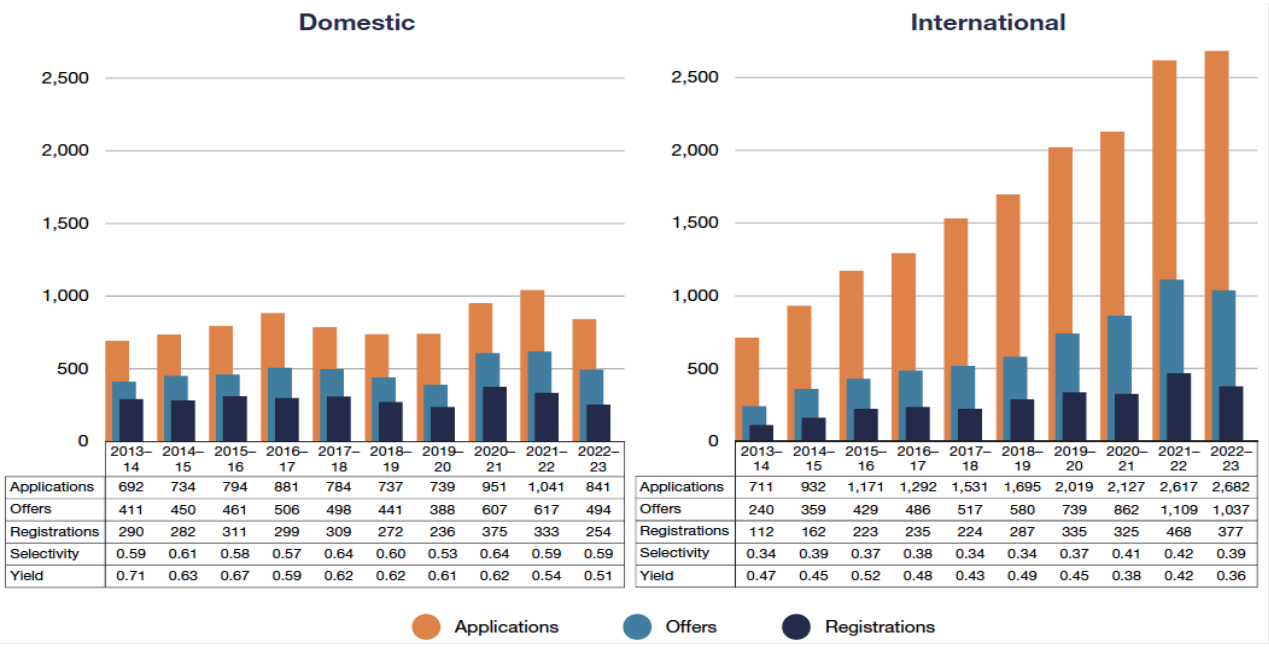


	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Applications	215	226	239	227	218	272	242	248	248	223
Offers	121	124	131	125	136	153	131	133	141	143
Registrations	110	109	117	117	119	146	121	118	122	123
Selectivity	0.56	0.55	0.55	0.55	0.62	0.56	0.54	0.54	0.57	0.64
Yield	0.91	0.88	0.89	0.94	0.88	0.95	0.92	0.89	0.87	0.86

	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Applications	621	625	614	626	841	787	887	916	877	726
Offers	89	84	85	90	97	154	191	173	180	187
Registrations	73	69	66	72	70	116	158	133	142	118
Selectivity	0.14	0.13	0.14	0.14	0.12	0.20	0.22	0.19	0.21	0.26
Yield	0.82	0.82	0.78	0.80	0.72	0.75	0.83	0.77	0.79	0.63

Figure 4-2 PhD Applications and Admissions Data

(See Figure 2.1b from *By the Numbers 2023*)



	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Applications	692	734	794	881	784	737	739	951	1,041	841
Offers	411	450	461	506	498	441	388	607	617	494
Registrations	290	282	311	299	309	272	236	375	333	254
Selectivity	0.59	0.61	0.58	0.57	0.64	0.60	0.53	0.64	0.59	0.59
Yield	0.71	0.63	0.67	0.59	0.62	0.62	0.61	0.62	0.54	0.51

	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Applications	711	932	1,171	1,292	1,531	1,695	2,019	2,127	2,617	2,682
Offers	240	359	429	486	517	580	739	862	1,109	1,037
Registrations	112	162	223	235	224	287	335	325	468	377
Selectivity	0.34	0.39	0.37	0.38	0.34	0.34	0.37	0.41	0.42	0.39
Yield	0.47	0.45	0.52	0.48	0.43	0.49	0.45	0.38	0.42	0.36

Figure 4-3 MEng + MHSc Applications and Admissions Data

(See Figure 2.1c from *By the Numbers 2023*)

4.2.2 Recruitment Strategies

U of T Engineering recruits the most promising graduate students through Faculty, department and institute initiatives, and by individual professors.

For the past eleven years, U of T Engineering has been part of the Canadian Graduate Engineering Consortium (CGEC), which includes engineering Faculties in other leading Canadian universities: the University of British Columbia, McGill University, McMaster University, Queen's University and the University of Waterloo.

CGEC hosts large joint graduate recruiting fairs at each institution in the early fall. The goals of this partnership are two-fold: to raise awareness among undergraduate and master's students about pursuing graduate studies, and to recruit graduate students and join forces on common projects such as conducting market surveys across Canada.

For the past three years, due to the COVID-19 pandemic these fairs have been online but are returning to an in-person format in the fall of 2023. During the pandemic, CGEC transitioned successfully to an online virtual graduate studies fair from 2020 to 2022. Despite returning mainly to in-person recruitment, engineering departments have learned to take advantage of the online format to offer virtual graduate studies information sessions for those who cannot make the in-person events, and for those who are not in Toronto. For instance, it has been possible to connect with prospective students online from India and South America

Historically, when operated in-person, these fairs have been attended by several hundred students, and the consensus among the partner universities is that they are a very effective way to connect with prospective graduate students. U of T graduate application data from the most recent in-person period showed an upswing in applications from the schools visited. CGEC aims to grow this initiative in the coming years i.e., for this upcoming academic year the partnership has expanded to include York University, Toronto Metropolitan University and Concordia University.

Some departments and institutes (such as BME) also send graduate studies personnel to select conferences and other graduate studies fairs.

Since 2015, the Faculty has also been hosting Graduate Research Days (GRD), a Faculty-wide event focused on recruiting domestic students with 150 prospective students from across Canada, and a few from abroad, in attendance. Prospective students arrive in Toronto and attend a welcome reception on a Thursday evening; each department and institute organizes a full day of events and meetings with professors and current graduate students on Friday; all participants attend a dinner on the Friday evening; and the event ends with a campus tour on Saturday morning before the students head home. This allows U of T Engineering to showcase its professors, research and facilities. Most attendees receive an admission offer soon after the event, which enables students to make an informed decision (2019 and 2020: on average 64% of attendees are given offers and an average of 78% of these offers are accepted).

Post-GRD event surveys indicated that prospective students found the event to be a valuable and exciting way to connect to staff, current graduate students, and faculty and were more likely to accept an offer from U of T Engineering after attending the event. Professors also formally and informally recruit for their labs at professional conferences and through professional connections. As well, prospective graduate students self-recruit by finding professors in their desired area of study. This is especially true of U of T Engineering undergraduate students, who

will identify professors through course work and research opportunities.

4.2.3 Recruitment in Underrepresented Communities

The Faculty is committed to creating a more diverse environment within our engineering graduate student body and is working towards attracting students from underrepresented groups through various initiatives in collaboration with the office of the Assistant Dean and Director, Diversity, Inclusion and Professionalism (**See Chapter 10**).

Addressing the urgent need for more Canadian Indigenous peoples (First Nations, Inuit, and Métis) and Black professors in engineering and computer science industries in Canada, the Faculty was one of the six original institutions including engineering faculties of University of Waterloo, McMaster University, the University of Ottawa, Queen's University and Western University to provide a fellowship valued at $25,000 annually over four years to pursue a PhD within engineering at their institution. This initiative was named the Indigenous and Black Engineering and Technology (IBET) Momentum Fellowships program and has scaled up significantly across the country. IBET fellows also receive academic and professional mentoring from the IBET network, as well as support from their engineering institution.

Since the inception of the fellowship in Fall 2021, U of T Engineering has welcomed six IBET fellows; three Black women, two Black men and one Indigenous woman. The fellows are leaders in their own underrepresented communities and we are working with them to support them with their academic and professional goals. The Faculty has also partnered with Massey College to provide a unique mentorship and learning opportunity for IBET fellows. IBET fellows are invited to become a Massey College Junior Fellow, where they will have access to a diverse caring community that allows all members to grow their horizons academically, socially, and culturally. The Faculty has also been working closely with the current fellows to obtain feedback on their experience and provide opportunities and support when needed.

Recruitment staff and current students attend the National Society of Black Engineers (NSBE) conferences, and the Faculty provides financial support for current Black graduate engineering students to attend as well. Engineering Graduate Connections (EGC) is a student group composed of Black undergraduate and graduate engineering students. Formed in Fall 2022, the goal of the group is to connect Black undergraduate engineering students with Black graduate engineering students, faculty, and alumni to learn more about graduate studies and career pathways. With support from the Faculty, EGC introduced two successful events in 2022-2023, connecting Black undergraduate students with Black graduate engineering students and alumni.

The Faculty sends recruitment staff annually to the NSBE Hackathon and the Black Excellence in STEMM event hosted by the Canadian Black Scientists Network to recruit for prospective Black graduate students. We also have representation at the national Women in Science and Engineering (WISE) Conference. The School of Graduate Studies (SGS) recently created the Inclusive Excellence Admissions Scholarships (IEAS) which aim to diversify academia by supporting the recruitment of underrepresented groups, specifically first-year Black and Indigenous master's students to PhD-stream programs. However, it has far been difficult to leverage this opportunity for U of T Engineering students, as the funding covers only one year of the master's program and the awardees are selected from the pool of Ontario Graduate Scholarship applicants.

U of T Engineering has had some success with the Mastercard Foundation Scholars Program, which is a fully funded scholarship program for master's level studies in healthcare, aimed at

students from countries in sub-Saharan Africa. Upon completion of the program, it's expected that these scholars will return to their home countries and advance healthcare outcomes. Three students funded by the Mastercard Foundation Scholars Program joined BME in 2022 to pursue their MEng degree. Recruitment efforts to diversify our cohort of postdoctoral fellows (PDF) are described in **section 4.7.**

4.2.4 Admissions

At U of T, graduate student applicants must meet university-wide minimum admission requirements set by the School of Graduate Studies (SGS). Graduate units are free to set higher requirements; for both our MASc and PhD programs, the competitive nature of admissions means that most students entering the programs have incoming averages considerably higher than the SGS minimums.

Admission to a master's degree requires a four-year bachelor's degree in a relevant field, with a final year average of at least a mid-B (or U of T equivalent). PhD admission requires an appropriate U of T master's degree or its equivalent, with an average of at least B+ or demonstrated comparable research competence. Direct entry from a bachelor's degree into the PhD requires at least A- final year average.

After students apply through SGS, some graduate units use a second local system for ease of administering applications. Research-stream students must secure a supervising faculty member prior to being admitted, while MEng do not.

MASc to PhD Fast-Tracking: The fast-track option is available to qualified, academically strong MASc students, allowing them to transfer into the PhD program before completing the MASc, thus earning a PhD in a shorter period of time. Each graduate unit has its own policies on when a student can apply to fast-track, but it typically occurs at the end of the second or third term. In 2017-2018, 44 students fast-tracked from the MASc program to the PhD and this number has been stable over time. Data for the past 10 years is in **Appendix C: Figure 2.6a.**

PhD Direct Entry: U of T allows exceptional undergraduate students to be admitted directly from undergraduate degrees into PhD programs. The number of students admitted in this manner has doubled since 2017-18 in the Faculty which surpasses the goal of increasing this proportion by 10% outlined in our previous Academic Plan.

In 2017-2018, 13 students were admitted directly into the PhD program while there were 36 in 2022-23. Direct entry is still not common practice in the Faculty although all graduate units now have the option available to qualified students, usually requiring them to have some research experience during their undergraduate studies, summer work or after graduation. Data for the past nine years is in **Appendix C: Figure 2.6b.**

4.2.5 Graduate Student Enrolment

Overall graduate student enrolment (**Figures 4-4 and 4-5**) has increased steadily over the past decade. The goal of the 2017-22 Academic Plan to increase graduate enrolment by 15% (domestic and international combined) was attained in 2020 and we are now at 24% above the levels of 2017–18.

This success has been mostly driven by increases in PhD enrolment, which grew by 25% since 2017–18, and strong demand for our MEng program, particularly among international students.

MEng enrolment is now 49% above 2017–18 levels. We have nearly reached our Academic Plan goal of a ratio of 40% graduate students to 60% undergraduate students; the current ratio is 37%, up from 32.9% at the time of the last Academic Plan.

The rising demand for the MEng program, and the increasing emphasis on encouraging direct-entry or transferring into the PhD program, combined with the elimination of the international fees in the PhD program has slowed growth in the MASc program.

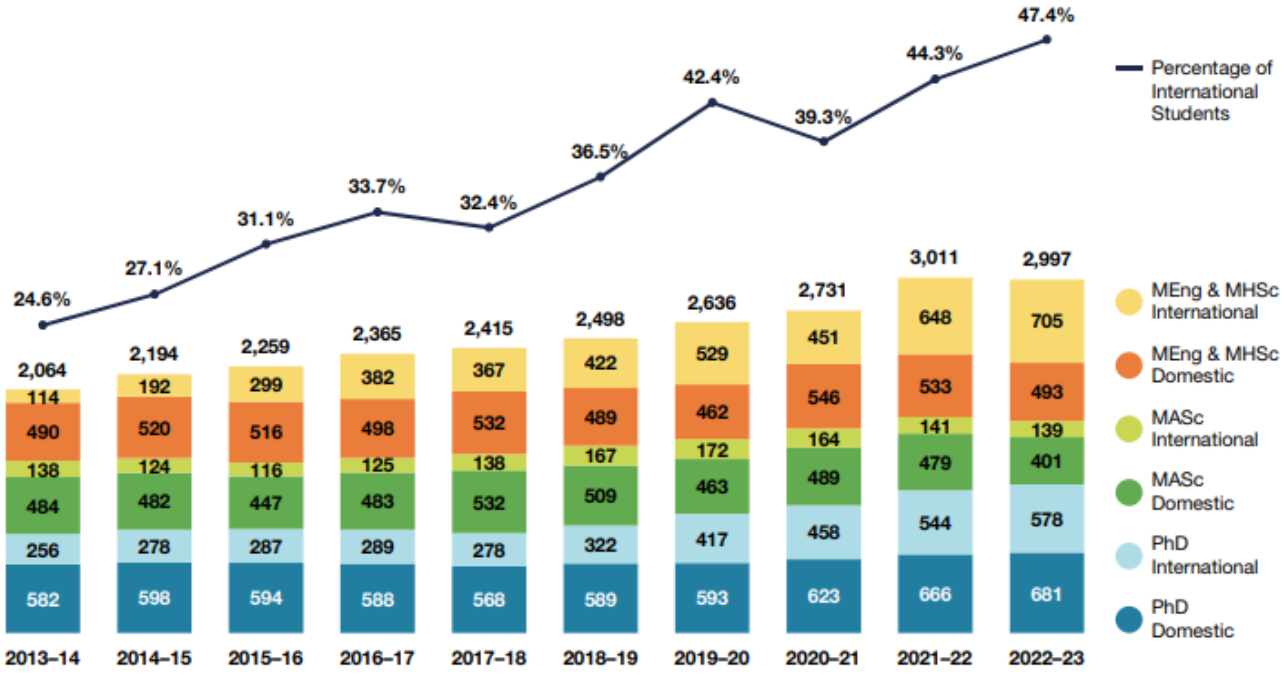


Figure 4-4 Graduate Student Enrolment by Degree Type, International vs Domestic

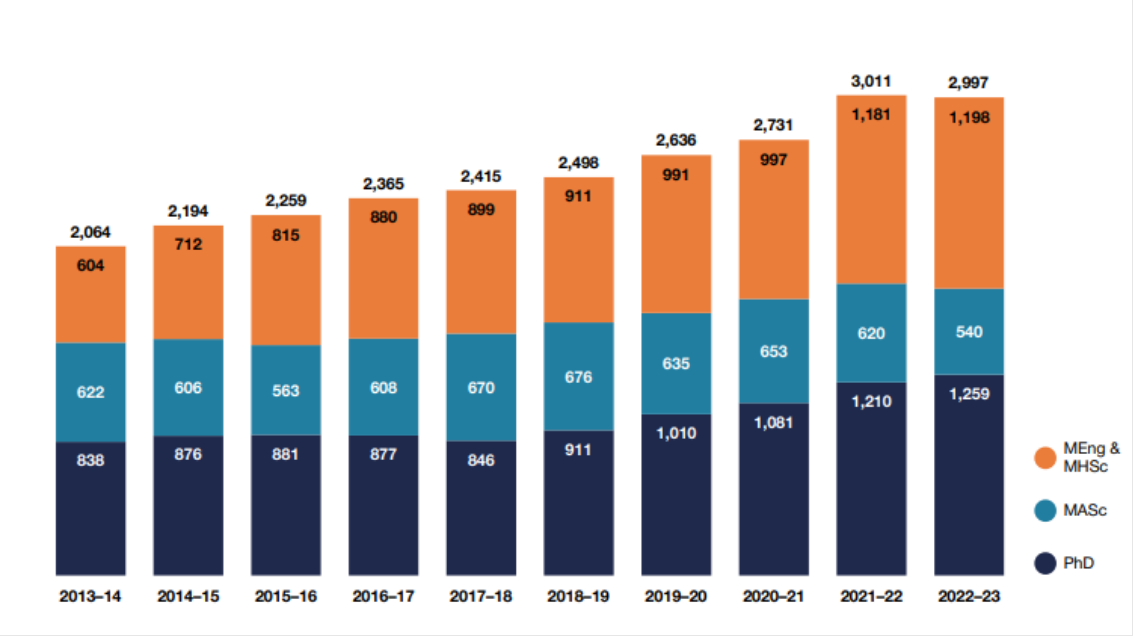


Figure 4-5 MASc vs MEng/MHSc Full-Time Equivalent Enrolment

(See Figure 2.2a from *By the Numbers 2023*)

4.2.6 Graduate Student Funding

U of T requires that PhD-stream students be funded for at least four years. Increases in the cost of living and inflation prompted the creation of several working groups across the university with the mandate to address the challenges related to raising the minimum guaranteed stipend for research-stream students.

In the Faculty, the minimum guarantee covers tuition and fees (and health insurance for international students) but excludes TAships. The guarantee also includes an annual living stipend which can vary from one graduate unit to the other but is at least $20,000 (for 2023-24) which is an increase relative to $17,500 in 2022-23. In our Faculty, all graduate units guarantee funding for two years for MASc students, four years for PhD students, and five years for fast-tracked and direct entry PhD students.

Funding packages are comprised of a combination of supervisor-provided research assistantships, fellowships provided by the graduate units, and internal and external scholarships. When students win large scholarships, the graduate units will reduce other funding, although the net stipend that such students receive is more than the minimum set by the graduate unit.

In the Faculty, teaching assistantships are awarded competitively, and are paid on top of the guaranteed funding package. As well, several graduate units within our Faculty already provide increased minimum stipends relative to the rest of the University, especially for PhD students. As a result, according to SGS data, the average income of a fourth year domestic PhD student in our Faculty was $41,720 in 2020-2021, the most recent year for which data are available. Professional stream students are self-funded.

International MASc students pay substantially higher tuition fees than domestic students. The current differential is approximately +$23,500 per year. As international MASc students are also guaranteed a minimum living stipend, they must be provided a larger funding package that covers the differential and this funding is provided by the supervisor and graduate unit. The departments and institutes may also receive less money through the Faculty budget allocation for each international research-stream student as the province of Ontario does not provide universities with funding for international MASc students. These factors magnify the interest in recruiting more domestic MASc students, or domestic or international PhD students (Section 4.2.1).

External and Endowed Scholarships: Students are encouraged to apply for external (e.g., NSERC, CIHR, OGS) and internal endowed scholarships. However, there are very few external scholarships for which international students are eligible, in particular for MASc students which exacerbates the challenge mentioned above in terms of finding sufficient funding to recruit those students. Awardees are provided additional "top-up" funding to a level above the guaranteed minimum. The top-up rules vary somewhat by graduate unit. While students are always pleased to be awarded a scholarship, some expressed frustration in our self-study consultations that the net benefit of most scholarships is relatively small due to the fact that other funding is reduced.

Total graduate student funding for 2022-2023 was $59.9 million, up from $51.0 million in 2017-2018, with $10.4 million coming from scholarships, $25.3 million from Faculty and department and institute funds, and $24.2 million from research funds (**Appendix C: Figure 2.4a**). These ratios vary somewhat by graduate unit (**Appendix C: Figure 2.4b**), each of which sets its own funding policies.

The contributions from research funds and departmental funds to graduate funding have increased steadily over the last decade while the contributions from scholarships have been relatively constant from $9.6 million to $11.1 million. This reflects the fact that the number of scholarships from the provincial (OGS) and federal (NSERC, CIHR) governments has not kept up with the recent growth in graduate enrolment, nor have award amounts kept up with inflation. **Appendix C: Figures 2.5a** show little growth in total support over the past decade.

The situation is exacerbated by the fact that some government scholarships are now given to universities for internal distribution, resulting in fewer scholarships for talented U of T students who in the past tended to win scholarships at a better-than-average rate.

4.3 Teaching and Supervising Graduate Students

Our Faculty is committed to ensuring that faculty members adhere to high standards of teaching and supervision, and that the workload expectations of academic programs are reasonable. There is some variation among departments and institutes regarding the responsibilities and workload of faculty who are authorized to supervise graduate students.

4.3.1 Graduate Faculty Teaching

Faculty members in U of T Engineering will typically teach one or two graduate level half-courses per year. This is in addition to undergraduate teaching responsibilities, as listed in the Undergraduate Studies chapter (**Section 3.4**). Graduate courses are evaluated via the same online system as undergraduate courses, and the overall results indicate that the quality of teaching is good to excellent. The 2022 Canadian Graduate and Professional Student Survey (CGPSS) indicated that the quality of graduate level teaching is at a level similar to Canadian

peer institutions.

In 2022-2023, 286 graduate half-courses were offered, largely by faculty members but also by adjunct faculty and some sessional lecturers with graduate faculty appointments.

Some MEng students noted a lack of variety of courses in certain technical areas, especially in the smaller graduate units, and pointed out that some courses are not offered every year. They also stated that it can be difficult to enrol in popular courses and that graduate course schedules are often adjusted at the last minute, making it difficult for them to plan their programs. Part-time students want more courses offered during evenings and on weekends. Departments have increased the number of courses offered in the spring and summer to accommodate requests made by MEng students.

4.3.2 Graduate Student Supervision

Graduate student supervision is managed at the department and institute level. Our average for research-stream supervision, in terms of the number of MASc and PhD students, is currently approximately 7.1 to 7.3 students per tenure-stream faculty member (**Appendix A: Figure 2.3a**). For professional stream students (MEng and MEng CEM) the number is 4.1, although many of these students receive little one-on-one supervision unless they are pursuing an MEng project. The number of research students supervised by each professor varies depending on available research funding and their administrative and teaching commitments.

The Faculty met its goals of the 2017-2022 Academic Plan to increase research group size (research-stream student to faculty ratio) which was 6.5 in 2017-18 and increased to 7.1 in 2022-23 (7.3 was the highest ratio in the Faculty's history, achieved in 2021-22).

Although graduate supervision is managed locally, the School of Graduate Studies (SGS) promotes best practices: it publishes and distributes different guidance documents such as Graduate Supervision Guidelines for Students, Faculty, and Administrators (2nd edition) and Best Practices for Supervisor of Students with Family Responsibilities. SGS also offers workshops on graduate student supervision and selects, each year, two recipients across the university for the JJ Berry Smith Doctoral Supervision awards and two Early Career Supervision Awards to recognize exemplary records of graduate supervision. During the last decade, two Engineering faculty members (Professors Ted Sargent (ECE) and David Zingg (UTIAS)) were selected as the recipients of the JJ Berry Smith Doctoral Supervision award. In 2023, Professor Kevin Golovin (MIE) was a recipient of the Early Career Supervision award. SGS has also recently launched a Centre for Graduate Mentorship and Supervision where both supervisors and graduate students can get advice and support to overcome challenges in their supervisory relationship.

SGS sets standards for PhD student supervision, requiring that a supervisory committee be formed within the first year of the student's program and that it meets at least annually with the student to review progress and produce a written record of the outcome of this meeting. SGS also oversees and conducts all PhD final oral exams and graduate academic appeals. The formation of a committee to evaluate MASc students' theses, either via an oral exam or written feedback, is administered locally by individual professors.

As assessed in the 2022 CGPSS survey, doctoral and master's students rated the overall quality of their relationship with their supervisor as 89.8%. This was based on the supervisor's knowledge, availability for student meetings, dissertation exploration, preparation for qualifying

exams, general support, ability to help direct research, and other mentoring activities.

4.4 Graduate Student Professional Development

We continuously enhance our curricular and co-curricular offerings to ensure that our graduate students receive the most rigorous preparation possible, whether they aspire to work in academia, industry, the public sector or in other fields.

During our consultations prior to 2017, research-stream students felt that professional development should be an integral part of their programs, and that to the extent possible, such programming be offered locally, by graduate units and/or the Faculty, to ensure relevance and insure a consistent approach.

We make a variety of professional development opportunities available to our graduate students as they prepare to set out on their careers. MEng students in particular are well served by the many ELITE courses (**Section 4.1.2.5**); the high enrolment numbers confirm that students understand the importance of the competencies and knowledge taught in these courses. The Prospective Professor in Training (PPiT) program focuses on preparing those who aspire to become teachers and academics. The OPTIONS program is directed toward MEng, MASc and PhD students wishing to apply their expertise in industry.

Prospective Professors in Training (PPIT) Program

Since 2006, the Vice-Dean, Graduate Studies and ISTEP have offered PPIT to over 600 students. PPIT introduces participants to curriculum, teaching, and learning within the context of engineering education, provides participants with learning opportunities to support the development of a research program, and offers insights on the academic job search and nature of academic life.

This program consists of: 1) TEP1203, a course on teaching in higher education; 2) a professional development series with a focus on building a research program and the academic job search; and 3) a personalized review and feedback of a dossier. At the end of the PPIT program, students have developed a polished application package and a comprehensive proposal for a new course.

Our self-study consultations indicated that some students, postdoctoral fellows in particular, may not be aware of the PPIT program. We are working to increase the visibility of this option for all graduate students and postdoctoral fellows.

Graduate Maps

Graduate Maps provides an overview of the opportunities available to students at every stage of their degree to help them maximize their research potential, develop their professional skills, connect with their peers and mentors, build their professional network, and launch their career plan. This initiative began at the School of Graduate Studies.

Orientation

Welcome to Graduate School is a new event for first-year graduate students and postdoctoral fellows to take a deep dive into U of T Engineering's programs and services that will enhance their graduate school experience and later ease their transition into a rewarding career. At the event students will: 1) build community by networking with their peers; 2) learn about U of T

Engineering's programs and services; and 3) participate in short, experiential activities to gain insight into these programs and services. This event, developed in partnership with ISTEP, will be offered for the first time in September 2023.

Graduate Communication Initiative

The Graduate Communication Initiative, a partnership with U of T's Graduate Centre for Academic Communication, brings engineering-specific communication training to graduate students. The initiative, led by an ISTEP faculty member, provides non-credit courses, workshops, dissertation writing groups, embedded lectures, and individual student consultations that focus on the conventions and discipline-specific requirements of communication in engineering.

Since 2022, more than 1,000 students have enrolled in 35 program offerings. In Fall 2023, we will pilot a post-entry language assessment program for incoming MEng students and assess the effectiveness of our foundational, engineering-specific graduate writing curriculum.

Career Exploration

Launch Your Career Plan

Developed in partnership with ISTEP, Launch Your Career Plan supports research-based graduate students and postdoctoral fellows in career planning early in their studies. This event guides students to critically reflect on career opportunities including further graduate studies, academia, and industry, and equips them with strategies and tools to explore their unique career aspirations. Since 2022, we have offered this program to almost 120 participants. In Fall 2023, we will offer Launch Your Career Plan to MEng students.

The OPTIONS Program

Since 2017, the Vice-Dean, Graduate Studies and the Troost Institute for Leadership Education in Engineering has offered OPTIONS, an initiative to support graduate students and postdoctoral fellows to explore diverse career options beyond the academy. The program consists of an eight-week, non-credit, cohort program for 30 participants. In the program, participants create a career exploration plan, develop job application materials, and apply networking tools to advance their career exploration. Participants also gain access to career management tools, participate in an informational interview with alumni, participate in a mock interview, and have three, one-on-one meetings with a career coach, an engineering professor, and an industry professional to review their resume and cover letter.

Eight cohorts of PhD students and postdoctoral fellows have completed OPTIONS since it launched, and in September 2019, we expanded it to masters students. We have hosted three cohorts for MEng students and one cohort for MASc students, for a total of nearly 400 graduate students in all. In addition, we offer complementary events. These are two-hour to full-day workshops that provide an introduction to the school-to-work transition, tools to develop skills critical to the success of a professional, and a venue to network with engineering alumni. Over seven years, we have hosted 83 events for over 4000 participants.

Career Fairs

From 2017 to 2019, we hosted a Graduate Engineering Career Fair that was attended by 500 students and over 40 employers. We are now partnering with U of T Engineering's You're Next

Career Network (YNCN), the university's largest student-run professional development organization, that hosts two career fairs per year. This partnership will provide graduate students and postdoctoral fellows with access to 250+ employers across 20+ industries.

Graduate Engineering Networking Series

The Graduate Engineering Council of Students (GECoS), a group of representatives from all graduate student associations in U of T Engineering, hosts two to three alumni networking events per year. These events, which are themed around a particular industry, provide a forum for students to have small group conversations with alumni from that field.

4.4.1 Other Opportunities for Graduate Professional Development

U of T's School of Graduate Studies (SGS) hosts a university-wide Graduate Professional Skills (GPS) program for all graduate students. This includes a large suite of workshops and classes in communications, personal effectiveness, teaching competency, and research skills.

Mitacs is a national not-for-profit organization that designs and delivers research and training programs that connect academics to industry, including internships and job shadowing programs. As part of that mandate, Mitacs offers a range of professional development workshops that are free of charge to graduate students and postdoctoral fellows. U of T Engineering has two co-funded dedicated MITACs directors of business development, and supports a third focused on the IBET program.

School of Graduate Studies – Centre for Graduate Professional Development

The Centre for Graduate Professional Development is the central hub that supports graduate student professional development needs at U of T. It offers workshops and events to support students to develop communication, teamwork, teaching, and research skills.

School of Graduate Studies – Graduate Centre for Academic Communication

The Graduate Centre for Academic Communication (GCAC) provides graduate students with advanced training in academic writing and speaking. They offer one-on-one appointments, courses, workshops, and writing intensives. The ISTEP faculty member who teaches the U of T Engineering Graduate Communication Initiative programming is cross-appointed to the GCAC; this makes for a close, collaborative relationship between the two units.

School of Graduate Studies – Centre for Graduate Mentorship & Supervision

The Centre for Graduate Mentorship & Supervision has a mandate to support successful mentorship and supervisory relationships. It offers workshops for students and supervisors, developing resources on best practices in mentorship and supervision and facilitating conflict resolution.

Career Exploration & Education – Division of Student Life

Career Exploration & Education is a central career centre that provides supports to students, postdoctoral fellows, and recent graduates (up to two years post-graduation). They offer workshops, one-on-one appointments, employer information sessions, and career fairs to help students learn about potential jobs and further education opportunities. Workshops include the Flexible Future Programming which offers a wide-range of career-related topics for graduate

students and postdoctoral fellows such as job search strategies, creating a resume, and interview practice.

4.4.2 Teaching Assistantships

As noted in Section 4.2.5, graduate students (including those in the MEng program) can work as TAs to increase their income and gain teaching experience by leading laboratory and classroom activities and grading assignments. Currently, TAs are paid an hourly rate of $47.64. In our self-study consultations, a few students noted dissatisfaction with departmental policies on awarding TA positions and how this affects other funding.

TA training is mandatory. The collective agreement for employees of CUPE 3902 unit 1 requires that all new TAs (prior to TAing their first course) be provided with four paid hours of pedagogical training. In addition, the university-wide Teaching Assistants' Training Program (TATP) aims to enhance the teaching competencies of TAs and improve the effectiveness of grading and tutorials. Workshops, short courses, and two certificate programs are also offered to assist graduate students with various aspects of teaching.

The Faculty offers a full-day, in-person workshop for first-time teaching assistants to complete their mandatory paid training. This training is also open to returning TAs who want to upskill. The training is a collaborative effort among the Vice-Dean, Graduate, the Vice-Dean, Undergraduate, ISTEP, and the First Year Office. The training covers topics such as protecting student privacy; equity, diversity and inclusion in the classroom; and student wellness.

In collaboration with ISTEP, the Faculty piloted a number of optional and unpaid activities to strengthen the TA community in Engineering and provide support. For instance, lunch and learning seminars are held once a term to discuss best practices and a Teaching Assistant Mentor program was implemented. Information gathered in this session helps inform future teaching assistant training. The modest participation rate of TAs in some of these optional activities suggests that more consultations are required to understand and target programs that will be well-attended and viewed as valuable by the TA community.

In response to the COVID-19 pandemic, the Faculty transitioned to delivering first-time teaching assistant training virtually. In addition to providing synchronous training to new teaching assistants, permanent online modules were also developed. Recognizing the challenges of online learning during COVID-19 for students, the Supporting Student Mental Health online module was also created. This module serves to help teaching assistants recognize students who may be experiencing mental health challenges and learn how to identify, assist and refer students to the appropriate health resources to support them.

Both Supporting Student Mental Health and Equity, Diversity, and Inclusion online modules developed by the Faculty are unique modules not offered by the Centre for Teaching Support & Innovation which offers training to new teaching assistants across University of Toronto. During the pandemic, the Faculty offered virtual check-in events for teaching assistant feedback and support on how to support student learning virtually.

The Centre for Teaching Support & Innovation offers the Teaching Assistants' Training Program (TATP) that is open to all Teaching Assistants across University of Toronto. This program has a broad selection of modules on various topics and complements the training offered in the Faculty.

4.4.3 Outreach Programs

Graduate students interested in gaining teaching experience are encouraged to submit course proposals to the Da Vinci Engineering Enrichment Program (DEEP) summer academy, run by our Engineering Outreach Office. DEEP is a unique summer program designed to provide gifted and highly motivated high school students from across the world the opportunity to experience a variety of engineering, technology, business and science disciplines through hands-on activities.

4.5 Graduate Studies Completion

For many years, our graduates have successfully entered a wide variety of careers across the private and public sectors. The 10,000 PhDs study from SGS was released in 2017 and was based on career information publicly available on social platforms. The information retrieved for 401 PhD graduates from the Faculty who completed their degree between 2012-2015 indicated that, in 2016, 47% of the PhD graduates were working in the private sector and 44% were in the post-secondary education sector; of those in the post-secondary sector, 33% were in a tenure-stream faculty position and 43% were postdoctoral fellows.

One of our 2017-2022 Academic Plan goals was to reduce the time-to-graduation for MASc and PhD students by 10%. However, this has proved challenging, in particular given the disruptions caused by the COVID-19 pandemic. As a result, the median time-to-graduation for PhD students has remained relatively constant at approximately five years. The median time-to-graduation for MASc students has always been two years; full-time MEng students tend to complete their programs in one year, and extended full-time and part-time students in less than two and three years, respectively. (**Appendix C: Figure 2.7a** presents all of this data).

One factor affecting overall time-to-graduation (i.e., from end of undergraduate to end of PhD) is the recent rise in the number of students directly admitted in the PhD from their undergraduate degrees. Their overall time in graduate school is shorter than students who complete both a MASc and a PhD degrees. However, because the direct-entry program requires them to take a larger number of courses, their time to completion can be longer than someone who was admitted with an MASc. In the last decade, the number of direct-entry admissions to the PhD program increased five-fold (**Appendix A: Figure 2.6b**). Our goal is for the PhD to be the program of choice for students interested in pursuing research, and we will continue to promote accelerated paths to the PhD for exceptional students.

4.6 Graduate Student Experience and Services

U of T Engineering is dedicated to providing innovative educational programming and support to each of our graduate students, in or outside the classroom. The School of Graduate Studies (SGS) shares responsibility for graduate studies with graduate units and divisions within each Faculty. Each Engineering department or institute has a graduate office to help students navigate their programs and achieve their goals. Graduate offices are led by a faculty Associate Chair of Graduate Studies and Graduate Coordinator, and are typically assisted by a Graduate Administrator and one or more Graduate Assistants.

The university also provides centralized services that complement those of departments and institutes through the School of Graduate Studies (SGS). With a mandate to support and enhance the overall graduate student experience, SGS offers a broad range of opportunities to assist students in managing their program and gaining academic and professional competencies. They also promote opportunities for students such as international exchanges, student clubs, and membership in the Grad Room, a dedicated space for student programming.

In our self-study consultations, some postdoctoral fellows expressed the desire for a coordinated approach to orientation. While they all eventually found the information they needed on the many aspects of, in many cases, entering a new country, joining a new institution, and settling themselves (and often their families) in a new city, they expressed the desire for a welcome package that would summarize what they need to know before their arrival.

Graduate Student-Focused Career Services: Graduate students can access a broad range of career education services of the U of T Career Centre. The Centre delivers extensive customized career programming for graduate students and postdoctoral fellows on building resilience and identity, experiential and peer-to-peer learning, and learning how to represent themselves in the academic job application process. (See section 4.8)

Family Services: Support for families is centralized at U of T through the Family Care Office (FCO). The FCO provides students, staff, faculty, postdoctoral fellows, and their families with family care-related issues, including guidance, information, referrals and advocacy, if needed. The goal of the office is to raise awareness of family care and quality of life issues central to the achievement of educational equity and employment equity at the U of T. Their emphasis on inclusivity encourages all members of our diverse Engineering community to access the support and services they need for their own circumstances.

4.7 Graduate Students Associations

The Graduate Engineering Council of Students (GECoS) formed organically in early 2018 from a tight knit community of graduate students and the strong support from the Faculty member who served in the Vice-Dean Graduate role from 2012-2017. It was created to act as a representative to all Engineering Graduate Student Associations at the University of Toronto to collaborate on academic, social, and professional events, and to discuss concerns that impact engineering graduate students with the Faculty.

Acting as the voice of graduate students, GECoS shares feedback from graduate students with the Faculty through monthly meetings throughout the academic year. With this feedback, the Faculty is able to stay informed on student concerns and provide support that will improve their student experience.

During the COVID-19 pandemic, this partnership was key in supporting students in response to concerns of isolation due to lockdowns. An online platform was created that shared health and wellness resources and graduate students could also participate in an online forum and virtual meetings to stay connected to each other. GECoS and the Faculty also hosted together virtual Graduate Student Town Halls with the Dean, Vice-Deans and Environmental Health and Safety authorities to provide student updates on the ongoing pandemic. GECoS has now a formal role in the governance of the Faculty as their elect graduate student representatives for the different standing committees of Faculty Council (including but not limited to EGEC and FC).

Each department and institute has a graduate student association that organizes social events and serves as a liaison between their graduate student body, GECoS, the graduate unit, the university-wide Graduate Students' Union (GSU), and the Teaching Assistants union (CUPE 3902 unit 1). The graduate student associations in our Faculty include:

- Aerospace Students' Association (ASA)
- Association of Mechanical and Industrial Engineering Graduate Students (AMIGAS)
- Biomedical Engineering Students' Association (BESA)

- Chemical Engineering Graduate Students' Association (CEGSA-Chem)
- Civil and Mineral Engineering Graduate Students Association (CivMin GSA)
- Electrical and Computer Engineering Graduate Students' Society (ECEGSS)
- MSE Graduate Students' Association (MEGSA)

The GSU represents the university's more than 15,000 graduate students, providing services such as supplementary health insurance and advocating for graduate student funding and participation on various committees at the university level.

CUPE 3902 unit 1 is a labour union local that represents only those graduate students who work as TAs and negotiates contracts with the university.

Extra-Curricular Activities and Clubs: Graduate students at U of T Engineering can join clubs related to many interests and disciplines. Examples include the Human Factors Interest Group, the Chinese Engineering Students' Association (including graduate and undergraduate students), and the Institute for Leadership Education in Engineering (ILead), that provides graduate students with the opportunity to develop self-awareness and team, communication and leadership competencies.

4.8 Postdoctoral Fellows

Postdoctoral fellows (PDFs) have either an employee or trainee status, depending on the source of their funding they receive (i.e., their supervisor's research funding or their own fellowship). Their status as employee or trainee impacts their terms of engagement, taxation, benefits and union membership.

SGS has a dedicated office which compiles information and resources for PDFs and has a listserv. SGS and the Faculty jointly administer some awards such as the Banting Postdoctoral Fellowships and the Provost's Postdoctoral Fellowship Program for researchers from underrepresented groups. U of T Engineering also has a unique PDF exchange initiative with Technion University in Israel, supported by philanthropy gifts (Lyon Sachs) which has brought a dozen PDFs to the Faculty since 2017-2018.

PDFs have access to resources at the university such as campus housing, employee and family assistance programs and SGS' professional development resources as well as the Center for Graduate Supervision and Mentorship. Besides the union, there are no formal associations for PDFs within the Faculty and within the university. Consequently, unlike graduate students, it has been challenging to include PDFs in Faculty Governance processes. Nonetheless, PDFs represent a significant portion of PPIT (section 4.4.3) and OPTIONS (section 4.4.4) cohorts. This has been one of the Faculty's most efficient ways to connect with them.

The Faculty created a fund to mirror some of the resources offered to graduate students to address the negative impacts of the pandemic on research. For instance, the COVID-19 Postdoctoral Training Completion Fund provided 4-month extension to postdoctoral fellows who had experienced severe delays during the pandemic. In discussions with PDFs, one challenge has been being able to afford the high cost of living in Toronto and PDFs are requesting higher salaries to meet these costs.

4.9 Accessibility Considerations for Graduate Students

The School of Graduate Studies (SGS) has recently made available the Accessibility Services Graduate and Professional Program Student Handbook to inform graduate students about the

process at the University to develop accommodations and get support. SGS also offers an accessibility grant to help students cover some accommodation costs. SGS also has a financial aid and advising office where students in need can apply for emergency loans and bursaries, or receive advice on how to access external support. In recent years, staff from Accessibility Services have been invited to meet with Associate Chairs and Directors of Graduate Studies to inform graduate units about the types of accommodation that might be requested by students, and policies within the University in the context of graduate studies.

In recent years, SGS has a designated accessibility advisor available for graduate students. SGS policies are generally flexible in terms of leave-of-absence approvals and program extension. However, students are often unaware of the option to consider a leave of absence or policies surrounding a leave of absence. As a result, in recent years, we have improved messaging on our websites (e.g., linking to SGS's "Manage Your Program" page) and have encouraged graduate units within the Faculty to share this information with students. In addition, the Faculty has provided financial and administrative support to the Graduate Engineering Council of Students' (GECoS) mental health commission for their student-facing activities. In research-stream programs, students who take a leave of absence may not receive their full stipend or scholarship and this may present a significant barrier. Financial resources to decrease this barrier are scarce and challenging to administer.

Besides leaves, students are often not aware of other means by which they can receive accommodations during their studies. To help raise awareness about ways students can receive accommodations during their studies, the Faculty distributes a resource to instructors outlining recommended elements to include in course syllabi, including information on Accessibility Services and accommodations.

In 2021, the Faculty launched a Graduate Academic Wellness Bursary (GAWB) fund to provide bursaries to students in any graduate program who are facing financial difficulties due to unexpected expenses related to their physical and mental health. The GAWB has also provided emergency financial aid to graduate student groups who require immediate funds to support one of their members to obtain mental health services.

4.10 Challenges and Opportunities

Over the past four years, the Faculty has collected graduate student feedback through surveys and consultations on topics ranging from academic advising and mental health to professional development and career support. While the Faculty has taken action to address some aspects of the feedback, there are several areas for improvement in the future – particularly within our professional master's offerings.

The results of a 2021 gradSERU survey yielded positive results from graduate student respondents overall:

- A median of 79% provided positive answers to the 15 questions related to their overall satisfaction, with the highest satisfaction (90%) for quality of library resources and support and the lowest satisfaction (59%) for financial support and funding.
- A median of 84% agreed with the seven statements related to the quality of the program climate, with the highest score (93%) for fair treatment from faculty and the lowest score (70%) for a sense of solidarity among students.

- A median of 87% agreed with the eight statements related to feelings of belonging, with 90% agreement that faculty respect them regardless of their background, and the lowest agreement (58%) on playing an active role in departmental decisions that affect them.
- A median of 86% agreed with the 10 statements related to the strength of Equity, Diversity and Inclusion in their program, with the 96% agreement that their program was tolerant of religious beliefs, and the lowest agreement (79%) that the climate for international students is similar to that of domestic students.

When the results of the survey were segmented by program, there were no marked differences between scores associated with overall satisfaction, except for the statement related to agreement about the value of education received in relation to its cost. Only 53% of professional master's students agreed the cost was fair; by contrast, 75% and 80% agreed in the doctoral and research master's programs, respectively.

Student experience in MEng program: Additional surveys and consultations reveal that compared with students in research-stream programs, students in course-based programs such as the MEng may have fewer opportunities to develop a sense of community and, therefore, can feel isolated. MEng students can feel disoriented at the beginning of their studies, impacting their ability to develop peer relationships due to the absence of a real cohort.

To help address this, the Faculty launched the Graduate Peer and Career Support (GradPACS) initiative in 2018-2019. The Faculty hired and trained a group of graduate students in career coaching and crisis response to guide and assist students in need, and to organize community-building events. GradPACS aimed to lower barriers for graduate students to seek and obtain career, wellness and mental health counselling when needed. During the pandemic, meetings continued virtually, but in 2022, GradPACS paused due to modest uptake. However, training for first-time TAs has been revised to include a mandatory module that includes information on how to respond to students in crisis.

- Additionally, the Faculty has created several dedicated study spaces for MEng students in the Myhal Centre and within ECE and UTIAS; the newest space in ChemE was added in fall 2023.

Increasing satisfaction among MEng students continues to be a priority for the Faculty.. Historically, the MEng was designed to be a flexible program, for working professionals wanting to upskill by taking courses with research-stream students in an accelerated full-time or part-time format. Over the past decade, the size and proportion of international students increased exponentially. Today, MEng students are mostly comprised of individuals with no prior work experience, with a keen interest in entering the Canadian job market for the first time.

The extended full-time option of the MEng program is advantageous for those students seeking a three-year postgraduation work permit. Consequently, in 2019, the Faculty created a version of our OPTIONS career exploration program (see **Section 4.4**) specifically to help MEng students with this transition. Many sessions have been added to address topics relevant to international students such as visas and work permits.

Apart from the MEng in BME and CivMin's CEM, the MEng program is not designed to support international students who are seeking a work permit to complete an industrial internship during their studies. Internships are not formally defined as a requirement of the MEng degree. Another barrier is that the summer term is not defined as a scheduled break in the MEng and normally students would be expected to take courses during this period.

In 2019-2020, a pilot project with the Engineering Career Centre (ECC) was launched with the goal to provide internship placements to 25 MEng students in the summer of 2020. A dedicated graduate internship coordinator was hired to prepare students to apply for work term positions and expand ECC's employer network. Unfortunately, the unexpected restrictions and context created by the COVID-19 pandemic made it difficult to draw definitive conclusions from this pilot. We repeated the pilot project in 2020-2021 with mixed results. Both pilots had high drop rates and when surveyed, participants indicated challenges keeping up with both their regular classes and preparatory workshops hosted by the ECC.

In addition, students reported low ratings for the ~80 available roles, which was surprising given the hiring companies also participate in the well-established PEY Co-op Program for undergraduate engineering students. However, the shorter duration of the work term for MEng students (four months) may have had an impact on the roles available. Another possible explanation is that MEng students have different expectations, which were still not clearly captured in the surveys or articulated in the consultations. Further, surveys indicated that MEng students felt that the preparation activities and internship should have counted for credit in the program.

A potential model for a revised MEng internship program is the creation of an optional co-op concentration where the internship and preparation course would count as a formal program requirement. As students would apply and be admitted directly into the concentration, it would allow sufficient time for international students to obtain a work permit. Another alternative model would be to create a new program or modify the MEng program so that the summer terms are scheduled breaks. It appears that in other universities, including the University of Ottawa, that this is sufficient for a number of international MEng students to obtain work permits to complete summer internships. However, the full range of ramifications of this type of program design have not been thoroughly explored at this time.

Funding in research-stream programs: Despite the fact that the average stipend at U of T Engineering is much greater than the minimum (see **Section 4.2.6**), there are a few students who receive only the minimum. In our self-study consultations, students noted that it is very difficult for a single person to live on $20,000 per year in Toronto. Students also noted that minimum funding levels are increasing in other faculties such as Medicine, and that the amount of guaranteed funding is not uniform within Engineering.

Graduate student funding continues to be a significant point of discussion. In recent years, SGS implemented a number of measures to support funding transparency, including the provision of detailed funding letters to graduate students at the beginning of each academic year. The Faculty has adopted this practice. We are currently on a trajectory to have most units offering a minimum annual stipend of $25,000 by the 2025-2026 academic year.

During our self-study consultations, some PhD students noted that the PhD funding guarantee is only for four years, which can be an issue when the average time-to-completion for PhD students is closer to five years (**Section 4.5**). The four-year funding guarantee is related to the Ontario provincial funding framework, which provides a portion of funding for domestic students for that period of time. Beyond the four-year period, the provincial government does not provide any funding for those students. In most cases, supervisors will continue to support their students for a fifth year, but graduate units no longer provide fellowships (based on limited resources due to the provincial funding framework). As a result, total funding received by the student may be lower than in the first four years, as there is a higher burden on the supervisor. Moreover, SGS, the Faculty and all seven graduate units share the administration of the

Doctoral Completion Award (DCA) fund which provides a small amount of funding for PhD students beyond the funded cohort that are in good standing. All graduate units receive yearly allocations of DCA based on their PhD student enrolment. A similar award exists for MASc students.

Students who are experiencing unexpected delays in their research progress and need to extend the duration of their graduate program are eligible for a tuition waiver for one or two terms. These waivers were created by SGS during the pandemic and still remain to address a broader variety of challenges that research-stream graduate students might face. Although they were created by SGS, approval of the tuition waivers is entirely the responsibility of the graduate units who set their own eligibility criteria and threshold, as the financial model of the Faculty implies that this results in a corresponding loss of tuition revenues. The Faculty and graduate units should increase awareness of these awards among students early in their program.

Some of the items raised in the recent surveys that still require some attention include the process for graduate appeals in 500-level courses, and the development of a tool for chairs and directors to anonymously monitor graduate student wellness and satisfaction in terms of the research supervision they are receiving. The 500-level courses are administered by the undergraduate registrar, but graduate students can take a limited number of them for credit. As the petition and appeal process is different for undergraduate and graduate students, the regular pathways in place were not suitable and confusing to graduate students taking these courses. Therefore, appeals in 500-level courses by graduate students have recently been added as a domain of EGEC (see **Section 4.1.3**). A system to monitor graduate student satisfaction with their supervisor has been in use for three years in MSE; the Faculty aims to expand this system in the future.

5.0 Research

The calibre and global impact of the research produced within our Faculty contributes to our international reputation and ranking as Canada's premier engineering school. We are further strengthening our research programs by attracting strong research investments, upgrading our infrastructure, and enhancing multidisciplinary collaboration within our Faculty, across the University, and with external organizations.

5.1 Overview

Our complement of over 250 tenured and tenure-stream professors, nearly 3,000 master's and PhD students and over 300 postdoctoral fellows and research assistants, produces world-leading research that addresses a range of global challenges, such as leveraging the power of robotics to explore the unknown, delivering clean, affordable and renewable energy, diagnosing disease and extending human life.

We recognize that some of the most innovative solutions come from cross-disciplinary collaboration. U of T Engineering is home to more than 30 multidisciplinary research centres and institutes (**Section 5.3**). These centres facilitate partnerships with leading experts from other U of T divisions and peer institutions around the world. Each year we work with more than 400 industry collaborators, ranging from local startups to major multinationals.

We continue to attract strong support from both federal and provincial research funding agencies and have strengthened our industry collaborations through strategic grants. In 2021-

2022, the most recent year for which complete data are available, our research operating funding per faculty member was $363,273, up 25.9% from 2014-2015. The proportion of total NSERC funding that came through NSERC Industrial Partnerships programs was 47%, up from 44% in 2014-2015.

U of T Engineering has increased our number of research chairs, including endowed research chairs, Canada Research Chairs, U of T Distinguished Professorships and University Professorships, from 77 in 2016 to 90 today. Our faculty members are recognized nationally and internationally as leaders in their fields, from early-career awards to lifetime achievement awards. We have enhanced our support for early-career faculty by conducting workshops on research fundraising, reviewing grant applications, and developing funding resource documents.

Through strategic investments, we have renovated existing facilities and built new ones such as the Mega-Scale Multi-Dimensional Experimental Facility for Enhancing Canada's Infrastructure Resilience located in CivMin (**Section 5.6**). In 2018, the Faculty built the Myhal Centre for Engineering Innovation & Entrepreneurship, a space designed to foster collaboration between researchers, students, industry partners and alumni to catalyze innovation. This building features prototyping facilities, multidisciplinary research hubs, design studios and technology-enhanced learning spaces.

5.2 Strategic Research Themes and Priorities

The 2017-2022 Engineering Academic Plan identified four themes to represent our multidisciplinary cross-Faculty research: Data Analytics and Intelligent Systems, Advanced Materials and Manufacturing, Sustainability, and Engineering and Human Health. These four themes are aligned with the University of Toronto's research goals and with the research agendas of Canada's major funding agencies.

Research strategies within each theme have evolved to address challenges and opportunities, and collectively point to a renewed vision that harnesses our strengths. These research themes also align with our six innovation clusters that represent our advanced research efforts addressing a vast range of social, economic, environmental and industrial challenges. Our progress within these four themes is summarized below.

5.2.1 Data Analytics and Intelligent Systems

Our world is more connected today than ever before, and our enhanced ability to sense, store and transmit data efficiently has led to major changes in all areas of science and technology. Neural nets, deep learning algorithms and artificial intelligence (AI) have enabled us to create autonomous systems such as self-driving cars, improve human health through personalized medicine, and enhance our lives through smart connected systems.

U of T Engineering is at the forefront of the AI revolution, with 30% of total industry partner funding in the Faculty supporting this research area. The Faculty is home to the Centre for Analytics and AI Engineering (CARTE), which drives extensive collaborations and partnerships between AI researchers and those in other sectors (**Section 5.3**). Our researchers are applying AI and machine learning to a broad spectrum of research challenges. Examples include:

- At CARTE, CivMin professor Jeffrey A. Siegel and, along with Bowen Du (PhD candidate), developed an unsupervised machine learning model for evaluating the limitations of low-cost air quality monitors in indoor environments. This model uses

data from a single low-cost sensor to calculate pollutant loss rates and estimate air change rates providing a novel solution to monitor pollutant removal rates with applications for evaluating filtration and ventilation as well as characterizing indoor emission sources.
- A team of researchers supported by Apple Machine Learning and led by Professor Tim Barfoot (UTIAS) is researching ways to make robots predict the future locations of dynamic obstacles, allowing them to navigate spaces without colliding with people. In 2020, Barfoot was also elected a Fellow of the Institute of Electrical & Electronics Engineers (IEEE) Robotics and Automation Society, for his significant contributions to mobile robot navigation.

5.2.2 Advanced Materials and Manufacturing

Advanced materials and manufacturing will play a critical role in achieving Canada's goal of net-zero emissions by 2050. Our Faculty is strategically located in Southern Ontario, a major manufacturing hub in Canada. By leveraging knowledge and expertise in advanced materials and manufacturing, and our partnerships with the Canadian manufacturing industry, we can help develop and scale up innovative manufacturing practices for the 21st century.

We do this through the creation of multidisciplinary, multi-departmental networks focused on sharing knowledge, ideas and resources. Our global leadership in advanced materials and manufacturing synergizes well with the U of T Strategic Research Plan priority of translating lab-based technologies into commercial, scaled-up processes, and contributing to education and the training of Highly Qualified Personnel (HQP). With more than 30 researchers in the Faculty focusing on manufacturing, and more than a dozen research-based startups related to materials manufacturing, the Faculty has established itself as a leader in the field. Examples include:

- In 2023 the University of Toronto received a $200M grant from the Canada First Research Excellence Fund (CFREF) in support of the Acceleration Consortium's self-driving labs research. Many researchers at this centre are from U of T Engineering and will share in the spaces and partnerships it catalyzes, helping to build a world-leading centre for accelerated materials discovery and innovation.
- An academic-industry collaboration between Ford and Professor Mohini Sain (MIE) has produced a new sustainably sourced, production-ready engine component for high-performance vehicles. The Carbon Fibre-Composite 5.0L Engine Timing Cover was created over the course of five years through an NSERC-supported partnership and ORF-RE project between Sain's lab group and Ford Canada's Powertrain Research and Development Centre.
- An international team, led by Professor Yu Zou (MSE), is using electric fields to control the motion of material defects. This work has important implications for improving the properties and manufacturing processes of typically brittle ionic and covalent crystals, including semiconductors, a central component of electronic chips for computers. In 2022, Zou received an Early Career Research Award for his research in materials and manufacturing.

5.2.3 Sustainability

Achieving a sustainable future and mitigating the adverse effects of climate change requires the responsible use and protection of our natural and built environments through the development of clean technologies. More than half of our faculty members are engaged in sustainability research, and the Faculty works with more than 70 companies on collaborative research focused

on sustainability. Examples include:

- CivMin's Drinking Water Research Group targets methods to combat emerging and challenging threats to our drinking water quality, such as microplastics and per- and polyfluoroalkyl substances (PFAS, also known as 'forever chemicals' due to their resistance to natural processes of chemical breakdown via heat and light).
- Professor Emma Master (ChemE) leads a national Genome Canada initiative called SYNBIOMICS aimed at developing processes to create value-added products from forest biomass that is discarded by traditional pulp and paper processing plants. Working with several industry partners across the value-chain such as Canfor and Dupont, SYNBIOMICS aims to meet the precise specifications and consistency the market requires while reducing reliance on fossil fuels and revitalizing Canada's forestry sector.
- Professors Daniel Posen and Heather MacLean (both CivMin) conducted a life-cycle assessment (LCA) that can be used to identify limitations and bottlenecks associated with large-scale vehicle electrification. Their Fleet LCA and Material Flow Estimation (FLAME) model can be used for tracking vehicle characteristics, fuel use across the vehicle fleet, primary and secondary material demand and calculating environmental impacts. An associated paper received over 10,000 views and nearly 200 citations in the last three years.

5.2.4 Engineering and Human Health

The applied sciences and engineering play an important and growing role in addressing health challenges. The Faculty of Applied Science & Engineering has significant strengths in the areas of aging, neural engineering, human factors, medical robotics, pain management, regenerative medicine tissue engineering, bionanotechnology, and natural and urban environments.

There are over 75 researchers across the Faculty with a human health focus. Some notable projects include:

- In 2023, Professor Michael Sefton (BME, ChemE) launched Cell and Engineering Approaches to Preserve and Rejuvenate Organs (CEAPRO), an NSERC CREATE project that will provide training and mentorship in the areas of fundamental biology and target discovery, organ rejuvenation technologies and pre-translation and commercialization.
- Translating Cardiovascular Remote Diagnostic and Monitoring Technologies for Equitable Healthcare (CaRDM Eq) led by Professor Azadeh Yadollahi (BME) supports digital innovation for equitable access to high-quality heart failure care. It provides training for the development of digital health technologies, such as point-of-care diagnostic devices, wearables and other sensors, with a focus on equity.
- In April 2022, U of T announced a strategic research agreement with Moderna Therapeutics to advance research in RNA science and technology. This was Moderna's first research partnership with a Canadian university, with $1.7M in funding provided. Many of the centres and facilities that will be conducting this research are housed in, or supported by, U of T Engineering.

5.3 Multidisciplinary Research Centres and Institutes

In addition to the collaborations mentioned in the previous section, our Faculty is home to 31 research centres and institutes that bring together world-leading expertise from many fields (**Appendix G: Research Centres and Institutes**). Extra-departmental units (EDUs) are flexible and multidisciplinary entities organized around emerging research and teaching areas

that span disciplines. There are four types of EDUs: A, B, C and D. An EDU:A or B may offer degree programs and administer funds. EDU:Cs are typically a multi-departmental unit fostering research and scholarly interest in a defined research domain. EDU:Ds are defined as a group of scholars working together to pursue a specific research objective or offer courses in an area of academic interest.

There are 12 EDU:Cs hosted in, or supported by the Faculty of Applied Science & Engineering, listed below:

5.3.1 BioZone

Launched in 2011, BioZone is a multidisciplinary unit that leverages recent advances in molecular biology and genomics to address engineering challenges in a number of sectors, including environmental bioremediation, industrial bioprocesses and energy. Solutions include enriched microbial cultures that can degrade hazardous compounds, bio-derived fuels and commodity chemicals and anaerobic digestion of waste. BioZone houses state-of-the-art infrastructure for molecular biology, protein purification and identification, substrate and metabolite analysis, microscopy and cell growth.

5.3.2 Troost Institute for Leadership Education in Engineering (Troost ILead)

Troost ILead was created in 2010 to provide transformative learning opportunities for students and professionals to develop leadership success competencies. Its mandate is to empower engineers to maximize their potential and contributions. Troost ILead undertakes student programming, academic and industry-focused research, and outreach to engineering leadership educators and engineering-intensive enterprises.

5.3.3 Institute for Water Innovation (IWI)

The Institute for Water Innovation develops solutions for sustainable water management. In collaboration with industry partners, its researchers conduct market-relevant research and create advanced technologies that address domestic, commercial and industrial water challenges.

5.3.4 Toronto Institute for Advanced Manufacturing (TIAM)

Created in 2014, TIAM expedites the research and development of advanced manufacturing technologies by creating a multidisciplinary network focused on sharing knowledge, ideas and resources. The Institute demonstrates global leadership by translating lab-based technologies into commercial, scaled-up processes and by contributing to the education and training of highly qualified personnel in the manufacturing sector.

5.3.5 University of Toronto Transportation Research Institute (UTTRI)

UTTRI was established in 2014 as a cross-disciplinary institute that includes principal investigators across the University. Its members study urban transport systems and design new ones that are efficient, cost-effective, equitable, sustainable and resilient. UTTRI takes a leadership role in contributing to the development of city regions that are sustainable, healthy and prosperous. In 2022, UTTRI became part of the Mobility Network (see **Section 5.4.10**).

5.3.6 Centre for Analytics and AI Engineering (CARTE)

CARTE is the hub for collaborations and partnerships in analytics and artificial intelligence. They seek to translate and commercialize effective solutions in engineering and to be a catalyst for partners to make a significant and lasting impact in the global marketplace. CARTE partners with industry and government to drive collaborative research between technical analytics and artificial intelligence experts and those with domain-specific knowledge. With 104 faculty affiliates, CARTE applies analytics, artificial intelligence and machine learning techniques to tackle issues in a variety of sectors.

5.3.7 Centre for Global Engineering (CGEN)

CGEN is a multidisciplinary research institute that is mobilizing engineering researchers and students to solve some of the world's most intractable problems. Its mandate is to catalyze research and produce evidence-based solutions to the grand challenges facing the world's most vulnerable populations. CGEN has undertaken research projects on food insecurity, water access, sanitation, energy poverty, safe housing, education and community capacity-building both in low-income countries and in Indigenous communities in Canada. Through these projects and through specialized educational initiatives, CGEN trains the next generation of engineers to adapt to growing trends in globalization and to become effective global citizens.

5.3.8 CRANIA NeuroModulation Institute (CNMI)

Comprising over 50 faculty members from 16 participating departments, institutes and research facilities in Toronto, CNMI is the educational arm of CRANIA, operating within the Faculty of Applied Science & Engineering. CNMI brings together experts and students in the fields of neuroscience and engineering in a collaborative hub for neuromodulation research. The CNMI has created a Collaborative Specialization focused on neuromodulation and hosts ongoing workshops and lecture series that engage students in hands-on experience in neuromodulation research. Going forward, CNMI will increase interdisciplinary research collaborations and forge new academia-industry partnerships that will help students develop, validate and commercialize advanced neuromodulation technologies as well as participate in neuromodulation-based research activities in health care institutions throughout Toronto.

5.3.9 Institute for Identity, Privacy, and Security (IPSI)

Established in 2007, IPSI is dedicated to developing new approaches to security that maintain the privacy, freedom and safety of the individual and the broader community. The Institute strives to facilitate linkages between the diverse body of researchers working in this area at U of T and the national and international community. IPSI is funded by U of T's Academic Initiatives Fund. The institute spearheads several educational initiatives such as a Master of Engineering program with a focus in security technology, and a Master of Information program with a focus in identity, privacy and security.

5.3.10 Institute for Sustainable Energy (ISE)

The Institute for Sustainable Energy (ISE) is an inclusive, multidisciplinary centre designed to bring researchers, students and teachers from across U of T together with partners from industry and government, with the goal of increasing energy efficiency and reducing the environmental impact of energy use and conversion.

University of Toronto Lassonde Institute of Mining (LIM)

The Lassonde Institute is an integrated, multidisciplinary innovation and discovery hub that is home to world-leading mining experts solving global challenges. LIM's interdisciplinary researchers collaborate with over 40 industry partners across several major Lassonde Research and Innovation Areas to help transform the critical resource development sector.

5.3.11 University of Toronto Robotics Institute

The U of T Robotics Institute is the largest, most diverse robotics research program in Canada. Through strong cross-divisional collaboration, the Institute brings together robotics researchers and graduate students with expertise spanning health care, manufacturing, the future of mobility and machine learning across several branches of U of T including: the Department of Computer Science, the Temerty Faculty of Medicine and the John H. Daniels Faculty of Architecture, Landscape & Design. The Institute was created through the Dean's Strategic Fund within U of T Engineering in 2010 and eventually became an Institutional Strategic Initiative (see **Section 5.4.4**).

5.4 Major Cross-Faculty Research Collaborations

Through strategic collaboration with other divisions within U of T as well as leading researchers across the Greater Toronto Area (GTA), U of T Engineering is home to six Institutional Strategic Initiatives (ISIs) and supports an additional seven. The mandate of these initiatives is to launch, grow, and sustain large-scale interdisciplinary strategic networks across U of T. Below is a summary of these ISIs.

Institutional Strategic Initiatives administered by a U of T Engineering academic unit:

5.4.1 Medicine by Design

Medicine by Design is a convergence hub for scientists, engineers and clinicians to conceive and translate regenerative medicine discoveries into living therapies that will transform human health. Medicine by Design was launched in 2015, with an unprecedented investment of $114M from the Canada First Research Excellence Fund. Over the past seven years, Medicine by Design has strategically curated and funded a high-risk, high-reward research portfolio with the potential for "moonshot" breakthroughs to defeat diseases that today are considered incurable such as blindness, heart disease and diabetes.

5.4.2 Centre for Research and Applications in Fluidic Technologies (CRAFT)

CRAFT is a unique, long-term partnership between U of T and Canada's National Research Council to advance the field of microfluidics — the manipulation of fluids at micron length scales by developing devices with improved precision, lower detection limits, and the capacity to parallelize procedures. It focuses on the development of new microfluidic-enabled technologies and their translation into commercial products. Based at both the University's St. George campus in downtown Toronto and the Council's Boucherville campus outside of Montreal, CRAFT has also launched two state-of-the-art open research facilities at the University: the Device Foundry and Tissue Foundry. In 2022, these facilities were used by more than 100 trainees from 44 research groups across four divisions and hospitals for over 6,300 tool-hours. CRAFT's facilities support collaborative R&D projects co-led by the University, NRC, hospitals and industry.

5.4.3 Climate Positive Energy Initiative

The Climate Positive Energy Initiative is U of T's centre for interdisciplinary clean energy research. This initiative links researchers developing social, scientific, technical, economic and policy solutions around a common goal — supporting Canada and the world in achieving net-negative carbon emissions by 2050 while mitigating inequities in access to energy and the consequences of production.

5.4.4 Robotics Institute

The University of Toronto Robotics Institute is the largest, most diverse robotics research program in Canada (see **Section 5.3.11**).

5.4.5 TRANSFORM-Heart Failure (TRANSFORM-HF)

Launched in 2020, TRANSFORM HF is a partnership between U of T and the Ted Rogers Centre for Heart Research. This initiative aims to enable new health-care models that are proactive, personalized and decentralized to improve access to equitable, high-quality heart failure care. TRANSFORM HF unites a diverse team of experts in technology innovation and implementation, basic science, heart failure medicine, data analytics and artificial intelligence, health technology assessment, patient engagement and Indigenous health focused on working collaboratively to advance digital medicine and remote health-care monitoring technologies in service of its mission. There are currently 168 members from 11 institutes in TRANSFORM HF.

5.4.6 AGE-WELL

Launched in 2015 through the federally funded Networks of Centres of Excellence (NCE) program, AGE-WELL addresses a wide range of complex issues in technology and aging through receptor-driven transdisciplinary research, training programs, partnerships, knowledge mobilization and the commercial development of technologies. AGE-WELL is funded through the NCE program to the end of fiscal year 2023-2024. AGE-WELL will be relocated from UHN to an Engineering-managed space at 800 Bay Street.

Institutional Strategic Initiatives financially supported by U of T Engineering:

5.4.7 Acceleration Consortium

The Acceleration Consortium is leading a transformative shift in scientific discovery that will accelerate the development and commercialization of new and advanced materials. The Acceleration Consortium is a global community of academia, industry and government that leverages the power of artificial intelligence, robotics, materials sciences and high-throughput chemistry to create self-driving laboratories. These autonomous labs rapidly design materials and molecules needed for a sustainable, healthy and resilient future, with applications ranging from renewable energy and consumer electronics to drugs. The Acceleration Consortium recently received a seven-year $200M grant from the Canada First Research Excellence Fund, the largest-ever research grant to a Canadian university. U of T Engineering contributed $2.75M for the Acceleration Consortium towards training and to match a $5M Chair donation from Edmond Clark.

5.4.8 PRiME

PRiME was established to align research efforts in the area of Precision Medicine. This initiative leverages U of T's world-class expertise in biologics, omics, molecular chemistry, liquid biopsy, nanomedicine, biology-on-a-chip and related domains to develop new solutions to unmet needs in human disease. The multidisciplinary approach at PRiME goes beyond genomics and mutational profiling to more fully understand the biology of disease, create new tools for disease diagnosis, and develop novel therapeutic strategies that will deliver on the promise of precision medicine.

5.4.9 Emerging Pandemic Infections Consortium (EPIC)

EPIC brings together researchers across U of T and five partner hospitals, facilitating clinicians, scientists, engineers and public health and policy-focused infectious disease experts to converge on innovative approaches that ensure future emerging infections and pandemics do not wreak devastation. Anchored by the Toronto High Containment Facility (THCF), containing Toronto's only research-focused Containment Level 3 (CL3) unit for the study of high-risk human pathogens, a CL2+ pathogen research facility and emerging pathogen Biobank, EPIC's research and training ecosystem aims to empower innovative and collaborative approaches to infectious disease challenges, be a magnet for world-leading talent to train the next generation of leaders, and an authority on infectious disease-focused education and science-based advocacy.

5.4.10 Mobility Network

The Mobility Network is a multidisciplinary, collaborative and diverse network of mobility researchers that connects U of T's strengths in data sciences, engineering and social sciences to address the technological, social, environmental and health disruptions facing society globally. Through interdisciplinary basic and applied research, Mobility Network identifies pathways to more equitable and efficient urban mobility and provides the evidence and decision-support needed for effective and lasting societal change.

5.4.11 Data Sciences Institute (DSI)

U of T's DSI is a tri-campus hub for data science research, training and partnerships. DSI offers a range of programs and initiatives aimed at fostering collaboration, facilitating the development and application of new data science methodologies and tools, and creating a training-focused environment. CARTE (**Section 5.3.6**), initially funded by the Dean's Strategic Fund, was a key pillar for the creation of DSI. Since its launch in 2021, DSI has funded 52 collaborative projects that include Faculty researchers and trainees, totaling $1.9M in funding. DSI collaborates with the U of T Engineering Centre for Analytics and Artificial Intelligence Engineering (**Section 5.3.6**) to support the annual DSI-CARTE ML Bootcamp for faculty, as well as to invite a renowned data scientist to the Data Sciences Speaker Series.

5.4.12 Institute for Pandemics (IfP)

IfP brings together transformative researchers and educators from across disciplines and around the world to address the complex, global public health challenges posed by pandemics. Their work centers around three pillars: 'readiness' to prevent and track evolving pandemics; 'resilience' of health systems and communities, and to improve public health policies and interventions; and equitable 'recovery' to reduce health disparities in pandemics, and to build back stronger and more fairly. Situated at U of T, IfP serves as a knowledge nexus informing

public health responses, helping to strengthen systems and equip future health leaders with a multi-faceted skillset to combat pandemics and epidemics.

5.4.13 Sustainable Development Goals (SDGs@UofT)

Launched in 2023, SDGs@UofT aims to have a global impact by supporting the United Nations' 17 sustainable development goals (UN SDGs) through building on existing research initiatives, forming new interdisciplinary and global partnerships, and producing a map for advancing the UN SDGs at the University.

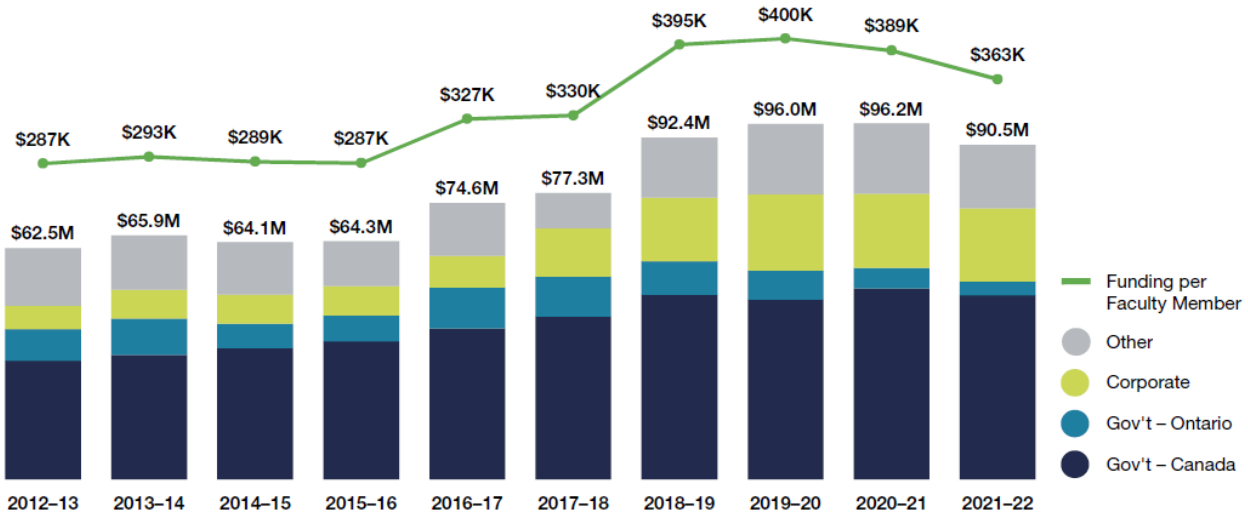
5.5 Research Funding

In 2020-2021, the Faculty reached a record $39.1M in Tri-Council funding, and in 2021-2022 we received $34.7M. While the subsequent transition of various NSERC programs has had an impact on the total funds awarded (**Figure 5-1**), our goal is to return to the previous level of funding in the near future. The Faculty acknowledges that our researchers have been impacted by the COVID-19 public health crisis as well as the discontinuation of NSERC's Industrial Research Chair (IRC) and Collaborative Research and Development (CRD) grants in 2019. These funding opportunities were intended to give companies that operate from a Canadian base access to the unique knowledge, expertise and educational resources available at post-secondary institutions and to train students in essential technical skills required by industry. These programs were consolidated into the NSERC Alliance grant, which provides expanded opportunities for these types of collaborations. Engineering researchers have accessed significant funding by leveraging ongoing partnerships to successfully pivot to this new program.

From 2019-2020 to 2021-2022, U of T's cumulative share of NSERC funding was 8.8%, the third-largest in Canada (behind the University of Waterloo and University of Alberta). The allocation of Canada Research Chairs (CRCs) to U of T and its divisions is updated every two years and is based on its portion of national Tri-Council funding (including NCE). The Faculty currently has a total of 36 CRCs (16 Tier 1 and 20 Tier 2), up from 29 in 2015-2016.

From 2014 to 2021, the Faculty had seven to eight Collaborative Research and Training Experience (CREATE) grants from NSERC in any given year. As of 2023, there are now six active grants.

Each faculty member received on average $363,273 in annual operating research funding, up 25.9% from $288,549 in 2014-2015.



	Gov't – Canada	Gov't – Ontario	Corporate	Other	Total	Funding per Faculty Member
2012–13	$32,118,918	$8,511,021	$6,277,980	$15,621,407	**$62,529,326**	**$286,832**
2013–14	$33,593,784	$9,884,984	$7,749,947	$14,683,976	**$65,912,691**	**$292,945**
2014–15	$35,408,489	$6,656,150	$7,917,673	$14,075,459	**$64,057,772**	**$288,549**
2015–16	$37,393,309	$6,908,331	$7,952,218	$12,090,798	**$64,344,655**	**$287,253**
2016–17	$40,760,609	$11,077,395	$8,547,459	$14,244,259	**$74,629,723**	**$327,323**
2017–18	$43,979,471	$10,801,133	$13,019,563	$9,531,372	**$77,331,539**	**$330,477**
2018–19	$49,823,982	$9,156,559	$17,144,876	$16,243,448	**$92,368,865**	**$394,739**
2019–20	$48,542,745	$7,848,266	$20,653,506	$19,001,615	**$96,046,132**	**$400,192**
2020–21	$51,552,979	$5,653,066	$20,020,252	$18,943,797	**$96,170,094**	**$389,353**
2021–22	$49,775,264	$3,620,586	$19,862,011	$17,197,014	**$90,454,874**	**$363,273**

Figure 5-1 Research Operating Funding by Year, Source and Funding per Faculty Member, 2012–2013 to 2021–2022

(See Figure 4.1c from *By the Numbers 2023*)

5.5.1 Support in Obtaining and Managing Research Funding

A strategic priority is to assist our PIs in accessing the best-matched sources of funding for their research program needs. We hold various workshops and information sessions on NSERC and other major funding competitions to help our faculty members prepare excellent applications. We are expanding this support to other Tri-Council funding opportunities, including the Canadian Institutes of Health Research (CIHR) and the Social Sciences and Humanities Research Council (SSHRC), as well as to international funding opportunities such as those offered by the US National Science Foundation (NSF), the National Institutes of Health (NIH) and EU funders. We are also making targeted efforts to support teaching stream faculty in applying for relevant funding opportunities. In 2022, U of T changed eligibility requirements to allow teaching stream faculty to serve as PIs on research funding applications. We will work closely with teaching stream faculty members to access internal and external funding opportunities and maximize their chances for success.

The Office of the Vice-Dean, Research has prepared various resources for faculty, including a service map of grants supported by the office, an annual funding opportunities calendar, as well as detailed process flowcharts for major grants offered by the Tri-Council and the Canada Foundation for Innovation (CFI). The office is preparing a Faculty Resource Guide, which includes key information about various funding opportunities; faculty supports within Engineering and U of T; equity, diversity and inclusion (EDI) resources; and guidelines on administrative procedures and requirements.

A range of initiatives exist within U of T Engineering and through U of T's Office of the Vice-President, Research & Innovation (OVPRI) to support the research activities, training and professional development of faculty members, students, research staff and administrators. These activities contribute to OVPRI's mandate to support U of T in strengthening its position as one of the top public research universities in the world, and to facilitate an environment that promotes and fosters innovation. OVPRI's services include pre- and post-award management, accounting and ethics oversight, entrepreneurship and innovation activities, and guidance on policies and procedures. OVPRI offers some support for grant writing and budget review, but it is limited due to the large number of faculty members and students at the University.

To support new faculty and large and complex proposals, the Office of the Vice-Dean, Research created two new positions in 2022. The Research Funding, Awards and Honours Officer offers direct support with grant preparation and proposal review and editing to faculty members. The Research Communications Officer produces the Faculty's weekly newsletter, the *Engineering WRAP-Up*, which publishes funding opportunities, deadlines, and information on various funding resources, including information sessions.

U of T Engineering provides several initiatives to help our researchers obtain and manage research funding. Overseen by our Vice-Dean, Research, our Faculty's research committee is comprised of Associate Chairs, Research from our departments and institutes. The committee promotes research, mentors colleagues, and identifies and creates new multidisciplinary research opportunities. In addition, our departments and institutes support their unique strengths and redefine the forefront of research and innovation in their fields, further strengthening our Faculty's research endeavors.

In partnership with the Associate Chairs, Research, our Faculty has implemented mechanisms to increase research funding success and commercialization activities, including:

- Offering targeted editorial and budget reviews of grants for early-career faculty members, new hires, and first-time applicants to key provincial and federal funding opportunities. Optional grant reviews are available for faculty members at all levels upon request.
- Holding introductory meetings with new faculty members on the CFI-JELF application process and offering support throughout proposal preparation, including liaison with departmental/institute facilities and business offices to assist with financial and infrastructure requirements.
- Offering support to faculty members through the U of T Engineering Partnerships Office by identifying and pursuing new industry partners. This support also extends to developing, structuring, and reviewing large-scale grant proposals, and engaging external partners to support the application effort and ultimately participate in the research.

- Hosting panel sessions for faculty members on best research practices, with a focus on partnerships and collaborative research.
- Hosting workshops and facilitating internal expert reviews during award competitions to critique faculty members' applications and increase research success. Panelists at these sessions include successful applicants, NSERC review committee members, and early-career researchers, to offer a breadth of perspectives and practical input to applicants.
- Providing seed funding for collaborative research projects through the Joint Seed funding program.
- Providing operational support funding for large infrastructure projects, such as CFI.

In response to suggestions made by our stakeholders in the previous self-study exercise, the Faculty's Research Office has implemented the following:

- A formalized planning and consultation process for CFI-IF competitions. The Faculty's goal is to promote and endorse large infrastructure projects that are well-integrated and highly innovative; align with U of T Engineering strategic priority areas; involve multidisciplinary teams, including inter-divisional and international partners; and have the necessary team expertise and experience to conduct the proposed program. The Research Office works closely with the Engineering Facilities & Infrastructure Planning team to ensure project leaders obtain all necessary estimates, costings, and project scopes in a timely manner. This is essential for research teams to meet U of T infrastructure requirements and be better positioned for overall project success. Technical grant writers are available to support these proposals through U of T's Major Research Project Management (MRPM) fund.
- The Research Funding, Awards and Honours Officer conducts internal editorial reviews of various funding proposals to strengthen grants prior to submission. This support is offered directly to eligible PIs and/or promoted in the *Engineering WRAP-Up* newsletter depending on the funding opportunity.

To further identify areas where our industry partners' medium-to-long- term strategic priorities overlap with the expertise of our professors, and to increase our responsiveness and the development of productive partnerships, the Engineering Partnerships Office has been restructured. The position of Executive Director was filled in early 2023, providing strategic guidance and leadership, in addition to continuing to drive front-line business development. The roles of Strategic Research Development Officer and Partnership Development Officer were also filled in early 2023 and will increase capabilities of the office in numerous ways. These include additional bandwidth for partnership prospecting, outreach, relationship and proposal development, all of which are core business development functions of the office. Leveraging these internal resources increases the ability of the Faculty to identify and pursue ambitious grants and initiatives that generate lasting impact and position the Faculty at the leading edge of research and innovation in a particular area.

During recent consultations between the Office of the Vice-Dean, Research and various U of T Engineering units, Chairs and Directors expressed the need for the Office to organize more information sessions and create additional resources on unit-specific research topics, Partnerships opportunities, as well as funding supports and opportunities specifically targeted to mid-career researchers.

5.5.2 Recent Successes in Research Funding

This section highlights some of the programs and competitions in which our researchers have been awarded in the last five years (2018 to 2023). We first highlight external funding successes and then profile the Joint Seed program, an internal funding initiative led by U of T Engineering that supports multidisciplinary research efforts within U of T.

Program	**Canada First Research Excellence Fund (CFREF)**
Description	CFREF is a unique institutional program to support large-scale research programs focusing on an existing institutional theme aligned with the Government of Canada's science, technology and innovation (ST&I) priorities. CFREF aims to boost the strengths of Canadian post-secondary institutions so that they can achieve global success in research areas that create long-term social and economic advantages for Canada. CFREF objectives support the full range of research — from fundamental to applied — and give institutions the ability to: • pursue the best in the world for talent and partnership opportunities to enable breakthrough discoveries; • seize emerging opportunities and strategically advance their greatest strengths on the global stage; and • implement large-scale, transformational and forward-thinking institutional strategies.
Measure of Success	The project *Acceleration Consortium: Self-Driving Labs for Molecular and Materials Discovery* was awarded $200M in the most recent competition. The funding – the largest federal research grant ever awarded to a Canadian university – will support the consortium's work on self-driving labs that combine artificial intelligence, robotics and advanced computing to discover new materials and molecules in a fraction of the usual time and cost. Applications range from life-saving medications to biodegradable plastics to low-carbon cement and renewable energy. The application was led by the Faculty of Arts & Science, with 19 engineering PIs from BME, MIE, MSE and ChemE involved in the proposed research.

Program	**New Frontiers in Research Fund (NFRF) – Transformation**
Description	The Transformation stream is designed to support large-scale, Canadian-led interdisciplinary research projects that address a major challenge with the potential to realize real and lasting change (high-reward). The challenge may be fundamental, leading to a scientific breakthrough, or applied, with a social, economic, environmental or health impact. Projects are expected to be world-leading, drawing on global research expertise where relevant.

Measure of Success	The U of T Engineering-led project *"CANSTOREnergy: Seasonal storage of renewable energy"* was awarded $24M in 2023. The multidisciplinary team includes six U of T Engineering PIs from MIE, CivMin, ChemE, ECE and MSE. The team also includes U of T PIs from the departments of Chemistry, Political Science, U of T Mississauga (UTM) Anthropology, UTM Geography, and U of T Scarborough Management, as well as researchers from the University of Calgary, McMaster University, University of British Columbia, University of Winnipeg, University of Victoria, Toronto Metropolitan University, Yukon University, Dalhousie University, and University of Waterloo.

Program	**NSERC Collaborative Research and Training Experience (CREATE) Program**
Description	The CREATE program supports the training and mentoring of teams of highly qualified students and postdoctoral fellows from Canada and abroad through the development of innovative training programs that: • encourage collaborative and integrative approaches, and address significant scientific challenges associated with Canada's research priorities • facilitate the transition of new researchers from trainees to productive employees in the Canadian workforce These programs must foster the acquisition and development of important professional skills among students and postdoctoral fellows that complement their qualifications and technical skills, and improve their job readiness for careers in industry, government, non-governmental organizations and/or academia.
Measure of Success	The Faculty has received a total of $9.9M in funding through the CREATE program in the last five years. • Design of Living Infrastructure for Ecosystem Services (CivMin, 2019) • NSERC CREATE for BioZone: An open science collaborative centre for industrial biotechnology in the context of the circular economy (ChemE, 2019) • CREATE in Healthcare Robotics (HeRo) (MIE, 2019) • NSERC CREATE in Thermal Management of Electrification Technologies (TherMET) (MIE, 2022) • NSERC CREATE in Cell and Engineering Approaches to Preserve and Rejuvenate Organs (CEAPRO) (BME/ChemE, 2023) • Translating Cardiovascular Remote Diagnostic and Monitoring Technologies for Equitable Healthcare (CaRDM Eq) (MIE, 2023)

Program	**Canada Foundation for Innovation – Innovation Fund (CFI-IF)**
Description	CFI-IF supports large-scale infrastructure projects (total project costs >$1M) that involve acquiring or developing research infrastructure to increase research capacity and support world-class research. The objectives of the latest Innovation Fund competition were to: • Enable internationally competitive research or technology development through the equitable participation of expert team members • Enhance and optimize the capacity of institutions and research communities to conduct the proposed research or technology development program(s) over the useful life of the infrastructure • Lead to social, health, environmental and/or economic benefits for Canadians. [source: https://www.innovation.ca/apply-manage-awards/funding-opportunities/innovation-fund]
Measure of Success	Total CFI-IF funding over the last five years has been over $10 million CFI contributed $6.9 to the project *Mega-Scale Multi-Dimensional Experimental Facility for Enhancing Canada's Infrastructure Resilience* currently under construction in CivMin. Key infrastructure includes the world's first fully movable, adjustable, multidirectional, large-scale and large-capacity loading frame, new state-of-the-art sensing equipment and the redesign of 500 square metres of lab space.

Program	**Canada Foundation for Innovation – John R. Evans Leaders Fund (CFI-JELF)**
Description	Funding provided to institutions through the CFI-JELF helps institutions to recruit and retain outstanding researchers, acquire the tools that enable the innovative work of leading researchers and offer research support that, when combined with research support from our partner organizations, is highly competitive.
Measure of Success	Over the last five years, 25 CFI-JELF projects have been funded, with a total of $4.9M awarded from CFI.

Program	**NSERC Discovery Grants**
Description	Discovery Grants support ongoing programs of research with long-term goals rather than a single short-term project or collection of projects. These grants recognize the creativity and innovation that are at the heart of all research advances. Discovery Grants are typically five years in duration and provide long-term operating funds and can facilitate access to funding from other programs but are not meant to support the full

	costs of a research program.
Measure of Success	Total funding through NSERC Discovery Grants has been $57M over the last five years (2019-2023). U of T Engineering's success rate in the most recent Discovery Grant competition was 79%, compared with a 67% rate for U of T, and 64% success rate across Canada.

Program	**Ontario Research Fund - Research Excellence (ORF-RE) Award**
Description	ORF-RE provides research institutions with funding to support the operational costs of major projects of strategic value to the province. Priority is currently given to applications focused on: • connected, autonomous, electric vehicles (including battery and powertrain technology) • industrial/mining technologies related to electric vehicles, spanning the entire value chain from minerals to manufacturing to recovering resources from vehicles or their component parts at end-of-life
Measure of Success	In the last five years, U of T Engineering received $21.7M through ORF-RE. Projects include: • Laser Nano-Engineering of Smart Glass Technologies (ECE, 2018) ($1.4M) • Next-Generation Point-of-Care Multiplexing Blood Analyzers Using High-Sensitivity NanoPhotonic Devices (ECE, 2018) ($4M) • Ultra-Efficient Flexible Silicon Solar Cell Technology (ECE, 2018) ($2.8M) • Transforming Pathology Using Artificial Intelligence to Improve Patient Outcome and Hospital Efficiency (ECE, 2020) ($1.5M) • Characterization, Prediction and Control of Flap Noise Sources from Aircraft (UTIAS, 2020) ($685K) • Innovative and Cost-Effective Micro/Nanocellular Foaming Technology for Sustainable Lightweight Applications (MIE, 2020) ($600K) • iCity 2.0: Urban Data Science for Future Mobility (CivMin, 2020) ($3.9M) • All-Weather Autonomy: Securing Ontario's Leadership in the Self-Driving Revolution (UTIAS, 2020) ($3.3M)

Program	**Early Researcher Awards (ERA)**

Description	The ERA program provided funding to new researchers working at publicly-funded Ontario research institutions to build their research team. Funds support research assistants/associates, technicians, undergraduates, graduate students and postdoctoral fellows.
Measure of Success	In the last five years, 22 U of T Engineering faculty members have secured ERA funding, with a total of $2.2M.

Program	**NSERC Alliance**
Description	Alliance grants encourage university researchers to collaborate with partner organizations, which can be from the private, public or not-for-profit sectors. These grants support research projects led by strong, complementary, collaborative teams that will generate new knowledge and accelerate the application of research results to create benefits for Canada.
Measure of Success	Total NSERC Alliance funding awarded since 2019 is $19.8M.

Program	**Mitacs (all programs)**
Description	Mitacs is the key link between private sector and post-secondary institutions, driving collaborations at home and abroad to solve organizational challenges, and develop the nation's innovation capacity. For 20 years, Mitacs has funded cutting-edge research, created job opportunities for graduate students and helped companies reach their goals, achieving results that have bolstered the Canadian economy and impact.
Measure of Success	In the 2022-23 fiscal year, Mitacs approved $17,280,679 for the University of Toronto. Of that amount, 34.4% are tagged to Engineering, translating to $5,944,553.58 in approved funding. Note that this is likely underestimated as some members of the Faculty self-declare their applications as "Computer Science", which accounts for 35.7% of the approved funding in 2022-23.

In 2015, U of T Engineering created the EMHSeed funding program to support multidisciplinary research between PIs from Engineering and those from the Temerty Faculty of Medicine and U of T-affiliated hospitals. For the initial calls, matching funding was provided by three partner divisions: Temerty Faculty of Medicine, Medicine by Design and the Translational Biology and Engineering Program.

In 2018, the program was expanded to include the XSeed funding stream, which supports joint projects across all U of T campuses, significantly increasing the scope of research areas and partnerships. With the addition of this stream, the program was renamed Joint Seed. It currently includes eight partner divisions, which are outlined below.

Program	**Joint Seed Funding Program**
Description	• The Joint EMHSeed and XSeed program is an interdivisional research funding program designed to promote multidisciplinary research and catalyze new innovative partnerships between a co-PI from U of T Engineering and a co-PI from outside Engineering. Current partner divisions are: Temerty Faculty of Medicine, U of T-affiliated hospitals, Translational Biology and Engineering Program, TRANSFORM Heart Failure (TRANSFORM HF), KITE (Knowledge, Innovation, Talent, Everywhere), Faculty of Arts & Science, U of T Mississauga, U of T Scarborough/EaRTH District Collaborative Research Grant, and Dalla Lana School of Public Health.
Measure of Success	• Since 2015, the Joint Seed program has funded 96 interdisciplinary research partnerships – 50 through XSeed and 46 through EMHSeed – for a total of $11.5M in funding. U of T Engineering faculty have collaborated with PIs from 38 different departments across the three U of T campuses, as well as seven of U of T's nine affiliated hospitals or research institutes. • Joint Seed recipients have secured significant follow-on funding from tri-council agencies. Examples include a SSHRC Partnership Grant ($2.5M/5 years); NSERC Alliance Grant ($920K); $500K for two NFRF Exploration Grants; various CIHR grants totaling $5.14M; and two NSERC/CIHR Collaborative Health Research Grants (CHRP) totaling $1.1M. Significant U.S. funding was secured from the Mellon Foundation ($2.7M). • Joint Seed teams have published their findings in a range of journals, including Advanced Energy Materials, Political Communication, Environmental Pollution, Journal of Cities, Atmospheric Environment, Cells, Advanced Materials Technologies, Bioelectricity, Frontiers in Neuroscience, and Anesthesia and Analgesia.

5.6 Research Infrastructure

Over the past several years, we have renovated a number of existing facilities and created new ones through strategic investments. Examples include:

- the Translational Biology & Engineering Program (TBEP) Lab on the 14th floor of the MaRS Discovery District West Tower
- the Mega-Scale Multi-Dimensional Experimental Facility for Enhancing Canada's Infrastructure Resilience (CivMin) in the Galbraith Building
- BioZone on the third and fourth floors of the Wallberg Memorial Building

Replicating the success of bringing interdisciplinary researchers together to share resources will continue to have a major beneficial impact across the Faculty. The lack of space and existing aging infrastructure has been a challenge for the Faculty to provide modern facilities for researchers and students. For a complete list of core facilities please see **(Chapter 5 Supplemental Material).**

Through future efforts with large-scale, collaborative research applications, we will continue to support our research initiatives in the form of pre- and post-award management and other needed resources for infrastructure growth.

5.7 Benchmarks of Success: Publications, Citations and Media Coverage

We measure the impact of our research in numerous ways, including awards and honours received by faculty members, success rates for funding programs, and media coverage. Bibliometrics based on numbers of publications provide an additional way to benchmark our progress.

According to InCites™ Journal Citation Reports from Thomson Reuters, in the five-year period from 2017 to 2021, our Faculty produced 4,437 publications and received a total of 106,862 citations. We ranked third among our peers in the Canadian U15 group of research-intensive universities in terms of the number of publications, and second in the number of citations. Among our wider group of peers in the Association of American Universities, we ranked 10th in publication count and 9th in citation count. More data on publications, citations and rankings can be found in chapter 5 of *By the Numbers*.

In 2022–2023, U of T Engineering was mentioned in more than 4,500 news stories from media outlets, of which approximately two-thirds were outside of Canada. Collectively, these stories represented more than 9 billion potential impressions, that is, the number of viewers who could potentially have interacted with these stories. News about research discoveries and impact represented a significant proportion of this total, with 18.9% of stories mentioning research in sustainability, 15.7% mentioning research in human health, and 7.4% mentioning research in data analytics and/or AI. Further detail on our media coverage can be found in chapter 6 of *By the Numbers*.

5.8 Activities in Support of Student Research and Learning

Opportunities to participate in research at the undergraduate level — whether through thesis projects or summer research opportunities — are beneficial to all students, helping them develop abilities in project management, data analysis and communication. For students who plan to pursue research at the graduate level, such experience is crucial in acquiring research competencies and building professional networks.

All Engineering Science students complete an undergraduate thesis, supervised by a professor within our Faculty. Research is carried out throughout the term and is presented before a committee, enabling students to receive valuable feedback.

Students in several other departments may choose an optional thesis if desired. Some students who participated in self-study consultations noted that such thesis projects are not always effective in their current format, primarily due to the time constraints imposed by courses. One concept discussed was to link the thesis course with a summer internship to enable students to engage more deeply in their research.

In 2022, 214 undergraduates participated in summer research opportunities, 196 of which were within the Faculty and 18 were abroad. The number of students participating in international summer research opportunities dropped during the COVID-19 pandemic with an increase in virtual internships. The goal over the coming years is to return to the levels of engagements seen prior to the pandemic. In 2023, 39 students participated in summer research abroad through the Summer Research Exchange Program (SREP).

For more than a decade, U of T Engineering has sponsored the Undergraduate Engineering Research Day (UnERD), a one-day symposium where undergraduate engineering students present their summer research. It allows students to share their work with professors, graduate students and other undergraduate fellows across disciplines, through either a podium or poster presentation which is evaluated by an expert panel of faculty members.

Another program for undergraduate research is the Undergraduate Summer Research Program (USRP), led by Professor Dawn Kilkenny (BME). This experiential learning opportunity brings together undergraduate students who are participating in summer research at U of T Engineering to learn success skills from experts across the Faculty. It also provides a space for students from different disciplines to share their research experiences, expand their networks, and build community around research. It is open to all undergraduate students who are doing research at U of T Engineering (including non-Engineering and non-U of T visiting students). The group meets weekly throughout the summer. Topics covered include research lab health and safety, literature search strategies and lab communication best practices. The latter half of the program covers topics that prepare students to present their research at UnERD such as how to write a scientific abstract and how to create and deliver research presentations. This summer is the fourth year USRP has been offered with 88 students registered for the program in 2023.

5.9 Research Chairs

One reflection of the exceptional calibre of our investigators and their work is the number of research chairs and grants awarded to the Faculty. In 2016, we had 77 research chairs; today, we have 89, held by 82 individual chairholders. These include 36 Canada Research Chairs, 31 Endowed Chairs, 10 Industrial Research Chairs, 7 U of T Distinguished Professors and 4 University Professors. We continue to work with our industry collaborators and alumni network to develop strategic partnerships and secure the funding necessary for further research chairs.

5.10 Research Honours and Awards

Our faculty members are recognized for achievements in research and education, receiving early career to lifetime achievement awards. In 2022, our faculty earned more than 13% of the major national and international honours and awards given to Canadian engineering professors, despite making up only 5.5% of the nation's engineering faculty. A complete listing of recent awards and honours can be found in chapter 5 of *By the Numbers*.

Our Faculty's Committee on Honours and Awards nominations and our Director of Awards and Honours position have increased the success of our awards nomination program. We have also enhanced the process and capacity for disciplinary awards at the departmental and institute level by establishing awards committees in each unit and creating a centralized administrative position to help them develop nomination and award strategies.

The Connaught Fund is the largest internal university research funding program in Canada. The fund supports graduate students, early-career researchers, interdisciplinary teams, and innovators to meet the challenges facing our global society. The Connaught Committee distributes over $5M toward 200 awards annually and has supported thousands of innovative research projects with social impact across the University since its founding in 1972. Since 2017, the Faculty has received $4.9M of funding from the Connaught Fund.

5.11 Research and Industry Partnerships

Our researchers collaborate within U of T Engineering, with faculties and divisions across the University, and with many external bodies, including affiliated hospitals, industry partners, professional organizations and peer institutions across Canada and around the world. These partnerships may be facilitated by our multidisciplinary research centres and institutes or created to address specific challenges at the intersection of multiple fields. Each year, the Faculty hosts an Industry Partners Reception to recognize and celebrate our more than 400 industry partners and to develop new relationships. Individual academic units also host industry events, such as open houses, career fairs, panels and networking receptions to connect with industry on strategic areas relevant to their expertise (**Chapter 9**).

5.12 Innovation and Commercialization

U of T Engineering fosters an environment that support the translation of innovations into commercial ventures. Over the past five years, our faculty members have accounted for 70% of all invention disclosures at the University (**Figure 5-2**) and have launched 28 spin-off companies.

	2018–19	2019–20	2020–21	2021–22	2022–23	5-Yr Total
UTIAS	0.0	1.0	2.0	2.0	2.0	**7.0**
BME	20.0	19.0	9.0	11.0	18.0	**77.0**
ChemE	15.0	19.0	8.0	20.0	12.0	**74.0**
CivMin	3.0	7.0	4.0	5.0	3.0	**22.0**
ECE	43.0	53.0	43.0	41.0	37.0	**217.0**
EngSci	0.0	1.0	1.0	2.0	0.0	**4.0**
MIE	21.0	24.0	21.0	26.0	23.0	**115.0**
MSE	7.0	4.0	5.0	9.0	4.0	**29.0**
Annual Total	**109.0**	**128.0**	**93.0**	**116.0**	**99.0**	**545.0**
University Annual Total	**190.0**	**180.0**	**122.0**	**157.0**	**135.0**	**784.0**
Engineering Percentage	**57%**	**71%**	**76%**	**74%**	**73%**	**70%**

Figure 5-2 Invention Disclosures by Academic Area, 2018–2019 to 2022–2023

The Office of the Vice-President, Research & Innovation (OVPRI) and its Innovations & Partnerships Office (IPO) provide research-related support to the Faculty. The University has developed internal polices allowing inventors the flexibility to take personal ownership of and commercialize inventions on their own, or alternatively, to utilize the commercialization services the University provides.

Startup creation provides a clear pathway for commercialization. U of T Engineering's startup incubator is called The Entrepreneurship Hatchery, which supports undergraduates, graduate students, alumni and members of the broader University community in forming teams, learning from mentors, securing seed funding and launching companies. In the past 10 years, the Hatchery has accepted more than 400 new ventures to its programs and has launched more than 100 startup companies. Close to 30 of those ventures have created 600 new jobs in our economy. These companies are making social and economic impacts in Toronto and beyond.

The Hatchery provides its FEEL ™ methodology for human capital and venture formation in a comprehensive suite of activities, programs and novel methodologies designed to help individuals develop their entrepreneurial capital. Programs include:

- **Build-A-Team Matching Tool:** A matching engine of more than 3,000 individuals for founders seeking co-founders, or for startups to connect with future talent.
- **NEST:** A rigorous summer program that provides opportunities for startups to define their purpose with support from an advisory board and resources.
- **LaunchLab:** Enables companies led by graduate students, postdoctoral fellows and faculty to sustain themselves while they define their business models and attract investment.

- **Start@UTIAS Hatchery:** Caters to UTIAS master's student-led startup companies. Teams with strong potential are streamlined into the NEST or LaunchLab programs.
- **Alumni:** This program introduces U of T Engineering alumni to younger talent, inspiring them to create their own startups later in their careers.
- **Hatchery Social:** Students focus on creating software tools for non-profits and social enterprises.

Engineering researchers can also access other supports across the University community, such as the Banting & Best Centre for Innovation & Entrepreneurship, home to several entrepreneurship accelerators including the U of T Early Stage Technology Program (UTEST), the Health Innovation Hub, the Impact Centre, the Black Founders Network, and the Creative Destruction Lab.

Through U of T, our Faculty is also a member of MaRS Innovation, a non-profit organization that acts on behalf of Toronto's top universities, institutions and research institutes to bring their most promising research breakthroughs to market. We take full advantage of our prime location in the heart of Toronto, collaborating with our neighbours in the MaRS Discovery District, world-class hospitals, firms in Canada's financial district, and major multinational organizations headquartered here.

There are multiple Commercial Licensing Agreements within the University, and we believe there is more work to be done on a coordinated umbrella structure that serves both students and faculty members. Faculty-specific workshops and seminar series on innovation and entrepreneurship could better prepare and train our principal investigators to plan and manage the outcomes of their research.

Increasingly, governments, funding agencies and institutions like U of T are recognizing the important economic role played by commercialization and entrepreneurship based on academic research. Given the applied nature of engineering research and the strong networks we have built to support commercialization and entrepreneurship, our Faculty is well-positioned to be a leader in this area.

5.13 Challenges & Opportunities in Sustaining Research Excellence in Today's Research Funding Landscape:

U of T Engineering faces challenges and opportunities in critical areas of research, partnerships, accountability and compliance. The Office of the Vice-Dean, Research is committed to continuous evaluation of these challenges and opportunities as the research landscape evolves. We make use of Faculty and University resources and work on our best practices to ensure support for the groundbreaking research taking place across the Faculty.

Challenges

Research Security: In recent years, Federal and Provincial government guidelines and review processes related to national security, including the implementation of geopolitical risk mitigation measures, have been introduced. These guidelines and procedures are continuously evolving. These new measures have impacted research funding and partnerships at the Faculty. Researchers are adapting to increasing restrictions on acceptable collaborators and existing industry partnerships that are affecting funding decisions from government sponsors. Our

researchers undertake important work in sensitive areas, and managing these security risks often requires knowledge outside of the research team's expertise. The Office of the Vice-Dean, Research works closely with the research security team at the Office of the Vice-President, Research & Innovation (OVPRI) on individual cases, and keeping our faculty members updated on the changing landscape.

Research Grant Funding Levels: Important funding programs, including those managed by the Tri-Council, have not kept up with the rising costs of supporting highly qualified personnel (HQP) and of conducting research more generally.

Student Cost-of-Living: The rising costs-of-living in Toronto (a situation which has accelerated post-pandemic) has affected students disproportionately. Research funding and supports for the training of HQP from major programs have generally failed to keep up with these increasing costs and, in some cases, have been declining. We also note that student stipends at U of T are lower than at many peer U.S. universities (see **Chapter 4, Section 4.2).**

Government Matching Funds: The Federal and Provincial governments have increasingly decided not to fund their respective matching contributions for large infrastructure grants due to projects not aligning with their mandates. This has resulted in unexpected funding shortfalls, creating a bottleneck for our researchers, with some awards eventually revoked due to the team's inability to secure the required matching funds. We expect this issue to become more common due to added national security requirements.

Infrastructure Planning: Projects that include renovation or construction work incur significant costs that, due to delays in funding approvals, often end up exceeding budget estimates as they do not account for resulting inflation. To address this challenge, the Faculty is making a conscious effort to develop better preparatory processes for large research infrastructure projects. This includes detailed advance infrastructure planning with various Faculty stakeholders (see **Section 5.6)**.

Indirect Costs: Indirect costs (IDC), sometimes referred to as overhead, are those that the University incurs to support research. For every $1 received in direct research funding, the University incurs roughly $0.57 in indirect costs. To help offset these expenses, all industry-sponsored funding provided to U of T is required to include a 40% indirect cost rate. This rate does not apply to Federal, U.S. government, and other funders that have formal published IDC rates. As the overall financial situation of the University changes (e.g., the significant decrease in the proportion of provincial funding over the past decade), the importance of IDC and the pressure to fully fund all the costs of research projects is increasing.

CRC EDI Targets: With the implementation of equity, diversity and inclusion (EDI) targets set by the Canada Research Chairs (CRC) program, which all universities across Canada are required to meet by 2029, the Faculty has, since 2018, reserved allocations for candidates that self-identify in one of the four designated groups (women, persons with disabilities, Indigenous peoples, and members of visible minorities), as well as those who identify as trans, non-binary, or Two-Spirit. Ensuring that specific demographic targets are attained presents some challenges and also constitutes a significant workload for the Office of the Vice-Dean, Research.

ISI Management: The Institutional Strategic Initiatives (ISIs) are large-scale high-impact interdisciplinary research initiatives supported by OVPRI. As of October 2022, the Faculty is involved with administering a total of eleven ISIs as either the lead unit (four ISIs) or as a support unit (seven ISIs). Currently there is limited formal oversight, guidelines, or a framework

in place to manage these initiatives. These projects are funded by the University for a three-year period. Divisions are required to provide matching funding and secure external funding to ensure the sustainability of these initiatives. Decision making, administrative and HR responsibilities, and the overseeing of teaching, research, and day-to-day operations need clarity. Additional guidance around expectations, goals and definitions of success are essential in leading such collaborative projects.

Service Contracts: There is currently no required oversight at the University level for service contracts which are distinct from research agreements/contracts. Currently these are handled at the level of the academic unit. This has created challenges for the Faculty when significant funding has been provided to Engineering units through service contracts, with little to no knowledge or supervision of their implementation.

Opportunities

New Research Supports: Since January 2022, the Office of the Vice-Dean, Research has added two new positions to the team: a Research Funding, Awards & Honours Officer (RFA) and a Research Communication Officer (RCO). With the addition of the RFA, the Office of the Vice-Dean, Research now offers editorial reviews for strategic research proposals; supports early-career and new faculty; provides increased planning support for large funding initiatives; and develops funding resources for faculty. The RCO manages and publishes the Office's weekly newsletter, produces research features, profiles, and helps publicize engineering research and our faculty's accomplishments (e.g., through faculty interviews and the development of communication strategies around major funding accomplishments and initiatives.)

Diversifying Sources of Research Funding: The Office of the Vice-Dean, Research is exploring novel avenues for funding, something crucial in sustaining the Faculty's research excellence. New potential sources of funding include U.S. government and international sponsors, industry partners, foundations, and philanthropic funding. The Office of the Vice-Dean, Research liaises with the University's research offices (including the Research Services Office and Innovations & Partnerships Office) as well as the Faculty's Partnerships and Advancement offices to implement practical strategies to expand and diversify the Faculty funding portfolio.

Fostering Collaborative and Interdisciplinary Research: The Office of the Vice-Dean, Research and the Faculty continue to nurture interdisciplinary teams, partnerships and collaborations, crucial to addressing key societal and cultural challenges and producing greater research impact. The Office of the Vice-Dean, Research manages the inter-divisional annual Joint Seed funding (see section 5.5.2) and the Faculty administers or financially supports various ISIs (see section 5.4). These activities foster the creation of sustainable cross-divisional and interdisciplinary research and teaching teams, centres, and institutes across U of T.

Broadening Human and Social Dimensions in Large Grants: Working at the intersection of engineering education, professional competencies, and engineering practice, ISTEP faculty members offer unique expertise in areas that include: qualitative and community-based research (e.g., surveys and focus groups), EDI research, knowledge mobilization, and the human and social dimensions of technology implementation, which can strengthen a variety of research initiatives at the Faculty. The VDR Office is working to connect research teams with ISTEP to promote the integration of the expertise available in ISTEP into major engineering research projects.

International Partnerships: International collaborations are instrumental to research and education activities. The International Doctoral Cluster program at U of T facilitates such collaborations, helping our researchers to build global research teams and providing our students the opportunity to conduct scientific research internationally. The Office of the Vice-Dean, Research engages with the Office of the Vice-President International, the U of T Engineering Partnerships Office, and government stakeholders to plan for international outreach activities, increasing engagement with key regions, countries, academic institutions, and industry partners to promote partnerships and investments for the Faculty's researchers.

Chapter 5 Supplemental Material

U of T Engineering Laboratory Inventory Core Facilities

Laboratory	Dept / Facility	Principal Investigator	Laboratory Manager	Website	Location
Advanced Thermofluids Optimization, Modelling & Simulation Laboratory *(ATOMS)*	MIE	Cristina Amon	Carlos Da Silva Leal	link	MC 120F/G
Aerospace Mechatronics Design Laboratory/ Sub-sonic Wind Tunnel	UTIAS	M. Reza Emami		link	SF 4003
Antenna Anechoic Chamber	ECE	George Eleftheriades	Gerald Dubois	link	GB 502
Centre for Advanced Coating Technologies *(CACT)*	MIE	Javad Mostaghimi	Larry (Valerie) Pershin	link	BA 8204
Centre for Applied Bioscience and Bioengineering *(BioZone)* **Limited to Mass Spectrometry*	ChemEng	Elizabeth Edwards	Jordan Wosnick	link	WB 301-303, 305, 307, 308, 311-325, 327, 328, 333, 343-346 WB 403, 405, 407-413, 420
Centre for Research & Applications in Fluidic Technologies *(CRAFT)*	MIE	Axel Guenther	Dan Voicu	link	BA 7175 MC 403, 405
Experimental Fluid Dynamics Laboratory/ Water Channel	UTIAS	Alis Ekmekci		link	AS 144
Fabrication Facility	Myhal Centre		Max Giuliani	link	MY 460

Laboratory	Dept / Facility	Principal Investigator	Laboratory Manager	Website	Location
Flow Control & Experimental Turbulence Laboratory/ Wind Tunnel	UTIAS	Philippe Lavoie		link	AS 103
MarsDome	UTIAS		Jeff Cook	link	4925 Dufferin St.
Microsatellite Science & Technology Centre *(MSTC)*	UTIAS	Robert E. Zee		link	AS M135
MIE Machine Shop	MIE		Ryan Mendell	link	MC 78
Open Centre for the Characterization of Advanced Materials *(OCCAM)*	MSE	Charles Mims, Doug Perovic		link	PT 165-167
Open Centre for the Characterization of Advanced Materials *(OCCAM)*	ChemEng		Peter Brodersen	link	WB 101, 104, 105, 107, 108, 111
Propulsion & Energy Conversion Laboratory	UTIAS	Omer Gulder and Swetaprovo Chaudhuri		link	AS 140
QD Solar Inc.	ECE	Ted Sargent		link	GB445, 445A, SF4204, 4208 SF4105A SF4105F SF4105H
Sargent Group	ECE	Ted Sargent		link	GB 451
Toronto Nanofabrication Centre *(TNFC)*	ECE	Wai Tung Ng	Edward Xu	link	WB 38 PT 464
Vehicle Simulation	UTIAS	Peter R.		link	AS 133

Laboratory	Dept / Facility	Principal Investigator	Laboratory Manager	Website	Location
Laboratory		Grant			
Walter Curlook Materials Characterization & Processing Laboratory	MSE		Raiden Acosta	link	WB 147 WB 53

6.0 Organizational Structure and Resources

6.1 Administrative Leadership and Structure

Leadership in our Faculty is provided by the Dean. The Dean is assisted by the Senior Academic and Administrative Leadership Team, which consists of five Vice-Deans (Undergraduate, Graduate Studies, Research, First-Year, and Strategic); an Associate Dean, Cross-Disciplinary Programs; the Chairs and Directors of the Faculty's academic departments, institutes and divisions; and a number of administrative leaders, including the Executive Director of Advancement, Faculty Registrar, Chief Financial Officer, Assistant Dean, Diversity, Inclusion and Professionalism and others (**Appendix H: Organizational Chart 2023**).

Several new positions have been created since the time of the last self-study to enhance our Faculty's operations. These include the Vice-Dean Strategic, the Assistant Dean, Diversity, Inclusion and Professionalism and the Executive Director, Partnerships. The Vice-Dean Strategic role was created in 2021 to provide leadership on all aspects of strategic importance to the Faculty. The role aims to further advance U of T Engineering's role on the global stage through refining the Faculty's strategy, leading the upcoming Academic Planning process, furthering Institutional Strategic Initiatives, and facilitating infrastructure planning. The Assistant Dean, Diversity, Inclusion and Professionalism was appointed in 2019 and formed an Office with direct reports and resources in 2020. The AD-DIP reports directly to the Dean and therefore provides the Dean direct oversight to monitor the Faculty's outcomes within the portfolio of diversity, inclusion and professionalism, address challenges and drive improvements. The Executive Director, Partnerships position was created in 2022 to lead the overall partnership strategy of the Faculty and support its research and training mission through external collaborations. The roles of Strategic Research Development Officer and Partnerships Development Officer were filled in 2023 to help the office expand its activities and capitalize on opportunities. The office works in close coordination with U of T Engineering and Institute Directors as well as the wider business development community across the university.

6.2 Faculty Governance

The governing structure at the University of Toronto is unique among Canadian universities, with a unicameral system of Governing Council formed in 1972 by provincial statute that replaced the more common bicameral system of Senate and Board of Governors. To learn more about the structure and makeup of Governing Council, see **Appendix I: Governing Council**.

Within U of T Engineering, our formal governance body, the Council of the Faculty of Applied Science & Engineering (Council or Faculty Council), is similarly based on a unicameral system. Council is comprised of all faculty members and representatives of undergraduate and graduate students, professors emeriti, administrative staff and alumni, and serves as the Faculty's highest academic decision-making body. It has oversight and authority over academic policy, principles and priorities, and it sets the general direction for the teaching and research activities of the Faculty. It approves and regulates standards of admissions, establishes committees for the conduct of Council business, and advises the Dean on academic matters. Faculty Council generally meets four times each academic year and is effectively meeting our needs. Council's constitution, bylaws and minutes and documents from meetings are available on our governance webpage.

Initiatives were introduced in 2012 to improve the workings of Council, which continue today. These include working with the chairs and directors of departments, divisions and institutes to

encourage members to attend meetings, spending more time discussing strategic issues, and bringing forward items of broad interest for discussion earlier in their development cycle. Since then, Council meetings have included fruitful discussions on such topics as the core program curriculum, sponsored research, broad-based admissions, academic technology renewal, course evaluations, student mental health, technology-enhanced active learning rooms, and graduate attributes and accreditation, among others.

In July 2020, a Dean's working group was established to support the review and update of the domains, membership compositions and operating manuals of Council's eight standing committees and Academic Appeals Board. The working group created a template for operating manuals to provide consistency, and updated and expanded the Faculty's Procedures for Committees of Council to include general guiding principles pertaining to domains, elections, terms of members, membership composition, performance assessment, etc. The Speaker and Secretary of Council support committees as they continue to update their operating manuals.

Reporting to Council is an Executive Committee comprised of chairs and directors, standing committee chairs, and student, staff and alumni representatives. It is responsible for endorsing the agenda and motions for each Council meeting, reviewing and updating Council's constitution and bylaws, and monitoring the functioning of Council and its standing committees:

1. **Engineering Graduate Education Committee** – Responsible for new graduate courses, minor and major course and program changes; graduate degree level expectations; Faculty-originated, graduate-supervisor awards and University-level nominations; Faculty-level implementation of School of Graduate Studies policies and best practices; and professional development.
2. **Inclusivity, Diversity and Equity Advisory Committee** – Advises on initiatives with respect to undergraduate and graduate students, teaching staff, and non-academic staff, responsible for equity, diversity and inclusion, including aspects of member experience, safety and belonging, professional conduct and diversity in all its dimensions.
3. **Research Committee** – Serves as an advisory and coordinating body to advance engineering research excellence and innovation and strengthen the Faculty's research community; provides advice on research matters pertaining to strategic planning and supports the implementation of the strategic research plan.
4. **Teaching Methods and Resources Committee** – Advises on initiatives with respect to undergraduate and graduate classroom/course instruction, responsible for teaching methods, resources, and aids and evaluating and rewarding teaching effectiveness.
5. **Undergraduate Admissions Committee** – Responsible for admissions, advanced standing, enrolment planning policy, and awards for incoming first year students.
6. **Undergraduate Assessment Committee** – Responsible for course-level grading practices and standards; academic standing including honours, promotion, and Dean's List; final exams policy; use of non-grade statements and symbols; petitions in final exams and for special consideration; and policies concerning term work petitions.
7. **Undergraduate Curriculum Committee** – Responsible for curriculum change and quality control including Canadian Engineering Accreditation Board graduate attributes and accreditation units; selection of sessional dates; and U of T quality assurance and Degree Level Expectations.

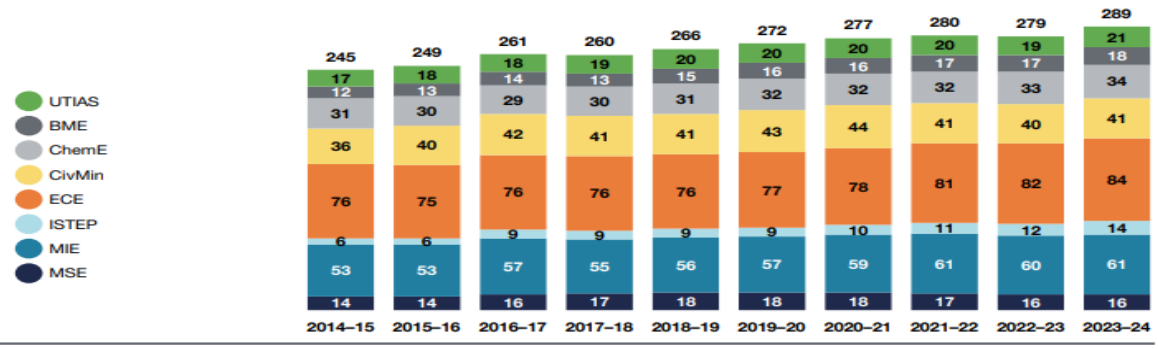
8. **Undergraduate Scholarships and Awards Committee** – Responsible for academic awards, grants and prizes controlled by the Faculty; and promoting student awareness of external awards and aid.

Reporting directly to Council is the Faculty's **Academic Appeals Board (Undergraduate)** which is responsible for hearing appeals of students against decisions of the standing committees of Council relating to petitions for exemptions from the application of academic regulations or standards and to make rulings on such appeals. Academic appeals for graduate students taking graduate courses are the responsibility of departments and the School of Graduate Studies' Graduate Department Academic Appeals Committee (GDAAC).

6.3 Faculty

As of July 2023, the Faculty's academic staff complement consisted of 286 tenured, tenure-stream and teaching-stream appointments (**Figure 6-1**).

In 2022–2023, our faculty members made up only 5.5% of Canada's tenured and tenure-stream engineering professors, yet they earned more than 13.7% of the major national and international awards and honours given to that group (**Appendix C: Figure 5.8b**).



		2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
UTIAS	Assistant Profs	5	4	3	2	3	3	1	1	0	0
	Associate Profs	4	6	6	8	6	6	8	7	7	7
	Professors	6	6	7	7	9	9	9	10	10	10
	Teaching-Stream Faculty	2	2	2	2	2	2	2	2	2	4
BME	Assistant Profs	4	4	4	2	3	3	3	4	4	5
	Associate Profs	3	4	4	6	7	6	6	6	6	6
	Professors	4	4	4	3	3	5	5	5	5	5
	Teaching-Stream Faculty	1	1	2	2	2	2	2	2	2	2
ChemE	Assistant Profs	5	4	4	3	3	1	1	2	3	4
	Associate Profs	5	5	2	4	4	5	5	4	1	1
	Professors	17	17	20	20	21	23	23	23	26	26
	Teaching-Stream Faculty	4	4	3	3	3	3	3	3	3	3
CivMin	Assistant Profs	8	5	8	6	7	8	6	9	6	7
	Associate Profs	9	14	12	12	9	11	10	9	8	8
	Professors	18	20	21	22	24	23	27	23	26	26
	Teaching-Stream Faculty	1	1	1	1	1	1	1	0	0	0
ECE	Assistant Profs	7	5	5	2	1	2	3	6	7	7
	Associate Profs	16	16	15	13	12	11	10	10	7	7
	Professors	49	50	51	56	58	60	61	61	63	63
	Teaching-Stream Faculty	4	4	5	5	5	4	4	4	5	7
ISTEP	Assistant Profs	0	0	0	0	0	0	0	0	1	2
	Teaching-Stream Faculty	6	6	9	9	9	9	10	11	11	12
MIE	Assistant Profs	6	6	9	7	7	9	7	8	8	8
	Associate Profs	15	12	11	12	10	8	8	7	7	7
	Professors	29	32	33	33	36	37	39	41	40	40
	Teaching-Stream Faculty	3	3	4	3	3	3	5	5	5	6
MSE	Assistant Profs	3	3	3	4	3	2	2	1	1	1
	Associate Profs	4	4	4	3	5	6	6	6	4	4
	Professors	7	7	8	9	9	9	9	9	10	10
	Teaching-Stream Faculty	0	0	1	1	1	1	1	1	1	1
Total		245	249	261	260	266	272	277	280	279	289

Figure 6-1 Total Academic Staff by Academic Area, 2014–2015 to 2023–2024

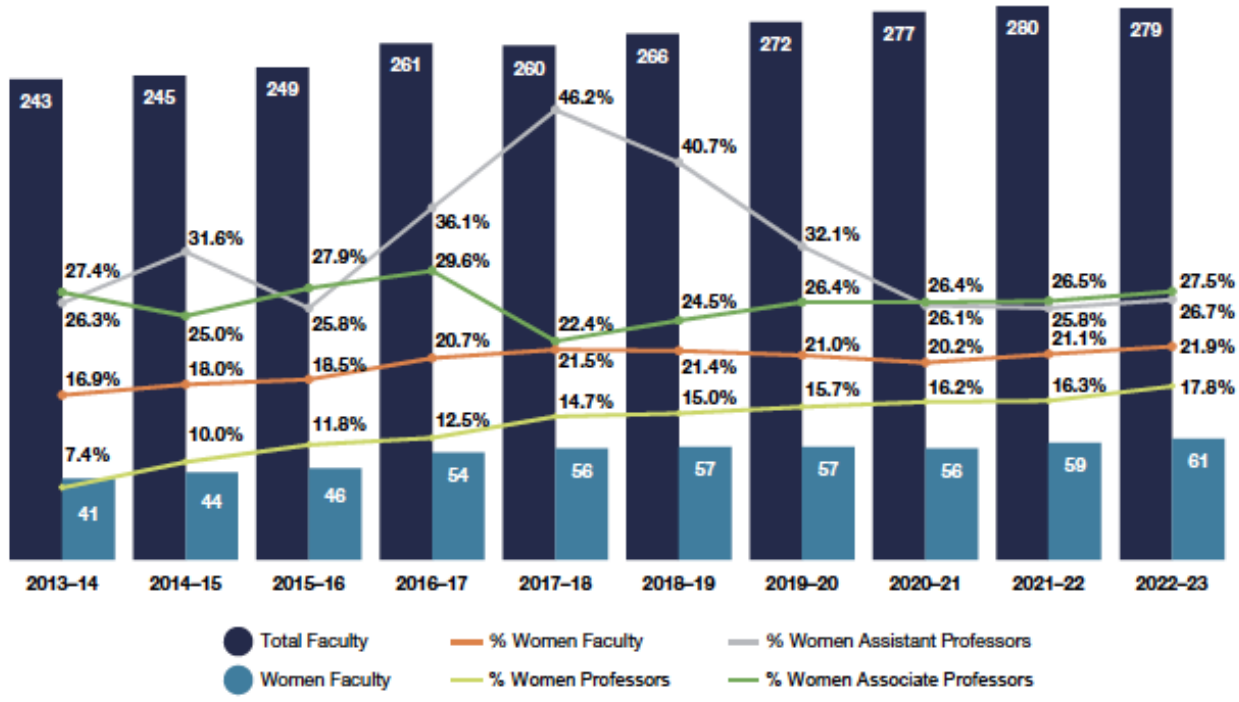


Figure 6-2 Total Academic Staff with Proportion of Women, 2014–2015 to 2023–2024

(See Figure 3.11 from *By The Numbers 2023*)

Over the past ten years, the total professoriate has increased by 17.7%, from 243 to 286. The proportion of women has increased over the past decade from 16.9% to 22.7% (**Figure 6-2**).

Since 2017, we have successfully recruited 47 new tenure-stream faculty, and 18 new teaching stream faculty, with the bulk of these hires completed during the pandemic years (2019-2021). While we have managed to continue to recruit excellent new faculty in strategic and emerging research areas, we have also faced some significant challenges in this area. Certainly, the travel restrictions during the pandemic forced us to adjust some of our traditional recruitment strategies, particularly for international candidates. Perhaps the most critical and challenging factor with recruiting new faculty has been the inflationary increases to the cost of living, particularly housing, in Toronto and surrounding communities. Faculty housing offered by the University is over-subscribed, so U of T Engineering, along with the Faculty of Arts & Science, made strategic investments in renovating 3 vacant University-owned buildings. Each building is being converted into a tri-plex to be used for faculty housing. Occupancy is expected by November 2023 and U of T Engineering will have 1 building, with 3 self-contained units, to assign to new faculty hires. We will continue to work with the University on other creative strategies to mitigate this continuing challenge to faculty recruitment.

In 2018, the University introduced a pathway to senior promotion for teaching-stream faculty. To date, 5 teaching-stream faculty members in U of T Engineering have been successfully promoted to the rank of Full Professor (1 has since retired).

Our faculty members conduct research that cuts across many engineering disciplines and areas

of study. We have particular strengths in strategic areas of bioengineering, information and communications technologies, sustainability, and enabling technologies. For more information on research, see **Chapter 5**.

6.4 Administrative and Technical Staff

U of T Engineering employs more than 420 highly qualified and engaged administrative and technical staff members (**Figure 6-3**). Their breadth of expertise ranges widely and includes financial management, information technology, writing and communications, fundraising, human resources, classroom laboratory support, among many others. In addition to the staff development support offered by the University, administrative and technical staff are provided opportunities to attend conferences, serve on committees, and have a strong and valued voice in strategic decision-making within the Faculty.

Since 2017, the shared service units in the Faculty have grown significantly in scope and size. We established several new administrative units and expanded some of our existing units. New offices include a comprehensive IT office, and a Diversity, Inclusion and Professionalism office. Areas of notable staffing expansion have occurred in the Advancement office, the Engineering Career Centre, the Partnerships office and the Educational Technology office. This growth, while necessary to support the academic mission of the Faculty, has created a strain on our administrative space allocation. With limited ability to expand our footprint, we are exploring shared, flexible workspaces on campus that can be made available within a hybrid work environment.

Recent consultations with staff identified a need for targeted and increased communication from senior management, more opportunities for community-building, and better access to technology and tools to streamline repetitive tasks.

The Faculty results from Pulse surveys conducted by the University in the summer and fall of 2022, show high rates of motivation (faculty 82%; staff 70%), commitment (faculty 85%; staff 76%) and overall satisfaction (faculty 82%; staff 83%) among faculty and staff in their work.

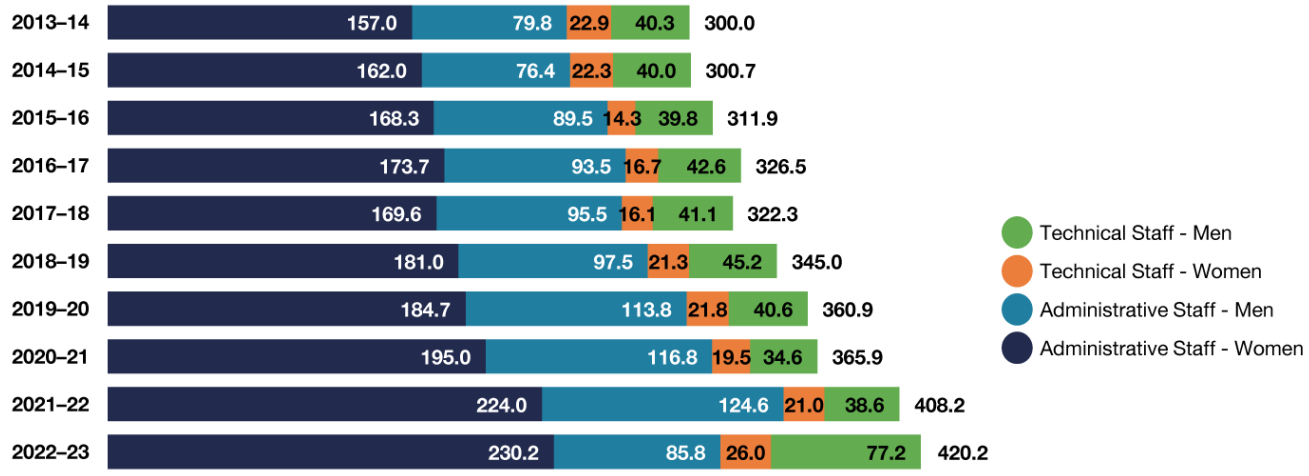


Figure 6-3 Total Staff by Type and Gender, 2013–2014 to 2022–2023

(See Figure 3.13 from *By The Numbers 2023*)

6.5 Advancement and Alumni Relations

In 2019 the University launched Defy Gravity, the most ambitious campaign in Canadian history. For the first time, the campaign includes a goal for alumni engagement: to inspire 225,000 alumni to get involved as volunteers, mentors, donors, participants, and leaders and encourage them to contribute their time and talent to the University one million times collectively. The campaign also seeks to raise $4 billion for the university's highest priorities.

U of T Engineering committed to a fundraising goal of $400M — 10 % of the campaign total. As of the end of fiscal year 2023 we have achieved $100M, 25 % of our total fundraising goal.

The U of T Engineering Defy Gravity campaign is based on the Faculty's strengths in four strategic areas.

Educating the 21st Century Engineer: Our students today arrive at university more educated than ever before, but they also graduate into a more complex world. To train the next generation of engineers, we have designed and continue to design programs that strengthen transdisciplinary competencies and creating curriculum that provides students with lenses to tackle the biggest global challenges. We are committed to increasing student support for mental health and improving equity, diversity and inclusion across the Faculty.

Sustainable Thriving Global Communities: The climate crisis is now incontrovertible, and we are meeting the challenge head-on. We are helping to create sustainable and thriving global communities by conducting groundbreaking research that advances knowledge in sustainable energy, water and more broadly, devising cutting-edge and practical climate and environmental solutions.

Healthy Societies: Over the last century, health science breakthroughs by the world's research community have enabled society to eradicate polio and smallpox, perform complex surgeries in utero and cure cancers that were previously incurable. The impacts of the COVID-19 pandemic, climate change and growing inequity have been a reminder that our collective health security is incredibly fragile. Today, as an international leader in biomedical engineering, U of T Engineering is training the next generation of engineers, finding novel and exciting ways to fight illnesses and developing groundbreaking solutions to some of the most vexing problems in health-care systems.

Intelligent Machines for Good: Helping vulnerable patients recover from injury or stroke at home, reimagining the factory, exploring harsh planetary surfaces— the rapidly changing field of robotics promises to do all these tasks and more. U of T Engineering has the largest and most diverse robotics program in Canada with more than 55 researchers and 7 Canada Research Chairs in robotics. We are training the next generation of robotics innovators, leading groundbreaking research and collaborating with a range of strategic and industrial partners to help initiate a future where robots will extend human capabilities, impact the economy and improve lives.

The year 2023 marked the 150th anniversary of U of T Engineering. To celebrate this historic milestone, we launched an integrated marketing and communications campaign that included global advertising, out-of-home advertising, events, social media, and a dedicated website. In April, we hosted a gala event at the Fairmont Royal York for 1,500 alumni, faculty, staff and students with keynote speaker Chris Hadfield. This once-in-a-lifetime event also marked the launch of Engineering's Defy Gravity campaign.

Restructuring and Staffing

A new Executive Director, Advancement was hired in May 2020 and an analysis of staffing needs to support the Defy Gravity Campaign goals for U of T Engineering was undertaken with key stakeholders across the university. As a result, the Office of Advancement grew from nine staff members to a complement of 31 between Spring 2021 and Winter 2022.

Prior to 2021, the subject matter experts in communications and stewardship were integrated into the alumni and development teams. The reorganization that began in Spring of 2021 created two service centres (operations & stewardship, and communications & events) allowing the alumni and development teams to focus on alumni engagement and solicitation of donors. Fundraising capacity was also substantially increased with the growth of the leadership annual and major gifts teams. Additional fundraisers and support positions were hired to increase major and principal gift capacity. To support the new Defy Gravity engagement goals, the alumni relations team was given an additional team member. All positions are currently filled, and we are in the process of developing a team culture to increase retention and engagement among the staff. We are working with an external consulting firm to build an extensive onboarding program and develop a strong foundation for a culture of inclusivity, trust and support.

Gift Highlights and Donor Stewardship

Another facet of the growth and development of the advancement team is the stewardship program. Now fully staffed, the stewardship and donor relations team is focused on ensuring a seamless experience for our donors. To more meaningfully recognize generosity, we are looking to connect the Dean more closely with our donors and will implement a new video platform to share the impact of their philanthropy and highlight the many initiatives they support.

A few notable major gifts include:

The Rogers Foundation - $30M ($15M to Engineering)

Building on its initial $130M gift in 2014, the Rogers Foundation made an additional gift of $30M in 2022 to sustain the Ted Rogers Centre for Heart Research in perpetuity and bring the promise of precision cardiac health to patients across Canada and globally. U of T Engineering received $15M of the donation, which will be dedicated to transformative research and commercialization at the Institute of Biomedical Engineering (BME)—a unique, multidisciplinary graduate research unit at the cutting edge of innovation in biomedical engineering.

Paul Cadario – Cadario Student Awards and Social Impact Internships - $4M ($2M to Engineering)

The Paul Cadario Student Awards will help create a pathway to experiential learning opportunities for all students, regardless of their financial situation. This endowment will dramatically increase the number of students able to access this valuable programming. The Paul Cadario Social Impact Internships will provide students with a living wage while they work at non-profits and community organizations.

Lorie Waisberg - $2M

A gift to the Department of Chemical Engineering & Applied Chemistry will allow us to

modernize engineering education by creating a sustainable unit operations lab and providing a unique training opportunity for students to learn about net-zero process engineering at scale. The Waisberg Sustainable Unit Operations Lab will be the first of its kind in Canada.

Planned Giving

Beginning in Fiscal Year (FY) 23, all development officers (across Major and Leadership Annual teams) were required to have at least one gift planning solicitation goal. These metrics raise sights, remind team members to focus on a comprehensive philanthropic experience for our donors and help our team reach more donors than ever before. A loyal donor mailing and branded merchandise giveaway was launched this year with two primary goals – stewardship and gift planning prospecting. New prospects identified were added into U of T Engineering advancement portfolios and included in the Division of University Advancement annual solicitation campaign.

Annual Giving (AG) and Leadership Annual Giving (LAG)

The annual and leadership giving program is currently defined by the University as gifts below $25,000. U of T Engineering further classifies gifts of $1,200 – $24,999 as Skule™ Society gifts and monthly donors totaling annual gifts in this range as Skule™ Friends Society members.

In FY23, the annual & leadership giving team outpaced set goals, totaling over $1.4M in donations. Goals for the next FY and beyond include continuing this year-over-year revenue growth, maintaining a high donor retention rate through focus on the donor experience and strategies to acquire new donors to the Faculty. In partnership with the alumni relations team, another goal is to encourage more of our alumni volunteers to become donors to the Faculty.

We piloted several creative mini campaigns to drive engagement, including a global cause funds solicitation, a LAG proposal focused on departmental giving, and a stewardship giveaway to loyal donors celebrating a donor anniversary year. We also developed a thank-you video featuring students for all donor segments, and a student video series solicitation focused on the 150th anniversary of the Faculty.

Alumni Relations

The COVID-19 pandemic provided both challenges and new opportunities. With programming going fully virtual, we saw a significant growth in our alumni engagement regionally. To sustain this growth post-pandemic, our programming has evolved into a blend of virtual, in-person and hybrid events.

In December 2022, we created the “Skule Challenge Coin” as a gift for the pandemic classes of 2020 and 2021. This coin was a physical symbol of all the challenges these students overcame, and a reminder of their constant academic, professional and personal growth to be displayed or carried with pride. This tradition has carried on post-pandemic and continues to be very popular amongst graduating students.

In addition to our regular programming, including speaker series such ask Skule™ Lunch and Learn and Disruptors and Dilemmas, as well as the Alumni Mentorship Program, we have expanded our programming to include regional engagement, affinity-building and young alumni and family programming. We have found continued success partnering with various divisions across the university including the Rotman School of Management, the Faculty of Arts &

Science, the Ontario Institute for Studies in Education, Temerty Faculty of Medicine and the Faculty of Law.

Through the support our Engineering Alumni Network (EAN) Board's Alumni Engagement Committee, we were able to roll out our Regional Ambassadors Program – engaging alumni in 11 different countries who assist our Faculty with hosting alumni events, acting as regional ambassadors for recruitment events, and offering job opportunities.

As our global U of T Engineering community continues to grow, we are actively working to improve methods for tracking and quantifying the social and economic impact of our alumni. In 2016 we piloted CONNECT, an online community where alumni can create a profile, engage with current students, lend expertise and stay engaged with the Faculty— no matter where they are in the world. The platform has been renewed, with the intention of monitoring the ROI as user preferences and social media landscapes change. ARBOR, the University-wide database, remains the most accurate and robust way to track alumni contact information and our interactions. Both ARBOR and CONNECT will assist in measuring engagement for the Defy Gravity Campaign goals.

Volunteer Structure and Recruitment

Throughout its history, U of T has benefitted from the dedication of alumni and fundraising volunteers whose leadership and commitment reflect the ambitions of Canada's premier university and who exemplify the philanthropic support that has helped elevate U of T into the ranks of the world's top twenty universities.

Our volunteers in alumni engagement and fundraising roles contribute in countless ways that support the U of T Engineering's excellence and its valuable connections to local, regional, and international communities of alumni and friends. Such volunteers extend the Faculty's reach and influence, its opportunities for partnership and support, and its profile as a preferred destination for extraordinary philanthropy and engagement.

Alumni Relations Leadership Volunteers

Through the support of the EAN's Nominations and Governance Committee and the support of alumni volunteers on that committee, we have created a process to engage, promote and recruit for our Leadership volunteer positions in Alumni Relations. We have seen approximately 80 applications on a yearly basis for these coveted roles. Many of these leadership volunteers have gone on to volunteer and make a significant impact at the University Level.

The Leadership Roles that we recruit and interview alumni for are as follows:

- The Engineering Alumni Network Board
- Alumni Representatives of Faculty Council
- Alumni Representatives of the following standing committees of Faculty Council:
    - Teaching Methods and Resources Committee
    - Engineering Graduate Education Committee
    - Inclusivity, Diversity and Equity Advisory Committee
    - Undergraduate Scholarships and Awards Committee

A recent survey of alumni volunteers found that the majority volunteer as a way of giving back to the community with the additional benefit of feeling connected to the university community.

Respondents particularly found value in networking and staying abreast of Faculty affairs. In keeping with the post-pandemic event shift, several respondents noted the need for more hybrid or remote volunteer opportunities. This data will be used to inform future volunteer outreach and programming.

Campaign Cabinet

The Campaign Cabinet, comprised of a number of volunteers from across industry sectors and academic backgrounds, are individuals with distinguished records of business, civic, or social leadership, whose stature and influence will attract and inspire the highest level of campaign support. The Cabinet acts as an important strategic and advisory sounding board to the Dean and Executive Director, Advancement, providing insight and advice on campaign strategies to deliver on the goals of the Defy Gravity campaign.

The Co-Chairs of this group will share a commitment to the University's excellence and aspirations, as well as recognize the wider good that every great university serves. They also help establish a tone of warmth, appreciation, and inclusion for those serving on the Faculty of Applied Science & Engineering Campaign Cabinet and other related committees.

Members are selected for the Campaign Cabinet by the Dean and Executive Director, Advancement based on their qualifications and their ability to participate meaningfully, and because they have the knowledge and personal relationships to help the University of Toronto and the Faculty of Applied Science & Engineering. The Cabinet meets quarterly with the Executive Director, Advancement, their personal assigned advancement lead and other institutional leaders, providing guidance on major campaign issues or opportunities that may impede or accelerate campaign progress.

6.6 Engineering Strategic Communications

Comprised of 11 team members, Engineering Strategic Communications (ESC) is responsible for upholding and expanding the Faculty's reputation for excellence among key audiences: prospective students, current students, faculty and staff, alumni, industrial partners, government policymakers and media. In addition to continuously striving for innovation in its cyclical products and projects, the team seeks out novel opportunities to raise U of T Engineering's profile locally, nationally and globally.

The strategy underpinning ESC's work is to show U of T Engineering at the heart of bold solutions to design a better world, with an emphasis on demonstrating impact. This strategy is carried out through a suite of owned communications channels and products:

- 20+ websites including the main Faculty website, sites focused on undergraduate recruitment, graduate studies and special campaigns like the 150th anniversary microsite (combined 2.2M pageviews in 2022–2023);
- Earned media in a variety of outlets worldwide (U of T Engineering earned mentions in 4.6K news stories in 2022–2023, with a combined reach of 9.1B+ impressions);
- Social media channels including LinkedIn, Twitter, Facebook, Instagram, YouTube and TikTok (combined 50K+ followers across platforms);
- Online and print materials to support undergraduate and graduate recruitment (combined 1.1M pageviews in 2022–2023);
- *By the Numbers* (internal-facing, data-centric annual report; 2K PDF downloads in 2022–2023);

- *Impact Report* (external-facing annual report focused on storytelling; 2K pageviews in 2022-2023);
- *Tell Me More: Coffee with Chris Yip* podcast (1.6K+ listens across all episodes);
- *What's Your Story?* faculty profile video series (43K views on first five videos);
- Faculty and staff biweekly newsletter (45% open rate in 2022–2023);
- Materials and event collateral that advance priority areas within the Faculty related to student recruitment; research; partnerships; EDI; health and wellness; and more.

ESC leverages these channels and products in integrated, multi-media campaigns that engage the Faculty's internal and external audiences to advance Faculty-level objectives, defined primarily by the Academic Plan. Recent examples include:

- **Communication during COVID-19** – When the COVID-19 pandemic struck in March 2020, ESC responded immediately, launching a plan to communicate streamlined updates to diverse audiences. Key messages clearly outlined how the Faculty would help students finish the term successfully, amid rapidly shifting information from public health authorities. In tandem, an urgent business need emerged: if incoming students chose not to register for Fall 2020, deferred their admission or withdrew early, U of T Engineering would face an enormous financial challenge. To mitigate this secondary crisis, ESC expanded its communications strategy into a recruitment and retention campaign that reinforced the Faculty's strong global reputation, supportive community and preparedness to deliver an excellent educational experience online. These efforts included news stories, videos, a microsite for incoming students and media relations. Working in collaboration with other areas across the Faculty, these efforts drove 1,359 prospects to accept their offers of admission for Fall 2020, meeting and exceeding enrolment targets. The campaign earned three professional communications awards at the national and international levels.
- **Black History Month** – Each February, ESC leads a Black History Month communications campaign. In 2023, the campaign focused on centering the experiences of Black community members, which achieved 140K impressions and 3K engagements online. The campaign included: a podcast episode featuring alumnus Herman Colquhoun; a story about a new mentorship program that promotes research opportunities to underrepresented students, a Q&A with Professor Philip Asare, Dean's Advisor on Black Inclusivity, and social media videos produced in partnership with the National Society of Black Engineers, which garnered 46K views. In partnership with the Office of Diversity, Inclusion & Professionalism, ESC also built and promoted the Faculty's Black Cultural Competency Toolkit.

ESC collaborates closely with more than 30 staff across the Faculty's academic and administrative units who have a communications function in their roles. Collectively, the group comprise the Engineering Communications Network (ECN). ESC also interfaces and coordinates with U of T Communications and Brand Hub (keepers of the Defy Gravity brand) to ensure work at the divisional level supports broader institutional objectives. As such, ESC creates a range of internal resources to ensure greater awareness and consistency in communication across the Faculty, including:

- Onboarding for new communications staff
- Monthly professional development for all ECN members
- Brand- and Accessibility for Ontarians with Disabilities Act-compliant WordPress themes, publishing tools and content management system support

- Web guidelines, training videos and workshops
- Editorial style guide, writing/editing support and mentorship for unit-level communicators
- Media training for faculty
- Brand-compliant design templates and workshops on graphic design
- Communications consultation on tactics and campaigns led by others in the Faculty
- Crisis communications support
- Speech writing for Faculty leadership
- Digital display system management (i.e., network of screens across buildings)

ESC has identified the following key areas for development for the near future:

- **Better differentiate U of T Engineering's brand from peer schools:** Almost all domestic peer institutions describe themselves as being the 'top engineering school in Canada' that prioritizes working across disciplines to educate the next generation of engineering leaders to address global challenges. U of T Engineering will need to better project a strong brand promise that sets it apart, rather than leaning on the Faculty's favourable position in university rankings as a differentiator. In 2022–2023, ESC engaged an agency to leverage its AI tools to research and analyze the current online presence of the Faculty against five peer schools, which confirmed the convergence in messaging. Looking ahead, the data from this and future communications research will help inform the strategic approach for messaging.
- **Revisit resourcing to support the Faculty's evolving web needs:** ESC created a Web & Digital Coordinator role in 2022 to support the Web & Digital Strategist in the day-to-day maintenance of 30+ sites across the Faculty (including departmental sites). ESC continues to outsource web operations to an external vendor to provide services such as front-end development, security, updates, backups, fixes, feature integrations and more. Reducing future reliance on an external vendor and creating greater in-house expertise around front-end development, search-engine optimization (SEO) and digital marketing would serve the Faculty well as its web presence continues to evolve. Further, it is likely the Faculty will need to explore external web hosting to address slow site load speeds experienced in using local U of T hosting.
- **Proactively build greater capacity among faculty to serve as media experts:** Earned media that spotlights faculty expertise in print and broadcast outlets is invaluable to U of T Engineering's brand. To ensure that all faculty are able to take advantage of this spotlight, ESC is planning to launch a more robust media training program for faculty going forward.
- **Revisit the model for photography and videography:** Reviewers of the Faculty's 2017 Self Study noted a gap in ESC's internal ability to produce photography and videography. The pandemic has delayed progress on this initiative. Instead, the entire ESC team actively enhanced their photography and videography skills, allowing for a democratization of these talents to address immediate need while replenishing professional photography through an external vendor. With campus bustling again and a growing need for strong visuals, ESC may reconsider the model for obtaining a steady stock of high-quality photography.
- **Improve internal communications:** In 2021, ESC created the role of Director, Stakeholder Communications to serve as the main point of contact among internal stakeholders, and to create an internal communications strategy to enable better information sharing among staff, faculty and students. This work remains a high priority, and will resume after a new Executive Director, Communications is hired.

6.7 Finances

6.7.1 University of Toronto Budget Model

In 2004, the University began to develop a new budget model loosely based on the practice of Responsibility Centered Management (RCM). This new model was implemented across the University in 2007–2008.

Under this model, all revenue coming into the University is fully attributed to the academic divisions. University-wide costs are apportioned to the academic divisions based upon related activity-based cost drivers, leaving divisions to manage their own financial well-being. The method incentivizes entrepreneurial behaviour at the unit level.

RCM models also rely upon strategic funds to support new initiatives, promote interdivisional collaboration and fund academic priorities. The University Fund supports those academic initiatives that may not otherwise be financially funded through public grants and tuition funding. Revenue, as defined under the new budget model, includes:

- Tuition
- Ontario Provincial Operating Grant
- Research overhead
- Endowment income
- Canada Research Chair (CRC) income
- Investment and other income

Tuition and Ontario Provincial Operating grants are student-generated and comprise 85% of the total revenue from all sources. However, research funding is not considered as part of the operating budget. The magnitude of student-generated income is an important consideration when setting annual enrolment targets for the Faculty. Any change in the number or mix of students (for example, between graduate and undergraduate, doctoral stream and professional stream, and international and domestic) impacts the Faculty's revenues. The full amount of each of these income types is now reported and is transparent to each of the academic divisions.

The University charges the academic divisions for all University-wide expenses, including:

- Space and utilities
- Information technology infrastructure and support
- University management
- Financial management
- Pension deficit
- Human resources
- University advancement
- Library system
- Research administration
- Student and registrarial services
- University-wide academic expenses
- University-wide general expenses

All costs of running the University are collected into 12 cost bins before being apportioned to the academic divisions based upon their imputed consumption, using activity-like cost drivers.

Two other cost components are deducted from revenues. The first is the Student Aid Set-Aside, which is an annual levy based on enrolment targets to cover the student aid needed that year. A portion of this amount is offset by a revenue stream from endowed scholarships flowing to the division as endowment income.

The second deduction is the division's contribution to the University Fund, which is derived from a 14% tax on the total revenue from the Ontario Provincial Grant, tuition, and investment and other income. The tax is not applied to restricted revenues, such as endowment, CRC or Research Overhead income. The University Fund is a key mechanism in the new model in that it allows the Provost to provide funds for academic priorities and was used to make all divisional budgets the same for the first year, as they would have been under the former model.

This new approach to budgeting provides academic divisions with a greater understanding of the effect of their enrolment and consumption on their budgets, which in turn allows for a better alignment of academic decisions with financial outcomes. It incentivizes divisions to increase research funding and service contract revenue, raise funds from philanthropic sources, and set enrolment targets and mixes that best meet their needs.

6.7.2 Faculty Budget Model

U of T Engineering established a budget committee in November 2005 to track the changes to the University's budget model and to advise on the need for internal changes. In July 2006, the committee was mandated to redevelop the Faculty's internal budget allocation process and this new model, implemented in 2009–2010, gave departments, divisions and institutes similar incentives to manage their budget funding, increase revenues and contain costs (**Figure 6-4**). The concept of attributing revenues and expenses and the principle of transparency were carried through, with the addition of student and faculty income metrics to guide units in their enrolment revenue generation.

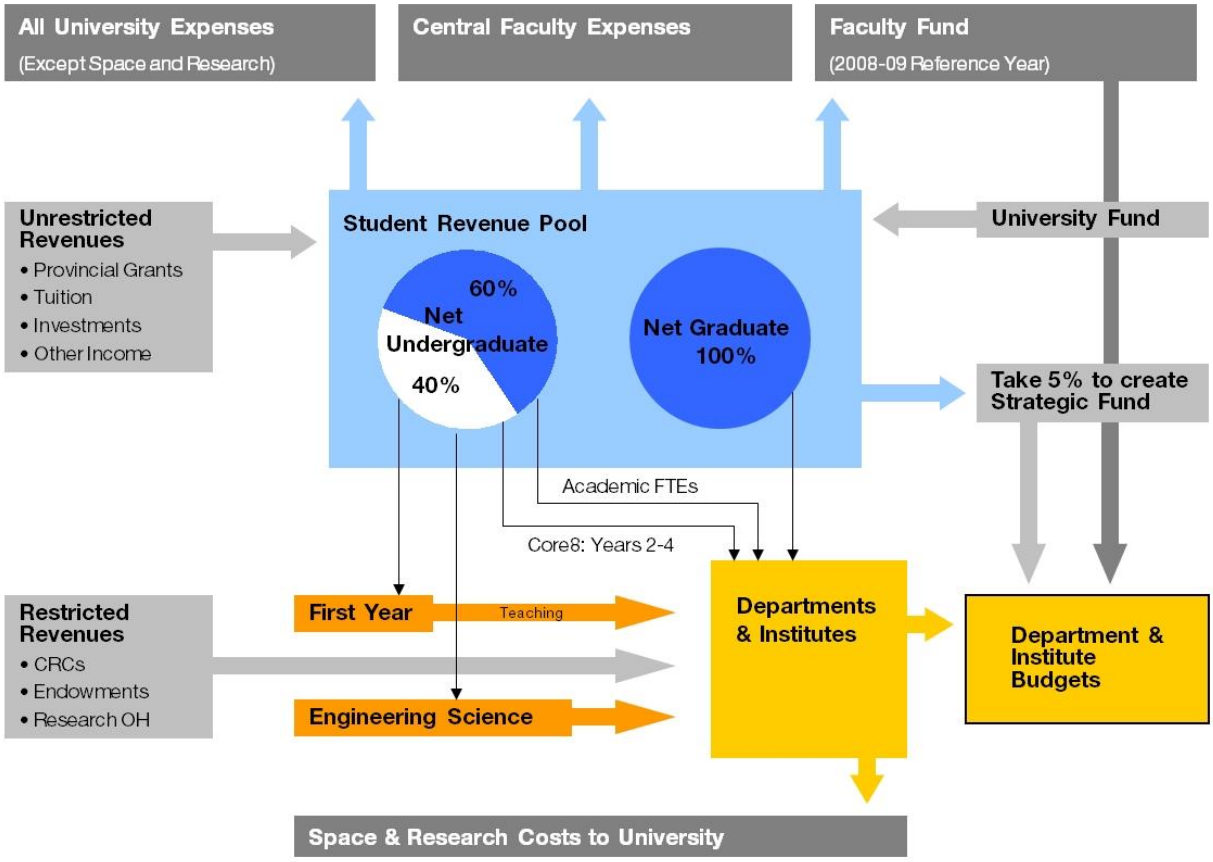


Figure 6-4 Faculty Budget Allocation Process

The revenue sources in the Faculty budget model remain consistent with the budget model for the University. These are unrestricted and restricted revenues. The restricted revenues are Canada Research Chairs, endowments, and research overhead that flow directly to internal units with no discount for central services. The remaining streams, such as provincial grants, tuition, investment and other income, are considered unrestricted. These revenues are first used to pay for selected University-wide and then central Faculty expenses. The method to allocate these revenues to the various internal units is based on a combination of student headcount, academic full-time equivalent and teaching in First Year and Engineering Science courses.

Specifically, the expenses paid by the Faculty to the University are the Student Aid Set-Aside, the Faculty's contribution to the University Fund, and 10 of the 12 cost bins. The two remaining cost bins, occupancy and research administration, are to be paid directly by the academic units within the Faculty. In total, these costs add up to approximately 50% of all Faculty revenues.

The revenue is then collectively used to pay for the central Faculty costs, which consist of salaries and benefits for the staff within the administrative units (Registrar's Office, Advancement, Student Recruitment and Retention, the Engineering Outreach Office, Engineering Computing Facility, Engineering Strategic Communications, and Decanal portfolios), as well as the operating costs for those units. The cost for some units is partially offset by revenues from participants, most notably the Engineering Outreach Office. The central Faculty expenses also include transfers to departments and institutes in support of research for

chairs and directors, the Professional Expense Reimbursement Allowance (PERA) for all academic staff, as well as Faculty-wide scholarships and awards. In total, the central Faculty expenses form approximately 18% of the net Faculty budget.

The final input to the Faculty's budget funding is the University Fund contribution and allocation. The University Fund contribution is derived from a tax on the total revenue from tuition fees, provincial grants, investments, and other income. After contributing, the money collected by the University Fund is then allocated at the discretion of the Provost to the academic divisions. The University Fund allows the Provost to provide funds for academic priorities.

A mechanism similar to the University Fund is employed by the Dean to make discretionary allocations. After an initial equalizing of new to old budgets in 2008–2009, the amount needed to achieve this equilibrium (representing 10% of unrestricted net revenues) is known as the Faculty Fund and has been preserved going forward. A separate fund, known as the Dean's Strategic Fund, is generated each year at a level of 5% of net Faculty revenues to support strategic initiatives (**Section 6.7.5**).

The pool of remaining revenues is apportioned to the academic units based on several revenue drivers. The revenue associated with graduate students is distributed fully on the basis of graduate student counts. The revenue associated with undergraduate students is divided as follows: 60% allocated to the academic units based on their full-time equivalent academic staff counts and 40% distributed based on their undergraduate student counts. Since students in First Year and Engineering Science are taught by the other academic units, an algorithm was created to distribute this revenue based on teaching. Similarly, courses taught for other units, specifically in minor programs, have been identified and an algorithm constructed to charge back the cost to the students' home departments.

The departments and institutes also receive 100% of the revenues from Canada Research Chairs, endowed chairs, and research overhead.

During the year, academic units are funded on a one-time-only basis for approved initiatives from the Dean's Strategic Fund. The academic units are then charged for their occupancy and research administration costs. The cost driver for the occupancy bin is the space in net assignable square metres (NASMs) in a unit's inventory. The three cost drivers for the research administration bin are total research funding (three-year average), the number of research funding applications, and the number of active research funds. The balance remaining is supplemented by their respective allocations from the Faculty Fund (as determined in the equalization year 2008–2009), and the total forms their operating budget.

In the summer of 2013, the Faculty undertook a formal review of its new budget model after three years of use. It was concluded that the Faculty's new budget model was serving the Faculty extremely well and that no significant change in direction was required. As needed, only minor changes are made to ensure the budget model continues to serve the Faculty. For example, in 2014–2015 an adjustment was made to realign the allocation of Central research and innovation administration costs to be consistent with a change made in the University's budget model. Another example, in 2021–2022, the Institute for Studies in Transdisciplinary Engineering Education & Practice (ISTEP) was fully incorporated into the Faculty's budget model after the institute's establishment within the Faculty.

The Faculty's budget model is regarded highly within the University, and in 2022–2023 the

Faculty met with the University of Toronto Scarborough to consult with them as they undertake implementing a new budget model. An additional Faculty is currently considering the U of T Engineering budget model as the template for their own going forward.

6.7.3 Overview of Faculty Finances

Figures 6-5 and 6-6 show the Faculty's budget values for revenue earned and associated central costs attributed prior to any year-end adjustments for the last ten years.

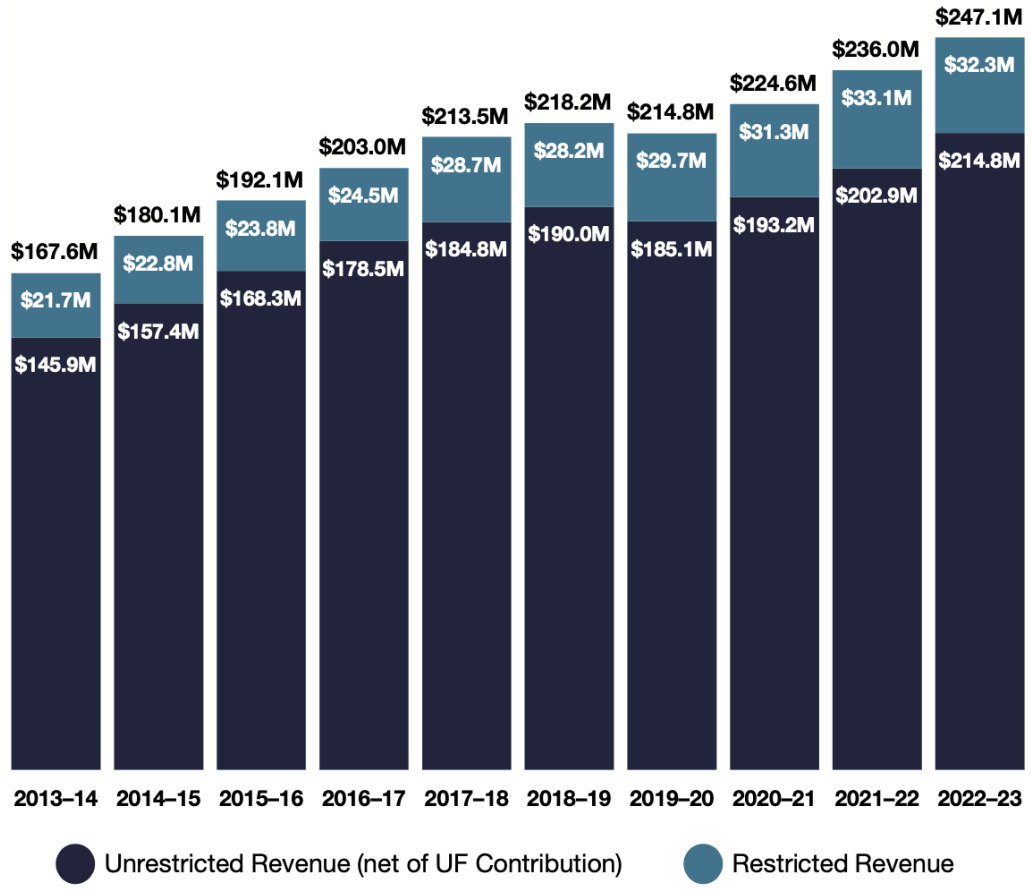


Figure 6-5 Total Revenue

(See Figure 7.1 from *By the Numbers 2023*)

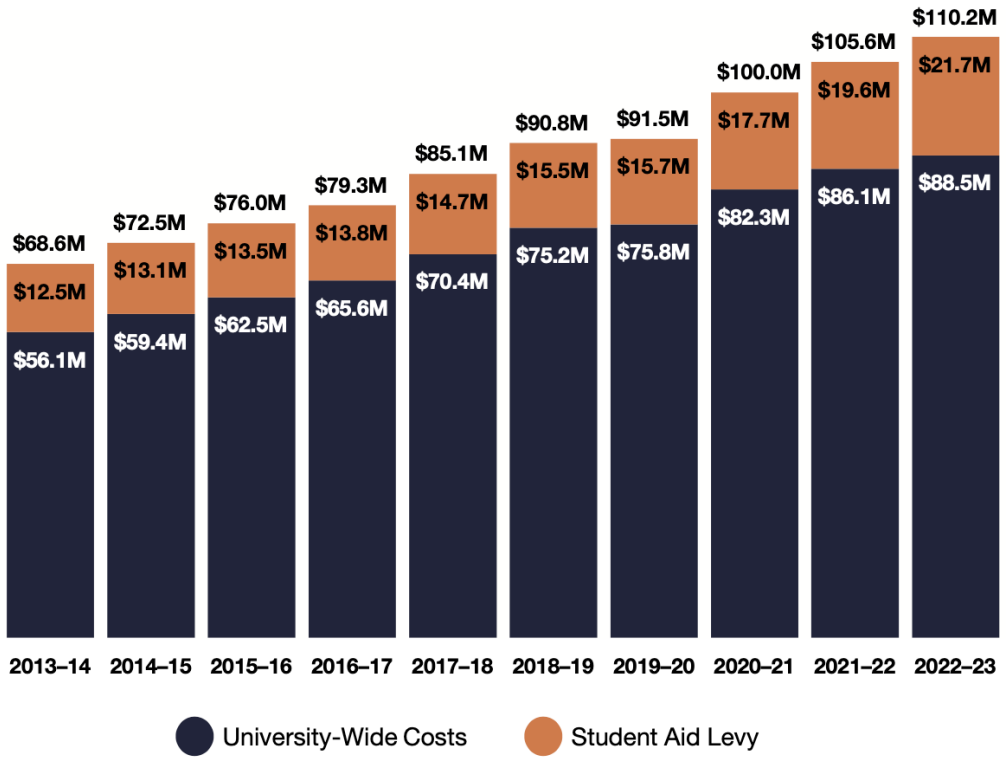


Figure 6-6 Total Central Costs

(See Figure 7.2 from *By the Numbers 2023*)

Figure 6-7 shows data for the fiscal year 2022–2023. The (unadjusted) net revenue for the Faculty, after University-wide expenses, Student Aid Set-Aside, and the University Fund contribution have been paid, is $127.5 million. This is almost exactly half of revenues. This amount is augmented by the University Fund allocation, research overhead, and investment income for a total operating budget of over $150.0 million. The sources of revenue are noted in **Figure 6-8**.

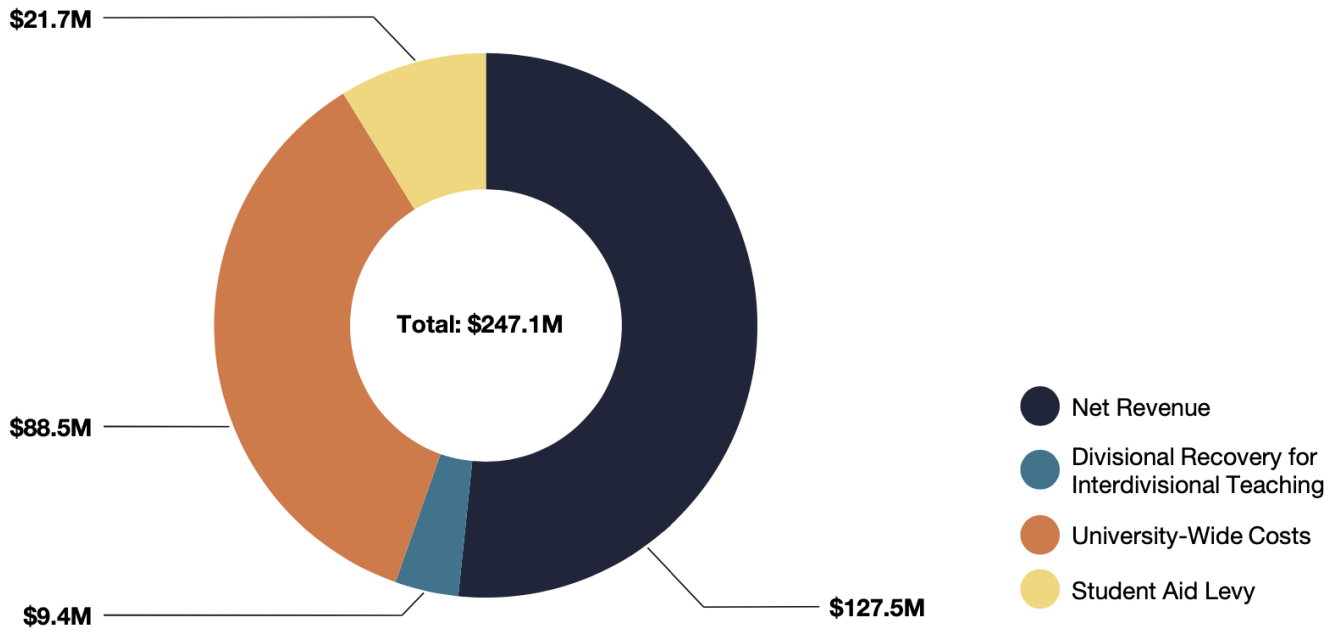


Figure 6-7 Revenue Distribution

(See Figure 7.5 from *By the Numbers 2023*)

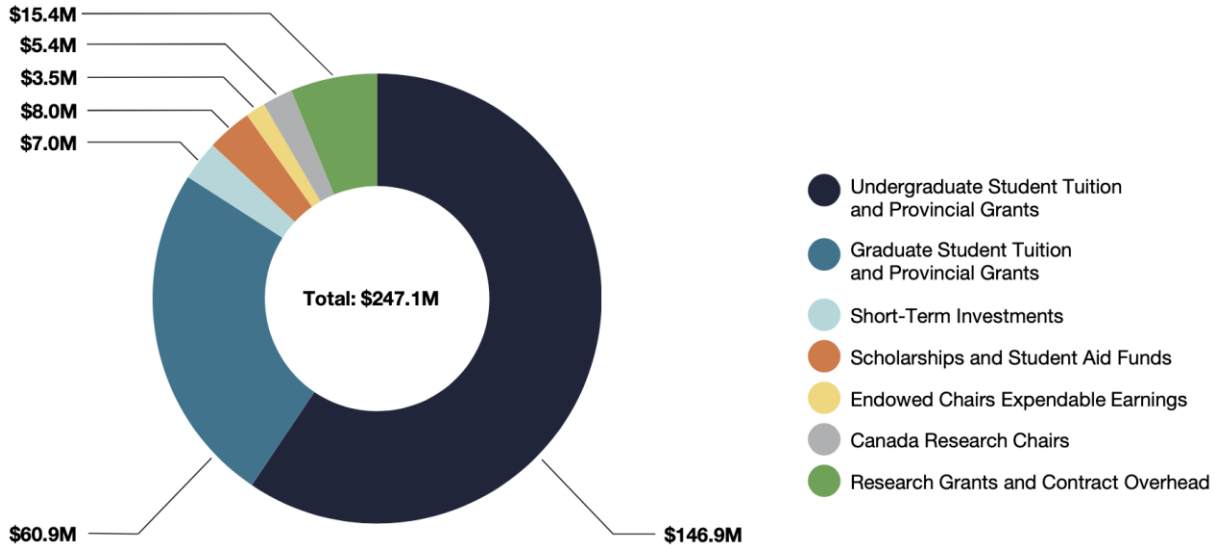


Figure 6-8 Revenue Sources

(See Figure 7.4 from *By the Numbers 2023*)

6.7.4 Interdivisional Teaching Agreement with the Faculty of Arts & Science

The Faculty of Arts & Science and the Faculty of Applied Science & Engineering have a long-standing teaching relationship wherein Arts & Science provides teaching to undergraduate students in Engineering. In 2022–2023, they taught 12% of the undergraduate curriculum for Engineering students, principally across mathematics, physics, computer science and electives.

Prior to the introduction of the University's new budget model in 2006–2007, the teaching and funding relationships between the two Faculties were governed by a number of agreements at both the divisional and departmental levels. After the implementation of the new budget model, these arrangements were essentially frozen into the budgets of the two divisions with no systematic approach to funding the incremental cost of interdivisional teaching provided by Arts & Science to Engineering since 2006–2007.

A revenue-sharing agreement between the Faculties commenced in May 2015 to address the funding of teaching and to provide an academic framework whereby we commit to work together to achieve our educational missions to the benefit of students, faculty and administrators across the units. We established joint committees to oversee and guide interdivisional teaching activities between the divisions and ensure that the main academic objective of maximizing benefit to the students is realized on an ongoing basis. The agreement includes an incentive structure that is positive and appropriate for both divisions and focuses on enhancing the quality and quantity of teaching provided.

6.7.5 Dean's Strategic Fund (DSF)

U of T Engineering launched the Dean's Strategic Fund (DSF) in 2011 to provide seed funding for multi-departmental and collaborative initiatives that will have a broad impact within the Faculty and advance the goals of our Academic Plan. Since its inception in 2011, the DSF has been a powerful catalyst for innovation, providing more than $50M in seed funding to 180+ projects and collaborations that have a broad impact across U of T Engineering. Some examples of DSF-funded initiatives include:

- **The Entrepreneurship Hatchery** — The Hatchery is where U of T Engineering students gain their first experience in translating an innovative idea into a viable business. Established in 2012 with DSF funding, the Hatchery provides a full suite of programs and services to nurture a culture of entrepreneurship.
- **Expansion of the MIE Machine shop** — U of T Engineering is home to more than 100 student clubs and design teams, as well as a variety of design courses, each working through the engineering process – design, build, test, repeat. While ideation can take place anywhere, creating and testing prototypes requires physical space and advanced equipment, not to mention knowledgeable operators. Starting in 2014, the DSF has supported several investments in the MIE Machine Shop, which houses state-of-the-art equipment and provides technical services for all U of T Engineering students and faculty. The facility is open to U of T Engineering community members who successfully meet certain requirements, including passing a basic machining course.
- **BioZone** — In BioZone, multidisciplinary teams work at the interface of biology and engineering to address urgent societal needs in energy, environment, and health. Graduates of BioZone are highly qualified personnel who go on to work in a variety of industries related to bioprocesses engineering around the world. BioZone projects within

it were supported by DSF grants in 2014 and 2017 as well as by industry and government partners.

- **Reconciliation Through Engineering Initiative (RTEI)** — Established with DSF funding in 2018, RTEI is an initiative of the Centre for Global Engineering. RTEI is a participatory research program intended to co-develop solutions to infrastructure-related challenges faced by Indigenous communities across Canada. Working directly with the Elders and residents of Georgina Island, Sioux Lookout and Cat Lake First Nation, U of T Engineering researchers have been exploring pathways for participatory engineering research for some of the most pressing problems in those communities.
- **Positive Zero Transport Futures** — Meeting Canada's target of net-zero emissions by 2050 will require, among other things, a commitment to decarbonizing the transportation sector. Yet simply replacing fossil-fuel vehicles with electric ones will not get the job done, because it does nothing for communities which are already mobility poor and/or experiencing the largest effects of air pollution. Positive Zero Transportation Futures is a DSF-funded, multidisciplinary collaboration that brings together researchers from across U of T, including the Department of Civil & Mineral Engineering, the School of Cities, and the Dalla Lana School of Public Health. Its goal is to take a holistic approach to decarbonization, one that re-imagines cities in ways that make low-emission modes of transportation – walking, cycling, public transit – more accessible.

Initial investment through the DSF often attracts additional funding from other sources, multiplying their impact. In addition, some U of T Engineering research institutes that began as DSF-funded initiatives have gone on to become Institutional Strategic Initiatives (ISIs) at the University level. Examples include the Robotics Institute, the Mobility Network (which evolved from the University of Toronto Transportation Research Institute) and the Centre for Research and Applications in Fluidic Technologies (CRAFT).

6.8 Challenges and Opportunities

The Faculty faces uncertainty with respect to the provincial tuition framework for next year. The provincial Government reduced tuition fees by 10% for the 2019–20 school year. At this time, for the fourth consecutive year, domestic tuition fees remain frozen (i.e., 0% increase) for 2023–2024. While revenues have plateaued with domestic tuition continuing to be frozen, expenses are increasing with inflation remaining high and payroll expenses continuing to grow at a rate of 4–5% (or more) per year. Identifying potential new revenue streams, to supplement our traditional income sources, will be essential to ensure our financial sustainability.

The rising proportion of international undergraduates (now at 27.9% across all years and academic areas) has had a positive effect not only on enriching our diverse environment, but also on funds raised through tuition. This has been particularly important in light of provincial limits on domestic tuition and reductions in the size of provincial grants received for each domestic student. International undergraduate tuition accounts for 55% of undergraduate enrolment tuition revenue and 42% of overall undergraduate revenue.

A healthy balance of domestic students and international students from a diverse set of countries not only enriches our programs, but also protects against regulatory or geopolitical changes that could affect the number of admissions we are able to offer to students in any one jurisdiction. We continue our strategic recruitment efforts domestically and in emerging markets.

We guarantee our graduate student funding through a combination of fellowships, and research and teaching assistantships. Provincial grants cover the bulk of these costs for domestic students, but costs for international graduate students must be covered out of operating funds. We currently receive approximately 74% more applications for MASc degrees from international students than from domestic students; for PhD students, the number of international applications is 2.8 times larger than the domestic number. In response, we have ramped up our efforts to recruit highly qualified students from Canada (**Section 4.3.1**). We have also successfully petitioned the provincial Government to provide some funding for international PhD students in certain circumstances. We will continue these efforts in the coming years to provide the best options to our students, while serving both Canada and the world.

Communications opportunities range from a big-picture rethinking of U of T Engineering's brand identity to implementing an internal communication strategy and better supporting the Faculty's evolving web needs. Building greater capacity among our faculty to serve as media experts and revisiting how we create high-quality photography and videography were also identified as areas for growth and development in future.

7.0 Infrastructure

7.1 Physical Infrastructure: Opportunities

A comprehensive Divisional Space Review undertaken in 2008-2009 determined that the quantity and quality of the physical space available at that time no longer met the needs of the Faculty. We have since completed major upgrades and renovations to research, teaching and student space and continue to do so annually.

The most substantial change to our infrastructure over the past decade has been the successful design, construction, occupancy, and operation of the $100M Myhal Centre for Engineering Innovation and Entrepreneurship (Myhal Centre), which opened in the spring of 2018 (**Section 7.5**).

The Faculty currently occupies 70,913 net assignable square metres (NASMs) across 17 buildings and is committed to an additional 3,521 NASMs in two additional buildings that are forecasted for occupancy in 2024 and 2026 (**Table 7-1**).

Table 7-1 Summary of Buildings and Total Net Assignable Square Metres (NASMs) Assigned to the Faculty of Applied Science & Engineering, 2022–2023

Building	Dean's Office	EngSci	ISTEP	UTIAS	ChemE	CivMin	ECE	IBBME	MIE	MSE	Total NASM*
Aerospace (Downsview)				5,289							**5,289**
Bahen Centre for Info Technology	1,561	581			67		5,528		1,665		**9,402**
Engineering Annex	241						924			91	**1,256**
Electrometallurgy Lab										149	**149**
Fields Institute	332										**332**
Galbraith	1,520		39			5,312	4,318				**11,189**
Haultain	35				198	110			727	721	**1,790**
MaRS West Tower								1,285			**1,285**
Lassonde Mining						1,138		1,362	1,890	832	**5,222**
Mechanical Engineering	63								5,384		**5,447**
Myhal Centre	5,234		573								**5,807**
D.L. Pratt							1,327			1,488	**2,815**
Rosebrugh								949	2,231		**3,181**
Sandford Fleming	629		137	692		1,558	3,547				**6,564**
Wallberg	340				8,299		130			1,381	**10,151**
256 McCaul Street	528										**528**
255 Beverley Street	506										**506**
Total (in-service)	**10,989**	**581**	**749**	**5,981**	**8,565**	**8,118**	**15,774**	**3,596**	**11,898**	**4,662**	**70,913**

Building	Dean's Office	EngSci	ISTEP	UTIAS	ChemE	CivMin	ECE	IBBME	MIE	MSE	Total NASM*
800 College (expected in 2024)	1,343								1,299		2,642
88 College (expected in 2026)	879										879
TOTAL (in service & for 2024-2026)	13,211	581	749	5,981	8,565	8,118	15,774	3,596	13,197	4,662	74,434

*Net assignable square metres (NASM) are a measure of the area that can be used by the occupants of the building.

7.1.1 Space Availability

The availability of space, in particular modern teaching and research lab space that meets current environmental health and safety regulations, continues to be an important issue. Another key concern is the need for modern, purpose-designed space for student-led design teams such as the Blue Sky Solar Racing Team, the Human-Powered Vehicles Design Team, the Formula SAE team and many others.

The Myhal Centre's major occupants can be broadly divided into two types: assigned spaces that accommodate Faculty entities, and spaces assigned to the University's Learning Space Management (LSM) unit that support centrally scheduled teaching and learning. Spaces under LSM's mandate include the Lee & Margaret Lau Auditorium on Levels 1 and 2 (468-person capacity) and the Design Studios and Technology Enabled Active Learning (TEAL) classrooms on Levels 3 and 4.

In December 2017, as construction of the Myhal Centre neared completion, the Faculty and LSM finalized an agreement on space exchanges. The agreement specified that in exchange for those new teaching and learning rooms in the Myhal Centre, which LSM would control, LSM would relinquish to the Faculty several of their rooms in other buildings that could be re-purposed for research and other activities. Most of those spaces have now been allocated to Departments and Institutes, enabling, directly or indirectly, the number of research and teaching labs to be increased. Several projects identified in this Chapter were beneficiaries of this agreement.

The Faculty continues to hold a block of four remaining rooms (**405 NASMs** in total) on the 4th floor of the Haultain Building as a 'strategic space reserve' that is available to address a priority need (e.g., one or more that may be identified in the Facilities Master Plan (**Section 7.1.4**). By having delayed their transfer, that block of rooms has provided much-needed relief to LSM, both during and in the aftermath of the pandemic, as additional scheduled classroom spaces were needed due to physical-distancing requirements and classroom modernization.

The renovation of BA-3008 and BA-3012, formerly LSM tutorial rooms, created a new suite of spaces, primarily for the Faculty's Human Resources team (**Section 7.4**), freeing-up 49 NASMs on the ground floor of the Fields Institute, on College Street. Similarly, the University's purchase of commercial condominium units on the 3rd floor and part of the 4th floor of 255 Beverley Street (at the corner with College Street) for the Experiential Learning Commons (ELC), of which the Faculty and its Engineering Career Centre (ECC) are a 1/3 partner in (**Section 7.1.2**), allowed ECC to vacate 283 NASMs on the ground floor of the Fields Institute as well. In total, **332 NASMs** of assignable space are available in the Fields Institute, on the condition that it not be used for administrative functions.

As the space agreements associated with the occupancies of two Industry and University

partners on Level 8 of the Myhal Centre (Section 7.5) approach their expiry within the next five years, there is an opportunity for the Faculty to either renew one or both of those agreements or to re-assign one or both to meet other priority needs. It's expected that the Facilities Master Plan will consider the pending availability of these two spaces, one at **200 NASMs** and at **219 NASMs**. The Faculty is securing a commercial lease at 800 Bay Street for an initial 12-year term, which is described in more detail in Section 7.1.2.

Over the past five years, ChemE had been developing a rooftop Sustainability Lab (S-Lab) situated atop the eastern half of the Wallberg Building. The fully designed project would have accommodated one wet lab for research, one research office for graduate students, and one exterior research roof-top lab. Despite two tenders, market conditions during the COVID-19 pandemic resulted in bids that simply were not affordable. While some re-design would likely be needed, this is a project that can be considered as a 'shovel ready' project for **437 NASMs** of new lab space.

In early 2023, the Faculty was made aware of an opportunity to become a stakeholder in the third and final phase of the EaRTH District development at the University's Scarborough Campus (UTSC). As described at the time, it is an 11,000 NASM building development. Planned completion is 2025-2030. U of T Engineering participation could be in, but not limited to, the Renewable Energy – EV Discovery Centre "level."

7.1.2 College Street – An East-West Axis of Opportunity

With the Faculty situated in the south-west quadrant of the University's St. George Campus, the Engineering Precinct is bounded on its south side by College Street, a principal east-west arterial thoroughfare that westward from Yonge Street crosses Bay Street, University Avenue, McCaul Street, and Beverley Street towards Spadina Avenue (see **Chapter 7 Supplemental Material: U of T Engineering Neighbourhood**). The University's Four Corners Strategic Framework sets out the intent for an efficient use of its real estate assets, with development plans underway for some of those properties along College Street, its southern baseline. Most prominently, the construction of Schwartz Reisman West, the first phase of the Schwartz Reisman Innovation Campus (SRIC), is nearing completion at 108 College Street, which will accommodate a number of University initiatives related to technology, society and entrepreneurship.

The historic presence of U of T Engineering along College Street is being further bolstered along this east-west axis of opportunity by a trio of projects:

- **Experiential Learning Commons (ELC) at 255 Beverley Street (2019-2023)**
  Since 2017, U of T Engineering, the Faculty of Arts & Science (A&S) and U of T Student Life have collaborated on work-integrated learning programming for students. In their commitment to continue this working relationship, the three divisions resolved to expand the ability to offer services to a growing demand by students through the creation of a new student service facility – the Experiential Learning Commons (ELC).

  In November 2019, the two Faculties, along with support from the Provost, executed a purchase of sale agreement with the developer for the office space of 1,297 sq. m. (13,962 sq. ft.) in the condo/ retail / mixed use development tower located at the southeast corner of Beverley and College Streets. The shell space, comprised of nine commercial units on the 3rd floor and five commercial units on the 4th floor of the 29-storey building, was designed and fitted-out during the pandemic. Particularly noteworthy, the 3rd floor space overlooks the corner of Beverley and College, offering a view of a key gateway to

the St. George Campus. This is considered an optimal location for the new ELC facility due to its proximity to student service programming, both Engineering and Arts & Science student communities, and its prominent public location for prospective employers. Beneficial occupancy by the Faculty's Engineering Career Centre (ECC) and their A&S and Student Life counterparts occurred in March 2023 and is in full operation.

- **EngX Industry Partnerships Concierge Program at 88 College Street (2021-2026)**
  U of T Engineering will be establishing EngX, the Industry Partnerships Concierge Program, at 88 College Street, a University-owned building that is listed in the City's Heritage Register. Strategically located alongside current and future complementary programs at MaRS and SRIC, the program will provide local, national, and international industry partners with temporary space and access to resources to support innovation, collaboration, and co-creation with the Faculty's various departments, institutes and centres.

  The Engineering Precinct is located within a short walking distance to the west along College Street. To the east along College Street is 800 Bay Street where, as described in the next section, the 2nd floor is intended to meet the accommodation needs of the Faculty's industry partners in complementary ways.

  The project is one of eight selected by the City of Toronto, in a competitive process, to participate in and be a beneficiary of its Deep Retrofit Challenge program. Funding from this program will be used on energy retrofits that will offset the incremental design and construction costs required to achieve maximum greenhouse gas (GHG) emissions reductions. Architect selection is nearing completion, to be followed by the procurement of a Construction Manager. Occupancy of the renovated facility is expected to be in 2026.

- **A Commercial Lease of the 2nd and 3rd floors of 800 Bay Street (2013-2025) and the 3rd floor of the Rosebrugh Building**
  Leasing space on the 2nd and 3rd floors at 800 Bay Street (at the corner with College Street) for an initial term of 12 years presents an opportunity to address a critical shortfall in space within the Faculty in general. More specifically, as outlined in the MIE Spring 2022 Self-Study Report, the lease could provide space to expand and develop Mechanical Engineering undergraduate teaching labs.

  The 2nd floor can accommodate 1,350 NASMs of program area and will be used by the U of T Engineering Industry Partnerships Office as well as AGE-WELL to foster and promote links to a range of external partners. This leased space will allow the Faculty to fast-track and bridge the Industry Partnerships Office to their new facilities at 88 College Street while also providing the swing space (up to **1,047 NASMs**) to enable the renovation of spaces in the Engineering Precinct. AGE-WELL is a U of T Institutional Strategic Initiative housed within U of T Engineering that, among other activities, will study safety in aging at home by designing, building, and operating a research-based suite (66 NASM) that is typical of a fully furnished residential apartment or condominium unit.

  The 3rd floor can accommodate 1,300 NASMs for several MIE research groups (Human Factors, Operations Research Healthcare, and Thermo Fluids Healthcare) to be relocated from the 3rd floor of the Rosebrugh Building. Leasehold improvements will be needed on both floors of 800 Bay Street. Those MIE research groups will return to the St. George

Campus as space, charted by the Facilities Master Plan, is developed there in the coming decade. It is anticipated the leasehold approvements could commence in November 2023, for completion in early April 2024.

In turn, the vacated space in the Rosebrugh Building will allow for doubling the size of MIE's primary mechatronics facilities as well as potential future expansion of other labs. Both the Faculty and MIE are looking into the basis of a research collaboration with the Temerty Faculty of Medicine that would see Bio/Chem labs developed on a portion of the 3rd floor of Rosebrugh for Temerty Medicine's temporary use, whereupon they will be handed over to MIE once Medicine's new MSB West Wing accommodations are ready. Alternatively, should the Medicine collaboration not proceed, MIE could fulfill its undergraduate lab plans on the 3rd floor by accommodating two research labs focused on high power electronics and modern manufacturing.

7.1.3 Myhal Centre Space Review (2023)

Located in the Engineering Precinct, the Myhal Centre was occupied in 2018 on completion of its construction (**Section 7.5**). Following the first year of occupancy, a Post-Occupancy Evaluation Report was undertaken by the Faculty.

Now, at the five-year waypoint, and in light of new hybrid alternative work arrangements, the Faculty is undertaking a comprehensive space review of its occupancies in the building. The Space Review will assess how current spaces are being used, identify known and emerging accommodation needs, priorities and opportunities, and recommend actions to improve effective use of space. This review is intended to guide the Faculty's accommodation planning in the Myhal Centre for the next five years by addressing such matters as the Robotics Institute's Consolidation Proposal. It will inform the Faculty's Facilities Master Plan (**Section 7.1.4**) which in turn will be one of the key plans underpinning the development of the Faculty's new Academic Plan.

7.1.4 Facilities Master Plan Study (2023-2024)

Together with University Planning, Design & Construction, U of T Engineering will undertake a Facilities Master Plan (FMP) Study through 2023 and 2024. The FMP's goals are threefold:

1. Build a comprehensive catalogue and assessment of current space use and future needs
2. Outline renovation and improvement projects to respond to these needs
3. Identify larger capital investment through additions and new buildings, either through sole sponsorship or through partnership, across the University's various campuses.

The FMP will complement and enforce the strategic visioning of the Academic Plan that is being renewed simultaneously. Additionally, the FMP will establish a long-term facilities and infrastructure vision for the Faculty and develop a framework that provides guidance for present and future space-planning decisions.

7.2 Research Infrastructure

Over the past several years, we have created new facilities and renovated existing ones to accelerate the world-leading research of our faculty members. Some highlights include:

- **Canadian Centre for Research and Applications in Fluidic Technologies (C-CRAFT) Program of Projects (2019-2023)** — As a cornerstone of the University's 2018 Master Collaboration Centre Agreement with the National Research Council of Canada, the C-CRAFT initiative, supported by the activities within the upgraded Toronto Nanofabrication Facility (TNFC), is fostering translational collaborations that will elicit breakthroughs in polymer-based micro-devices, human organs-on-chip systems, bio-manufactured tissues and semiconductor-based devices. Its activities will foster highly-qualified personnel and will make use of three renovated/consolidated Core Laboratory facilities:
    1. MIE's CRAFT Device Foundry, located on the 7th floor of the Bahen Centre, formerly occupied by ECE's TNFC.
    2. MIE's CRAFT Tissue Foundry, located on the 4th floor of the Mechanical Engineering Building, formerly the Centre for Microfluidic Systems (CMS) facility.
    3. ECE's consolidated and enlarged TNFC facility, building on an existing presence already on the 4th floor of the Pratt Building and having relocated from the 7th floor of the Bahen Centre.

- Together, this trio of projects, with the first two now in full operation, was made possible by means of a Memorandum of Understanding that was reached in 2020 amongst the Faculties of Applied Science & Engineering, Arts & Science, Temerty Medicine, and Pharmacy and the Office of the Vice-President, Research and Innovation, and Strategic Initiatives.

- **Adjustable Multi-dimensional (AMD) Loading System and Upgrade of Structural Testing Facilities (2020-2024)** — CivMin is undertaking a revitalization of the Structural Testing Facility in the Galbraith Building, as part of the proposed long-term research project to establish a mega-scale AMD experimental loading facility for enhancing Canada's infrastructure resilience. Based on a Feasibility Study funded by the Dean's Strategic Fund (DSF), it consists of two separate projects which, together, are substantively funded under a Canada Foundation for Innovation (CFI) Innovation Fund 2021 award:
    1. Demolition and alterations that are underway in the Structural Testing Facility to construct a strong floor to support the new AMD, and
    2. Design, fabrication, and site-assembly of the AMD itself.

- **MC120 Energy Laboratory Renovation – Phase 1 (2020-2023)** — The first phase of a two-phase project to address the upgrading of the Mechanical Engineering Building's Energy Lab is nearing completion to redevelop two new research laboratories within the larger, open-concept MC 120 Energy Laboratory envelope. The two laboratories are:
    1. The CO2 Electrolyzer Pilot Plant (CERT) – to support the research endeavors of Professor David Sinton and his research team in the removal of CO2 from the atmosphere and its subsequent conversion into valuable industrial materials via electrochemical means.
    2. The Thermal Management Systems (TMS) Laboratory – to address the thermal management of battery and charging systems applicable to the design and operation of electric vehicles. This initiative is headed by Professor Cristina Amon and will investigate the heat management of battery cells, modules, and packs to provide invaluable information pertaining to the effective implementation of

battery technology in both vehicular and stationary applications. Once the delivery & installation of the 600 & 800 amp disconnect switches has been completed, and Toronto Hydro has approved them, power can be fed into their grid.

The second phase will address the renewal of undergraduate labs throughout the remainder of MC120 in support of electric and autonomous vehicles and related emerging green technologies.

- **Electrocatalysis and Accelerated Materials Research Lab (2021-2023)** — Conversion of GB-405, formerly a classroom, into a chemical lab for ECE to enable the Sargent Group to carry out research in CO2 utilization and accelerated materials discovery. This renovation meets the need for lab space precipitated by a significant expansion of the research program in Electrocatalysis and Accelerated Materials. The lab will hold 30 trainees, providing access to appropriate lab space for electrochemical workstations and characterization equipment. This $3.2M project is nearing completion and occupancy, with commissioning underway.

- **BME Immuno-Engineering Laboratory (2020-2023)** — The Institute of Biomedical Engineering (BME) is expanding in the area of immuno-engineering. BME does not currently have a wet lab for such research. The plan is to convert the Rosebrugh Building's RS-405 to 412 from offices/seminar room to wet lab space, creating a state-of-the-art facility that meets the Public Health Agency of Canada's Containment Level 2 (CL2) Laboratory certification. This project is one of several projects that will improve the functionality and space utilization in the buildings BME occupies.

Additionally, in 2023 the Faculty identified and assembled an inventory of research facilities that align with the University of Toronto's criteria associated with its Core Facilities (Institutional, Divisional, and Departmental). Twenty such facilities were identified.

7.3 Teaching and Educational Programming & Resources Infrastructure

Recent upgrades to undergraduate classroom, laboratory, and learning resource facilities include:

- **Gull Lake CAMP Bunkhouse (2018-2023)** — The Faculty and CivMin undertook a project to design and build modern and accessible facilities and infrastructure at the University's Gull Lake property in the Township of Minden Hills, 200km from Toronto. The accessibility features include a barrier-free path of travel with two ramped entrances, a barrier-free water closet stall in each washroom, a Universal single-user washroom, two barrier-free shower stalls, and six automatic door operating devices. The ground-breaking ceremony on September 7, 2019, coincided with a celebration to mark the 100th anniversary of Civil and Mineral Practicals (CAMP) at Gull Lake. Built through the pandemic, the new facilities and infrastructure were first used in the summer of 2021.
    - The CAMP program has a renewed focus on environmental, social and economic sustainability to better prepare our students to take their place among the world's engineering leaders as champions of change and stewards of our planet. In addition to land surveying, the curriculum incorporates elements that relate to geology, hydrology, water treatment, woodlot management and sustainable energy systems.

    - The new accessible facilities that were built include the Heavy Construction Association bunkhouse (with six separated bedrooms accommodating up to 96 people), a washroom and shower facility, and a communal meeting space, the MacGillivray Common Room. New infrastructure includes both a Waterloo Biofilter sewage treatment system and a second Hydro One electrical service to the property.

- **Stewart Blusson Visualization Facility (2021)** — Located on the Lower Level of the Myhal Centre, the Stewart Blusson Visualization Facility is a state-of-the-art space featuring a large high-resolution display wall and surround sound system that provides for a unique and immersive viewing experience. It is the first narrow pixel pitch (NPP) direct view LED-based solution deployed for research at the university-level in Canada. The 486-inch screen is 10 feet (high) x 39.3 feet (wide), with 9450 x 2400 pixels. With seating for 20 people, the facility can be reserved. User fees fund the cost of technical support plus the facility's ongoing maintenance cost.

- **Engineering & Computer Science Library Renovations (2018-2022)** — This jointly funded University of Toronto Libraries, Faculty of Applied Science & Engineering (including, but not limited to Dean's Strategic Fund funding), and Facilities & Services project is in use; with the official opening taking place on May 10, 2022. The renovated spaces include four new group study rooms, a new classroom, new windows, new carpet tile, improved ventilation, and refreshed spaces on both floors with new individual study carrels.

- **Printed Circuit Board (PCB) Lab Renovation (2022-2024)** — Following the opening and operation of the Myhal Fabrication Facility (MYFab) in the Myhal Centre, both ECE and MIE have searched for the best way to integrate their activities within the purpose of MYFab and its capabilities and resources. The need to better support work related to printed circuit board (PCB) prototyping and fabrication was identified and resulted in a successful Dean's Strategic Fund application. This project is intended to create an industry-grade prototyping space that is needed by multiple units of the Faculty and will be located across the corridor from the Light Fabrication Facility.

7.4 Administrative & Ancillary Spaces and Related Infrastructure

Some recent improvements to spaces assigned to the Faculty or shared with other University Divisions include:

- **Divisional Human Resources (2022)** — The Divisional Human Resources team was relocated from their accommodations on the ground floor of the Fields Institute into space that was renovated during the pandemic on the third floor of the Bahen Centre, near other Dean's Office occupancies. Formerly centrally managed tutorial rooms, BA-3008 and BA-3012 had been transferred to U of T Engineering under the Myhal Centre project agreement. In addition to accommodating the HR suite of offices, the renovation also provided separate offices for the Assistant Director, Student Experience & Teaching Development, the Mental Health Programs Officer, and the Faculty Health & Safety Advisor.

- **Galbraith West-side Landscaping (2018-2019 & 2022-2024)** — The Faculty initiated and funded a landscaping project to upgrade the outdoor space running along the Galbraith Building's west side, with the intent of designing and building an

attractive, durable, accessible and low maintenance landscape that would appeal to and provide exciting exterior space where students could congregate. Accessibility features include a gently sloping, granite stone, barrier-free path of travel between the St. George Street sidewalk and the colonnaded entrance to the Galbraith Building. The large granite steps also provide for a gradually rising, direct approach from the sidewalk. The sloped walkway and the steps have a built-in heat trace system intended to keep the granite walking surfaces free of snow and ice. While the project achieved that intent, some of its landscaped features also became an attraction to skateboarders, requiring a second project to design and install suitable deterrent measures along the central path of travel between St. George Street and the Galbraith Building's west side entrance, while continuing to maintain accessibility for those needing it.

- **Sandford Fleming Atrium Renewal (2021-2025)** — This project was initiated by the Faculty and the U of T Engineering Society and supported by Provostial funding from a successful Student Space Enhancement Fund (SSEF) application. It will modernize and renovate the basement Atrium spaces in the Sanford Fleming Building, including the food court, corridors, washrooms and student space by improving accessibility, safety, security, functionality, inclusivity and attractiveness. After extensive stakeholder consultations, the architect is preparing two schematic design options: one that adds a ramp to the existing recessed floor, and the other that raises this floor to be level with the surrounding floor.

7.5 Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre)

The Myhal Centre was last reported on in the 2017 Faculty Self-Study for External Review after the building's design had been completed and construction was underway. Since then, construction was successfully completed on time and on budget with occupancy taking place in the spring of 2018. Today, the Myhal Centre is a vibrant hub within the Engineering Precinct for students, faculty and staff.

This building is accessible by gesture-controlled automatic exterior door operators and by elevator from the underground parking garage. Most floors include universal single-user washrooms. The barrier-free Lau Auditorium includes large tables for four to six people, some of which are suited for wheelchairs and accessible from both floors.

While the occupancies within the Myhal Centre continue to include those that were planned for in the 2017 Self-Study, occupancies on Level 8 have expanded under term-based space agreements to include offices for National Research Council of Canada (NRC) researchers and industry and University of Toronto partners: respectively, Fujitsu Consulting (Canada) Inc., and the Faculty of Arts & Science's School of Cities. The 20 project rooms (up to 36 NASMs in size, each) that are intended for short-term (up to two years) usage have proven to be indispensable to the Faculty in helping to manage space-related needs.

The Fabrication Facility (MYFab), operated by the Dean's Office on Level 4 of the Myhal Centre, consists of a Light Fabrication Facility and a Rapid Prototyping Facility, with the Rapid Prototyping Facility operated in collaboration with the Entrepreneurship Hatchery, U of T Engineering's startup incubator. MYFab, a Gold-certified lab within the University's Sustainable Labs program, provides democratized access to physical prototyping resources, with oversight provided by expert staff facilitators. With a focus on hands-on experiential learning, emphasizing the acquisition of troubleshooting and problem-solving skills, MYFab's resources enable students to gain experience with the fundamentals of novel manufacturing technologies,

particularly additive manufacturing, featuring centralized access to:

- materials such as wood, plastics and foams
- digital fabrication using 3D printing and computer numeric controlled laser cutting (with expanded equipment selection provided by MIE)
- traditional fabrication,
- consultation with staff experts,
- safety and tool training,
- mechatronic components, and
- electronic diagnostic and surface soldering equipment (in collaboration with ECE).

The facility's collaborative community building spaces are meant to encourage cross-pollination throughout different engineering disciplines and academic stages. Collaboration with the Faculty's departments and institutes allows for suitable equipment to be placed in MYFab, making it accessible to the entire Faculty community seven days a week.

7.6 Health & Safety

Since the previous Self Study and External Review, the Faculty and the University's Office of Environmental Health and Safety (EHS) collaborated in 2019 on establishing and staffing a new continuing position for a Faculty Health & Safety Advisor (HSA), similar to an existing position within the Faculty of Arts & Science. The HSA reports to both the Faculty and EHS's Executive Director of Research Safety and Compliance.

The HSA is the key point of contact for staff, faculty and students for any requests and questions in the areas of safety, security, occupational risks, laboratory and workplace hazards, assessments, tests, compliance and procedures. During investigations, risk assessments and institutional policymaking, the HSA represents the Faculty's interests, integrating activities, guidelines, training, and risk analysis with various University central units such as the EHS, Community Safety, Fire Prevention, Provost's Office, Vice-President Research & Innovation's Office, Student Life, CRISIS Office, and Facilities & Services. Working together and bringing multiple stakeholders to the table, the HSA provides a comprehensive analysis of risks and facilitates a path forward, protecting individuals (students, faculty and staff) and the organization.

At the outset of the COVID-19 pandemic in April 2020, the HSA guided the controlled closure of the Faculty's laboratories, evaluated risks, and assured the continuity of critical research activities during the closure. The HSA's weekly updates on the University's General Workplace Guidelines provided the Faculty community with up-to-date information about the COVID-19 pandemic and the University's efforts to return everyone back to campus safely. During the 2020-2021 and 2021-2022 academic years, the HSA reviewed departmental return-to-campus plans, along with over 800 individual COVID-related workplace assessments prepared by researchers, student groups and administrative units to manage risk as they resumed their in-person activities. All research, administrative units and student clubs, teams and events were able to safely return by February 2022.

Recent contributions of the HSA include analysis of teaching practices within the Faculty's departments, teaching/learning infrastructure and training. From that analysis, the Faculty was provided with recommendations to pilot the Minerva Institute's safety modules in the undergraduate programs of ChemE and ECE; this is an ongoing project. Additionally, as a member of the Faculty's Design Teams Working Group, the HSA participated in the review of

the standard operating procedures, practices, and activities of Engineering-Society-affiliated design teams and provided the Working Group with recommendations on training, infrastructure improvements and supervision.

In collaboration with Campus Safety, the HSA evaluated the safety and security of several buildings, resulting in recommendations to install AEDs, safety cameras and emergency buttons. In support of individual academic units, the HSA conducted risk assessments and provided recommendations regarding infrastructure and operational changes for high-risk activities, including 3D-metal printing, mold/asbestos/mercury remediation, Level 2 biological hazards and Levels 2 and 3 chemical hazard containment, CRAFT/TNFC and participating in the commissioning of newly constructed and renovated labs.

In the post-COVID period, the Faculty identified a need for additional in-person student training. An effort should be made to unify undergraduate and graduate student requirements for health and safety training, supervision and hazard assessment across academic units. The Faculty's decentralized model presents both a challenge and an opportunity to combine the expertise and best practices across academic units and create one set of training modules or micro-credential courses.

The second challenge is to improve the overall safety culture and awareness among researchers and supervisors. Incident/accident investigations have revealed that many laboratory users are not aware of the requirements to have risk assessments, supervisor permission and regular inspections, which also contributes to weak safety culture in some research fields.

7.7 General Facilities & Infrastructure Needs

Many of the buildings in which the Faculty and its departments and institutes reside are older and have mechanical and electrical limitations. The absence of significant NASMs of 'swing spaces' — which could provide temporary accommodation for up to three years while other facilities are being renovated — and in particular, swing spaces including wet and dry lab facilities, poses an additional challenge to building renovations and retrofits.

Although laboratory facilities are usually identified as either dedicated teaching or research space, the increasing demands of a growing curriculum combined with growing student populations has made it necessary for some academic units to continuously double-up on space utilization, such that laboratory facilities are frequently used for both research and teaching activities. Where necessary, academic units also negotiate for access to additional laboratory facilities that may be available through cognate units. As academic units with specialized wet lab needs are seeing no substantive opportunities to acquire additional space, they are instead seeking to maximize space through consolidation and intensification.

Academic units are also seeking to bring research labs up to current codes and standards, and renovate or expand undergraduate teaching labs, including, but not limited to mechatronics, electric-vehicle themed electronics, artificial intelligence (AI) and robotics. If growth trends continue, there will be shortfalls in office accommodations for faculty, staff and graduate students. In at least one department, several researchers are using ductless fume hoods, in accordance with the EHS approval for their use, as ducted fume hoods cannot be installed.

There continues to be a demand for purpose-designed facilities that can accommodate student-led design teams requiring specialized ventilation, power, fabrication, and the ability to readily move vehicles in and out of garages, including by trailer. While the Myhal Centre has provided many new spaces for fabrication that are often used for fourth-year capstone projects, some of

these projects — for example, those in the biomedical field — require wet lab space, including some that require Level 1 or 2 certification under the Public Health Agency of Canada guidelines: these cannot be added within the Myhal Centre as it is a 'dry' building.

The Galbraith Building continues to be the Faculty's historical 'anchor-building' in the Engineering Precinct of the St. George Campus; accommodating, in addition to Civil & Mineral Engineering and Electrical & Computer Engineering labs and offices, many services that the Faculty provides to current and potentially future students. The current suite of offices, located on the 1st floor of Galbraith, dedicated to the delivery of core services to undergraduate students is no longer meeting the needs of the staff and the students they serve. These offices include the Registrar (within which sit the Recruitment and Admissions offices), the First Year Office (including the Engineering Strategies and Practices Office), and the Outreach Office. While these offices have undergone minor renovations over the last 20 years, the space itself has not been substantially updated to meet growth in both staffing and the scope of services being offered. A redesign of the entire space would align directly with the Faculty's goal to enhance the student experience in FASE. The opportunity before us is to include, as a priority project in the FASE Master Plan, a vibrant and welcoming student service suite of offices, that include a mix of workspaces that foster collaboration among the staff, while also providing the private spaces required for student counselling. It has been recognized that the Engineering Welcome Centre needs to be reimagined and modernized as a hub for student services. There is also the need to enlarge the capacity of the Faculty Council Chambers on the 2nd floor of the Galbraith Building, for both Council meetings and events.

Since the start of COVID in 2020, non-residential building renovation & construction price indexes have seen significant year-over-year increases in the metropolitan Toronto area (e.g., 8.1% Q2 2022 to Q2 2023), with no indication of an easing in escalation. That multi-year escalation needs to be factored into proposals for research funding. Higher than estimated tender results require Academic units to either fund the difference, postponing or reducing other activities, or cancelling a capital project altogether. Often academic projects provide opportunities to address deferred maintenance in buildings, with central University authorities having the discretion to determine the extent of their funding contributions towards those needs; needs that they otherwise deem to be non-discretionary. With aging buildings and infrastructure, this, together with inflationary pressures, also poses an increasingly significant financial risk to the Faculty.

Emerging from the COVID pandemic's restrictions and returning to work in a hybrid environment, has created a heightened awareness and expectations on the part of faculty, staff and students regarding their personal safety and security within buildings on campus. At the same time, there is a recognition of the need to provide access into and through buildings during the workweek. There needs to be clarity between faculties and central University offices regarding the responsibilities for, and funding of, safety and security enhancements (e.g., CCTV, AEDs, emergency call buttons, security patrols) associated with the common spaces of buildings that the Faculty occupies and pays for annually on a dollar-per-NASM basis.

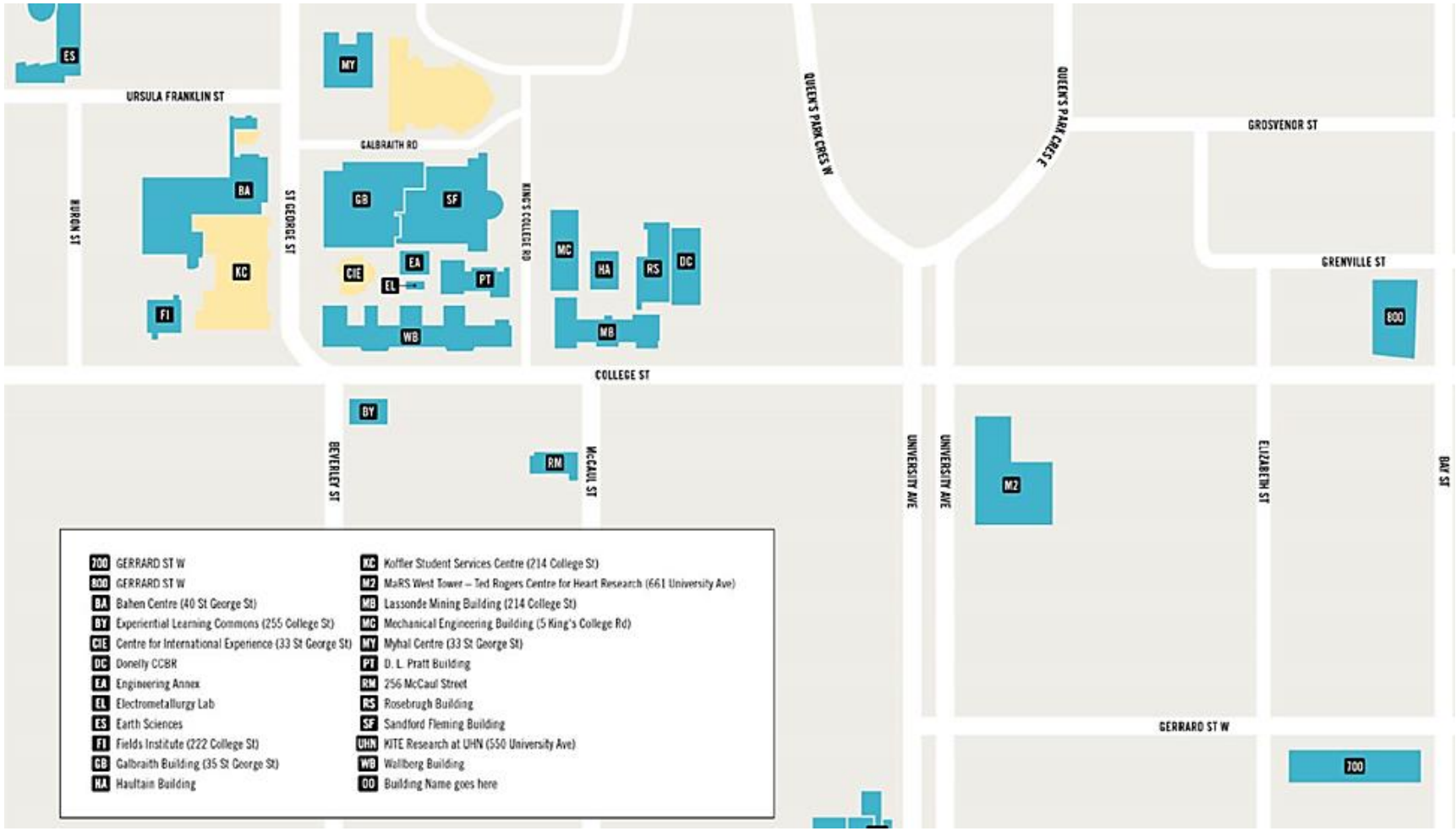
7.8 Challenges and Opportunities

Challenges related to the facilities and infrastructure needs for the Faculty include the need for temporary space during construction, rising construction costs due to the Non-Residential Building Renovation and Construction Price Index (NRBCPI), and reduced funding for the 2023-2024 academic year. Finding accommodations for wet and dry labs is particularly challenging, and proposals for new construction and renovation must factor in NRBCPI

increases. Many of the student-facing services provided by the Faculty are accommodated in spaces that are in need of modernization and renewal to make them both functional and attractive to current students, future students, and their parents.

Opportunities include the Sustainability Lab (S-Lab), a project which is ‘shovel ready’ and would add 437 NASMs of lab space on the Wallberg Building's roof. The Schwartz Reisman Innovation Campus (SRIC) is nearing completion and will house leaders in AI, biomedicine, entrepreneurship, and startups. The Facilities Master Plan (FMP) Study, being conducted in 2023 and 2024, aims to assess current space, outline renovation projects, and plan for future infrastructure needs. The FMP will provide a long-term vision and guidance for space-planning decisions.

U of T Engineering Neighbourhood



8.0 Information Technology

The Faculty of Applied Science and Engineering recognizes that Information Technology is an integral part of enabling research, teaching, and administrative success.

The Academic Planning Framework for 2017-2022 set a goal to create a base-level provision of Information and Technology services across the Faculty and to enhance professional development opportunities for staff and faculty in the use of new technologies.

In response to the academic planning directive, a Task Force on Information Technology was established by the Dean in 2018 to review the state of Information and Technology services, expertise and resources and to identify the critical, baseline needs across the Faculty.

The Faculty Information Technology (FIT) Office was established in November 2019, based on the recommendations of the Task Force. The FIT office was provided with a mandate to lead strategic planning for IT with an overall goal of helping departments and individual units across the Faculty to leverage information technology to deliver outstanding services for faculty, staff and students, and to develop collaborations across all areas of the Faculty in partnership with the University. The FIT office is part of the Shared Services portfolio, which also includes Finance, Human Resources, Academic HR, Data Management, and Infrastructure, all reporting to the Chief Administrative Officer of the Faculty.

This self-study provided an opportunity to review, receive additional feedback, identify key opportunities and to propose recommendations for a path forward for the Information Technology portfolio across the Faculty in preparation for the Academic Planning process.

8.1 Consultations

The Faculty Information Technology (FIT) office team has met with the following departments to solicit feedback on current challenges, opportunities, and vision for the future state of Information Technology. This includes support and resourcing across the Faculty and in the departments, division and institutes, opportunities for better integration, collaboration and collective identification of priorities.

- Department of Civil & Mineral Engineering
- Department of Chemical Engineering & Applied Chemistry
- Department of Electrical and Computer Engineering
- Department of Mechanical & Industrial Engineering
- Institute of Biomedical Engineering

The FIT office team is planning an engagement strategy for administrative and decanal units to receive additional feedback from across the Faculty, as part of the Academic Planning process.

8.2 Key Focus Areas

Areas that need attention and have opportunities for improvement have been grouped into the following six categories: Organization of IT, Client Services, Business Services & Application Development, Data Management, Technology Infrastructure, Risk Management and Cybersecurity. For each area, a brief overview is shared for context, and overall planning objectives and corresponding activities have been identified and presented below.

8.2.1 Organization of IT

The FIT office has been tasked with organizing and collaborating between departmental, Faculty, and institutional IT teams by the Task Force on Information Technology.

Information Technology support and services are distributed across 5 departments and several Faculty units, including the FIT office. In total, there are 52 staff members at the Faculty with Information Technology related job functions: 23 within departments, 7 at the Engineering Computing Facility, 11 at the FIT Office, 5 in the Office of the Registrar, and 6 in the Educational Technology Office. In addition, there are 18 direct managers for staff members with IT-related jobs in the Faculty, 8 of which are also responsible for overseeing non-IT related portfolios. An organizational chart of roles related to Information Technology is provided in **Chapter 8 Supplemental Material.**

The main areas of IT support relate to the Faculty's research, teaching, and administrative work. There is also a growing demand to provide application development and redundancy to support Faculty-wide academic and administrative processes, such as the teaching assistant lifecycle and graduate student management. There is further demand for a Faculty-wide standardized approach for process management and data management through institutionally supported platforms.

Faculty and departmental IT staff have a strong track record of collaboration and continue to work on projects and initiatives with divisional and institutional IT partners around cybersecurity, service delivery, infrastructure, application development, and operational excellence. Faculty IT has organized monthly meetings with IT stakeholders across the Faculty to better share information, align objectives, and to share expertise. Work will continue to deepen the relationship and knowledge sharing between other Faculty, divisional and institutional IT units.

Faculty IT has also set up regular quarterly meetings with the Chief Information Office (CIO) at the University to discuss progress on institutional and Faculty initiatives, as well as to provide feedback to shape institutional IT priorities moving forward.

The Faculty has been an active participant in the institutional pilot projects, initiatives, and working groups, including work on the Institutional Information Security Incident Response Plan and Information Risk Self-Assessment, taking part in the pilot on Cybersecurity training, contributing to the creation of the Institutional Data Management Guidelines, and work on multiple institutional RFP committees.

Faculty IT is also represented on the Advisory Committee on Enterprise Information Technology (ACE-IT) to engage in discussions on direction, planning, priorities and investment for the University's enterprise-level information technology services.

The following objectives have been defined based on feedback received as part of this self-study and drawing from goals set for the 2022-23 academic year.

Objectives:

- Organization of IT resources across the Faculty to ensure consistent, efficient and effective delivery of services.
- Develop capacity for resiliency & agile response in IT service delivery and operations.

- Improve quality of IT service delivery through Faculty-wide guidelines, standards, and best practices for utilizing technology, and leveraging economies of scale for procurement, shared tools and technologies, and services.

Activities:

- Establish an Advisory Committee on Information Technology to set direction and objectives for Faculty-wide IT priorities. This will provide prioritization and direction on how to best allocate the resources of the Faculty to meet the objectives of the Academic Plan.
- Collaborate at the Institutional and Divisional levels to pilot new services, technologies and to share knowledge and expertise across the University.
- Plan for training and education for both faculty and staff, and professional training and opportunities for IT staff, including career development pathways.

8.2.2 Client Services

In today's environment, there are multiple points of contact, and multiple teams focused on the delivery of IT Client Services. Faculty departments offer local, dedicated support services, while the Faculty IT (FIT) office focuses on delivery of services to the decanal office, administrative units, and institutes (ISTEP/Troost ILEAD) in the Faculty. The FIT office also acts as an ambassador for institutionally supported platforms to lead digital transformation for enterprise technologies, such as:

- ServiceNow, a service desk management platform to streamline operations, improve efficiency, and to continue our journey through the stages of operational maturity.
- KACE, a centralized systems management solution to track and manage devices, automate tasks, enforce compliance, and deploy patches for improved security.
- SentinelOne, a cybersecurity platform to protect faculty and staff devices against cyber threats.

In addition, specialized support services are offered both through the Educational Technology (EdTech) office to help faculty members integrate new technologies and tools into their classroom, and the Engineering Computer Facility (ECF) to provide lab computing services for undergraduate and graduate teaching.

The IT Client Services team has made significant progress in enhancing user experience by focusing on the quality of technology deployed. In particular, Client Services has focused on the effective deployment and use of collaboration tools like Microsoft Teams and SharePoint to allow connectivity for a distributed workforce. IT Client Services is also investing in standardized hardware such as laptops to support flexible work in the Faculty, with elevated technical specifications to increase performance, reliability, data security, and privacy.

Effective partnerships have been established across key projects and initiatives, although there is an opportunity to organize services in a way that allows for a combination of centralized and departmental support. This approach is often adopted to strike a balance between standardization, efficiency, and meeting specific needs within individual academic or administrative units. The model aims to deliver a seamless and efficient IT experience to faculty, staff, and researchers while catering to diverse requirements across departments, divisions and institutes.

Looking ahead, the FIT office is poised to continue their impactful work, leveraging emerging technologies, fostering innovation, and delivering exceptional user experiences to further propel technological advancements throughout the Faculty.

Objectives:

The Client Services team within the FIT office aspires to be at the forefront of customer-centric IT services, making a positive and lasting impact on the success of our clients across academic, research, and administrative areas.

- Be the trusted partner and enabler of exceptional client experiences, through innovative technology solutions and unparalleled support.
- Develop a service catalogue and funding models that provide improved transparency for the delivery of common IT services, tailored to the unique needs of each department, division and institutes with scalability and sustainability.
- Strive to promote a culture that fosters greater collaboration, teamwork, communication, engagement, and professional growth for each team member.

Activities:

- Maintain a single Faculty Service Desk that supports IT and audiovisual (AV) technologies and services, and encompasses all key functions and relevant team members, to facilitate effective delivery of client services via a single point of contact model.
- Develop a common IT service delivery strategy to enable delivery of services to departments, divisions and institutes. For departments who decide to opt-in and utilize the FIT office for the delivery of common services, develop an onboarding process that focuses on supporting current-state operations, while managing a transition towards alignment to Faculty-wide standards.
- Leverage industry standards and best practices in IT Service Management (IT Infrastructure Library), Project Management (PMP, Agile), and Continuous Improvement (Lean SixSigma).
- Rollout in-room AV technology within shared spaces for administrative units, transforming the way we communicate and collaborate, facilitating engaging virtual meetings and presentations.
- Utilize a balanced scorecard approach (Key Performance Indicators, Metrics) to measure performance across numerous areas, including financial, customer satisfaction, service level agreement (SLA) compliance, organizational capacity, and learning and growth.

8.2.3 Application Development and Data Management

The Business Services, Application Development, and Data Management team in Faculty IT is responsible for developing enterprise-grade applications to support, standardize, and streamline the business process of individual departments, divisions and institutes in service of the academic mission of the Faculty.

Currently, Faculty IT has been focused on ensuring the necessary resources are available for the Application Development team.

There are 3 full-time developers in 2 Faculty units (Faculty IT and the Registrar's Office), and additional developers in two other departments supporting custom business applications. Each

office is currently using different technologies to develop applications. The Department of Mechanical and Industrial Engineering has recently provided funding for their previous developer role to sponsor the Senior Application Developer position in the Faculty IT office with the goal of better organization for development of business applications for the department and the Faculty.

The application development team for Faculty IT has also recently been hired to address a significant backlog of development work. Their primary focus will be to support & standardize departmental business processes with custom enterprise-grade applications, starting with the Teaching Assistant Management System. This application will improve quality, efficiency, and standardization of the hiring lifecycle for Teaching Assistants for both departmental and decanal (Business Office, Human Resources) units in the Faculty.

The increase of institutionally supported workflow platforms also provides opportunities for the Faculty to support standard business processes without requiring significant development effort. As these opportunities are identified, the FIT application development team will work closely with institutional and departmental stakeholders to implement these tools.

Faculty IT also recognizes that the landscape and expectations for IT infrastructure and service have evolved significantly over the past five years. Currently, research data requests are vetted through institutional research board, and then maintenance, storage, and security of the data is left to individual researchers or departments. Operational data requests are generally managed in an ad hoc fashion by the Registrar's Office or the Office of the Dean. These offices are then responsible for managing all aspects of the data request, including governance, secure storage, and data life cycle. This also creates duplicated effort in creating identical datasets for multiple stakeholders and complicates the data request process. Data stewardship and governance have become a pressing issue for both the institution and the Faculty and require both expertise and cross-departmental collaboration to manage efficiently for researchers, instructors, administrative staff, and students.

To support the development of transparent and streamlined business processes, the team is also reviewing business processes associated with IT (procurement, systems integrations, etc.). The team is starting with the purchasing and reconciliation processes to standardize business services and to provide a higher level of service quality for our departments, Division of Engineering Science, institutes, and other administrative units.

Objectives:

- Develop transparent & streamlined IT business processes that support all units in the Faculty
- Provide expertise for units to improve quality and efficiency of all business processes that leverage IT infrastructure.
- Guide and facilitate data management, stewardship, and governance for all units in the Faculty

Activities:

- Organize resourcing for developers in the Faculty to ensure continuity, professionalization, and specialization that keeps pace with technological innovation
- Mature the Faculty's application development approach to meet current industry best practices

- Build a collaborative, standardized platform for sharing best practices for application development and data management
- Continue developing a Faculty-wide portfolio of business services supported by either institutionally-supported platforms or custom development for the Faculty
- Establish best practices for project and portfolio management to ensure work is prioritized
- Instantiate a business analysis center of excellence for the Faculty.

8.2.4 Technology Infrastructure

The objective of the infrastructure team in Faculty IT is to provide reliable, scalable, and secure technology infrastructure to departments and Faculty units in support of their research, teaching, and administrative functions.

The infrastructure team in Faculty IT has been focused on high-value projects that support all units in the Faculty. The team is working on projects such as implementing ransomware protection through immutable data storage, strengthening availability and redundancy of critical systems, providing more reliable and secure data storage, maturing tools and best practices for network management, and upgrading AV facilities in Faculty spaces.

The team is also planning to work with colleagues across all departments in the Faculty to implement a common authentication platform with single sign-on using the University's UTORID to access all IT services across the Faculty. Single sign-on provides the ability to use our UTORID login to access devices, services and shared files.

Objective:

- Enable departments and Faculty units to provide reliable, scalable and secure technology infrastructure in support of research, teaching, and administrative functions.

Activities:

- Collaborating with departments to implement best practices for efficient and effective network management and support, and appropriate resourcing for enterprise management tools and network equipment renewal.
- Provision of reliable and secure data storage for faculty, staff, and research groups as a baseline Faculty service. Currently, file sharing is done in several ways, often through non-University systems or local storage solutions. These solutions can be insecure, particularly for sensitive information such as research. Increasingly, outside entities are demanding compliance with respect to research data: Non-Disclosure Agreements, sponsored research, research where security practices are based in the country of origin, and collaborative research projects across multiple universities.
- Develop and support co-ordinated responses for disaster recovery, business continuity planning, emergency preparedness and information security incidents.

8.2.5 Cybersecurity and Risk Management

U of T Engineering recognizes that information is a critical asset and that how information, particularly sensitive or protected information, is managed, controlled, and protected has a significant impact on the delivery of services and our ability to achieve our education and research mission. Digital assets must be protected from unauthorized use, disclosure,

modification, damage, and loss, while still being available when needed, particularly during emergencies and times of crisis.

The decentralized nature of the computing environment within U of T Engineering makes it inherently difficult to manage and secure. Most academic units operate their own systems and applications. However, there has been a steady shift towards much greater collaboration across the Faculty and the University.

Over the last four years, progress has been made to improve the information security posture and overall risk levels across the Faculty. This was achieved through participation in the annual institutional Information Risk Self-Assessment process, the introduction of enterprise-grade IT platforms, and collaborative engagement from all departments, divisions, institutes and administrative units in partnership with colleagues from across the University and the IT&S.

In early 2023, the Faculty was able to complete enrolment of all faculty and staff into an institutional two-factor authentication platform (UTORMFA) with one of the highest rates of adoption. This was achieved with strong support of the leadership of our academic departments, division and institutes and collective efforts of all IT staff across the Faculty.

Significant work remains, as the level of security threats continues to increase, and reliance on information technology, data and information continues to permeate all areas of operations and research. Appropriate resourcing of efforts related to Information Security, risk and management of IT are essential. To assist our departments, division, institutes and the Faculty, a new role was established in 2022 - Manager, Information Systems Security. The goal of this role is to help all units across the Faculty to improve Information Security posture, minimizing the risk of compromise to all of the Faculty's IT services and resources, and to champion collaborative institutional efforts in partnership with the Chief Information Security Officer (CISO) of the University.

Objectives:

- To advance, lead and support the use of information technology, while ensuring trust and confidence.
- To deploy and use IT systems in a manner that reduces and mitigates vulnerabilities by following standards, guidelines, and procedures for protecting the University.

Activities:

- Identify and develop Faculty guidelines, standards, and best practices. They should include minimum standards for physical security, vulnerability detection and patch management, identity modernization, end-point protection, timely incident response, and tools/technologies that are low-cost, effective, and efficient.
- Continue to mature the level of information risk by conducting an institutional Data Asset Inventory and Information Risk Self-Assessment with the goal to develop a robust information risk management program to ensure resiliency through effective risk management.
- Conduct an ongoing cybersecurity awareness campaign in partnership with the CISO office, including simulated phishing for faculty and staff, including students/postdocs (in relation to their roles as TAs and/or "system administrators" for their research groups) to establish an information security-aware culture.

8.3 Key Challenges and Opportunities

The primary challenge in the current environment is clearly defining responsibilities between Faculty-level, departmental, and the University-level support in IT services, and aligning efforts between these areas while still delivering efficient and tailored services to further the Faculty's academic mission. Multiple teams provide support for various categories of IT services at various service levels. This leads to overlap, fragmentation and inconsistency in availability, service quality, and standards across units. The decentralized nature of the computing environment within the Faculty of Applied Science and Engineering, both at a Faculty and academic unit level, also makes it inherently difficult to manage and secure.

With the establishment of the Faculty Information Technology (FIT) Office, over the last five years, there has been a shift towards greater collaboration and consolidation of IT-related resources in partnership with academic units across the Faculty and institutional partners. This alignment of resources supports Faculty IT's ability to effectively scale delivery of baseline IT services across the Faculty, to develop enterprise applications in support of Faculty-wide administrative and operational priorities, to modernize and support IT infrastructure in support of research and teaching, and to continuously increase the maturity of cybersecurity and risk management solutions. There is still a need for greater clarity for what is being supported through the University-wide IT operational model and what should be supported through FASE.

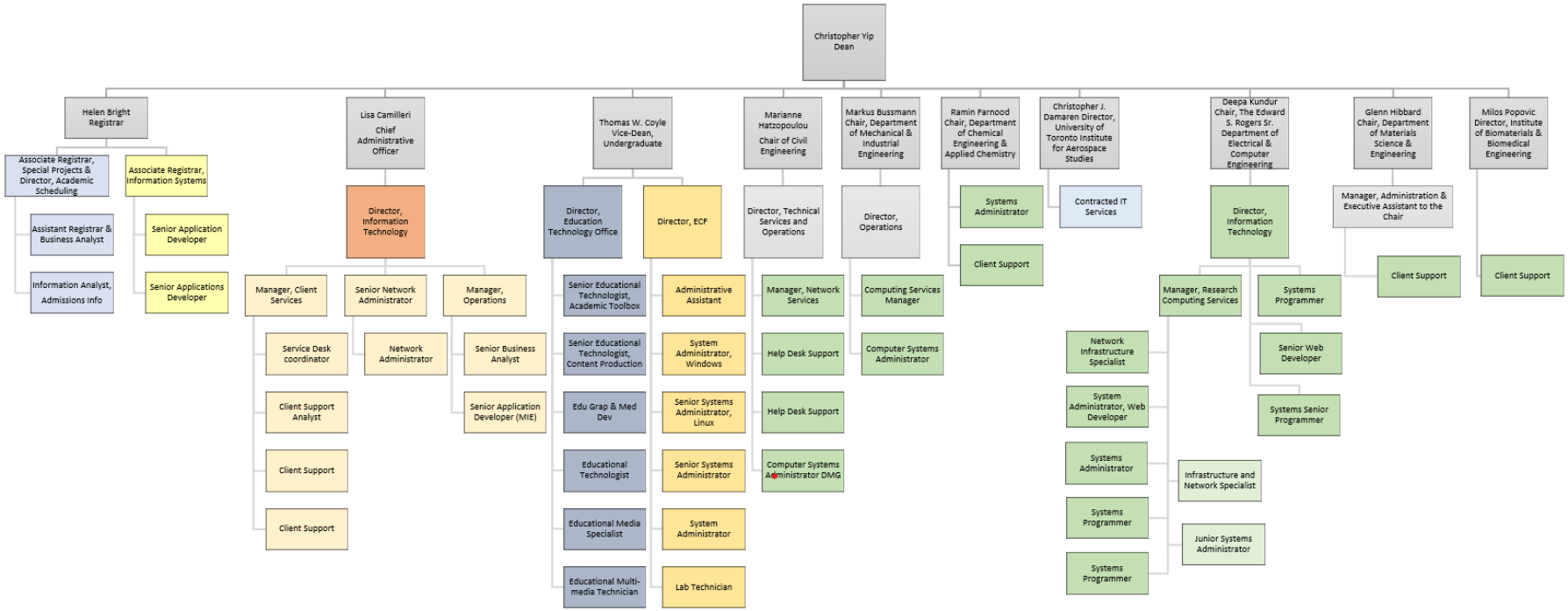
Another significant challenge is talent acquisition. Finding high-performing IT professionals with niche skill sets has become challenging due to a highly competitive labour market for candidates with specialized capabilities. This leads to delays in initiative implementation and ultimately the delivery of the goals and objectives for academic departments and the Faculty.

However, there is an opportunity to develop these required specialized IT skills in our existing talent pipeline by improving our skill development plan and career path plan for IT staff in the Faculty. While not a complete solution, this will begin to address the challenge of recruiting external resources with the skills and abilities needed to fulfill the critical IT mission of the organization by minimizing the need to hire externally. Improving our skill development plan and career path plan will also improve our ability to retain current staff.

Faculty IT's largest opportunity in the next five years is to leverage and to align resources at the Faculty to transform the current IT delivery model with a focus on enhancing user experience, improving efficiency, fostering collaboration, and leveraging technology to advance IT as an enabler to achieve the Faculty's education and research mission. This will only be possible through the building of partnerships as we work together to position the Faculty for success in leading technological change and being prepared for the future.

Chapter 8 Supplemental Material

Faculty of Applied Science and Engineering Information Technology - Organization Chart



9.0 Relationships, Contributions, and Influence

U of T Engineering actively seeks strategic collaborations with other Faculties and Divisions at the University as well as with partner institutions in Canada and around the world. These partnerships enrich our educational programs, accelerate our world-class research, and ensure that our innovations are translated to the marketplace or clinical setting. We are committed to strengthening our existing partnerships, including our network of more than 400 industry partners and more than 50,000 alumni worldwide, while developing new partnerships through strategic initiatives such as joint teaching, exchanges, internships, research collaborations and policy discussions. We have built strong relationships with governments at all levels, as well as with transnational entities such as the Organisation for Economic Co-operation and Development (OECD), for example, through their Climate Change and Health Discussion Group. We also work with non-governmental organizations both here in Canada and around the world on specific research projects as well as on larger educational initiatives.

9.1 Relationships with U of T Faculties and Divisions

The University of Toronto — comprised of 18 Faculties and Divisions and an even greater number of departments, colleges, centres and institutes — is among the top 50 institutions worldwide across all major international rankings. Collaborations between our Faculty and other groups within U of T include joint degree programs (8.1.1 and 8.1.2), professional development offerings (8.1.3) and multidisciplinary research networks (8.1.4). Current partners include the Faculties of Arts & Science, Information, Music and Dentistry, the Leslie Dan Faculty of Pharmacy, the Daniels Faculty of Architecture, Landscape and Design, the Temerty Faculty of Medicine, the Dalla Lana School of Public Health, the Ontario Institute for Studies in Education (OISE), the Rotman School of Management, the School of Continuing Studies, U of T Mississauga and U of T Scarborough.

9.1.1 Collaboration in Undergraduate Programs

We provide our undergraduate students with opportunities to complement their degrees with non-technical elective courses offered by other Faculties within the University of Toronto. We also collaborate with other Faculties to provide technical and math offerings in our programs. In 2015, we developed an Interdivisional Teaching Agreement with the Faculty of Arts & Science to formalize this relationship (6.7.4). This agreement enables our Faculties to work together more effectively and guarantees a number of non-technical elective course slots for engineering students. It enables us to provide core teaching to a number of programs within the Faculty of Arts & Science (such as Materials Chemistry) and we are open to including students from outside our Faculty in our minors and certificates.

Many of our minors and certificates are delivered in collaboration with other U of T Divisions, such as the Engineering Business minor and certificate (Rotman School of Management) and the newly launched certificate in Public Policy (i.e., Munk School of Global Affairs & Public Policy in the Faculty of Arts and Science).

One notable and recent example is the new Minor in Global Leadership that launches in September 2023 With a focus on interdisciplinary curricular and experiential opportunities, this unique tri-campus minor aims to prepare students to become globally confident future leaders who recognize and embrace diversity, face challenges with empathy and champion respectful collaboration in a globalized world. The program will be open to undergraduate U of T

Engineering students, as well as undergraduate students at U of T Mississauga, U of T Scarborough, the Faculty of Kinesiology & Physical Education and the John H. Daniels Faculty of Architecture, Landscape, and Design. The final course, a hands-on capstone project, will be delivered by U of T Engineering.

Some engineering students undertake additional courses to complete an Arts & Science minor program, such as economics, sociology, languages, cinema studies, philosophy, history and music, among others.

9.1.2 Collaboration in Graduate Programs

Our graduate collaborative specilizations formally recognize multidisciplinary expertise and enable our graduates to distinguish themselves in a competitive global environment. In addition to receiving a graduate degree conferred by their home program, students who complete a collaborative specialization receive a transcript notation indicating the additional specialization.

The Faculty administers five graduate collaborative specialization:

- **Collaborative Specialization in Psychology, Psychiatry & Engineering** — First launched in 2017, this specialization allows MA, MSc, MASc and PhD students to contribute to the interdisciplinary scholarship at the intersection of psychology, psychiatry and engineering. Participants come from the following units:
    - Faculty of Applied Science & Engineering (MIE, CivMin, ECE)
    - Faculty of Arts & Science (Psychology)
    - Temerty Faculty of Medicine (Psychiatry)

- **Collaborative Specialization in Neuromodulation** — Launched in 2022, this unique program introduces MSc, MASc and PhD students to various neuromodulation modalities, preparing them for research or industrial endeavours in neuromodulation. Participating units include:
    - Faculty of Applied Science & Engineering (ECE, ChemE, MSE, MIE, BME)
    - Temerty Faculty of Medicine (Medical Science)

- **Collaborative Specialization in Robotics** — Launched in 2022, this program enables MSc, MASc and PhD students to build a structured community of practice that combines engineering and computer science approaches to robotics and its applications, including health care, mobility and advanced manufacturing. Participations come from:
    - Faculty of Applied Science & Engineering (UTIAS, BME, ECE, MIE)
    - Faculty of Arts & Science (Computer Science)
    - Temerty Faculty of Medicine (Rehabilitation Sciences)
    - U of T Mississauga

- **Collaborative Specialization in Biomedical Engineering** — Offered by the Institute of Biomedical Engineering (BME). MSc, MASc and PhD students in this program can expand their expertise in a particular research field while gaining knowledge in biomedical engineering. Students are supervised or co-supervised by faculty with an appointment to BME, and come from the following participating units:
    - Faculty of Applied Science & Engineering (ChemE, ECE, MSE, MIE)
    - Faculty of Arts & Science (Chemistry and Physics)
    - Faculty of Dentistry

    - Temerty Faculty of Medicine (Biochemistry, Laboratory Medicine & Pathobiology, Medical Biophysics, Physiology, Institute of Medical Science, Rehabilitation Science Institute)
    - Leslie Dan Faculty of Pharmacy (Graduate Department of Pharmaceutical Sciences)

- **Collaborative Specialization in Engineering Education (EngEd)** — Created in 2014, this program enables MA, MASc and PhD students to join a community of scholars interested in research and learning at the nexus of education and engineering practice. Participants come from the following units:
    - Faculty of Applied Science & Engineering (ChemE, CivMin, MIE, ISTEP)
    - Ontario Institute for Studies in Education (Curriculum Studies and Teacher Development)

In addition to these programs, our students can choose to participate in numerous other collaborative specializations led by other Faculties within the University:

- Cardiovascular Sciences (Medicine) — Open to BME MASc and PhD students, and ChemE MASc and PhD students
- Developmental Biology (Medicine) — Open to BME MASc and PhD students
- Environment & Health (Arts & Science) — Open to ChemE MEng, MASc and PhD students
- Environmental Studies (Arts & Science) — Open to ChemE and CivMin MEng, MASc, and PhD students
- Genome Biology & Bioinformatics (Medicine) — Open to ChemE and BME PhD students
- Global Health (Public Health) — Open to ChemE MEng, MASc and PhD students
- Health Care, Technology & Place (Medicine) — Open to BME and MIE PhD students
- Knowledge Media Design (Information) — Open to MIE MEng, MASc and PhD students
- Musculoskeletal Sciences (Medicine) — Open to BME MASc and PhD students
- Neuroscience (Medicine) — Open to BME MASc and PhD students
- Next-Generation Precision Medicine (Pharmacy) — Open to ChemE PhD students
- Resuscitation Sciences (Medicine) — Open to BME PhD students and MIE MEng, MASc, and PhD students

9.1.3 Collaborations in Professional Development

Since 2009, the Faculty of Applied Science & Engineering has partnered with the School of Continuing Studies (SCS) to offer a suite of professional development courses such as building science, energy management, AI and robotics, and certificate programs that support international engineers seeking professional engineering opportunities in Canada.

This collaboration has evolved steadily as professionals in industry leverage the expertise of U of T Engineering researchers to advance their knowledge through leading-edge training. Recent examples include:

- **Electric Vehicles** — A bespoke offering in 2022 of micro credentials in electric vehicle technologies for 300 staff at Porsche Cars Canada, leveraging the expertise and leadership of the U of T Electric Vehicle Research Centre.

- **Biomanufacturing** — In fall 2023, a set of three micro-credential courses in biomanufacturing will be offered publicly for the first time. These hybrid courses include an in-person component at the facilities of the Centre for Commercialization of Regenerative Medicine located in MaRS. Course development was supported through the Ontario Ministry of Colleges and Universities' Micro-credential Challenge Fund.

9.1.4 Collaborations in Research

Our faculty and students address complex challenges that cut across traditional disciplines. Through our active partnerships with industry and collaborations with other faculties and divisions across U of T, we ensure that our research and commercialization solutions are timely and relevant.

9.1.4.1 Multidisciplinary Research Centres, Institutes and Initiatives

U of T Engineering leads more than 30 multidisciplinary research centres and institutes that unite professors from across the University. Examples from the past five years include:

- **Centre for the Sustainable Built Environment** — Launched in 2023, this institute brings together seven researchers from across U of T, as well as a dozen companies in construction and related industries. The goal is to identify strategies that will lower the environmental footprint of new infrastructure across the board by reimagining how they are designed, where they are built and what materials they are made of.

- **Lassonde Institute of Mining (LIM)** — Expanded to a multi-department institute in 2021 with researchers from CivMin, MIE, UTIAS and Earth Sciences, the institute is focused on the innovation and sustainability of mining for the 21st century.

- **CRANIA NeuroModulation Institute (CNMI)** — Established in 2020, CNMI is the educational arm of the Centre for Advancing Neurotechnological Innovation to Application (CRANIA) led by the University Health Network in partnership with U of T. Operating within the Faculty of Applied Science & Engineering, CNMI brings together experts in the fields of neuroscience and engineering in a collaborative hub for neuromodulation research and education.

- **Centre for Analytics and Artificial Intelligence Engineering (CARTE)** — Launched in 2019, CARTE brings together more than 30 professors with expertise in optimization, analytics and AI, as well as diverse domains such as energy, transportation and life sciences.

- **Robotics Institute** — Created in 2014 within the Faculty of Applied Science & Engineering and expanded to a University-level Institutional Strategic Initiative (8.1.4.2), the Robotics Institute brings together researchers from U of T Engineering, the Faculty of Arts & Science, the Temerty Faculty of Medicine, U of T Mississauga and U of T Scarborough. Its members study a wide range of robotics applications, from planetary exploration to the delivery of health care.

Since its inception in 2011, the Dean's Strategic Fund (DSF) has been a powerful catalyst for innovation. The intent of the DSF is to encourage novel ideas to be implemented that might otherwise not begin due to a lack of startup funding. Preference is given to proposals that bring

forward collaborative, multidisciplinary ideas, as well as projects that expand on current resources established throughout the Faculty and leverage existing institutional initiatives.

Over the past decade, the DSF has provided more than $50 million in seed funding for projects and collaborations that have a broad impact across the Faculty, including both CARTE and the Robotics Institute mentioned above. Many have gone on to become self-sustaining, permanent additions to U of T Engineering — from internationally recognized research institutes to upgraded laboratories and enhanced manufacturing facilities.

Recent examples of DSF-funded projects include:

- **Reconciliation Through Engineering Initiative (RTEI)** — Established with DSF funding in 2018, RTEI is an initiative of the Centre for Global Engineering and a participatory research program intended to co-develop solutions to infrastructure-related challenges faced by Indigenous communities across Canada. Working directly with the Elders and residents of Georgina Island, Sioux Lookout and Cat Lake First Nation, U of T Engineering researchers have been exploring pathways for participatory engineering research for some of the most pressing problems in those communities. By engaging in projects that blend traditional knowledge and western engineering research precepts, RTEI seeks to facilitate long-term partnerships between engineering researchers and communities on focus areas including food security, clean water, housing, energy and transportation.

- **Positive Zero Transport Futures** — Formed in 2022, this multidisciplinary collaboration brings together researchers from across U of T, including CivMin, the School of Cities and the Dalla Lana School of Public Health. Its goal is to take a holistic approach to decarbonization, one that re-imagines cities in ways that make low-emission modes of transportation — walking, cycling, public transit — more accessible.

9.1.4.2 Institutional Strategic Initiatives

The University's Institutional Strategic Initiatives (ISI) portfolio increases U of T's capacity to support large-scale, high-impact interdisciplinary research.

Several of U of T's 22 ISIs were founded within U of T Engineering, are led by U of T Engineering professors, or have strong connections with U of T Engineering Researchers. These ISIs are described in detail in Chapter 5 (see section 5.4). A short list of ISIs with strong U of T Engineering involvement, along with a description of those connections, is provided below: of ISIs founded within U of T Engineering:

- **The Acceleration Consortium —** Several U of T Engineering researchers with expertise in materials, additive manufacturing and energy are a core part of this work, including Professors **Jason Hattrick-Simpers** (MSE), **Gisele Azimi** (MSE), **You Zou** (MSE) and **David Sinton** (MIE).

- **Aging Gracefully across Environments using Technology to Support Wellness, Engagement and Long Life NCE Inc. (AGE-WELL)** — Professor **Alex Mihailidis** (BME) is the founding Scientific Director and CEO of AGE-WELL.

- **The Climate Positive Energy Initiative** — Professors **David Sinton** (MIE) is the founding Academic Director of the Climate Positive Energy Initiative.

- **The Centre for Research and Applications in Fluidic Technologies (CRAFT)** — Several U of T Engineering faculty bring their expertise in biomedical engineering, chemical engineering and mechanical engineering to CRAFT, including Professor **Axel Guenther** (MIE) who serves as its co-director, and leads the Biomanufacturing pillar, and Professor **Milica Radisic** (BME, ChemE) who leads the Organ-on-a-chip pillar.

- **Medicine by Design** — Professor **Michael Sefton** (BME, ChemE) is the Scientific Director of Medicine by Design, and Professor **Alison McGuigan** (ChemE) is a member of its executive leadership team.

- **The Mobility Network** — The Mobility Network grew out of the University of Toronto Transportation Research Institute (UTTRI) which was founded in CivMin. Professor **Eric Miller** (CivMin) the Director of the Mobility Network, and several key faculty members involved in this ISI contribute their expertise in chemical, computer, industrial, aerospace and civil engineering.

9.2 Relationships with Industry and Other External Partners

We continue to establish and nurture a broad set of relationships on the local, regional, national and international levels in order to remain at the leading edge of global engineering education and research.

9.2.1 Industry Collaborations

Over the past five years (2019 to 2023), U of T has received funding from more than 260 unique industry partnerships from across Canada and around the world, including multinationals such as Fujitsu, Vale, LG, Johnson & Johnson and Hitachi, as well as Ontario companies such as Magna, Litens Automotive, and Kinross Gold. A full list of industry partners from the last five years can be found in **Appendix C, Figure 4.6b.**

Many of these partners collaborate with faculty or institutes on research and may sponsor design projects through capstone courses or the University of Toronto Institute for Multidisciplinary Design & Innovation. They may also employ students directly through the Professional Experience Year Co-op Program, hold recruitment fairs, deliver guest lectures in our Faculty, or provide philanthropic support.

In 2023, the position of Executive Director, Partnerships was filled to set and execute strategic priorities and partnership initiatives for the Faculty. Two supporting positions, Partnership Development Officer and Strategic Research Development Officer were also created to support these efforts. The U of T Engineering Partnerships team serves to increase the sustainability and impact of Faculty research and development through partnership revenue, long-term industry and public sector connections, knowledge sharing and transfer and student experience.

This team works alongside the partnership teams in the Office of the Vice-President, Research and Innovation and the Office of the Vice-President, International to amplify the Faculty and University profile in international markets. For example, framework agreements with strategic partners like Fujitsu, LG, and Vale have been established. Framework agreements outline the overall terms of the collaboration allowing multiple PIs to launch projects with the partner

quickly and easily as Statements of Work requiring little in terms of further negotiations.

The University of Toronto's Innovations and Partnerships Office (IPO) also enables researchers to strengthen their relationships with industry. For example, IPO and our Faculty have partnered to organize industry visits that showcase our unique capabilities. In our self-study consultations, researchers noted that such activities are helpful, and must be highly targeted. There is also an opportunity to further improve IPO's intellectual property agreement process by streamlining the procedures, reducing the turnaround time, and developing clear timelines and milestones.

The Partnerships office also works with the Faculty's dedicated Mitacs Business Development Advisors to assist faculty in securing funding for trainees to gain valuable professional experience and skill building through internship and exchange with academic, public and private sector partners. In 2019, U of T Engineering created a shared position with Mitacs for a Business Development Director (Wil de Vega) to help promote the program within the Faculty, create matches with industry partners, and streamline the administrative process of proposal preparation and submission. This led to more uptake by faculty and to a measurable increase in the number of Mitacs internships within U of T Engineering. A second position was added in 2022 to build on this success.

Since 2019, there have been several international business development trips with the objective of initiating new relationships and opportunities, and for stewardship of current partners. Connecting with industry leaders in Japan, Germany, Sweden and Taiwan show promise in the mining/industrial sectors, automotive industry, AI and other sectors for which U of T Engineering has priority and talent including electrification and clean energy, materials discovery and environmental biotechnology.

Recently, the Faculty Partnerships team held consultation meetings with stakeholders including partners and PIs. The aim of these consultations was to better understand our capacity to meet opportunities and challenges ahead successfully by assessing our current standing, gathering feedback on the progress of the partnership, and identifying areas that require additional support. The following summary provides an overview of these consultation reports from five specific partnerships, providing a representative sample of the various types of partnership agreements we have established.

1. **The Fujitsu Co-Creation Research Laboratory at U of T**

U of T has had a longstanding relationship with Fujitsu, spanning 25 years. In 2018, U of T and Fujitsu partnered on a framework agreement to form the Fujitsu Co-Creation Research Laboratory, that has engaged more than 10 faculty members and 25 graduate students and post-doctoral researchers. Since its launch, the Fujitsu Co-Creation Research Laboratory has been credited with major advancements such as the advent of the Digital Annealer, a computing architecture that is inspired by quantum principles. This technology has been employed by Fujitsu for optimizing the transformation process of legacy telecommunications networks and marks the first time in the world that quantum inspired technology has been applied to network modernization. In addition, our collaboration with Fujitsu involves philanthropy, research internships and co-location. For example, some U of T Engineering students have had internships at Fujitsu in California and Japan.

U of T's collaboration with Fujitsu was established by Professor Ali Sheikholeslami, who takes an active role in supervising and training students on how to interact and engage with our

partners, ensuring that both students and our counterparts at Fujitsu have adequate support. Fujitsu has expressed satisfaction with their collaboration with U of T Engineering, stating that it has resulted in significant returns. In particular, Fujitsu values U of T researchers' diverse backgrounds and experiences, that enables us to develop unique research perspectives and solutions, highlighting how this synergy brings added value to both Japan and U of T. The success of this partnership is now used as a model for engaging industry and a relationship that we strive to extend beyond electrical and computer engineering and into our other departments as well.

The Partnerships office has identified a need for increased support in this collaboration, specifically in terms of administrative assistance for U of T scientists visiting the company. It is essential to engage professors in a timely and consistent manner, and bureaucratic challenges such as delayed responsiveness to the requirements of visiting scientists and unclear administrative procedures can hinder the development of this relationship. Moving forward, our office will strive to establish more defined administrative procedures to address these issues effectively.

2. Framework Agreement with Vale

In 2019, U of T began a partnership with Vale Energy Transition Metals, a multinational mining company and leading global supplier of responsibly sourced nickel, copper, cobalt, and platinum group metals. The initial partnership consisted of individual sponsored research projects that Vale tells us "relied on a relationship or conversation with a Vale team member and a professor to begin scoping; the success was dependent on the type of professor and the experience level of the Vale team member" and that "internally, they were hard to manage".

In 2023, U of T established a framework agreement with Vale. This type of advanced partnership will not only seek to drive sponsored research projects, training, professional development, and research for community engagement for the Faculty, but also strengthen Canada's position in the critical minerals sector by developing sustainable mining solutions and fostering Canadian skills and talent. For Vale, this multiyear strategic partnership accelerates and expands their portfolio of decarbonization efforts and circular mining knowledge. It creates a research program that focuses on the recovery of minerals critical to battery development, providing an opportunity for Vale to benefit commercially as the electric vehicle industry in Ontario grows. An initial $1.6 million investment from 2023-2025 will fund several multidisciplinary projects led by experts from both institutions.

This unique partnership is seen by Vale as having maximum benefit. An official at Vale notes that "having the [Framework Agreement] is helping us communicate and prioritize goals that would have been lost. [It] is creating opportunities that we never would have realized in the old model." Vale also cites U of T's reputation as a top reason for moving forward in partnership: "We want to leverage the breadth of expertise at the University and learn from professors who are top in their fields. We are also looking to attract top talent and grow as an employer of choice. It is important to work with U of T because of the variety of experts and the recognition as the top university in Canada."

3. Joint Initiative between U of T and NRC: CC-GEM

The Collaboration Centre in Green Energy Materials (CC-GEM) is a joint initiative of the National Research Council of Canada (NRC) and the University of Toronto, formally launched in June 2019 with an initial 7- year term. Under the agreement, NRC and U of T will each

contribute 50% of the cost of graduate students and post-doctoral fellows (PDFs) involved in joint projects. With this partnership, CC-GEM aims to integrate synergies between U of T and NRC to develop next generation photovoltaics and platform technologies that will power a greener Canadian economy.

CC-GEM is currently involved in 10-15 active projects with NRC and there have been 4 calls for proposals over the past 5 years. Although student exchange plans with NRC were temporarily disrupted due to the pandemic, the intent is to revive this opportunity at the earliest. One important element of this partnership is the need to sustain the program by involving an industry partner. This approach offers an excellent opportunity to foster technology development at lower technology readiness levels in partnership with NRC, with further commercialization opportunities following subsequent industry support.

Overall, the NRC has had a positive experience with negotiating and finalizing research agreements with U of T, primarily because both institutions share a common understanding regarding the purpose and utilization of intellectual property (IP). Likewise, the process of establishing the partnership and aligning the scope of work between NRC and U of T scientists has been highly productive. This is largely because U of T researchers' overall interests and capabilities align with the complementary expertise of our NRC colleagues. The Engineering Partnerships office has supported this partnership through administrative support and project coordination. However, it is crucial to leverage the partnership further and actively explore opportunities to increase the budget and the number of projects funded per year.

4. Infrastructure Donations and Collaborative Research with Hitachi High-Tech Solutions (HTS)

The U of T-Hitachi HTS relationship is a more than three-decade-long collaboration that was recognized with a Synergy Award for Innovation from the National Sciences and Engineering Research Council of Canada (NSERC) in 2022. Synergy Awards recognize partnerships that demonstrate effective models of relationships between industry and academia.

The partnership, which began as a dealer/customer relationship when assistant professor Doug Perovic bought a Hitachi Field Emission Microscope, grew when Perovic set up the Ontario Centre for the Characterization of Advanced Materials (OCCAM). Since 2008, Hitachi HTS has provided nearly $5 million in support for OCCAM, a facility containing leading-edge equipment for studying and manipulating materials using electron microscopy accessories and techniques.

Hitachi HTS draws on practical challenges encountered in OCCAM to develop new technologies and procedures creating a reciprocal partnership. This partnership has led to scientific discoveries, publications in high impact journals, worldwide commercialized licenses of new software, training opportunities for highly qualified personnel and graduate students, and Hitachi HTS employment for U of T Engineering graduates. Currently, there are 3 U of T graduates working at Hitachi HTS that are playing critical roles in the partnership: 2 former master's and 1 PhD student. Hitachi HTS is also sending a scientist to U of T's Department of Materials Science and Engineering for a year-long placement to strengthen the partnership.

Hitachi HTS provides a deep discount for U of T Engineering on electron microscopes and works with our researchers to demo and test various applications. They have also previously held an office in the MSE department and were interested in having their name on the OCCAM facility. This history is suggestive that a future co-location model may be of interest to this partner.

Hitachi HTS notes that beyond the publishing of collaborative papers and the hardware and software research and development funneled into product development for them, one of the most positive aspects of the partnership with U of T is our reputation. This helps them with their own client groups. The people we train on their equipment are highly specialized and have unique skills that transfer directly into Hitachi HTS and they feel that our professors and students are of very high quality. They note that as this partnership continues, there is room for improvement in terms of remediating delays and problems with processing and executing agreements and contracts that hold up the work.

5. Specialized Stronach Centre for Innovation (SCFI) MEng program with Magna International Inc.

Launched in 2008, the MEng program for the Stronach Centre for Innovation (SCFI) is a joint initiative with Magna International Inc. to provide Magna employees with the opportunity to pursue a specialized MEng through a major technical project and coursework. This program began when Magna identified that there were some gaps in their training, and had the sense that employees proficient in innovation, patent protection, and development of new products would be critical to enabling their business to survive.

When Magna put the idea out to bid, U of T's training proposal was the most attractive. Over the years, trust has been built with adjunct professor Kornel Farkas, who recruits instructors, drives the design of courses specific to Magna's needs, and seeks feedback on courses. He has consistently responded to any requests or perceived need for changes. Magna is happy with this partnership which has established several quality relationships between professors and instructors hired to teach the Magna specific courses. Building on the theme of customized educational offering for partners, the Centre for Analytics and Artificial Intelligence Engineering has successfully established a model of training industry members in AI/ML and Data Science methods, yielding micro credentials for the learners. The high demand for this type of training and the fact that it is sector-agnostic in nature has contributed to its rapid growth. A similar initiative was devised by Prof. Olivier Trescases (ECE) in collaboration with SGS to train Porsche Canada employees in Electric Vehicle technology and literacy. A significant advantage of this approach is that the core content is transferrable to other automotive companies and is therefore scalable.

Going forward, we will seek to meet market demand by increasingly offering flexible, industry-relevant micro credentials while building strong relationships with specific entities that could yield more in-depth, long-lasting corporate education partnerships.

Summary

The partnership narratives presented above were chosen to capture a diverse set of relationships established at U of T Engineering, and to uncover details pertaining to their success or to the challenges they face. Below is a partial summary of these learnings:

- Trust and good relationships between PIs and partners is of paramount importance – it represents the foundation of collaboration and is a necessity for initiating and growing successful partnerships.
- Our largest and most successful partnerships are not transactional in nature. Although we are delivering to our partners tangible benefits, some with commercial potential, the relationship is usually seen as symbiotic by both parties, and anchored at a deeper level,

especially when featuring more than one engagement mechanism (R&D, talent, philanthropy, co-location, etc.)

- The role of a PI Champion(s) in leading a large-scale partnership is key – that leadership is a strong driver in creating additional opportunities for collaboration with colleagues.
- The process of establishing an ambitious framework agreement ($1M+) cannot be understated in its complexity. This requires consistent and persistent relationship building over time with multiple organizational stakeholders and key decision-makers within both the company and the Faculty, as well as a cultivation of the partner to a stage at which a large proposal is mutually agreed upon as the desired route.
- Once established, framework agreements confer a range of benefits that partners appreciate, such as flexibility and simplicity.
- Institutional partnerships such as those with NRC are crucial to maintaining high relevance as Canada's premier University, advancing our impact in key strategic areas and securing graduate student funding.
- The NRC partnerships offer opportunities to do research at low-to-mid technology readiness levels (TRL) and to bridge the technology gap by then engaging industry partners to sponsor and collaborate on high-TRL projects closer to commercialization.
- Partners that provide us with donated or heavily discounted equipment/infrastructure, as well as participate in collaborative research with us are of particular interest – these include many benefits for both parties. For the Faculty, that includes access to and use of leading-edge instrumentation that enables new discoveries, advances research programs and trains students on relevant technology. For the company, it includes a branded presence in the university, and the establishment of their platform as the principal tool used in the field – the familiarity that students develop with the tools.
- Corporate education programs are unique partnership mechanisms that can generate substantial overhead revenue for Faculty departments. These are challenging to establish and grow, but we have several successful models as examples, and once again the role of a champion is crucial. Each of these touchpoints can lead to spillover effects in building multi-faceted partnerships that employ more than one mechanism of collaboration.
- We continue to focus on reducing the administrative costs associated with processing of contracts and agreements – working to reduce lead times, coordinating internally between university divisions, and generally elevating our partners' experiences with us.

9.2.2 Alumni Partnerships

Our network of more than 56,000 alumni enriches the educational and research activities of our Faculty by delivering guest lectures, serving on advisory boards and mentoring students. Philanthropic contributions from our alumni support new research facilities, educational initiatives, co-curricular activities and improved infrastructure. The fact that many alumni are now hiring managers means that their existing relationship with U of T Engineering puts us top of mind when it comes to hiring new talent, which greatly benefits our graduating students. Nearly 1,000 jobs have been posted on our online community, CONNECT, over the past 5 years.

We have been making great efforts to develop, nurture and engage our global alumni network and to develop new opportunities to strengthen the role that alumni play in mentorship, entrepreneurship, and innovation.

Select alumni initiatives include:

- **Regional activities** — We encourage and support regional alumni chapters all over the world. In particular, we have strengthened our connections to alumni in Asia-Pacific regions in recent years through various means, including multiple trips to the region by the Dean and other Faculty leaders. In the past year, we hosted more than 60 alumni events, including the *Disruptors* & *Dilemmas* Speaker Series and networking receptions in Canada, the U.S. and the Middle East. Currently, we have engaged 11 Regional Ambassadors, local alumni who take the lead in promoting alumni services to our graduates in key areas.
- **Volunteering** — Alumni volunteer in a myriad of ways, including the evaluation of the undergraduate admissions process as part of the Faculty's broad-based admissions initiative and mentoring students through The Entrepreneurship Hatchery, Troost Institute for Leadership Education in Engineering (Troost ILead) or the Engineering Society. We leverage our alumni networks around world to engage with current students through regional ambassador programming, PEY connections and in-country events. We continue to look for new ways to partner alumni with on-campus groups to provide rich and meaningful volunteer opportunities, from co-supervising theses or capstone projects to assisting at outreach events and advising new startups. In our self-study consultations, alumni agreed with this approach, particularly as it relates to entrepreneurship.
- **Mentorship** – Mentorship plays such an important role in student development, while at the same time, provides a natural platform for alumni engagement. Based on prior alumni consultations and feedback, a dedicated resource was assigned to this area during our growth phase in 2021. Since then, our Alumni Mentorship Program has witnessed remarkable growth and success. Notably, student participation has surged by an impressive ~78%, marking a substantial increase in engagement. Among these participants, approximately 20% were graduate students, reflecting a diverse range of academic backgrounds. Formally, the program has also expanded to include students and mentors from all degree programs including undergraduate, graduate and PhD level programs.

Several factors have contributed to this significant expansion:

- **Strategic Partnerships**: Collaborations with organizations like You're Next Career Network (YNCN), Engineering Career Centre (ECC), Engineering Society, Graduate Engineering Council of Students (GECoS), and Student Life broadened our reach within the U of T Engineering Community.
- **Diverse Event Programming**: We offered a range of events, including Industry Talks, EDI discussions, skill development sessions, and networking opportunities, ensuring equity of access, opportunities, and results.
- **Micro-Mentoring Opportunities**: Increased number of events to create impactful one-time interactions, benefiting both mentors and mentees (specifically targeting unmatched pairs).
- **Multimedia Integration**: Increased the use of multimedia marketing strategies and email campaigns that aligned with our goals, increasing interactivity and accessibility, and enhancing engagement.
- **Online Adaptation**: Adapted to the pandemic and leveraged online tools to connect students and mentors globally, thus increasing flexibility and accommodating diverse time commitments.

These efforts, driven by properly resourcing this critical area, have collectively contributed to enriching the experiences of our students and alumni, fostering deeper engagement, expanded networks, and opportunities for collaboration and innovation.

9.2.3 Global Initiatives

Our Faculty is committed to providing students with experiences that enrich their understanding of complex global challenges. These experiences develop their cross-cultural fluency, which is crucial to working with partners of all backgrounds, disciplines and perspectives, anywhere in the world. Recent initiatives and offerings focused on enhancing global perspectives include:

- **MIE International Capstone course** — For many years, MIE has run a capstone course in which teams of students from U of T Engineering and its partner universities — such as Beihang University, Shanghai Jiao Tong University and Tsinghua University — work collaboratively across continents and cultures on industry-sponsored engineering projects.
- **International Virtual Engineering Student Teams (InVEST)** — Launched in 2020, U of T Engineering launched a new program focused on using online collaboration tools to build effective, multidisciplinary design teams with members all over the world. While it was developed prior to the COVID-19 pandemic, InVEST became an important model that embraced virtual-international teams — a global reality our graduates need to prepare for. During InVEST, student teams from all undergraduate departments undertake technical projects under the supervision of faculty members at partner universities.
- **Praxis III** — A new course launched in the fall of 2021 enables second-year Engineering Science students to gain experience working on practical design projects in teams spread across the world. Praxis III builds on the success of Praxis I and II, two first-year classes that introduce students to the models and tools of engineering design, including communication, teamwork and professionalism.
- **Minor in Global Leadership** — U of T launched a tri-campus minor in Global Leadership that will begin in September 2023. With a focus on interdisciplinary curricular and experiential opportunities, the program aims to prepare students to become globally confident future leaders. Students will learn to recognize and embrace diversity, face challenges with empathy and champion respectful collaboration in a globalized world. The minor will include a core series of three global leadership courses to be taken in students' second, third and fourth years — each delivered by one of U of T's three campuses. The final course, a hands-on capstone project, will be based at U of T Engineering.
- **Centre for Global Engineering (CGEN)** — First launched in 2009, CGEN is dedicated to creating a community of practice to develop innovative solutions that impact the world's most vulnerable populations. On the curricular side, CGEN offers a Certificate in Global Engineering at the undergraduate level, and an emphasis in Engineering and Globalization for MEng students. Since 2014, CGEN has also sponsored 36 capstone design projects in which multidisciplinary teams of students from all departments collaborate with clients on four continents. The clients for those projects are typically non-governmental organizations or private firms with a mandate for social impact.
- **Paul Cadario Chair in Global Engineering —** Professor Nicole Weckman (ISTEP, ChemE) was appointed the inaugural Paul Cadario Chair in Global Engineering in 2022.

A cross-appointment between ISTEP and ChemE, the role will further advance engineering solutions for vulnerable communities through CGEN's teaching and research activities. The chair was made possible by a $1.5-million donation from alumnus, adjunct civil engineering professor and Distinguished Fellow in Global Innovation, Paul Cadario.

- **International Doctoral Clusters** — An International Doctoral Cluster (IDC) is a research and training agreement between the University of Toronto and international academic partners. IDCs create opportunities to recruit talented graduate students to U of T and partners institutions and provide recruited students with extraordinary access to mentoring by a global network of leading researchers. U of T Engineering researchers are involved in many of the 16 IDCs across U of T, and are leading three of them: the IDC in Urban Water, Waste and Energy Solutions (National University of Singapore, led by Professor **Ramin Farnood** (ChemE)); the IDC in Advanced Manufacturing (Korea Advanced Institute of Science and Technology (KAIST), led by Professor **Chi-Guhn Lee** (MIE)); the IDC in Multidisciplinary Approaches for Sustainable Rural Development in India (multiple partners including IIT-Bombay, IIT-Delhi and University College Cork, led by Professor **Amy Bilton** (MIE)) and the IDC in Cybersecurity (National University of Singapore, led by Professors **David Lie** (ECE) and **Deepa Kundur** (ECE)).

Other ways engineering undergraduates develop global fluency include international exchanges, summer research abroad and global work opportunities through the Professional Experience Year Co-op Program (PEY Co-op). In 2022–2023, more than 50 U of T Engineering students participated in either course-based or summer research opportunities with institutions such as the National University of Singapore, Hong Kong University of Science & Technology and the University of Stuttgart. A further 27 engineering students were hired for PEY Co-op positions outside of Canada in 2022–2023. As the world rebounds from the deep impacts of the COVID-19 pandemic, we expect future numbers to surpass pre-pandemic levels (for comparison, 89 students travelled abroad for research and exchange opportunities, and 85 PEY Co-op students worked outside of Canada in 2018–2019). Even students who remain at U of T are exposed to international perspective due to the high numbers of inbound exchange students from these partner universities who join them for summer research or course-based exchange programs.

U of T Engineering holds numerous memoranda of understanding (MOUs) with institutional partners across 12 countries worldwide. These agreements yield joint research collaborations, courses, exchange opportunities for faculty and students, training pathway programs and more. Some agreements, such as the MOU with Fudan University in China, create streamlined pathways for students from partner institutions to enter higher degree programs (e.g., MEng, MASc) at U of T. Others, such as the MOU with University of Stuttgart in Germany, focus on student mobility (i.e., exchanges) between partner institutions. While all of these MOUs are specific to the Faculty, students and professors also have access to many more partner universities through institution-wide MOUs that apply to students in all programs across all three campuses.

We also actively engage with scholarship programs that support pathways for international students to study at U of T Engineering, including:

- **Mastercard Foundation Scholars Program** — Funded by the Mastercard Foundation, this program provides scholarships to talented young people from economically disadvantaged communities, particularly in sub-Saharan Africa. In April 2013, U of T was selected as one of three Canadian institutions to participate in this

program. The most recent cohort of Mastercard Foundation Scholars graduated in 2022. Since the start of the program, more than 25 students graduated from U of T Engineering programs.

- **Lester B. Pearson International Scholarship** — This University-wide, four-year scholarship recognizes exceptional academic achievement, creativity, leadership potential and community involvement. Since its establishment in 2017, 27 international students from around the world joined U of T Engineering through the scholarship program — including India, Jamaica, Malaysia, Slovakia, Trinidad and Tobago, Türkiye and the United Kingdom.

- **Karta Catalyst Scholarship Program** — Established in 2019 at U of T, this program is aimed at enabling talented, low-income students from rural India to study at U of T. Since its launch, one student has joined U of T Engineering through this program.

To better support undergraduate students as they seek curricular or co-curricular opportunities abroad, the Faculty created a new role in 2022: Undergraduate Research and International Experience Coordinator. Likewise, incoming international students are supported by two dedicated roles, both created in 2020: First Year Advisor, Intercultural Learning & Experience for students in the Core 8 programs, and the Undergraduate Advisor for international students in the Engineering Science program.

Given the importance of global perspectives on training the next generation of engineering leaders, we have established an informal 'stretch goal' of having 100% of undergraduate students graduate with some form of international experience on their resume.

For the past three years, travel restrictions associated with the COVID-19 pandemic hindered progress on this goal. As we emerge from the pandemic, remaining challenges include: limited flexibility in some engineering programs based on the high number of prerequisites; sourcing enough high-quality, compatible experiences for all students; and the high cost and logistical difficulties associated with international travel. Cataloguing, tracking and monitoring the wide range of applicable experiences will also be a challenge.

9.2.4 Community Building

Located in the heart of Canada's largest metropolitan centre, we leverage our urban setting to contribute to the life of our local community. Faculty-led and student-led examples include:

- Local groups facing challenges frequently solicit projects in our first-year design courses such as Praxis and Engineering Strategies & Practice. Past clients have come from organizations involved in sustainability, accessibility, education, preservation of old and rare artifacts, seniors' homes and more.
- Throughout May 2019, U of T Engineering participated in the Scotiabank CONTACT Photography Festival with an exhibit titled *Ambition, Innovation & Excellence: A Decade at Skule*. Located in the Myhal Centre's atrium, the exhibit featured the photography of students, staff, professors and alumni. This multimedia installation provided an intimate portrayal of the engineering spirit to Torontonians, attracting more than 1,500 visitors.

- U of T Engineering hosted an event on December 6, 2019, to remember the 14 women whose lives were taken 30 years prior at École Polytechnique. As part of a national initiative, U of T Engineering was one of 14 engineering schools to shine a beam of light into the sky in a stand against gender-based violence and discrimination. More than 200 community members attended with another 300+ watching on livestream.
- Throughout 2019–2020, a STEM teacher with the Toronto District School Board was seconded to U of T Engineering as the STEM Educator in Residence. Through this new position, the Faculty hosted several events to further enhance collaborations between U of T and elementary school educators. One of these events was STEM Day, which challenged graduate students in U of T Engineering's Prospective Professors in Training program to design activities that communicated curriculum-relevant science and engineering concepts.
- Two graduate students launched Stitch4Corona, a volunteer-driven initiative to sew fabric face masks to help protect Toronto's most vulnerable at the start of the COVID-19 pandemic. In just one month, more than 200 volunteers stitched 2,000 masks for Toronto's Michael Garron Hospital, several local walk-in clinics, as well as respite centres in the city.

9.2.5 Relationships with Governments, NGOs and Professional or Academic Associations

U of T Engineering is a key player in the research and innovation policy landscape locally, nationally and internationally. We maintain strong relationships with external organizations, including governments, funding agencies and professional associations to help shape their mandates and goals, and to ensure that our voice is part of strategic discussions that will influence future decisions. In addition, we have increasingly been aligning our business development activities with institutional partners that share the same goal of attracting investment to Ontario's innovation ecosystem.

Recent examples include:

- Initiating and developing relationships with Global Affairs Canada and their network of Trade Commissioners around the globe, particularly in Taiwan, Japan, Germany, Sweden and regions of the United States. This has strengthened our international business development efforts in those regions by creating connections to industry, academia and government agencies, and has solidified collaborative business development efforts, such as specialized events in our home market of Ontario.

- The development of closer ties with the Ontario Centres of Innovation (OCI), in particular the Ontario Vehicle Innovation Network (OVIN). This has led to the initiation of several collaborative industry partnerships supported by OCI, as well as engagement with OVIN's Skills, Talent and Workforce initiative for the future of the automotive industry in Ontario.

- In the spring of 2023, U of T hosted NSERC President Alejandro Adem and Manal Bahubeshi (Vice President, Research Partnerships) to discuss the evolution of the NSERC Alliance program and offer feedback on how it could be improved to better support collaborations and enable the establishment of industry-academia partnerships. Also on the agenda was a commitment to work together under the new national security framework governing the evaluation of risk in research security.

- Toronto Global has become a key business development partner for U of T Engineering. The relationship was initiated by Dean Christopher Yip when in the position of Associate Vice-President, International Partnerships, and has grown to include multiple business development professionals, including the Executive Director, Partnerships at U of T Engineering, Adriano Vissa. Toronto Global acts as an agent of three levels of government to attract foreign direct investment to the Greater Toronto Area, and as such its interests are aligned with the University regarding foreign multinational investment in research & development centres, collaboration, and infrastructure; commercial and manufacturing ventures which require talent and highly qualified personnel development; and support for local startups. Toronto Global and U of T personnel have executed successful joint business development missions, to markets such as Korea, Japan, Taiwan and the United States.

Advocacy has resulted in critical support from governments. For example, in the 2016 provincial budget, $15 million was allocated to support the construction of our Myhal Centre for Engineering Innovation & Entrepreneurship (**Section 7.5**). This speaks to the strategic alignment of our goals with those of provincial policymakers.

We also work closely with professional organizations such as the Engineering Institute of Canada, the Canadian Academy of Engineering, and the Canadian Society for Mechanical Engineering. Over the past several years, our professors have served as president of these groups, and each year our faculty members are honoured with fellowships or awards from their disciplinary societies.

We actively contribute our expertise on NSERC and other government agency panels, as well as on Canadian Engineering Accreditation Board review teams. The faculty members who participate not only strengthen these organizations, but also gain valuable insight into how we can enhance our own programs and internal systems to align with the best practices they observe.

Each year, we partner with Engineers Canada, Professional Engineers Ontario and the Ontario Society of Professional Engineers on initiatives that promote excellence in the engineering profession and enhance public understanding of its impact on society. These events include National Engineering Month and the Professional Engineering Awards Gala.

9.3 Key Challenges and Opportunities

Challenges:

1) Aligning our curriculum and training approaches to meet emerging and changing industry needs.
2) Establishing additional framework agreements that support a wide range of PIs and projects, i.e., a single partnership at scale - quality and quantity with the same partner, yielding longevity and sustainability.
3) Reducing administrative delays between divisions and units through the partnership cycle – elevating the partnership development experience for our collaborators and professors.

Opportunities:

1) Embracing a new approach to learning and education – microcredentials. Increasingly offering these to industry members and our own students to create diverse and flexible educational offerings that meet demand and can be customized.
2) Capitalizing on the growth of certain industries in our local market (i.e., electric vehicles, battery manufacturing, vaccines, therapeutics, and biomanufacturing) to attract research and development partnership investment and create relevant training programs that contribute to Ontario's economic competitiveness on the global stage.
3) Establishing a compelling model for EngX at 88 College Street – The Engineering Partners' Hub – by considering the inclusion of government partners (NGEN, OCI, etc.) who have funding mandates to support grassroots innovation, growth of local companies and training of talent – to create a lynchpin and ecosystem nexus that becomes an attractor of industry partnerships, provides opportunities for our students, and is known as a critical centre of research, innovation and training.

10.0 Diversity, Inclusion and Professionalism

Culture is at the heart of the Faculty's strengths and opportunities. U of T Engineering is committed to fostering a culture in which each member of the community can excel, contribute and benefit from different perspectives. Attracting, supporting and retaining students, staff, and faculty from a wide range of backgrounds, we create opportunities to work collaboratively across diverse lived experiences, and build a community that reflects the society we serve.

The Faculty is advancing a culture of inclusion and professionalism by implementing accountability and quality assurance frameworks. Leading this work is the Assistant Dean and Director, Diversity, Inclusion and Professionalism (AD-DIP) Marisa Sterling, P.Eng. (ChemE 9T1). This senior staff position was created in 2019 and in 2020, the DIP office was launched with direct reports and resources. The AD-DIP reports directly to the Dean, providing oversight of the Faculty's efforts in the domains of diversity. inclusion, and professionalism.

Many of the results discussed in this chapter were realized since the appointment of the AD-DIP.

10.1 Overview of Diversity and Inclusion within the U of T Engineering Community

Diversity deepens the engineering creative process and enriches the student experience and the quality of the academic programs, teaching and research. The Faculty has implemented many actions, resources, and supports to broaden the diversity of its students, faculty, and staff and to improve the sense of belonging that they experience.

10.1.1 Undergraduate Students

By 2016, the Faculty had increased the number of women in the undergraduate first-year to 40.1%. Since then, the percentage of undergraduate women learners in the Faculty has steadily increased (**Figures 10-1 and 10-2**). U of T is part of a national coalition working toward increasing the proportion of women to 30% of all newly licensed professional engineers by 2030 (30 by 30).

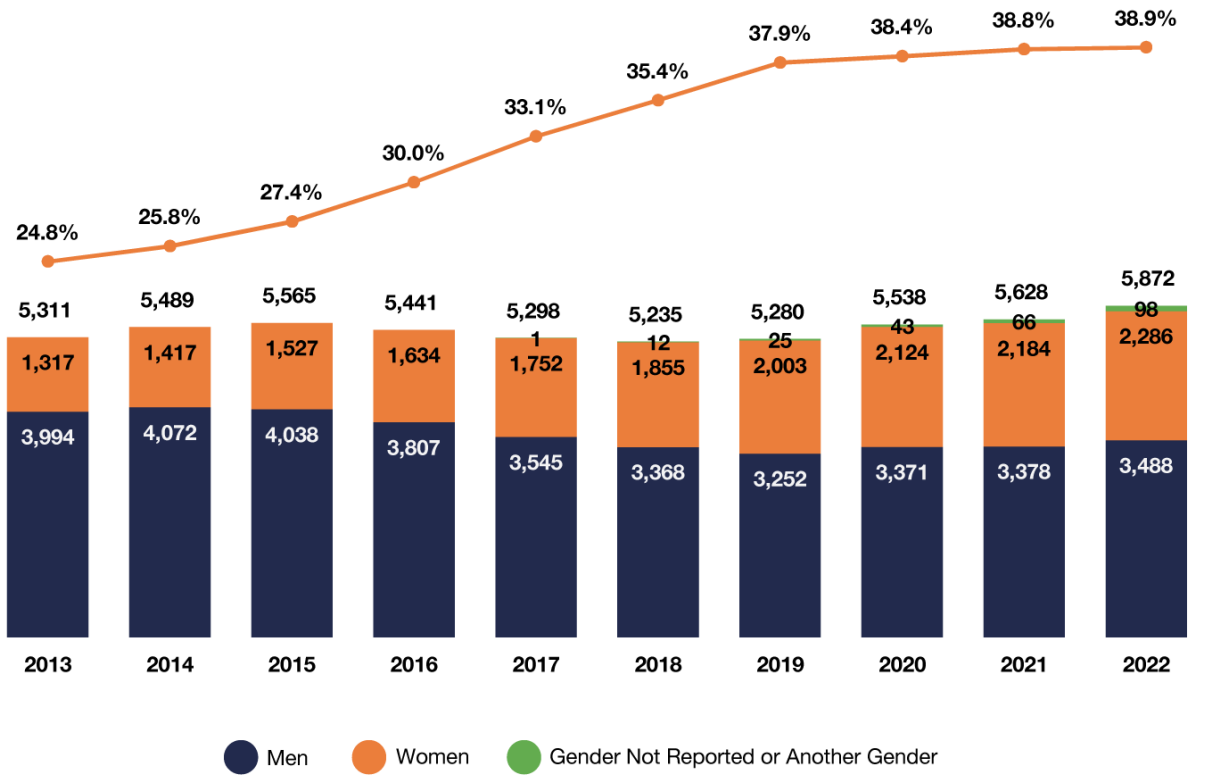


Figure 10-1: Undergraduate Enrolment by Gender with Percentage of Women

Value above bars is total undergraduate students. (See Figure 3.3a from *By the Numbers 2023*)

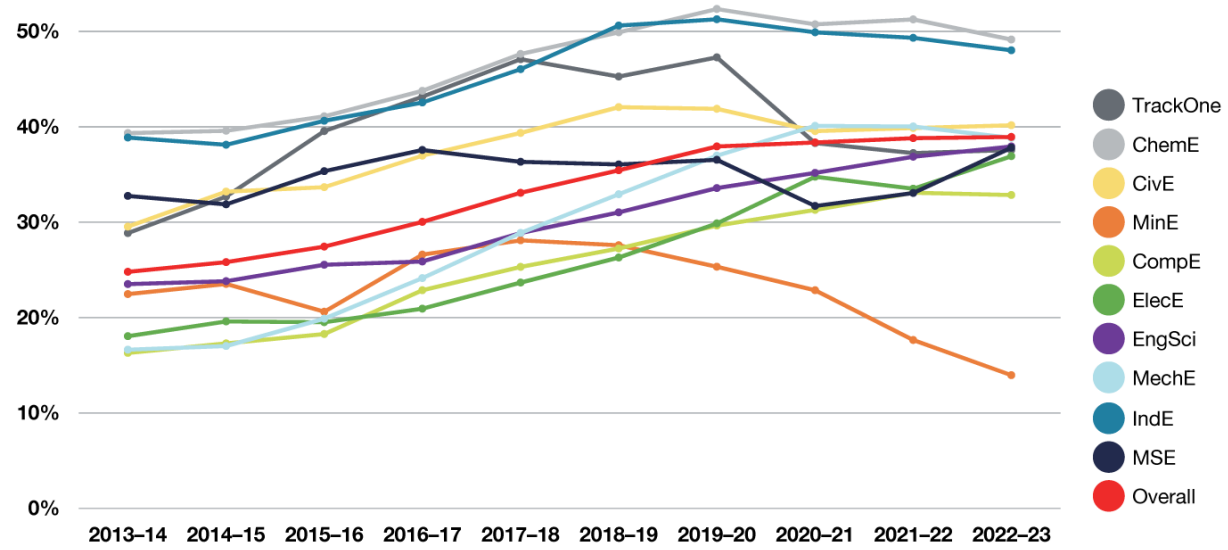


Figure 10-2: Percentage of Women by Undergraduate Program

Overall (red line) and in each academic area by year. (See Figure 3.3b from *By the Numbers 2023*)

Our progress is a direct result of the Faculty's consistent intake of approximately 40% women in the incoming first-year undergraduate class since 2016. By 2022-2023, almost all academic areas are now over 30% women and U of T Engineering currently leads all other Ontario and Canadian engineering institutions in the percentage of women enrolled in and graduated from the undergraduate program.

Collecting and reporting demographic data on other identities, such as Black, Indigenous, and 2SLGBTQ+ undergraduate students, has started to be institutionalized at U of T. In November 2020, the University launched the voluntary U of T Student Equity Census under the leadership of Interim Vice Provost Micah Stickel (ECE) modeled after a pilot conducted in U of T Engineering earlier in 2020. The University student census gathered gender, sexual orientation, disability, Indigeneity, race, and parental education demographic data of current undergraduate students. Given a low response rate of 10% in the first year (2020) of its implementation, the 2021 census was embedded in ACORN, U of T's student information service with results to be reported in Fall 2023.

In October 2020, U of T Engineering piloted the Engineering Applicant Census (EAC), in which applicants to the undergraduate programs voluntarily disclosed their gender, ethnicity, race, Indigeneity, sexual orientation, religion, disability, parental educational and geographic community size demographics. The purpose was to assess if the applicant pool is representative of the diversity of the Greater Toronto Area youth population and if that diversity translates to admitted students, to understand the impact of the Faculty's admissions process on the diversity of students. In its first year, the census received a very high voluntary response rate at over 78%. Findings included:

- 25% of applicants identified as a woman, 5% identified as Black, and 0.3% identified as Indigenous, all proportions that are less than the Toronto population at 50.7%, 8.9% and 0.8% respectively.
- Approximately 9.5% of applicants identified as having a non-heteronormative sexual identity, 1.7% identified as having a non-heteronormative gender identity, 11% identified as having some form of disability that was primarily invisible or non-evident and 9% identified as having parents with a college degree or lower.

In the 2022-2023 academic year, the First Year Office partnered with the DIP Office to collect demographic data on gender, race, sexual orientation, Indigeneity, and other identifiers within the existing First Year Student Survey to help the Faculty analyze the cohort more deeply and respond appropriately with relevant programs and supports. Survey participation included Core 8 students and Engineering Science students, with a 'prefer not to reply' option for both. The resulting response rate was close to 90%. Results are being analyzed and will be compared with other data sets for insights.

10.1.1.1 Student Experience — The Voice of the Engineering Student

In 2019, the Faculty conducted a quality improvement study of undergraduate and graduate student culture entitled *Voice of the Engineering Student*. The Faculty benchmarked the results with external survey data of Canadian youth.

Key findings include:

- Experience and culture of respect: Overall, respondents rated their experience as good to excellent: 75% of students reported an excellent, very good, or good overall experience,

and 81% of students rated the culture of respect in U of T Engineering as excellent, very good, or good.
- Discrimination and harassment experiences: Up to 8% of respondents reported experiences of bullying or prejudice, such as sexism, insulting or disparaging remarks, classism, and homophobia. 34% of respondents reported personal experiences with discrimination, harassment, or both. The incidences were elevated for respondents who identified as women (46%), Black (49%), and lesbian, gay or bisexual (53%). (Note that the data set for Indigenous student respondents was too small to analyze.)
- Knowledge of U of T harassment policies: 47% of student respondents knew 'almost nothing' or 'nothing at all' about U of T policies regarding harassment and abuse, whereas doctoral and/or male student respondents were more likely to know 'a lot', 'some', or 'a little'.
- Health and Stress Outcomes: Those experiencing discrimination and harassment also reported increased health and stress as a result, reporting symptoms of feeling overwhelmed, burned out, and physically exhausted.
- Knowledge of Canada's Truth and Reconciliation Commission (TRC): Only 33% of student respondents knew 'a lot', 'some, or 'a little' about the TRC, much lower than the Canadian Youth Reconciliation Barometer 2019 reporting that 64% of non-Indigenous youth between the ages of 16 to 29 have read or heard something about Indian Residential Schools or other government policies of the past.

Challenges and Opportunities

While the *Voice of the Engineering Student* was originally planned to be repeated after three years after the initial 2019 benchmark study, the COVID-19 pandemic disrupted programming and placed additional stress on the students. The next survey is now planned for Winter 2024.

U of T Engineering follows the best practices based on U of T's information security standards. This guidance ensures implementation of practices to mitigate security risks and protect people, data, and systems. The DIP Office has the opportunity to work closely with IT to ensure data protection continues to be a priority as new risks evolve.

U of T Engineering has conducted surveys concerning coping during the pandemic but has not yet conducted culture surveys with staff and faculty to understand their experiences and impact to the overall climate in the Faculty. These could be a focus for future surveys.

10.1.1.2 Pathways, Access and Recruitment

The DIP Office works closely with the Engineering Outreach Office (Outreach), Engineering Student Recruitment and Retention Office (ESRRO), Registrar, Vice-Dean, First Year and the Vice-Dean, Undergraduate to create access pathways into U of T Engineering for traditionally underrepresented groups within the engineering profession. Specific programming related to undergraduate programs is detailed below.

Access and Recruitment of Women

- Pre-university outreach: Each summer, Outreach has continued to run a Jr. DEEP program specifically to reach girls in grades 3 to 8, a Jr. DEEP Coding program for girls in grades 5 to 8, and an Engineering Day hackathon-style event to reach girls in grades 5 to 8. Newly added since the last self-study is a Girls in Medicine program for grades 3 to 6.

- Applicant events: ESRRO runs a free Girl's Leadership in Engineering Experience (GLEE) event for incoming women students to find community and meet faculty and alumnae. In addition, ESRRO has held unique recruitment events such as the Young Women in Engineering Symposium.

Access and Recruitment of Black Students

- **ENGage**: Since 2010, Outreach has run the ENGage program for Black students in grades 5 to 8, in collaboration with U of T's chapter of the National Society of Black Engineers (NSBE), to encourage STEM literacy, showcase Black role models, and help Black youth see the difference they can make in engineering. After a two-year pause due to the pandemic, ENGage was paused due to insufficient budget. An ENGage High School Saturday program was recently added to provide virtual mentorship between Black undergraduate and Black high school students in grades 9 to 12.
- **Blueprint**: Since the summer of 2020, Outreach – in partnership with the Dean's Advisor on Black Inclusivity – launched Blueprint, a four-week summer academic enrichment program for Black students in grades 10 and 11. For two years during the pandemic, the program was held virtually with an in-person three-day summit in 2022 to bring the 2021 and 2022 students together. Approximately 30-50 students from across Canada participate each summer, and Outreach continues to engage with the students when they enter grade 12. Black faculty serve as mentors to the student's design projects.
- **Black Applicant Support and Engagement (BASE) Program**: In 2022–2023, Outreach launched the BASE program to demystify the path to post-secondary engineering education at the University of Toronto. This free program provides Black-identifying grade 12 students with a customized experience and resources to assist them through the challenges of the University application and decision-making process. Twenty students participated in the program's first year and all had grades in the 90s for their university applications, suggesting a strong cohort of Black applicants for 2023 admissions.
- **Black representation at applicant events**: ESSRO continues to collaborate with NSBE on increasing the visibility of the Black student community and creating connections for prospective students. This has included hosting dedicated student panels, ensuring Black representation in clubs, fairs and open houses, and providing admissions presentations at the High School Conference and NSBEHacks. Data from the Engineering Applicant Census (EAC) informed the creation of the Black Student Community Welcome event to celebrate Black admitted students and facilitate connections to the U of T Engineering community.

Access and Recruitment of 2SLGBTQ+ Students

- ESRRO is considering how to expand the GLEE event to include trans women and incoming students who identify as non-binary and/or gender fluid.

Access and Recruitment of Indigenous Students

- **Labrador Engineering Awareness Program (LEAP):** In 2018, Professors Erin Bobicki (CivMin) and Naomi Matsuura (MSE) co-founded LEAP. Launched in five communities, LEAP focused on alleviating the geographic challenges faced by

Indigenous high school students in accessing engineering education in Labrador by emphasizing design projects tied to community-specific engineering challenges.

- **Indigenous Design and Engineering Academy (IDEA)**: Launched by Outreach, these Indigenous-led programs provide youth with the opportunity to explore connections and interactions between Land-based knowledge systems and STEM. IDEA: Leader-in-Training (IDEA: LIT) is a free, two-week summer program for Indigenous high school students that takes place at U of T's Gull Lake property; participants earn a high school credit in leadership while learning about STEM and traditional knowledge. IDEA: Horizons provides Indigenous students in grades 3 to 6 with an exciting, two-week STEM program for free; students also engage with traditional knowledge in a day camp format on the U of T campus. The Faculty's Outreach office has established a strong partnership with Wandering Spirit, the City of Toronto's high school for Indigenous students.
- **Applicant outreach**: Led by ESSRO and Jason Bazylak (MIE), the Dean's Advisor for Indigenous Initiatives, U of T Engineering invites Indigenous applicants to travel, at no cost, to U of T to spend two days with Professor Bazylak exploring campus, building community, and learning about learning and research opportunities at U of T Engineering.

Challenges and Opportunities

Programs like Girls' Jr. DEEP, GLEE and Blueprint/BASE are helping to increase the number of women, Black and Indigenous students at U of T Engineering and the participants have been remarkable. Many assume leadership positions within U of T Engineering's student organizations. The Indigenous-led IDEA programming is very well developed and a model of excellence for how to work in the spirit of reconciliation with First Nations, Metis and Inuit Peoples in Canada.

U of T Engineering sees an excellent opportunity to leverage these model programs into intentional programming to support access and recruitment of 2SLGBTQ+ students. The growing number of programs provided by the University of Toronto's Access Strategy & Partnerships Office (ASPO) are further helpful resources for U of T Engineering.

Measurement of the applicant's experience began in 2020-2021 and is the first time that the Faculty is collecting Indigenous and race data. This information will be helpful to help identify trends in the diversity of the applicant pool and to measure if that diversity is proportionally translated to the incoming first-year class through the admissions process. Applicants appear willing to provide their demographic data and more than half (57%) request to be contacted about specific programming to match their identity.

10.1.2 Graduate Students

As with undergraduate students, the proportion of women in U of T Engineering graduate programs has been growing steadily over the past ten years (**Figure 10-3**).

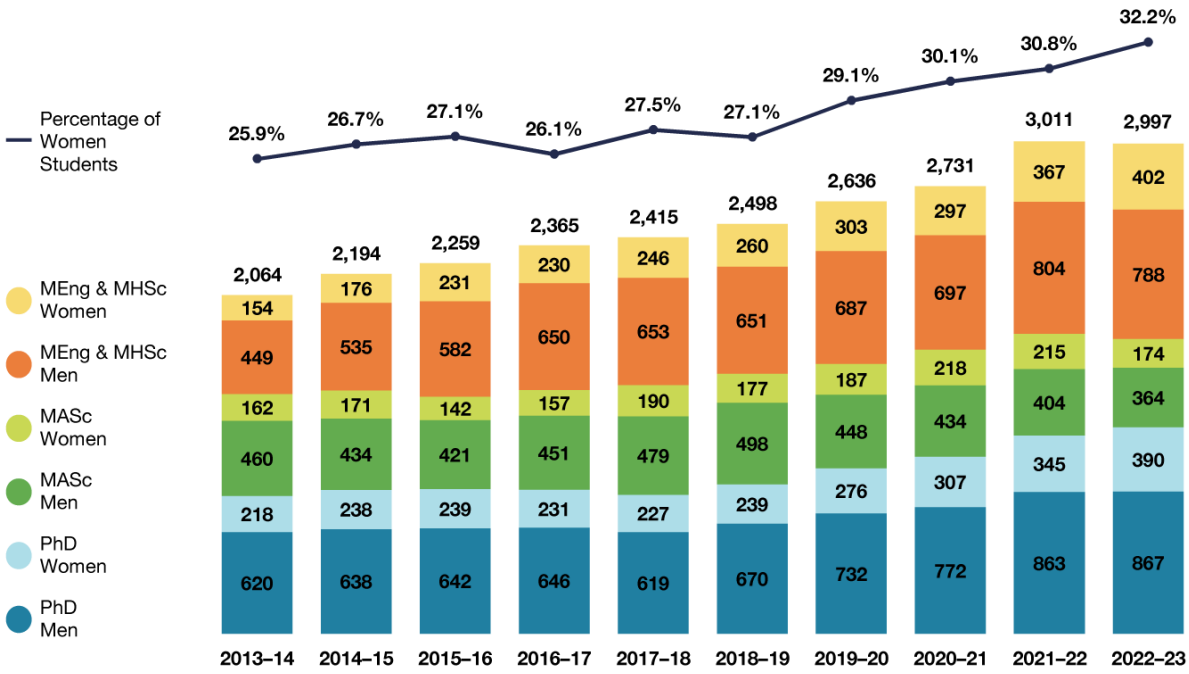


Figure 10-3: Graduate Students by Degree Type and Gender with Percentage of Women

(See Figure 3.6a from *By the Numbers 2023*)

Collecting and reporting on other demographic data of graduate students has begun to be institutionalized at U of T. Actions taken to move in this direction began in 2021, when the School of Graduate Studies (SGS) collected annual demographic data on graduate applicants (**Figures 10-4 and 10-5**) and in 2022 launched a portal for the Faculty to analyze this data in aggregate. The data assists us to look at conversion rates from offers to acceptances, better understand the diverse makeup of the cohort, and inform outreach strategies. Some figures from this data are provided below:

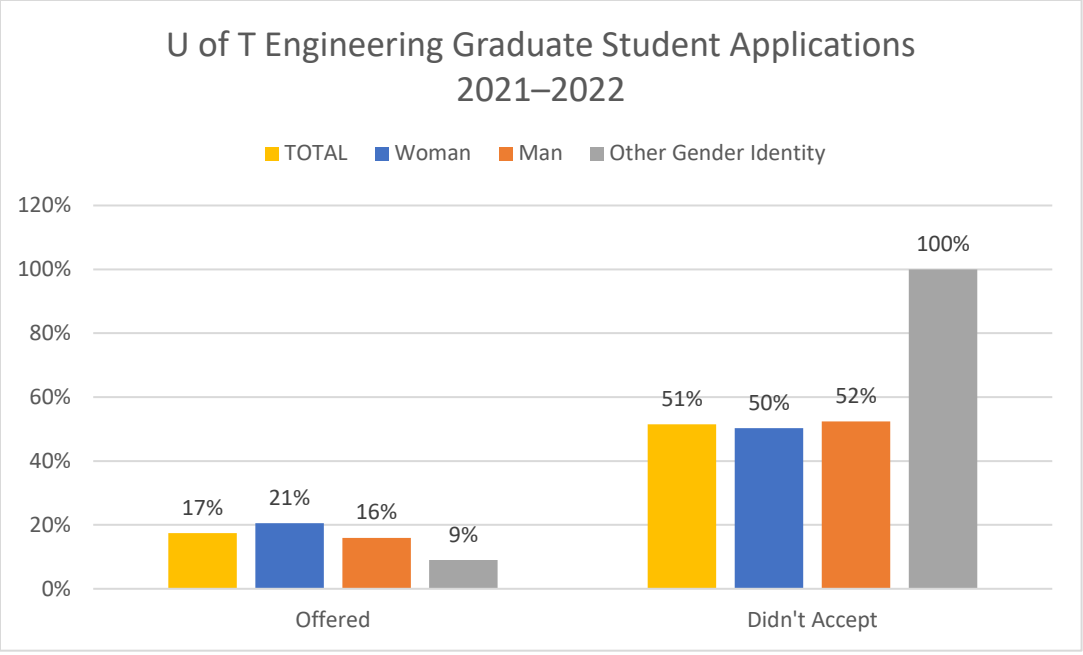


Figure 10-4 Graduate Student Offer and Acceptance Rates by Gender, 2021–2022

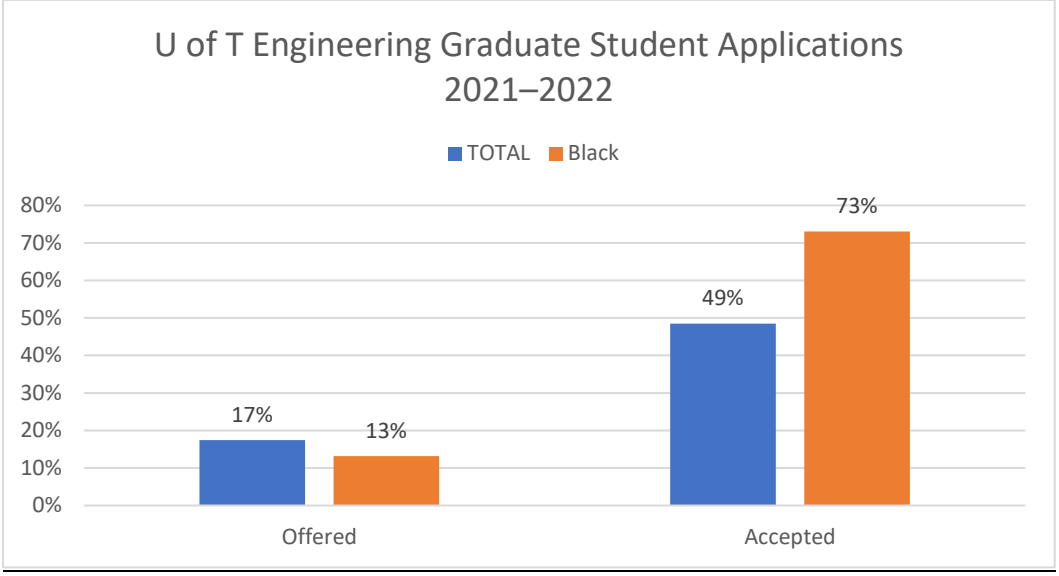


Figure 10-5 Graduate Student Offer and Acceptance Rates by Black Identity, 2021–2022

10.1.2.1 Pathways, Access and Recruitment

As with undergraduate students, the DIP Office works closely with the Vice-Dean, Graduate Studies on creating pathways into graduate studies at U of T Engineering for traditionally

underrepresented groups within engineering.

Access and Recruitment of Women

- **Building Pathways for Women into Engineering Graduate Studies**: In 2021, the Dean's Strategic Fund (DSF) approved a project entitled, *Building Pathways for Women into Engineering Graduate Studies*, with a grant of $335,000. The three-year project is uncovering key insights that address women's underrepresentation in engineering graduate studies. Extensive qualitative data has been gathered through interviews with more than 50 students, faculty and staff and a survey of more than 500 engineering students. These datasets are a rich tapestry of lived experiences and challenges facing underrepresented students. Recommendations are expected to span from policy reform to bespoke interventions, each carefully designed to encourage a culture of equity and justice within the Faculty.

Access and Recruitment of Black Students

- **IBET Fellowships**: In 2021, the Indigenous and Black Engineering and Technology (IBET) PhD Project was initiated with participation by a number of Canadian universities with the project providing a scholarship of $30,000/year to Black and Indigenous students over four years (Section 4.2.3). The initiative was a provincial collaboration and has grown to include 16 universities in a nation-wide collaboration. The goal is to provide access to Black and Indigenous scholars not already on the PhD track to encourage engineering professionals working in industry and/or in community to become faculty and researchers. The IBET fellowships provide access to internships and the Faculty co-funds a business development person associated with MITACS to guarantee that the fellows have an internship opportunity.
- **Collaboration with NSBE**: The office of the Vice-Dean, Graduate Studies attends the NSBE international conference as well as the undergraduate NSBEHacks event to raise awareness of U of T Engineering's graduate programs with Black students. In 2022, the Vice-Dean, Graduate Studies also formed the Engineering Graduate Connections (EGC) initiative to run events that connect Black undergraduate students with Black graduate students, faculty and alumni.

Access and Recruitment of Indigenous Students

- **IBET Fellowship**: The IBET fellowship program is intended to attract Indigenous students to pursue PhDs, which in turn will translate to more Indigenous engineering faculty in Canada. Since the program launched in 2021, only one of the six admitted fellows identifies as Indigenous. The program has received very few Indigenous applicants across the country, prompting reflection on how to create more accessible pathways.

Challenges and Opportunities

Graduate student outreach and recruitment of underrepresented groups presents an ongoing challenge as the Faculty works to increase the number of students from underrepresented groups.

The IBET program is mostly attracting applicants who already were on a path towards graduate studies and application rates, in particular of Indigenous applicants, are low. Considering that

the pool of undergraduate students with these identities is limited suggests that more work in these communities is needed to understand barriers to access and what further resources are needed to grow the pipeline of faculty and researchers with these identities and who may be coming from non-traditional educational backgrounds. IBET fellows have expressed a desire for more mentorship and networking opportunities, highlighting the ongoing need for more intentional mentorship programming in the Faculty.

10.1.3 Faculty Members

Diversity among faculty at U of T Engineering is an important component of building a culture of excellence, inclusion and professionalism (Figure 10-6).

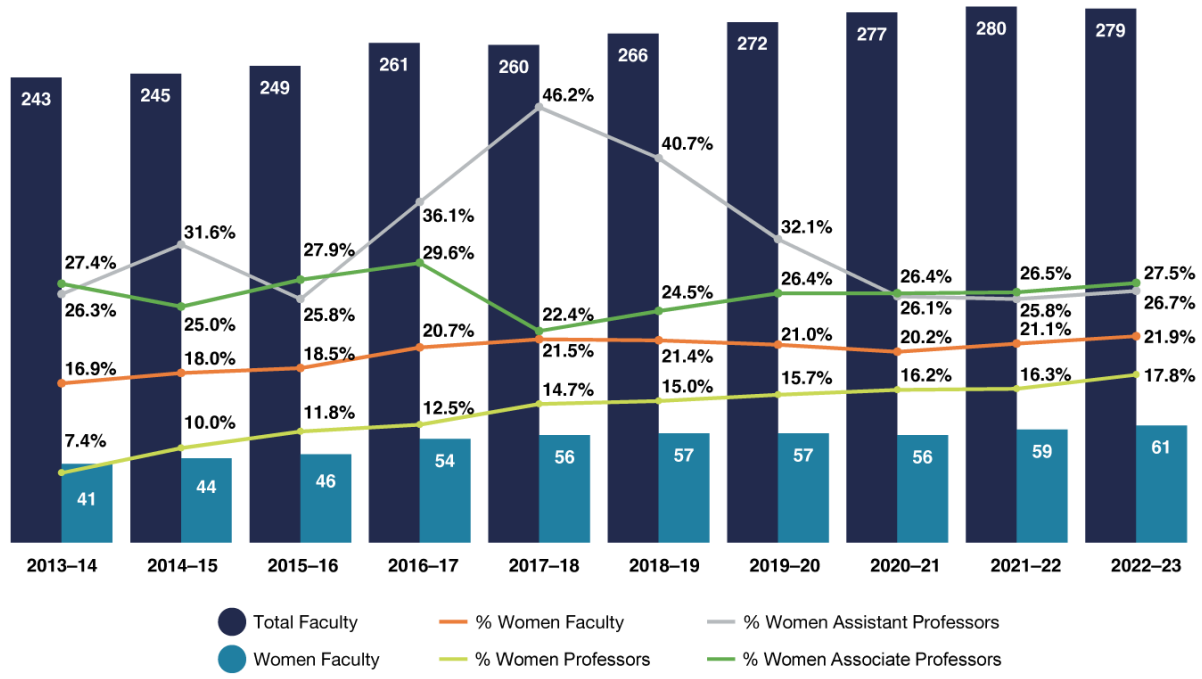


Figure 10-6 Total Number of Faculty with Percentage of Women Overall and by Academic Rank, 2013–2014 to 2022–2023

(See Figure 3.11 from *By the Numbers 2023*)

Since the time of the last self-study, the total proportion of women faculty at U of T Engineering has increased from 18.5% of the total faculty to 21.9%. Although this slow increase only represents an annualized growth of about 2.6%, the proportion of women with full professor status has seen a significant increase of 50%.

The Canada Research Chair (CRC) and Canada Excellence Research Chair (CERC) programs include targets for members of four federally designated groups. The current number of CRCs who identify within one of the four federally designated groups in Canada are shown in Table 10-1.

Table 10-1 Number of CRCs Who Self-identify within the CRC Program Designated Groups - in U of T Engineering Versus the CRC National Program Targets

Federally Designated Group	Tier 1 as of 2023	Tier 2 as of 2023	National 2022 Targets	National 2029 Targets*
Indigenous Peoples	0	0	1.5%	4.9%
Persons with Disabilities	0	0	4.5%	7.5%
Racialized Minorities	44%	35%	16.9%	22%
Women & Gender Minorities	50%	45%	33.0%	50.9%

*Based on 2016 Canadian census data

Collecting and reporting on broader demographic data of faculty has been institutionalized at U of T through the Employment Equity Survey (EES) – a voluntary, confidential questionnaire, for the purpose of improving employees' experiences across all stages of their careers. The EES gathers the demographic data of faculty, librarians and staff, including gender, sexual orientation, disability, Indigeneity, race and religious affiliation.

The most recent data available, from 2021, shows that the percentage of engineering faculty self-identifying as women was significantly lower than all faculty across the University (27% versus 48%, respectively). The percentage of engineering faculty self-identifying as racialized or persons of colour steadily increased by 7% over five years to 35%, surpassing the reported representation across the University at 26%. Some engineering faculty self-reported as 2SLGBTQ+ and persons with disabilities but the rates were less than half of those reported for faculty across the University.

Challenges and Opportunities

U of T Engineering has increased its complement of women faculty with full professor status and grown its compliment of underrepresented faculty identities. At the same time, the percentage of women, Black, 2SLGBTQ+, persons with disabilities and Indigenous identities of engineering faculty are still below the University faculty ratios and City of Toronto population averages.

U of T Engineering has taken steps to reach underrepresented groups and remove bias from the hiring process. For example, in September 2022, U of T Engineering faculty who planned to participate in faculty hiring committees attended an *Inclusive Hiring* workshop delivered by the Toronto Initiative for Diversity and Excellence (TIDE), sponsored by MIE.

U of T Engineering has the opportunity to review and advise on outreach, access, recruitment and hiring process for faculty with an EDI lens. Considerations include the practices of job postings, attracting marginalized candidates, anti-bias selection and hiring processes, equity in offer packages, equity in research collaborations and lab facilities, onboarding, mentorship, and

proactive promotion plans.

10.2 Support and Resources

10.2.1 Support for Marginalized and Underrepresented Groups

U of T Engineering is committed to providing support for communities that are marginalized in STEM. A key strength of the Faculty is the growing number of affinity groups that have grown both within and beyond U of T Engineering. Partnering with these groups offers a highly effective way to support students in finding and building community, and to provide safe environments to listen, discuss and develop action plans to address issues of inequity and exclusion. The AD-DIP has ensured that each engineering affinity group has a budget to accomplish meaningful work, along with a faculty advisor who shares the identity dimension of the representative community.

The following groups focus on advancing all marginalized identities across U of T Engineering:

- **Engineering EDI Action Group (EEDIAG):** This grassroots network of staff, faculty and students care deeply about advancing inclusion and belonging. Formed in 2018, it hosts Open Conversations and Towards Inclusive Practices Sessions (TIPS), while also identifying barriers to access and inclusion of underrepresented groups and advocating for solutions. It has advocated to the University for mental health supports in lieu of increased campus policing, piloted a demographic census of undergraduate program applicants, and collaborated with equity leaders to co-deliver workshops.
- **Inclusivity, Diversity & Equity Advisory Committee (IDEA):** This standing committee of U of T Engineering's Faculty Council grew out of the earlier Community Affairs & Gender Issues Advisory Council. Its mandate is to recommend strategies related to student recruitment and outreach and quality of life within the Faculty community, including such matters as the student experience, gender issues, diversity, safety and security, and personal conduct.
- **Engineering Society Equity and Inclusivity Director:** This undergraduate student role is overseen by the President of the Engineering Society to facilitate discussions and supports of undergraduate students.
- **GECoS EDI Commission:** In 2019, the Graduate Engineering Council of Students (GECoS) formed an EDI Commission from which additional affinity groups have since formed, including GradSWE, QueerSphere Grad and NSBEGrad, which is currently in development.
- **Central Equity Offices:** The Faculty collaborates with equity offices across U of T, including the Anti-Racism and Cultural Diversity Office (ARCDO), the Sexual and Gender Diversity Office (SGDO), the Sexual Violence Prevention and Support Centre, the Multi-Faith Centre, the Office of Indigenous Initiatives and the Accessibility for Ontarians with Disabilities Act (AODA) Office.

The following sections highlight some of the ways that U of T Engineering provides support for specific communities:

Support for Women

- **Women in Science and Engineering (WISE):** The U of T chapter of WISE was established in 1999 to support and empower all women in STEM fields and help them

achieve their full potential as future engineers, entrepreneurs, scientists and leaders. The AD-DIP supports and resources the WISE club by serving as Faculty advisor, speaking at WISE national student conferences, mentoring executive members, helping create programming, providing governance and conflict resolution advice, and providing funding.

- **GradSWE:** Society of Women Engineers (SWE) is an international education and service organization that advocates for women in engineering and technology. The AD-DIP supports and resources the SWE club for graduate students by helping to launch the club in 2019, serving as Faculty advisor, mentoring executive members, helping create programming, providing governance advice and funding.
- **Conferences:** In 2020, the AD-DIP provided funding for 14 women graduate students to virtually attend the SWE International Conference. In 2023, graduate students were funded to attend a regional SWE conference in-person.
- **National Day of Remembrance and Action on Violence Against Women:** Every year on December 6, people across the country remember the 14 victims of the École Polytechnique shooting and raise awareness about gender-based violence. The Faculty recognizes this memorial annually for its profound impact on women in engineering. Since 2020, the AD-DIP has collaborated with other units across U of T to co-host a university-wide memorial event.

Support for Black Students, Staff and Faculty

- **Steering Committee and Report:** In 2018, the Dean commissioned the Black Inclusion Steering Committee (BISC) with the mission to assess the Faculty's operational framework to identify ways to remove barriers to access, success and inclusion for current and prospective Black students, staff and faculty. The committee comprised the Vice-Dean, Undergraduate along with staff, students, faculty, alumni and an external resource with relevant lived experience, expertise and perspective of the Black experience. The committee delivered the Striving Towards Black Inclusivity report in 2019 to effect change overall and specifically for undergraduate students, graduate students, faculty and staff. Eighteen calls to action were identified in the areas of outreach, recruitment, admissions, mentorship, affinity group building, financial aid, research, training and alumni operations. The Faculty adopted the report and work is ongoing to implement all the actions; this work is tracked in Figure 3.15 of the By The Numbers.
- **Dean's Advisor:** In 2018, the Dean appointed the first Advisor on Black Inclusivity, Mikhail Burke (MSE 1T2, BME PhD 1T8) to be a resource to staff, faculty, and students. In 2023, the Dean appointed Professor Philip Asare (ISTEP) to the role.
- **NSBE U of T Chapter:** The U of T undergraduate student chapter was established in 1999 and hosts Canada's first Black student-run hackathon, NSBEHacks. A NSBE graduate student chapter is currently in development. Professor Myrtede Alfred (MIE) became NSBE's faculty advisor in 2022–2023.
- **U of T Engineering Black Grad & Beyond Group:** In 2022, an informal Faculty network for Black students, staff and faculty formed to build community and mentorship for this growing community.
- **Conferences:** The NSBE U of T Chapter hosts annually a High School Conference for Black students. The DIP Office funds between 10 to 20 U of T Engineering students to attend the international NSBE convention each year. Insights gained include ways the NSBE U of T chapter can leverage the international community, including Black-specific

job fairs, and ways to embed social justice education in undergraduate engineering curriculum.
- **Black History Month (BHM):** The Faculty's programming for BHM in February each year has grown to reflect the increased support for Black individuals at U of T Engineering. More information on this communications campaign can be found in Section 6.6.

Support for Indigenous Students, Staff and Faculty

- **Steering Committee and Report:** In 2017, the Dean established the Eagles' Longhouse, the U of T Engineering Indigenous Initiatives Steering Committee to identify Calls to Action for the Faculty within the University's Wecheehetowin: Answering the Call report. The committee comprised an Indigenous Elder and faculty and staff with Indigenous heritage and/or knowledge of Indigenous issues. The committee designed a Blueprint for Action in 2018 to effect immediate and ongoing improvements in the relationship between the Faculty and Indigenous communities. Seventeen calls to action were identified in the areas of spaces, curriculum, student access, and faculty and staff recruitment and hiring. The Faculty adopted the report and work is ongoing to implement all the actions; this work is tracked in Figure 3.14 of the *By The Numbers*.
- **Dean's Advisor:** In 2017, the Dean appointed the first Advisor on Indigenous Initiatives. Professor Jason Bazylak (MIE), a member of the Métis Nation of Saskatchewan, was appointed to the role and continues to serve in the role. Bazylak holds regular meetups with Indigenous students along with Lunch-and-Learn sessions with visiting Indigenous speakers funded through the DIP Office.
- **Conferences:** The American Indian Science and Engineering Society (AISES) was created in 1977 to promote the highest standards of education and professional excellence to widen the STEM workforce and grow sector support. The AISES in Canada National Gathering each year provides opportunities for Indigenous learners to network with other Indigenous engineering students and professionals, to learn about ways to create welcoming environments for Indigenous applicants and students, and to reflect on researcher responsibilities including the duty to consult with Indigenous nations. In 2020, one Indigenous engineering student expressed interest in attending and was funded to do so.
- **Events:** U of T's First Nations House hosts an Indigenous student orientation event each September and a graduation event each May that Indigenous engineering students have attended since 2022. On the National Day for Truth and Reconciliation and Orange Shirt Day, September 30 every year, U of T Engineering highlights the Calls to Action from the Faculty's Eagles Longhouse Blueprint for Action and educates about Residential Schools and the "Every Child Matters" campaign.
- **Indigenous Students Discord Channel:** Established for the 2022-2023 academic year by the Dean's Advisor for Indigenous Initiatives, the Discord server invites current self-identifying Indigenous undergraduate students to privately find community, participate in chats, receive mentorship and see announcements about scholarships, awards, work opportunities and Indigenous-related events. At the outset, approximately 13 students had signed up.
- **Reconciliation Through Engineering Initiatives (RTEI):** A notable example of scholarship contributing towards Truth and Reconciliation with Indigenous Peoples is the research led by Professor Amy Bilton (MIE) and the Centre for Global Engineering (CGEN). In 2018, CGEN launched RTEI, which takes a community-based collaborative

approach to infrastructure-related challenges faced by Indigenous communities across Canada.

Support for 2SLGBTQ+ Students, Staff and Faculty

- **Engineering Positive Space:** This faculty and staff-led committee builds community and takes action to combat barriers to inclusion. They work with QueerSphere to host a virtual Queer & Engineer meet and greet event, create banners and Positive Space decals for events, advocate for safety and supports, and collaborate on Pride Month communications. In 2023, they worked with the AD-DIP to advise the Faculty Recruitment Office on ways to evolve the programming for women students to include those in the gender minority.
- **QueerSphere:** The undergraduate group brings awareness of the 2SLGBTQ+ community and makes engineering a more welcoming and inclusive place for all. Programming includes fun events such as Gay!me Night and Gingerbread Bridge Building, as well as delivering EDI training modules for orientation week and student leaders.
- **QueerSphere Grad:** Formed in 2022, the club has been building community and mentorship among graduate students with start-up funding from the DIP Office. Programming includes Trivia Nights and a mentorship event focused on meeting undergraduate students and supporting them.
- **Conferences:** In 2023, the AD-DIP funded students to attend the inaugural EngiQueers Canada national conference. The high importance of this networking and community event was evident in the feedback from students.
- **Pride Month:** The Faculty's programming for Pride each June fully resumed in 2023 since the COVID-19 pandemic with the full return of the annual Toronto Pride Parade. Students in QueerSphere and Blue & Gold Committee design and build a unique parade float each year that is funded by the AD-DIP. Close to 100 students walk with the float demonstrating a strong public presence of U of T Engineering in the community. In 2023, the programming also included a campaign to create more positive spaces within the Faculty and also distributed pronoun buttons.

Challenges and Opportunities

Student clubs operate with a degree of independence and annual turnover, and EDI training for student leaders could enhance their abilities to lead difficult conversations on EDI topics and remove barriers for students to access central services. Finding ways to provide financial awards and/or remuneration for students doing EDI work or creating a staff position to support affinity clubs and project work of the EEDIAG and DIP Office could also enhance their impact.

U of T Engineering has the opportunity to recognize more dates of significance related to under-represented groups in engineering and STEM within courses, curriculum and pedagogy. Students are looking for their instructors to provide time for in-class reflection, awareness, and discussion of issues impacting marginalized groups. The DIP Office can be a resource to provide guidance to instructors on how to accomplish this.

10.2.2 Disclosure Framework

In January 2021, U of T Engineering launched a disclosure framework for students to seek resources and find resolution to allegations of harassment, discrimination and harmful unprofessionalism. The goal is to provide a process for informal discussion and disclosing in a

confidential manner, via any staff or faculty member that students are comfortable speaking with. We also provide the student with resources, a pathway for informal resolution and/or referral to the University's formal complaints processes.

The framework was developed in consultation with students, Vice-Deans of Undergraduate and First Year, Human Resources, the Dean's Advisors, and the University's equity offices. The framework was guided by a similar accountability process in place within the Temerty Faculty of Medicine. The framework is overseen by the AD-DIP who is the intake manager of the disclosures and coordinates case management and case conferences. The framework is guided by the Ontario Human Rights Code, the University's Code of Student Conduct, the University's Policy on Sexual Violence and Sexual Harassment, and the Professional Engineers Ontario Code of Ethics and definition of misconduct.

10.2.3 Curricular Content

As the student body becomes more diverse, U of T Engineering course materials need to consider the broader range of lived experiences that students bring and their social considerations. The Faculty has taken steps to enrich course content to highlight and remind students of their roles as eventual professional engineers in combatting social inequities.

Examples include:

- **Ethics and Professionalism Course Content:** Since 2019, the AD-DIP has developed and delivered lectures on the intersection of the ethics of professional engineering practice and equity to first- and fourth-year courses in several academic areas, as well as in the first-year Engineering Strategies & Practices course. In partnership with the author of the Law & Ethics for Engineers textbook, a lecture was also delivered to the first-year course, Orientation to Engineering.
- **EDI in an Engineering Context:** Introduced in the Fall 2021, "EDI in an Engineering Context" was the first graduate-level course at U of T Engineering to explicitly give students the chance to learn several social and equity-centric concepts while exploring various contexts for how EDI integration could be considered within engineering education, research, and workspaces.
- **Certificate in Justice, Equity, Diversity & Inclusion:** In 2023, Mikhail Burke, Associate Director of Access and Inclusive Pedagogy within the DIP Office, in partnership with the Office of Cross-Disciplinary Programs co-created a new undergraduate certificate in EDI. With the support of the Engineering Society and ISTEP, Faculty Council approved the certificate to launch in Fall 2023. To earn the certificate, students enroll in three courses from an approved list within the categories of equity and justice, technology and society, and ethics and broad considerations.
- **PEY Co-op preparatory programming:** In 2021, a collaboration with the DIP office helped build EDI and professionalism content into the new Professional Experience Year Co-op Program's preparatory programming. The first module addresses engineering careers, providing EDI training to alumni and industry mentors, tracking student experience by demographics, and providing processes for students to report experiences of unprofessionalism, bias, harassment, discrimination when working with organizations external to the University. The second module includes gendered language and the value of the professional engineer (PEng) licence in society. The third module includes ethics and professionalism content, employer best practices for equity policies, and linking work experience to PEng licence qualifications. The fourth module addresses ways

students can advocate for their rights and equity with employers and have access to University resources while completing their co-op work terms.

Challenges and Opportunities

A review in 2020 by members of the Engineering Society, NSBE and Engineers Without Borders confirmed that undergraduate students want to see more equity content in their mandatory engineering courses. Many steps taken to date were praised such as in the first-year courses Orientation to Engineering (APS100), Praxis I (ESC101) and II (ESC102) for engineering science students, Engineering Strategies and Practices I (APS111) and II (APS112/113) for Core-8 students, as well as the second-year Engineering and Society (ESC203) course for engineering science students. Positive feedback was received on content that discussed designing for equity, the role of engineers in society, positionality, bias, lived experiences of communities, how technology shapes culture and political systems, working in teams, and legal and ethical issues of design.

The actions the Faculty has taken to date responded well to the expectations of students; however, more can be done to embed EDI content within the mandatory and core engineering undergraduate curriculum in all disciplines.

10.2.4 Faculty, Staff and Student Training

Building positive cross-cultural interactions between faculty, staff, students, alumni and external partners is critical to enhancing inclusion and belonging. The DIP Office is partnering with University equity offices to develop and host a suite of cultural competency toolkits along with role-specific trainings for departments within the Faculty.

EDI training opportunities across U of T Engineering have increased significantly since the last self-study. There are many more EDI training courses available across the University; however, consistent feedback is that people want to attend training catered to their circumstances. Training developed for the U of T Engineering community include:

- **Indigenous Cultural Competency Toolkit:** The Indigenous Cultural Competency Toolkit was launched in March 2021 and directly responds to one of the recommendations of the *Blueprint for Action*, as prepared by the Eagles' Longhouse. It was created by an Indigenous engineering student in consultation with Indigenous leaders in the University's Office of Indigenous Initiatives and the Dean's Advisor on Indigenous Initiatives. Its three modules cover understanding and acknowledging truths, participating in the culture, and increasing self-discovery. Formats of learning include webinars, a Blanket Exercise as an interactive virtual session, readings, films, and events like a Powwow and a campus walk that highlights understanding Indigenous history and presence on the land. After two years, there have been 678 training experiences and over 100 faculty and staff have completed the first module. Students and alumni have also participated; however, the emphasis has been primarily on staff and faculty to take the lead in furthering an inclusive learning environment. To support this very personal exploration of cultural values, pre and post workshop support is provided to participants and feedback is collected after each session.
- **Black Cultural Competency Toolkit:** The Black Cultural Competency Toolkit was launched in February 2023 during Black History Month and aligns to the commitments and recommendations from *Striving Towards Black Inclusivity*, as prepared by the Faculty's Black Inclusion Steering Committee, as well as the University's 2021 Anti-Black

Racism Task Force Report. It was created in partnership with Black community leaders including ARCDO, NSBE, the Dean's Advisor on Black Inclusivity and the Faculty's Black Grad & Beyond peer network. The toolkit applies the four principles defined in the Scarborough Charter, which are Black flourishing, inclusive excellence, mutuality and accountability. The goal of the toolkit is to help staff, faculty, students, alumni, and partners better understand the Black experience in engineering and take proactive steps to prevent racial discrimination and harassment. The toolkit format was designed to be self-directed with three modules covering Black Canadian history, Black identity, and Blackness in STEM. The format uses various learning modalities including videos, podcasts, articles, workshops, and teaching resources. Since its launch, just over 40 people have registered to participate. Feedback and toolkit user testing were collected and improvements to the toolkit will be implemented in Fall 2023. It was found that a fully self-directed training was not preferred by users and instead an introductory webinar to provide an overview of the content was recommended to improve training registrations.

- **EDI training for teaching assistants:** To better support teaching assistants' (TAs) ability to work with students in an inclusive way, the DIP Office partnered with the Vice-Dean, Graduate Studies to create EDI-specific training modules as part of the annual orientation and onboarding for new TAs. Delivered in three asynchronous online modules, concepts covered include foundations of EDI, how power and privilege manifest in teaching dynamics, and how to interrupt bias with tools to create inclusive learning environments both online and in person classrooms. The modules include readings, videos, and activities to help TAs apply and reflect on the knowledge, and work at their own pace. Although not mandatory, approximately 100 TAs completed the training in the first year.

10.3 Inclusive Partnerships

The AD-DIP has built partnerships to advance EDI and professionalism beyond U of T Engineering. External organizations are looking for support and advice on advancing EDI and professionalism within STEM and engineering communities and the DIP Office is well situated to provide this help and partnership.

The AD-DIP is raising awareness of U of T Engineering's commitments and leadership in diversity, inclusion and professionalism and attracting PEY-Co-op positions as a sought out speaker by many industry organizations including Bloomberg's Women in Fintech international panel on pathways for girls and women in STEM, the City of Toronto's Women in Construction network, the Society for Women Engineers international women's day event with the President of NSERC, the Ontario Water Public Works Association Young Professionals Committee panel on diversity and inclusion in public works, the WISE high school conference, the Ontario Land Surveyors annual meeting on addressing equity and inclusion in professional practice, the Canadian Society for Chemical Engineering student chapter about cracking the glass ceiling, the Canadian Federation of University Women about equity progress, the Ontario Vehicle Innovation Network about workforce development goals, and CBC Metro Morning for a radio interview about removing barriers for internationally educated engineering graduates to become licensed in Ontario.

The AD-DIP is bringing active professional practice discussions and licensure assistance to U of T Engineering as the elected president of Professional Engineers Ontario in 2020 and subsequently an elected director of Engineers Canada in 2021, both professional organizations that oversee the CEAB process and licensing of engineers. While in these roles, she helped the

EEDIAG provide a voice into two equity motions that were passed in Ontario for the profession to undertake an exploration of its role in Truth and Reconciliation and the 94 Calls to Action in consultation with Indigenous engineers, and to update policies and legislation with the most current gender-neutral language, and normalize pronoun use. The later motion was prepared in consultation with the Ontario Fairness Commissioner and was the first of its kind for regulated professions.

In 2023, in partnership with the Wardens of Camp One, Jewish graduating students at U of T were supported with a weekday ceremony of the iron ring obligation ceremony normally held on a Saturday, the Jewish Sabbath. Currently the AD-DIP is providing input into the Futures of Engineering Accreditation national project, is the 30 by 30 Champion for the Faculty helping advance women students to obtain the requirements towards the P.Eng. license, has been invited to join the Ontario chapter of AISES as an ally to help grow the Indigenous STEM professionals network, and is helping to advise U of T's Data Sciences Institute as a member of their Equity, Diversity, and Inclusion Advisory Committee.

10.4 Challenges and Opportunities

The challenges facing the DIP Office include reduced funding occurring across the Faculty for the 2023-2024 academic year, finding ways to increase the hiring of individuals from underrepresented groups, and continuing to increase the available resources with a reduced budget.

U of T Engineering has the opportunity to review and seek advice on outreach, access, recruitment and hiring processes for faculty with an EDI lens to increase the percentage of women, Black, 2SLGBTQ+, persons with disabilities and Indigenous identities within the engineering faculty.

As financial resources of the Faculty tighten, it will be important to find ways to make the financial investments needed to support the EDI activities required to further an inclusive and professional culture to enable the Faculty's strategic initiatives.

Opportunities exist for embedding EDI content within the core curriculum, gaining valuable input from students via the *Voice of the Engineering Student* in 2024, and increasing graduate students outreach to underrepresented groups.

To respond to student expectations for EDI and social justice education within the university environment, optional trainings and certificates have been offered. However, much more can be done to embed EDI content within the mandatory and core engineering undergraduate curriculum in all disciplines with the goal being that every student gains this knowledge that is core to acting professionally, ethically and with consideration of social impact.

The 2019 benchmark study, *Voice of the Engineering Student* was originally planned to be repeated after three years, however, the COVID-19 pandemic disrupted programming and placed additional stress on the students. Therefore, it will be important to repeat the study in Winter 2024 and launch a similar culture survey of faculty and staff to ensure they are included in assessments of the Faculty's inclusive environment.

The Faculty has the opportunity to increase the outreach and recruitment of underrepresented groups at the graduate level. The opportunity is to direct more work towards communities to understand the barriers to access and what further resources are needed to grow the pipeline of faculty and researchers with these identities and who may be coming from non-traditional

educational backgrounds.

Future Directions

When the foundations of U of T Engineering — the School of Practical Science — first opened its doors 150 years ago, only a handful of students were enrolled in applied science and engineering courses. Our Faculty has since grown considerably in numbers and diversity. Today, we are a thriving hub of innovation and excellence, consistently ranked at the top of major global university rankings.

To continue this positive trajectory and elevate our presence and impact further, it is clear that the future of the Faculty of Applied Science & Engineering will need to be guided by the key tenets of **sustainability**, **interdisciplinarity** and **global impact**.

The pace of change in every sector is moving more rapidly than ever before. The technical abilities demanded of yesterday's graduates are vastly different for tomorrow's. The 21st-Century engineer will need to possess much more than core disciplinary foundations. Our graduates, across all levels and programs, must be agile, flexible, resilient and able to leverage their engineering education to drive positive impact. They must also be adept at addressing an enormous spectrum of social, technological and global challenges at the intersection of different disciplines.

U of T Engineering needs to further embrace the core concept of life-long learning and the goal of graduating the "sustainable engineer": one who understands what it means to constantly re-learn, re-invent, pivot and identify opportunities to create positive change.

Further, all of this needs to be framed in a global context. Our graduates will need to be prepared for the types of international dialogues they will be engaged in. International learning opportunities and nurturing greater global awareness among our students is a key part of the equation. Some of these opportunities may be curricular, but increasingly we are seeing tremendous opportunities for co-curricular partnering and learnings.

Delivering on this kind of interdisciplinary, sustainable and global educational promise requires a coordinated approach — not just among departmental offerings but among our external community as well. There is a tremendous opportunity for ISTEP to be truly integrated across the entire Faculty, starting with student recruitment and undergraduate and graduate programming, to life-long learning. To become the future-facing Faculty we aspire to be, we need to build new frameworks and innovate in how we deliver on our core academic mission.

Demand is high — and growing — for our programs and our graduates. While scaling up in size (be it in terms of staffing, resourcing, scheduling or space) may be warranted, there are several practical challenges at play; particularly in our constrained physical environment. In the short and long terms, we will need to be creative in finding the right opportunities to engage and partner to meet our goals for the future. For example, what role might our Faculty play across our three campuses? Could there be an opportunity to build an innovation campus outside our existing space?

The concepts of sustainability and interdisciplinarity also extend to how we can better support research and educational efforts that sit outside of our core departmental programs. We can look to the past for inspiration: in the 1960s, the seeds of our current-day Institute for Biomedical Engineering (BME) were laid. Through strategic collaboration and partnership, today BME is funded uniquely by three faculties at U of T with several external partners. What lessons can we learn here about creating new pathways to sustainably grow our interdisciplinary

research?

Corporate partnership and collaborations with not-for-profit foundations around the world are another key to creating an interdisciplinary, sustainable and globally relevant ecosystem within our Faculty. These relationships offer both resources and opportunities for researchers and students alike, and we aim to further engage these entities in ways that are truly collaborative and mutually beneficial. The key to success is for these partnerships to emerge from a non-transactional framework.

U of T Engineering has long been known for our highly collaborative and tremendous community spirit, largely from our undergraduates. For the community to thrive as a whole, we need to actively grow this sense of culture within our graduate and post-graduate programs. This is especially true for students in our MEng program. Aligning the needs of our professional master's students with our offerings will be key to building both a stronger community and a higher quality program. A successful MEng program will ultimately lead to increased revenues for the Faculty to invest back into strengthening the entire ecosystem.

Another opportunity for the future is to remove barriers between our teaching- and tenure-stream faculty in terms of their mission, impact and career development prospects. The Faculty needs to invest in programming and resources that support all faculty through all aspects of their career development. Teaching-stream faculty need to feel that they are key to the success of the overall academic mission, including the research mission, of the Faculty. Building programming and internal funding mechanisms to support this will be key.

Our Faculty is deeply committed to supporting our community members and creating a place of belonging that is accessible for all. Creating pathways for underrepresented populations within engineering among our students and faculty will continue to be a priority for U of T Engineering moving forward. Expanding resources that support the mental health and wellness of our students will also be critical.