

A woman in a lab coat is working at a workstation in a laboratory. She is looking down at a piece of equipment, possibly a microscope or a small robot. There is a large flexible duct on the left side of the workstation. The background is slightly blurred, showing other lab equipment.

Engineering Strategic Research Plan

In This Report

- 2** Preamble
- 3** Vision, Mission and Values of the Faculty
- 4** Advanced Manufacturing and Materials
- 5** Artificial Intelligence and Machine Learning
- 6** Automotive Engineering and Transportation Electrification
- 7** Energy, Environment and Sustainability
- 8** Information and Communication Technologies
- 9** Nuclear Engineering and Radiation Science
- 10** Robotics and Autonomous Systems
- 11** Software Systems and the Internet of Things
- 12** Measuring Our Success
- 13** Contact Us



Preamble

The Faculty of Engineering and Applied Science (FEAS) is committed to excellence in research, teaching and service. This Strategic Research Plan identifies the vision and priority areas for the Faculty.

Engineering at Ontario Tech is dedicated to promoting a culture of innovation in research and scholarship, and our exceptional researchers drive real-world solutions to complex problems. Our esteemed faculty members are at the forefront of cutting-edge research. For instance, our Faculty is home to four Canada Research Chairs in Adaptive Aerodynamics, Electric Energy Storage Systems for Transportation Electrification, the Internet of Things (IoT) and Nuclear Fuels and Materials. Moreover, the Faculty has an NSERC-UNENE Industrial Research Chair (IRC) in Health Physics and Environmental Safety, and two university Energy Research Chairs who focus on renewable energy, research and development. We seek to foster collaboration and partnerships with diverse communities, industry, stakeholders and the government, and our researchers strive to connect their research with the global community. In doing so, faculty members have attracted significant funding from various sources, including government agencies and the private sector.

The Faculty's research is supported by our quality development facilities, which provide the ideal environment for the continuation and growth of several globally acclaimed research programs. In addition, FEAS makes use of the world-renowned Automotive Centre of Excellence (ACE) in its research and collaboration with industry professionals. The Faculty research program and labs directly align with the university's investments in infrastructure and strategic research priorities.

The expertise our faculty members bring is shared with our students, making FEAS an attractive destination of choice for the leaders of tomorrow seeking the best learning experience. Students are exposed to research, innovation, entrepreneurship opportunities and experiential learning, and our graduates are prepared to face the challenges that lie ahead. We are also determined to strengthen our community by creating pathways for diversity, equity and inclusion and fostering an outstanding learning and work environment.

As we move forward, we strive for excellence in everything we do, and we intend to apply our knowledge for the benefit of society. This research plan will direct the Faculty activities and provide a strategy to reaffirm, support and strengthen our research culture of inquiry, innovation, creativity and entrepreneurship. At the forefront of our plan, we seek solutions to make the world a better place for all.

Vision, Mission and Values of the Faculty

The mission of the Faculty of Engineering and Applied Science is to deliver the highest quality of engineering and applied science education through teaching and research excellence, a state-of-the-art educational environment and innovative programs. It aims to provide our graduates with the knowledge and skills needed to succeed and become leaders of tomorrow. The Faculty of Engineering and Applied Science is market-oriented, and connects to the needs of industry and communities, striving to contribute to sustainable economic development through innovative research and highly qualified personnel, and the overall betterment of society.

We aim to:

- Offer high-quality, accredited undergraduate and graduate programs in engineering and applied science and related market- and career-oriented fields.
- Instil life-long learning abilities and prepare professionally competent and broadly educated students capable of addressing the demands of the twenty-first century.
- Conduct high-calibre basic and applied research in engineering, applied science, and related fields.
- Promote a vibrant and fulfilling student-centred experience and foster student success by providing necessary support.
- Utilize advanced and innovative teaching and learning methods and tools, including advanced information, computing and communication technologies, to facilitate successful learning within a technology-enriched learning environment.
- Foster a collegial, respectful and productive environment that attracts and retains the best faculty, staff and students and creates a sense of spirit and loyalty.
- Provide university-level educational opportunities for college students through appropriate transition mechanisms.
- Engage in value-added activities that serve and address the needs of industry and engineering professions, and advance and improve the economic, environmental and social welfare of the region, province and country.

Advanced Manufacturing and Materials

The field of advanced manufacturing & materials (AM&M) is at a stage of revolutionary change. Globally, it will be crucial to lead the next generation of professionals in this field. The Government of Canada has defined the Advanced Manufacturing Supercluster as one Canada's only five main strategic superclusters.

Southern Ontario is home to the Advanced Manufacturing Supercluster. The Department of Mechanical and Manufacturing Engineering (MME) is one of three universities in the country and the only university in Ontario to offer a Manufacturing Engineering program at the undergraduate level.

Specific research areas include:

- Additive manufacturing and 3D printing
- Biomaterials
- Ceramics and hybrid materials
- Design and optimization
- Digital and precision manufacturing
- Energy materials
- Functional coating
- Green and nano composite
- Nanomaterials
- Non-linear dynamics
- Solid mechanics
- Noise, vibration and harshness
- Subtractive manufacturing and high speed machining
- Surface functionalization and surface integrity

We will:

- Increase our capacities in manufacturing process modelling, precision manufacturing, intelligent inspection, control and diagnostics, embedded software, and their corresponding cyber-physical components aligned with the requirements of Industry 4.0.
- Develop new capacity in intelligent product design, manufacturing and smart materials.
- Provide support for building infrastructure for advanced manufacturing and smart materials.

Artificial Intelligence and Machine Learning

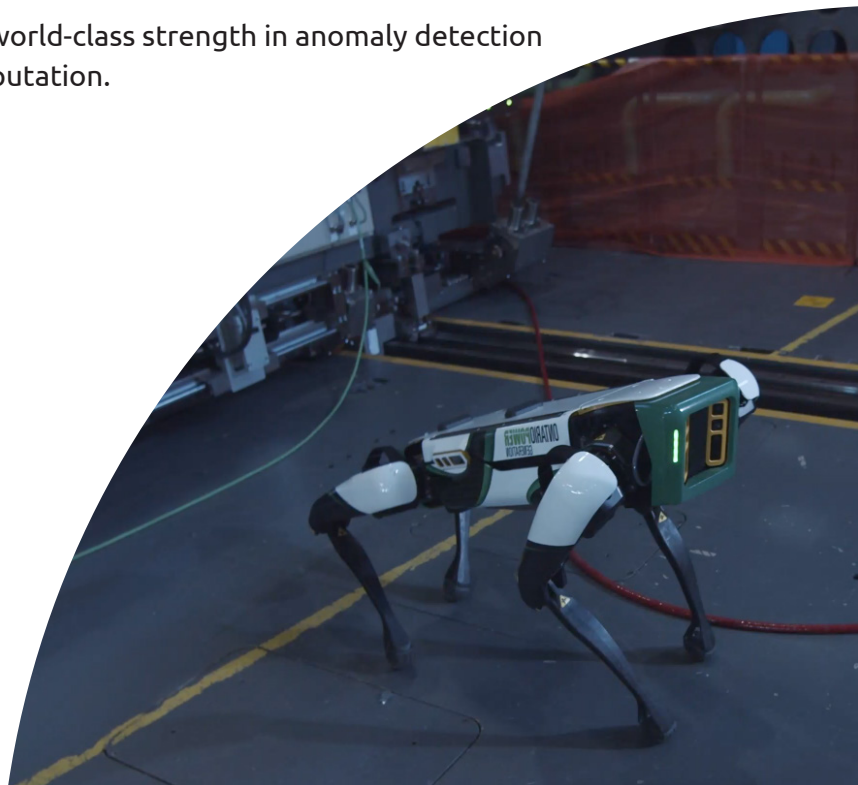
Users of digital technology are expecting machines to exhibit some level of intelligence, or the ability of the system to rationalize and take actions that have the best chance of achieving a goal. Researchers are investigating novel machine learning algorithms as well as applications in engineering.

Specific research areas include:

- ▶ Anomaly detection
- ▶ Adversary training
- ▶ Data analytics
- ▶ Evolutionary computation
- ▶ Machine vision
- ▶ Opposition-based computation

We will prioritize research that:

- ▶ Focuses on the use of AI techniques, including machine learning and deep learning, particularly in applications that can advance our utilization of big data analytics to achieve positive outcomes for society.
- ▶ Develops inquiry capacity on intelligent software applications for use by business and industry.
- ▶ Further develops our world-class strength in anomaly detection and evolutionary computation.



Automotive Engineering and Transportation Electrification

With the fast-rising global market share of Electric Vehicles (EVs) and the ambitious goals for Zero-Emission Vehicles to eliminate greenhouse emissions, research and development in EVs and autonomous vehicles are critical to strengthening the competitive capability of Canada's automotive industry for severe global competition. Autonomous vehicles can enhance the safety, accessibility, efficiency and convenience of road vehicle transportation. In addition, climatic engineering is emerging to address climate change and meet our climate goals.

Researchers are developing revolutionary technology for the automotive industry. The strategic research priorities include advanced propulsion systems; innovative design of autonomous and semi-autonomous vehicles; multidisciplinary vehicle systems design; design of hybrid and electric vehicles with autonomous driving capabilities; and risk and economic models that account, adapt and combat climate changes.

Specific research areas include:

- ▶ Vehicle dynamics, control and driver-vehicle-environment interactions
- ▶ Active vehicle safety
- ▶ Hybrid electric vehicle design and control
- ▶ Vehicle structure and chassis design
- ▶ Vehicle thermal aerodynamics and thermal management
- ▶ Battery charge and storage
- ▶ Autonomous and semi-autonomous driving and autonomous e-mobility
- ▶ Vehicle modelling, simulation and optimization
- ▶ Tire mechanics
- ▶ Driver behaviour modelling and simulation
- ▶ Transportation electrification and intelligent transportation
- ▶ Acoustics and aeroacoustics
- ▶ Advanced thermofluids
- ▶ Aerodynamic optimization, climatic aerodynamics, development of aerodynamic devices and active vehicle aerodynamic control
- ▶ Wind engineering, defrosting, and sensor cleaning in adverse weather

We will:

- ▶ Develop new opportunities with automotive Original Equipment Manufacturers (OEM) and in emerging sectors such as electric vehicles.
- ▶ Continue to be a research and talent anchor for the development of a manufacturing hub and supply chain in the region for autonomous vehicles and systems.

Energy, Environment and Sustainability

Researchers contribute to regional, national and international efforts to ensure that environmentally responsible energy technologies are developed and in place for the future.

Specific research areas include:

- ▶ Advanced safety and control systems for nuclear power plants
- ▶ Renewable energy systems
- ▶ Smart grids and microgrids
- ▶ Power electronics and electric motor drives
- ▶ Power systems and electric energy storage systems
- ▶ Advanced propulsion systems
- ▶ Alternative fuels
- ▶ Sustainable energy systems and communities
- ▶ District energy systems
- ▶ Energy storage systems
- ▶ Hydrogen energy and fuel cells
- ▶ Net-zero buildings
- ▶ Fluid-structure interaction
- ▶ Nuclear instrumentation and control
- ▶ Fluid mechanics

We will:

- ▶ Contribute to regional, national and international efforts to ensure that environmentally responsible energy technologies are developed and in place for the future.
- ▶ Focus on developing research and policy to achieve better efficiency, economy, resources use, ecosystem, resilience, design and analysis, management and practices.
- ▶ Address complex challenges involved in the transition to a net-zero carbon economy.
- ▶ Continue to build capacity for more international recognition.

Information and Communication Technologies

Information and communication technologies are crucial for information access and sharing. These technologies enable unified wireless connectivity among people, devices and machines for enhanced mobile broadband, mission-critical control and massive internet-of-things. This area of research drives the advancement of a wide range of economic sectors, including mobile broadband networks, intelligent energy systems, smart cities, autonomous transportation, health care, etc. Our engineers are conducting cutting-edge research contributing to the global technology advancement in this area.

Specific research areas include:

- Wireless communication and networking techniques
- Signal processing for communications and networking
- Massive data access, processing, storage and communication
- Energy harvesting and energy efficiency in wireless communications
- Network edge processing and computing
- Pervasive and mobile computing
- Autonomous vehicular networks
- Satellite communications
- Statistical signal processing
- Detection and estimation
- RF/microwave/millimetre-wave circuits and systems
- Antennas and antenna arrays
- Wireless sensor technologies and sensor networks
- Microwave filters and multiplexers
- Computer-aided design of RF circuits

We will:

- Develop and expand our world-class strength in next-generation wireless technologies for information access and sharing that drives the advancement of key economic sectors.
- Intensify our cutting-edge research to deliver transformative technologies that enable unified wireless connectivity for anyone anywhere and support emerging intelligent systems.

Nuclear Engineering and Radiation Science

The energy sector is evolving at a rapid pace to account for climate change and recent developments in nuclear plant construction techniques, modularity, and applications for Small Modular Reactors. Recent experience in refurbishing the CANDU fleet has clearly demonstrated the long-term value of nuclear power with electricity and jobs for 30+ years. Also, reactor-based medical and industrial isotope production methods are being actively pursued.

Our faculty members are conducting state-of-the-art research in collaboration with leading industrial partners in the areas listed below.

Specific research areas include:

- Advanced Nuclear Reactor Systems
- Advanced Nuclear Fuels/Materials
- Decommissioning Nuclear Facilities
- Environmental Protection and Health Physics
- Maintenance and Refurbishment
- Small Modular Reactors
- Nuclear Security
- Nuclear Modelling and Simulation
- Radiation Detection and Visualization
- Radioactive Waste Management
- Plasma Systems for Energy and Nuclear Applications

We will:

- Develop new radiation detectors, new radiation capture technologies, reactor simulation technologies, and fuel and material data to support the peaceful use of nuclear energy.
- Research to help create a new future that includes Small Modular Reactors, improved operations and maintenance, decommissioning and advanced integrated energy centres for remote communities.

Robotics and Autonomous Systems

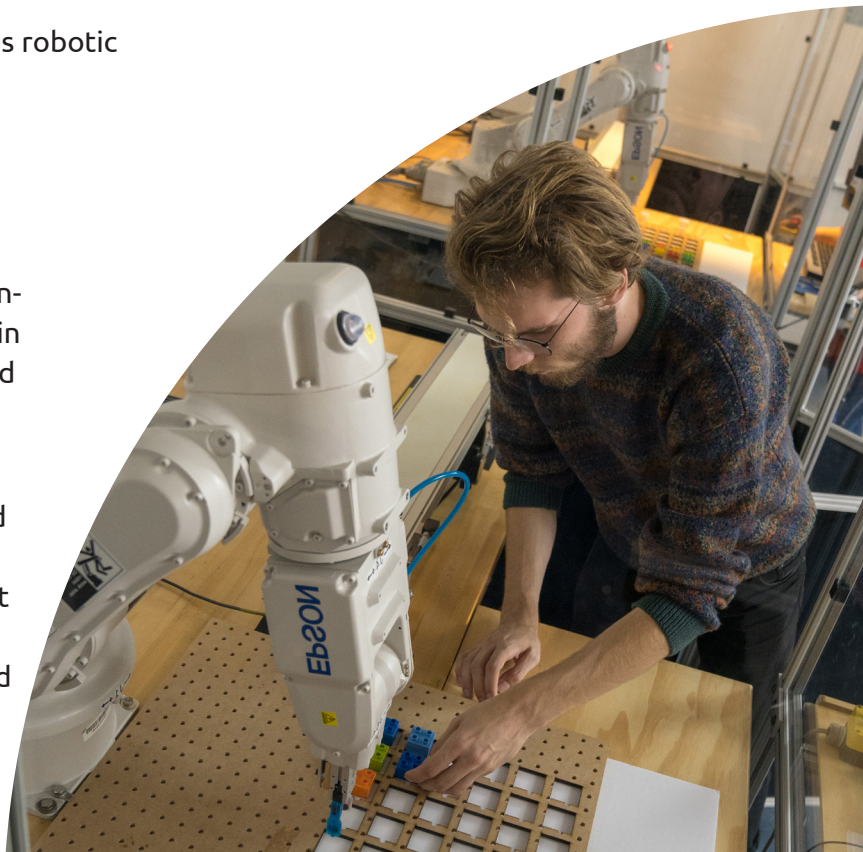
Autonomous mobile systems such as robots, drones and driverless equipment have become viable solutions for automation in many economic sectors. In keeping with this trend towards increased automation, researchers conduct cross-disciplinary research by leveraging our current research strengths in mechatronics and robotics. These strengths include autonomous and crewless robotic systems, advanced sensing, human-robot interaction (HRI), multidisciplinary mechatronics design, and machine learning and artificial intelligence (AI) in engineering.

Specific research areas include:

- ▶ Mobile manipulator systems
- ▶ Crewless ground/aerial vehicles
- ▶ Inverse problems in mechatronics, robotics and automation engineering
- ▶ Amphibious robots
- ▶ Machine vision, monitoring and fault diagnosis
- ▶ Interactive autonomous robotic manipulation
- ▶ Automated mechatronic design
- ▶ Automated construction equipment
- ▶ Predictive safety control
- ▶ Haptic devices for robotic surgery
- ▶ Autonomous medical robotic devices

We will:

- ▶ Develop advanced robotic and autonomous systems to improve Canada's competitiveness in the global economy and the betterment of humankind.
- ▶ Focus on designing and developing advanced autonomous intelligent systems for autonomy, productivity, safety and sustainability.



Software Systems and the Internet of Things

The Internet of Things (IoT) will be the foundation of our critical infrastructure and the basis for emerging and future smart services. FEAS researchers are addressing many of the unique challenges in engineering resilient software systems that enable the vision of IoT.

Specific research areas include:

- Cyber-physical systems
- E-Health and medical image processing
- Embedded and real-time systems
- Security, privacy and trust
- Smart cities
- Emerging technologies
- Software analytics
- Software quality and testing
- Model-based software engineering

We will:

- Develop methods and techniques for intelligent software systems.
- Continue building capacity in fields such as sensors, embedded and secure software systems and safety critical systems, which are at the cutting edge of where research on IoT is heading.



Measuring Our Success

Our Faculty is committed to pursuing research excellence in all our research programs and focus areas.

The following outlines our performance measures and success indicators:

- ▶ Publishing our scholarly research in reputable top-tier international journals and conference proceedings.
- ▶ Increasing our Faculty research portfolio and receive external research grants from government and industry.
- ▶ Intensifying our research capacity by increasing the number of research partnerships with industry, public and private sector organizations.
- ▶ Broadening our research opportunities through technology transfer and commercialization in collaboration with our industry partners.
- ▶ Recognizing our faculty members in the Engineering professional societies.
- ▶ Improving our Faculty ranking in all engineering disciplines and programs nationally and internationally.
- ▶ Expanding the size and research strength of our graduate student and postdoctoral fellow community.
- ▶ Integrating equity, diversity and inclusion (EDI) into our research activities and practices.



Contact Us


Faculty of Engineering and Applied Science Ontario Tech University

2000 Simcoe Street North
Oshawa, Ontario
L1G 0C5

 Ontario Tech University
Engineering

 OT_FEAS

 OTFEAS

 OT_FEAS

 Ontario Tech Engineering

 engineering.ontariotechu.ca