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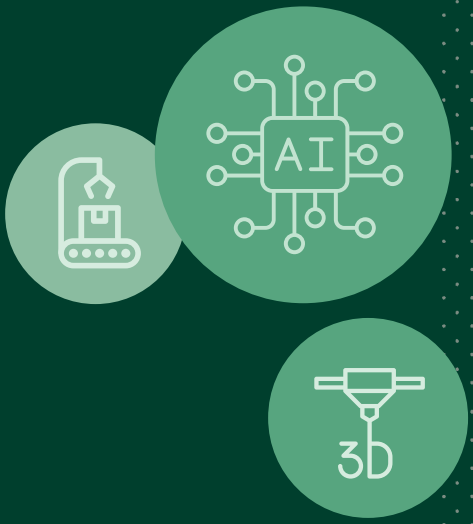

A Plan for Prosperity: Fueling the Advanced Manufacturing Supply Chain

From Critical Minerals to Electric Vehicles and Beyond

ONTARIO'S UNIVERSITIES
Partnering for a better future

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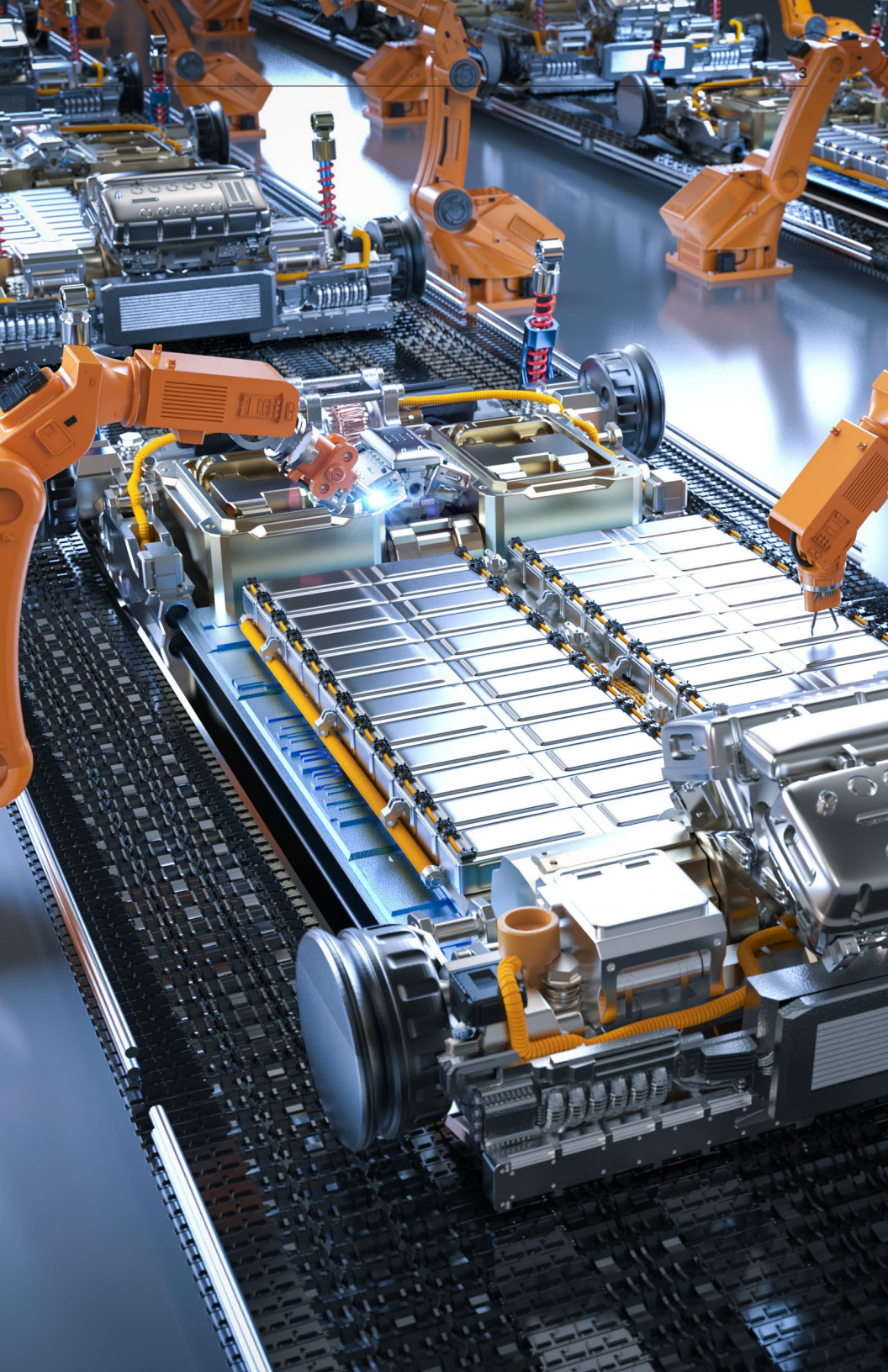


Introduction

Ontario's advanced manufacturing sector, which spans the fields of robotics, 3-D printing, modular housing, critical minerals, electric vehicles and much more, is the beating heart of the provincial economy, contributing significantly to job creation, exports and technological advancement.

Within this dynamic landscape, Ontario's universities play a pivotal role in fueling the advanced manufacturing supply chain through talent and skills development, partnership with community and industry, and research and innovation.

In today's fast-paced world, staying competitive in advanced manufacturing demands a skilled and adaptable workforce.

Recognizing this need, Ontario's universities are developing adaptable, highly skilled talent that is equipped with the knowledge required to navigate the

intricate world of advanced manufacturing. Through cutting-edge programs, work-integrated learning experiences and reskilling and upskilling opportunities, universities are preparing the next generation of skilled professionals and leaders. They're not just educating students; they're equipping them to become architects of tomorrow's manufacturing landscape.

Moreover, universities in Ontario understand that advanced manufacturing thrives on partnership and collaboration. By establishing robust partnerships with local communities and industry players, universities are fostering an ecosystem that encourages innovation, productivity and sustainability. These collaborations go beyond traditional boundaries, facilitating the exchange of knowledge, technologies and best practices. Universities are bridging the gap between academia and industry, enabling the seamless transfer of skills and expertise throughout the advanced manufacturing supply chain.

Research and innovation are the lifeblood of advanced manufacturing. Through partnership and ground-breaking projects that redefine possibilities, university researchers are driving innovation by addressing complex challenges, developing new processes and creating transformative technologies. This not only benefits immediate industry needs, but also contributes to the long-term sustainability and global competitiveness of Ontario's advanced manufacturing sector.

Universities are more than educational institutions - they are key drivers of Ontario's advanced manufacturing sector, ensuring its growth and success on a global scale. They are actively shaping the trajectory of advanced manufacturing by nurturing talent, fostering partnerships and fueling innovation.

From 3-D printed homes and building Canada's first zero-emissions vehicle to self-driving labs that create new materials and revolutionize discovery at a fraction of the time and cost, the stories showcased in this booklet demonstrate the tangible impact universities have on the province's advanced manufacturing ecosystem.

These stories illustrate just some of the ways we can keep Ontario at the forefront of advanced manufacturing through the endless opportunities that arise when universities and industry collaborate, shaping a future where advanced manufacturing in Ontario thrives without limits.

Strengthening Industry through Talent and Skills Development

The advanced manufacturing sector faces a pressing issue – the need for talent with the precise skills demanded by modern manufacturing processes. A competitive advanced manufacturing sector requires the next generation of workers to have the skills and knowledge to create, adopt and adapt to cutting-edge technologies, such as sensors, nanotechnology, electric vehicles and mobility, 3-D printing and artificial intelligence.

Universities are addressing this challenge head-on and shaping the future of advanced manufacturing by cultivating these in-demand skills.

Whether it's by working directly with local companies to develop new products and technologies outside of the classroom, or through courses in automation, machine learning and artificial intelligence (AI) within the classroom, universities are offering targeted programs that bridge the skills gap, ensuring graduates possess the expertise required to tackle industry-specific challenges.

To ensure the workforce remains agile in the face of rapid technological changes, Ontario's universities partner with industry stakeholders, aligning their programs with real-world industry demands. This not only benefits manufacturers by providing them with a skilled workforce, but also positions Ontario as a hub of manufacturing excellence, attracting investment and driving economic growth.

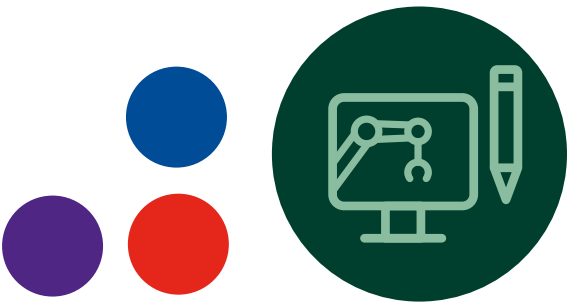
Developing skills through innovative programming and hands-on learning

Enhancing student learning with digital maker studio

By equipping students with the digital, tech and manufacturing skills they will need to thrive in a changing labour market, **OCAD University's** Experimental Fabrication Studio is enhancing student learning and complementing in-class programming.

The digital maker facility provides students with invaluable hands-on learning experiences where students work directly with advanced prototyping and manufacturing systems on leading-edge equipment, including robotic arms, laser cutters and 3-D printers.

Through the opportunities provided by the Experimental Fabrication Studio, students learn how to design in a real-world context, helping fuel the talent pipeline in industrial design, prototyping and manufacturing, UX design, data design and more.

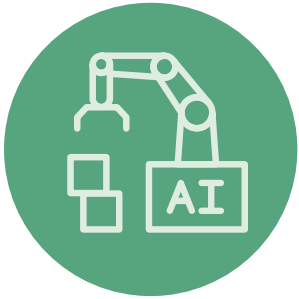


Building Canada's first zero-emission concept electric vehicle

Electric vehicles are vital to reducing greenhouse gas emissions and promoting sustainable transportation. To help fuel this critical industry, **Ontario Tech University** played a key role in a ground-breaking engineering project called Project Arrow, led by the Automotive Parts Manufacturers' Association (APMA) and in partnership with the Federal Economic Development Agency for Southern Ontario, which resulted in Canada's first zero-emission concept electric vehicle.

More than 20 Ontario Tech students gained valuable hands-on experience through their involvement in Project Arrow, gaining exposure to every aspect of vehicle development, from part design to fabrication, as well as to experts in the field.

The project included collaboration with various industry partners and further highlighted the university's position as an innovation hub and a key contributor to the energy and automotive sectors, driving economic growth.



Advancing manufacturing through AI skills development

Artificial intelligence (AI) in advanced manufacturing enhances efficiency, quality and customization, while optimizing resources and reducing costs. The Master of Management in Artificial Intelligence (MMAI) program at **Queen's University** is equipping the next generation of workers with the expertise and skillset to harness the transformative potential of AI.

This program offers a comprehensive understanding of AI's technical principles, business applications, ethical considerations and the skills needed to lead high-performance teams, enabling graduates to drive innovation and productivity in the industry.

The transferrable skills developed through the MMAI can be applied to improve and advance areas in manufacturing, such as process optimization, supply chain management, robotics and automation and human-machine collaboration.

Building regional workforces through reskilling and upskilling

Fueling the local talent pipeline

A recent study by PWC noted that, by 2030, 23.5 million jobs worldwide will be using augmented and virtual reality. It is why **Algoma University**, in partnership with Unity, a leading platform for interactive content, has launched the National Centre of Excellence (NCoE) to accelerate innovative education, training and research opportunities in augmented and virtual reality.

Through this partnership, Algoma is providing critical upskilling and reskilling opportunities for local talent, closing a skills gap and building a talent pipeline for economic growth.

The project also includes the development of new programming opportunities for prospective students to support the anticipated growth of augmented and virtual reality applications occurring in various occupational sectors across the globe.

Partnering to create industry-focused training

To help workers adapt and respond to Ontario's transforming manufacturing sector, while addressing labour shortages within the sector, **Brock University** and MTechHub Innovations Inc. have teamed up to provide reskilling and upskilling opportunities for local talent.

The specialized pilot training program is designed to address the growing trend towards automation and data exchange in manufacturing processes. Manufacturing workers will have the opportunity to learn through unique programming that includes a combination of online and classroom learning, hands-on labs, work-integrated projects and factory workshops.

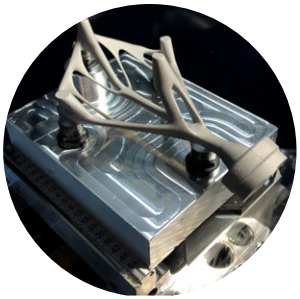
In addition to supporting manufacturing workers, the partnership between the university and the Burlington-based organization aims to support the needs of employers in workforce development and manufacturing optimization in their organizations.

Transforming industry through accessible and equitable workforce training

While human-machine collaborative manufacturing systems can make on-site training of skilled workers challenging and costly, the Design Innovation and Intelligent Manufacturing Lab at the **University of Guelph** is helping affordably equip workers with the specialized training they need.

Researchers at the lab have developed Labs-on-a-Cloud (LoaC) technology, which uses data from sensors and other sources to create high-fidelity digital replicas of manufacturing environments, production lines and labs. These replicas reliably simulate the behaviour of real-world manufacturing equipment and processes.

LoaC leverages multiple digital technologies, such as cloud computing, Internet of Things and machine learning to provide an innovative and effective platform for interactive digital learning and training. The technology is more cost-effective and adaptable than lab-scale manufacturing systems, making it accessible to small-to-medium companies for worker training opportunities.



Filling industry demand for experts in 3-D printing

Additive manufacturing, often referred to as 3-D printing, requires a high-tech skillset - one that can help companies scale up production of parts and services efficiently and effectively.

To help address the skills shortage in 3-D printing, the Multi-Scale Additive Manufacturing (MSAM) lab at the **University of Waterloo** offers programs and courses that support graduate students. The lab also runs regular workshops enabling both professionals working across sectors and those within the industry to reskill and upskill.

As the largest academic-based research and development facility in metal additive manufacturing in Canada, the MSAM uses leading-edge machinery and custom 3-D printers that work with metals, composites, functional inks, polymers and ceramics.

Partnering with Community and Industry

To help strengthen Ontario's advanced manufacturing industry and its supply chain, Ontario's universities are forging impactful partnerships with both communities and local industry. These partnerships are not just about sharing resources; they are about solving real-world challenges.

By collaborating closely with local communities, universities are establishing a strong connection to the pulse of the region by identifying pressing issues and working together to find innovative solutions. This not only benefits the university, but also the community, as they co-create opportunities for economic growth and prosperity.

Equally important are partnerships with industry. Through these collaborations, universities are able to tap into the insights and challenges that local industries often face. These relationships boost innovation, address pressing industry issues, such as operational efficiency and sustainability, and enhance the competitiveness of both students and manufacturers.

When universities, communities and industry work together they create a stronger, more resilient supply chain that helps drive Ontario's economic progress.

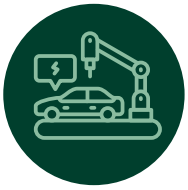
Fueling the automotive supply chain, from critical minerals to EVs

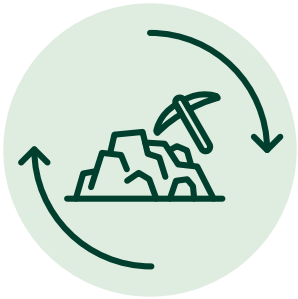
Training the next generation of automotive workers

To help build awareness of career pathways that fuel the electric vehicle supply chain – from mineral exploration to automotive and mobility – **Laurentian University** launched the Regional Future Workforce (RFW) program.

Through summer camps and in-person events at local schools, the program is helping introduce youth in the region to the variety of career opportunities available within Ontario's automotive and mobility sector.

The pilot program has been developed in partnership with local and community organizations, as well as with the Ontario Vehicle Innovation Network (OVIN) and the Ontario Centre of Innovation (OCI). Through the RFW, program partners aim to reduce the stigma associated with automotive industry careers and prioritize engagement with students from equity-deserving and underrepresented groups.





Building the critical minerals supply chain

Critical minerals are key components in the manufacturing of the high-tech products, renewable energy technologies and cutting-edge electronics that underpin economic growth and innovation. To support advanced materials development in the critical minerals sector, particularly in electric vehicle (EV) manufacturing, **Trent University** is partnering with Carbonix Inc., an Indigenous-led clean tech company, to convert locally sourced high-carbon feedstocks into battery-grade materials and meet the demands of the growing EV industry.

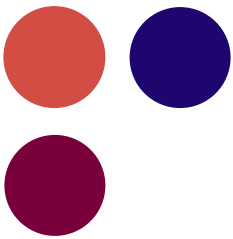
The project focuses on refining processes to convert mining waste into high-energy-density graphite for anode and cathode production, ultimately positioning the university, and Peterborough, as critical players in the EV supply chain and advancing clean economy efforts in Ontario.

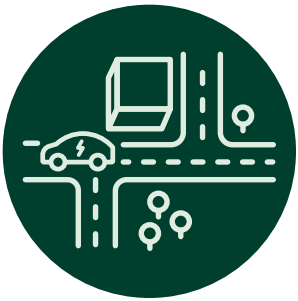
Creating a 'living lab' for electric cars

While electric vehicles reduce greenhouses gases and contribute to the green economy, a small, three-wheeled electric commuter car can also address issues related to city driving, such as traffic and parking. It is why when Project SARIT – a vision by Frank Stronach to create a small, three-wheeled electric commuter car – was launched in 2021, **York University** researcher Andrew Maxwell seized an opportunity to help boost the production of the car.

Using the campus as a "living lab" to test SARIT (Safe, Affordable, Reliable Innovative Transit) prototypes, the project has brought together researchers, students and staff to test the vehicles for various applications, including ride-sharing and accessibility features. Additional plans include creating a prototype dealership on campus to conduct market research and determine consumer preferences.

The initiative is a transformative effort that combines sustainability, innovation and social impact, aligning with York University's goals for a more sustainable transportation future.





Innovative housing solutions throughout Ontario's regions

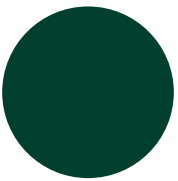
Partnering to build energy-efficient homes

In Canada, many housing developments direct most of their energy use toward the heating and cooling of indoor space, contributing greatly to greenhouse gas emissions. By improving the performance efficiency of building envelopes – which includes all building components that separate the indoors from the outdoors, such as exterior walls, foundations, roof, windows and doors – **Carleton University** is working to reduce emissions and find innovative housing solutions.

Through the Centre for Advanced Building Envelope Research (CABER), the university is partnering with industry to develop cutting-edge technology to maximize energy efficiency and discover new materials for building new homes in ways that prioritize energy conservation and affordability.

Innovations build upon advances in super-thin insulation materials, modular housing and construction, as well as panelized retrofits to develop new approaches to constructing building envelopes that are thinner and cheaper.

In addition, through collaborations with industry, government and academia, CABER provides learning opportunities for both students and workers, including construction workers, building designers, engineers, project managers and building science researchers.



Addressing housing and climate in Canada's North

Ensuring access to affordable and adequate housing in Canada's north is becoming increasingly challenging due to many factors, including floods and forest fires. Through student entrepreneurship opportunities, students at **Wilfrid Laurier University** are developing innovative ways to help address these growing housing challenges.

One such student-led enterprise is Kuponya Innovations, which works with Indigenous communities in the Northwest Territories to co-create sustainable, cost-effective tiny homes for rural and remote communities. The approach includes using climate-resilient and energy-efficient materials and methods; training residents to participate in the construction, manufacturing and maintenance of the homes; and building small businesses to support housing needs.

Through joint venture partnerships, the team creates housing solutions tailored to the unique conditions in each community.

Building Canada's first 3-D-printed homes

Recognizing that 3-D printing in construction significantly reduces construction costs, time and greenhouse gas emissions, a team of researchers at the **University of Windsor** are partnering with Habitat for Humanity Windsor-Essex to build Canada's first 3-D-printed homes for residential use.

The researchers are designing a cutting-edge, 3-D-printed home that will help address a vital need for more affordable and environmentally sustainable housing, while also meeting residential building code requirements.

The team, which includes engineering graduate students and laboratory technicians, will 3-D print concrete segments on a large-scale, industrial printer and test them for strength, sustainability and durability to ensure they're safe for residential use. Once the processes have been refined, 3-D homes will be able to be printed by as few as three workers within a significantly shorter timeframe and at a much lower cost.

From Critical Minerals to EVs and Beyond:

How Universities are Powering the Future of Advanced Manufacturing

From critical minerals and electric vehicles to modular housing, robotics and more, Ontario's universities are partnering to help drive competition in advanced manufacturing, create jobs throughout Ontario's regions and attract investment to our province.

Ontario's universities are not just shaping the future; they are fueling it. Their impact resonates across industries, fostering growth, innovation and a bright future for advanced manufacturing in the province.

Here's a glimpse of their remarkable impact:

Growth in EV Jobs

Electric vehicle technology jobs are projected to grow at rate of **39%** annually. By 2030, an estimated **184,000** people will be employed in the industry—a 26-fold increase from 2020, according to Clean Energy Canada.

STEM Demand

In 2021-22, **38%** of Ontario university students were enrolled in STEM programs, up from **30%** in 2011-12, according to Council of Ontario Universities data. This surge in STEM education is shaping a highly skilled workforce equipped for the challenges of tomorrow and the jobs of the future.

Tech Talent Hubs	**Toronto, Ottawa and Waterloo** are ranked among North America's top tech talent markets, fostering innovation-driven industries. London also joins the league as one of the continent's promising up-and-coming markets, as per Coldwell Banker Richard Ellis' Scoring Tech Talent 2023 report. These results demonstrate the positive impacts Ontario's universities have on the development of local innovation-driven industries.
In-Demand Skills	Ontario will need **more than 233,000 jobs** in STEM that require a university degree from 2021-2030, encompassing electronics, manufacturing, mining and computer and mechanical engineering, as projected by Stoke Economics. Universities are key in meeting this demand.
Life Sciences Pioneers	More than **720** life sciences start-ups have emerged from Ontario's universities between 2017-2022, according to Council of Ontario Universities data. These companies are pioneers in advancing biomanufacturing, developing advanced medical technology and life-saving treatments.
Mining Sector Contribution	In 2022, Ontario's mining sector produced minerals worth **$13.5 billion**, accounting for **22%** of Canada's total production value, according to the Ontario Mining Association. This supports the supply chain for advanced manufacturing, from resource extraction to materials refinement.
Auto-Related Expertise	**11 Ontario universities** offer auto-related research initiatives and training programs, according to Council of Ontario Universities data. They nurture skilled talent and pioneering innovations, attracting major investments from auto manufacturers to regions throughout the province.

Advancing Industry through Research and Innovation

Ontario's universities are leading the charge in research, innovation and commercialization, making ground-breaking discoveries that are helping propel advanced manufacturing throughout our province forward.

By nurturing environments that foster curiosity and experimentation, universities become incubators of innovation. They allow start-ups, students and researchers alike to find fertile ground to develop novel ideas and inventions. The advanced manufacturing industry benefits immensely from these innovations, gaining access to new technologies and practices that enhance efficiency, reduce costs and elevate competitiveness.

Through leading university research, Ontario's advanced manufacturing industry can tackle complex issues, such as process optimization, sustainable manufacturing and technological advancements. This important work helps strengthen the supply chain, fuels economic growth, helps small and medium sized enterprises (SMEs) scale operations and positions Ontario as a global leader in advanced manufacturing.

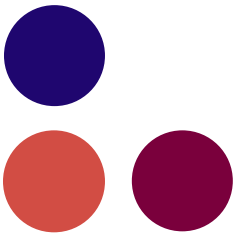
New discoveries in biomanufacturing and health care

First robotics system designed to work inside an MRI

There is a need for trained radiologists, particularly in rural and remote communities, who can read MRI scans to detect breast cancer, often leading to many women who need MRIs going without. It is why researchers at **McMaster University** and St. Joseph's Healthcare Hamilton are at the forefront of a project to manufacture robot-assisted biopsy and diagnostics for breast cancer, using technology first pioneered on the space shuttle's Canadarm.

The automated robot works in combination with MRI scanners to detect cancerous lesions, streamlining the manoeuvres involved in MRI scanning and in turn speeding up patient flow through the clinic. By using robotic technology, researchers are also helping avoid the need to transfer patients to specialized hospitals and can provide improved care to patients where they live.

MRIs for breast cancer can provide detailed scans, particularly for women with dense breast tissue or a genetic predisposition to breast cancer.



Advancing biomanufacturing to find innovative treatments, save lives

Over the last five years, there has been an unprecedented surge in demand for biotherapeutics and biomanufacturing to help treat life-altering diseases, such as cancer, cardiovascular disease, neurological disease and other conditions. To help respond to this demand, the **University of Ottawa** is partnering with the Ottawa Hospital's Biotherapeutics Manufacturing Centre (BMC) to manufacture much-needed biotherapeutics – essential tools for innovative treatments that not only improve quality of life for patients, but also save lives.

By advancing ground-breaking research in biomanufacturing, while also providing critical training and skills development opportunities for students in the field, the BMC is helping bolster Ontario's life sciences sector. In addition, the centre contributes to the Canadian Pandemic Preparedness Hub (CP2H) to help future-proof the country against further shocks to the health-care and life sciences systems.

Propelling Ontario's industries forward

Supporting sustainable mining and exploration

Ensuring sustainability practices is key for the mining and exploration of critical minerals in Northern Ontario. Through **Lakehead University's** Centre of Excellence for Sustainable Mining and Exploration, the university is leading sustainable practices in critical rare mineral mining and exploration across Ontario.

With a cross-disciplinary team of experts and partnerships with industry and local communities, the center examines the environmental, social and economic impacts of resource development.

Through skills development opportunities and innovation, the centre is also developing innovative technologies for eco-friendly mining, preparing students for the industry and prioritizing collaboration with First Nations and Métis communities. By integrating innovation, research and partnerships, Lakehead is helping shape a responsible and sustainable future for critical rare mineral mining and exploration in the region.

Driving research and commercialization in critical minerals and clean tech

Through collaboration and resource-sharing in order to drive ground-breaking research and commercialization for the province's economic growth, **Nipissing University** is partnering to establish the Northern and Rural Innovation Cluster.

The innovation cluster, in partnership with Lakehead University, Laurentian University and Trent University, focuses on critical minerals, clean tech and battery electric technologies, working to fuel the electric vehicle supply chain, from the mineral to automotive industry.

The partnership is centred around key areas that include research and commercialization support, knowledge sharing, access to professional expertise and advanced facilities, and ecosystem partnerships – with the common goal to accelerate commercialization efforts in the industry.

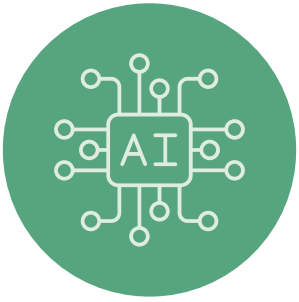
Revolutionizing discovery through self-driving labs

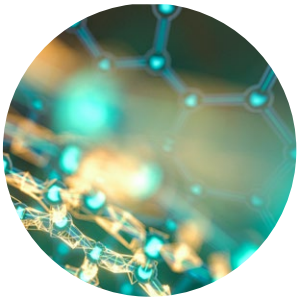
From life-saving medications and biodegradable plastics to low-carbon cement and renewable energy, the Acceleration Consortium (AC) at the **University of Toronto** is creating a wide range of new materials and molecules at a fraction of the usual time and cost.

The creation of these materials is made possible by self-driving labs, which employ artificial intelligence (AI) and automation to carry out more experiments in a smarter way and revolutionize scientific discovery.

Through partnership, the AC connects key players in government, industry and academia at critical points in the value chain to accelerate materials discovery alongside research translation and commercialization.

One notable example of ground-breaking discovery and commercialization at the AC is AC start-up member Erthos, a company that creates plant-powered alternatives to traditional plastics. Single use plastics made with erthos™ solutions are compostable, and compatible with existing plastic technology, making plant-powered plastics the natural choice.





Promoting industrial innovation using geometric computing

Optimizing a business' software for 3-D printing, refining industry design software to enhance manufacturing processes and building robots that can more effectively perform functions in small and/or hazardous spaces are just some of the ways that a **Toronto Metropolitan University** researcher is helping solve industry challenges.

Through geometric computing, Yeganeh Bahoo is driving innovation in wide-ranging fields within advanced manufacturing, including wireless communication, robotics, additive manufacturing, virtual reality, computer graphics and surveillance.

She and her team produce knowledge with a distinct industrial purpose, fueling a complete pipeline from theory to application, helping local industry and businesses solve their unique challenges and fuelling regional economic development.

Through partnerships with leaders of local businesses in the manufacturing and digital sectors, Bahoo is helping solve real-world problems and making meaningful impacts in the industrial sector. From collision detection for Roombas to route planning for search-and-rescue scenarios, the applications of computational geometry are immensely diverse.

Empowering Ontario's Advanced Manufacturing Consortium

To help companies in Ontario improve their manufacturing processes, create new technologies and provide employees with upskilling and reskilling opportunities, **Western University** has partnered to launch the Ontario Advanced Manufacturing Consortium (AMC), along with McMaster University and the University of Waterloo.

Through the consortium, Western works with industry in Southwestern Ontario to address businesses' manufacturing challenges by helping understand, assess, de-risk and deploy advanced manufacturing technologies for business growth. Businesses, particularly small and medium enterprises (SMEs) have access to dedicated research expertise and resources at the AMC to help scale their manufacturing operations.

Ultimately, the consortium aims to help strengthen innovation capacity and new product development in companies from various industries, such as automotive, electric vehicles, defense, aviation, mining, medical devices, robotics and automation systems.

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