Digital Techology Adoption Roadmap

Accelerating Digital Transformation in Canada's Automotive Manufacturing Sector

ICTC CTIC

NGen

Roadmap produced by the Information and Communications Technology Council (ICTC) in collaboration with Next Generation Manufacturing Canada (NGen)

Preface:

ICTC and NGen are proud to present this digital technology adoption roadmap covering the Canadian automotive manufacturing sector. The five-year roadmap details practical steps and considerations for Canadian manufacturers, particularly small- and medium-sized enterprises, interested in adopting advanced digital technologies, including artificial intelligence (AI), big data analytics, cloud computing, cybersecurity, digital twins, sensors and Internet of Things, and advanced robotics and industrial automation. The roadmap provides the automotive manufacturing sector with strategic-level guidance on digital technology adoption. The roadmaps have been developed in consultation with industry and include real-world examples and use cases on how digital technologies are being used on factory floors across Canada and integrated into production processes.

Other digital technology adoption roadmaps available for Canadian manufacturers in this series:



Aerospace



Biomanufacturing



Food and Beverge



Fabricated Metal Products

About ICTC:

The Information and Communications Technology Council (ICTC) is a neutral, not-for-profit national centre of expertise with the mission of strengthening Canada's digital advantage in the global economy. For over 30 years, ICTC has delivered forward-looking research, practical policy advice, and capacity-building solutions for individuals and businesses. The organization's goal is to ensure that technology is utilized to drive economic growth and innovation and that Canada's workforce remains competitive on a global scale.

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About NGen:

Next Generation Manufacturing Canada (NGen) is the industry-led, non-profit organization leading Canada's Global Innovation Cluster for Advanced Manufacturing. One of five national networks supported by Canada's ambitious Global Innovation Clusters Initiative. We are founded on the principle that digital transformation in advanced manufacturing will enrich the lives of Canadians, delivering better products and good jobs while generating the economic growth essential to a better future.

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Executive Summary

This five-year roadmap details practical steps and considerations for the Canadian automotive and automotive parts manufacturing sector, particularly small- and medium-sized Tier 2 and Tier 3 suppliers, interested in adopting advanced digital technologies and embarking on a digital transformation journey.

The roadmap provides a case study of real-world digital technology adoption in the Canadian automotive manufacturing sector, covering barriers, challenges, and solutions to digital transformation. It outlines how automotive and automotive parts manufacturing firms are adopting novel digital technologies, including artificial intelligence (AI), big data analytics, cloud computing, cybersecurity, digital twins, sensors and Internet of Things (IoT), and advanced robotics and industrial automation.

The roadmap also provides examples of practical planning tools to help Canadian automotive manufacturers, including Tier 2 and Tier 3 suppliers, plan and execute their digital transformation journeys, including:

1. **Digital technology use case matrix:** highlighting practical uses of the seven digital technologies in the automotive manufacturing sector.
2. **Return on investment (ROI) measurement framework:** outlining example metrics to assess ROI on digital technology adoption in categories including operational effectiveness, workforce productivity, capital productivity, market access, innovation, health and safety, and ESG measures, and align them with strategic firm objectives and investment inputs.
3. **Change management checklist and digital transformation project phase gate framework:** providing a systematic, phased approach to developing organizational change management strategies, and technology pilots to support digital transformation.
4. **Risk management tools:** demonstrating contemporary risks manufacturing firms may face when undergoing digital transformation in today's market, as well as an example risk register and risk management trigger scenarios.
5. **Talent and workforce training insights to support digital transformation:** overviewing baseline digital competencies for advanced manufacturing, workforce training and delivery models for manufacturers, and organizational strategies to foster digital competencies in the manufacturing workforce.
6. **Advice for developing strategic partnerships to advance digital transformation:** discussing key partnership verticals and example partnership models, as well as key considerations for data-sharing when developing strategic partnerships.

By providing these real-world case studies, insights, and practical tools, this roadmap seeks to accelerate the adoption of key digital technologies in Canada's automotive manufacturing sector and support ongoing digital transformation efforts. Adopting novel digital technologies is critical for continued sectoral success, addressing long-term stagnation in productivity in Canadian manufacturing, and maintaining the sector's continued global competitiveness.

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This roadmap was developed in consultation with digital transformation leaders from the Canadian automotive manufacturing industry, including 11 expert interviews and an industry roundtable. Representatives from OEMs, Tier 1 and Tier 2 parts suppliers, digital technology vendors with expertise in the automotive manufacturing sector, consultants, and other experts all contributed towards this roadmap.

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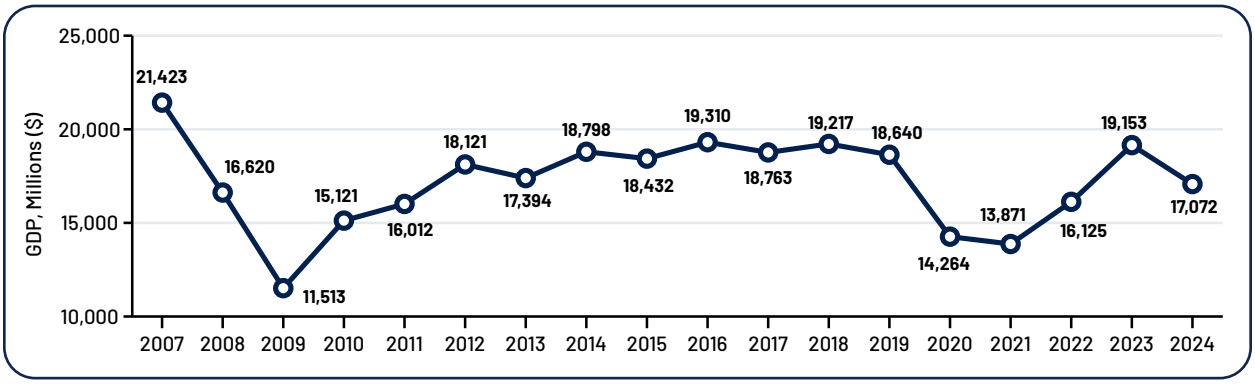
Why this Roadmap is Needed

Canadian manufacturing is experiencing notable economic headwinds brought on by declining productivity, underinvestment, and economic uncertainty brought on by international trade disputes. For the automotive manufacturing sector, these headwinds have amounted to flattened growth trajectory since the 2008 financial crisis (Figure 1).

These economic headwinds come at a time of technological disruption, brought on by rapid advances in digital technology, most notably in artificial intelligence (AI), but also in adjacent technologies such as advanced robotics, sensors and Internet of Things (IoT), and digital twins, alongside base digital infrastructure like cloud computing.

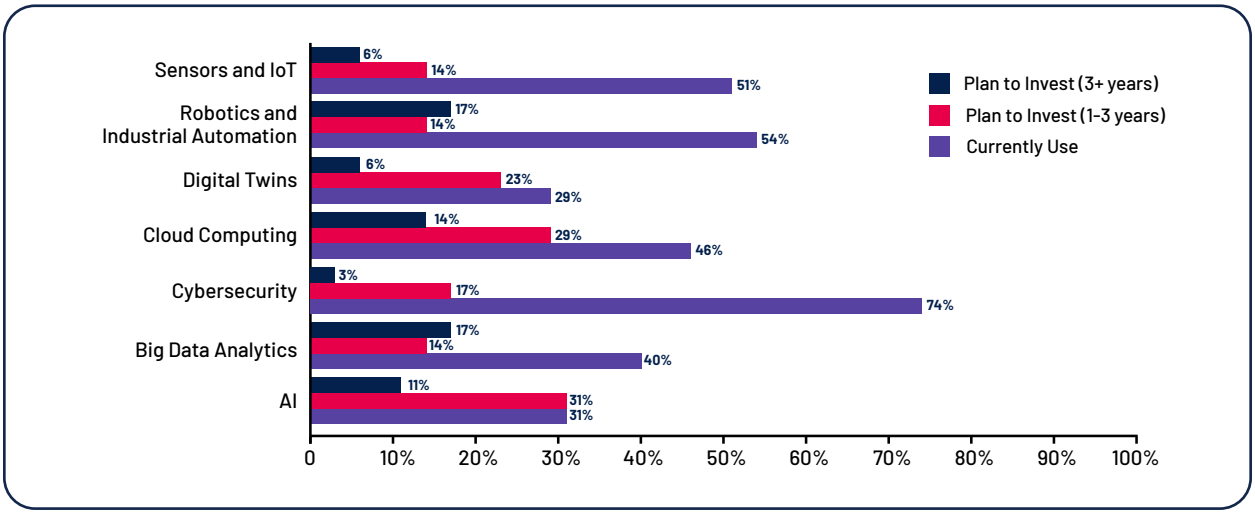
Canadian manufacturers, including automotive and parts manufacturers, have the opportunity to increase their productivity and accelerate growth by adopting greater amounts of digital technologies into their manufacturing operations. Yet, an industry survey conducted by ICTC finds that numerous advanced digital technologies, like AI and digital twins, have not yet been widely adopted in Canada's automotive manufacturing industry (Figure 2).

Figure 1. Canadian Automotive Sector GDP Value (2007-2024)



Source: Statistics Canada, Table: 36-10-0434-01 [NAICS 3361-3363].[1]

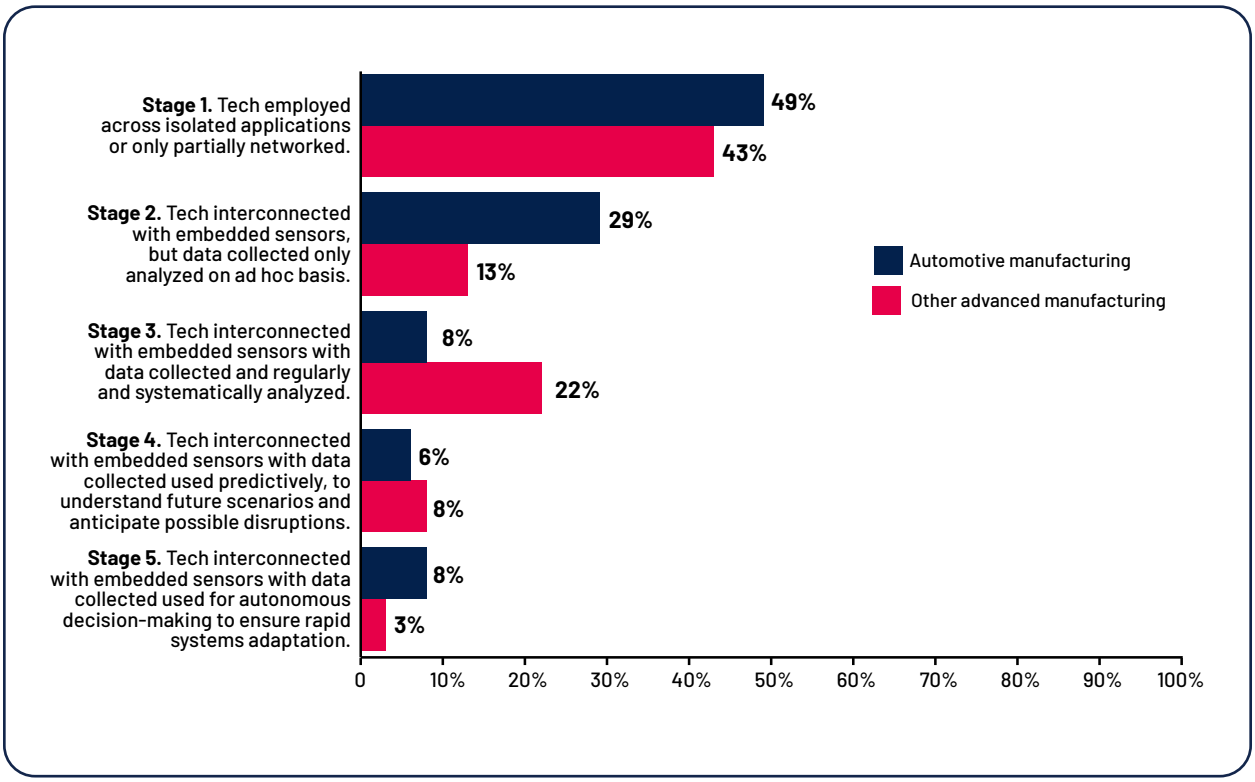
Figure 2. Canadian Automotive Manufacturing Digital Technology Adoption (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

1 Statistics Canada (Government of Canada), "Gross domestic product (GDP) at basic prices, by industry, monthly (x 1,000,000)," Table: 36-10-0434-01, last update August 29, 2025, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043401.

Figure 3. Canadian Automotive Manufacturing Advanced Digital Technology Implementation Stage (2025)



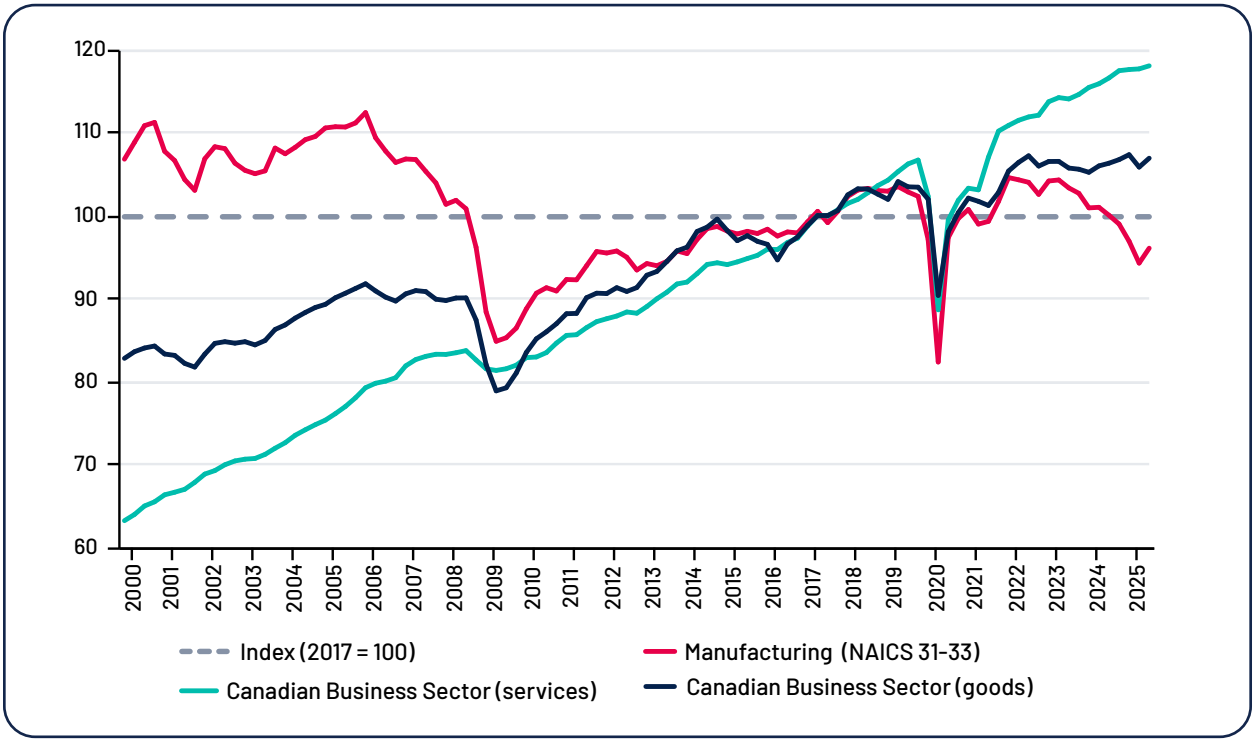
Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Canadian manufacturing technology adoption shows mixed progress across industries. Within the Canadian automotive sector, ICTC's Canadian manufacturing digital technology adoption survey found that 49% of automotive manufacturers employed digital technology piecemeal, as isolated applications or only partially networked, 29% employed interconnected digital technology but only analyzed collected data on an ad hoc basis, and only 8% employed interconnected digital technology and analyzed collected data regularly and systematically. Furthermore, 6% used data collected from networked sensors predictively, while only 8% used data collected from networked sensors to support autonomous decision making (Figure 3).

Leveraging networked digital technologies towards integrated, autonomous operations across a manufacturing process, or even an entire manufacturing enterprise, could have a positive effect on labour productivity in Canada's manufacturing sector (Figure 4). This would be a welcome development, as lagging productivity amounts to a persistent drag on the Canadian economy.[2]

2 Tim Sargent, "Productivity Growth in Canada: What is Going on?," University of Calgary, School of Public Policy Briefing Paper, October 2024, https://www.policyschool.ca/wp-content/uploads/2024/10/FP-9-ProductivityGrowth-Final.pdf.

Figure 4. Index on Canadian Manufacturing Labour Productivity (2000 to Q2 2025)



Source: Statistics Canada, Table: 36-10-0207-01.[3]

Productivity challenges are often discussed in national economic terms, but they have very real implications for individual businesses. Canadian manufacturers continue to lag behind peers such as the United States, which puts pressure on costs, pricing, and margins. For a typical Tier 2 automotive parts manufacturing SME with $20 million in annual revenue and a 15% EBITDA margin, even a modest 5–10% improvement in overall equipment effectiveness (OEE) can make a meaningful difference.

Improvements enabled by tools such as production monitoring, predictive maintenance, or better data use can increase throughput and reduce downtime without major new capital investment. For example, a 3% increase in output combined with small cost savings could translate into an additional $300,000–$600,000 in annual EBITDA—amounting to a 10-20% improvement in operating earnings. Seen this way, digital adoption is not just about upgrading technology; it is about strengthening profitability and long-term business value.

3 Statistics Canada (Government of Canada), "Indexes of labour productivity and related measures, by business sector industry, seasonally adjusted," Table: 36-10-0207-01, last update September 3, 2025, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610020701.

Seven Key Digital Technologies for Automotive Manufacturing

With an industry-wide need to adopt advanced digital technologies across Canadian manufacturing, including within Canada's automotive manufacturing sector, ICTC and NGen evaluate the seven digital technologies (Figure 5) as being essential to the future of Canadian manufacturing.

Figure 5. Seven Key Digital Technologies Essential for Canadian Manufacturing

Artificial Intelligence (AI) and Machine Learning (ML)	AI-enabled systems can quickly parse through large volumes of data, helping to optimize processes and predict outcomes, as well as automate decision-making tasks that would normally require human cognition. Machine learning models can ingest training data and learn to make predictions, or correct decisions, without explicit, hard-coded programming.
Big Data Analytics	Methods and tools used to collect and curate, process and integrate, and analyze extremely large volumes of data across a manufacturing operation to glean insights and improve decision-making.
Cloud Computing	On-demand, offsite computing services to access and store data, process information, and serve software applications via the internet. Cloud computing also allows manufacturers to dynamically scale their computing infrastructure as required.
Cybersecurity (IT and OT)	Protecting sensitive networks and data from threats. In a manufacturing environment, cybersecurity includes protecting both information technology (IT), such as networks and data, as well as operational technology (OT), such as machinery, control systems, and sensors.
Digital Twins	A virtual representation or model of a real-world asset, such as a piece of machinery, a production line, a manufactured product, or an entire manufacturing facility continuously updated with new data allowing the digital twin to mirror the status and condition of the real-world asset.
Sensors and Internet of Things (IoT)	Networks of machinery, sensors, and other electronic devices can be networked together to gather and share real-time data across a factory or supply chain, often referred to as the Internet of Things (IoT) or the Industrial Internet of Things (IIoT).
Robotics and Industrial Automation	Industrial robots have long been used in automotive manufacturing, but advanced robotics, including cobots and humanoid robots, can be used in manufacturing across a variety of applications and integrated using technologies such as AI and IoT networks.

Figure 6. Digital Technology Maturity Tiers for Advanced Manufacturing

Digital Transformation Stage	Maturity Tiers	Key Digital Technology	Firm Digital Transformation Maturity Level
Basic	Foundational Technologies	› Cloud computing/ cloud ERP › Cybersecurity	**Foundation:** establish prerequisite digital infrastructure.
Intermediate	Operational Optimization Technologies	› Sensors and IoT › Big data analytics	**Integrate and optimize:** build data collection and analytical processes from foundational digital infrastructure. Provide data platform for transformational technologies.
Advanced	Advanced Transformation Technologies	› AI/ML › Robotics and industrial automation › Digital twins	**Transformation:** adopt advanced digital technologies to transform enterprise manufacturing operations.

Source: ICTC analysis, 2026.

No single digital technology delivers its full value in isolation—the true business value for all of these technologies is unlocked only when they are adopted in tech stacks. Automotive manufacturers can think of the seven key digital technologies as being in three maturity tiers (Figure 6):

1. foundational technologies (cloud computing/ cloud ERP, cybersecurity),
2. operational optimization technologies (sensors and IoT, big data analytics), and
3. advanced transformation technologies (AI/ML, robotics and industrial automation, and digital twins).

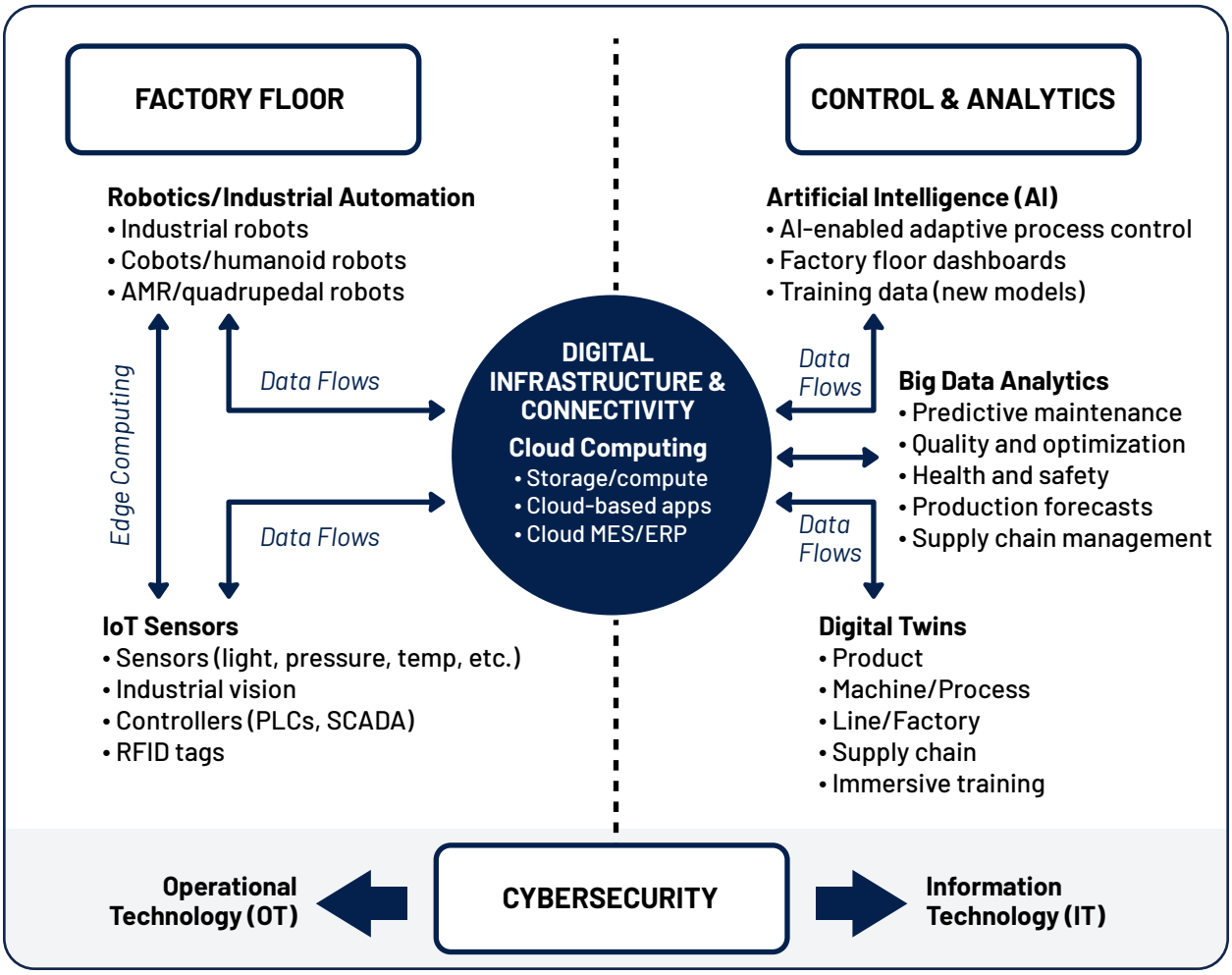
While any one of the seven digital technologies covered in this roadmap would be, on its own, consequential to advanced manufacturing in Canada, what makes these seven technologies truly impactful is how they interact with one another. These seven technologies can be digitally networked across a manufacturing operation, or even across an entire manufacturing supply chain, with significant resulting gains to operational excellence, productivity, safety, innovation, and market responsiveness.

For example, sensors deployed across a manufacturing operation, on industrial robots and other machinery, can collect significant amounts of data in real time (i.e., big data), which can be stored and processed in a cloud environment. The data can be used to create digital twins of individual pieces of machinery and robots, manufacturing processes, and even the entire manufacturing enterprise.

The data can also be used to train AI models and run inference to help manage and optimize manufacturing operations. The digital infrastructure and valuable data, integrated across a manufacturing enterprise's information technology (IT) and operational technology (OT) assets must be secured against cyber threats, such as data breaches and cyberattacks, through a robust cybersecurity program. Figure 7 outlines, at a high level, how the seven digital technologies covered in this roadmap can be integrated together on the factory floor and across a manufacturing enterprise.

The model presented in Figure 7 is intended to be aspirational, to provide an overview of what is possible in the long term. Today, most Canadian automotive manufacturers have not achieved this level of integration. Instead, Canadian automotive manufacturers interviewed for this roadmap tend to adopt stacks of digital technologies in an incremental manner, through strategic investments, pilot projects, and organizational learning.

Figure 7. Advanced Digital Technology in Manufacturing Integration



Source: ICTC analysis, 2026.

Digital Transformation and Digital Technology Adoption Time Horizons

When discussing digital transformation and technology adoption in Canadian manufacturing, it is critical to develop achievable, realistic timelines. The complexities of digital technology adoption, both technical and organizational, are significant. For automotive manufacturers adopting novel digital technologies for the first time—such as AI, digital twins, or advanced robotics—it can take years to derive the full value from the investment and get the most out of the technology.

A phased, five-year timeline provides automotive manufacturers, undergoing a digital transformation project for the first time, with a realistic timeline for effectively adopting digital technologies. Firms should expect to spend the first one to two years piloting new technologies, gathering data, and developing a full business case, and then up to three years scaling successful pilots across their manufacturing operations and beginning digital integration with other manufacturing and enterprise systems.

Case Study

Digital Technology Adoption in Canada's Automotive Manufacturing Sector

Canada's automotive manufacturers are in the midst of a digital transformation, one that is changing not just the products they make, but how they make them. From design to production to delivery, new tools and technologies are reshaping every step of the automotive manufacturing process.

This case study pulls together voices from across Canada's automotive sector, including OEMs, Tier 1 and Tier 2/3 parts suppliers, technology vendors, and researchers and innovators. Rather than focusing on a single company, it weaves their perspectives into a bigger story about where the automotive manufacturing sector is headed. Along the way, we hear directly from those leading this digital shift with insights into what's working, what's not, and how firms are tackling the challenges of digital adoption while keeping an eye on global competitiveness.

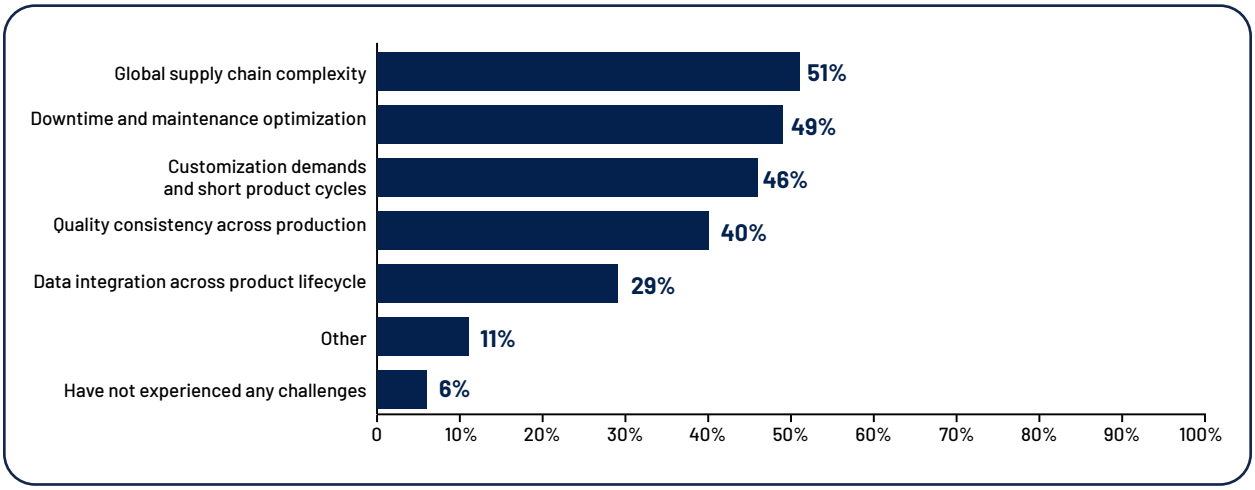
Industry Overview and Context

The Canadian automotive manufacturing sector has been a cornerstone of the national economy for decades, supporting hundreds of thousands of manufacturing jobs, both directly and indirectly, and reinforcing Canada's global competitiveness and technological prowess. Highly interconnected, the industry brings together global OEMs, and Tier 1 and Tier 2 parts suppliers, each contributing specialized expertise in metal fabrication, polymer molding, advanced welding, electronics and systems design, and technical innovation to meet rigorous national and international standards.

The companies featured in this case study range from small and mid-sized manufacturing operations to those employing over 3,000 people. What unites them is their leadership in digital transformation. Connected to Canada's growing AI ecosystem, with many backed by strategic partnerships with leading technology vendors, post-secondary institutions, and technology development incubators, these firms are putting advanced digital technologies to work, modernizing production, improving efficiency, and strengthening their competitive positions.

Driving their digital transformation is the need to solve practical business problems, including global supply chain complexity, reducing and optimizing maintenance downtime, meeting customer demands for customization, maintaining quality, and integrating data across their manufacturing enterprises (Figure 8).

Figure 8. Most Pressing Business Challenges (Choose Top Three) – Automotive Manufacturing Sector (2025)

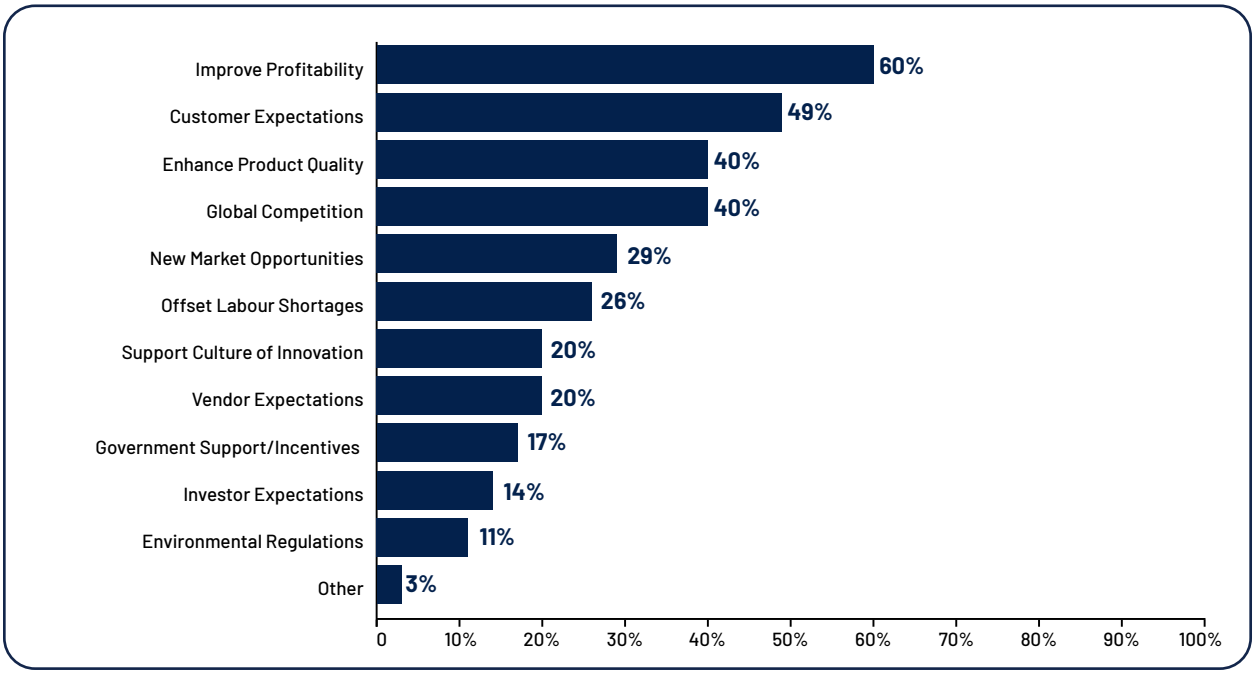


Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Strategic Approaches to Digital Technology Adoption

For Canada's advanced automotive manufacturers, digital adoption is widely seen as essential to remaining competitive. When deployed strategically, digital technologies can shift cost structures, streamline operations, and enable more automated, data-driven management. What constitutes "strategic" adoption varies by context, but major strategic goals of digital technology adoption include improving profitability, meeting customer expectations, enhancing product quality, keeping up with global competition and finding new market opportunities, and offsetting labour shortages (Figure 9).

Figure 9. Most Important Factors Driving Digital Technology Adoption – Automotive Manufacturing Sector (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

In brand-new facilities or high-volume production programs, the business case for digital transformation is clearer and broad technology rollouts can be easier to justify. As one interviewee explained, "So, if you want to do wholesale implementations of new technology, it's sometimes easier to do it in new facilities and in high-volume programs. And if you don't have those opportunities, then the business case to implement it becomes challenged." In legacy facilities, where adopting digital technologies can be more challenging due to legacy systems and equipment and floor layouts, there is an opportunity for smaller, modular pilot projects, designed to be flexible.

In contrast to older facilities, manufacturers with newer facilities tend to look for system-level efficiencies that can deliver measurable improvements across the operations, rather than isolated one-off upgrades. Some companies are moving toward end-to-end digitalization through tools like digital twins—virtual replicas of equipment or processes that can be updated in real time with sensor data. These technologies extend well beyond labour savings. They improve flexibility, help workers complete tasks more efficiently and safely, and support higher-quality output.

Customer requirements, particularly from large OEMs, are another major driver. Real-time system communication allows companies to adjust production to avoid stockpiling or to track components flagged for special handling. Predictive maintenance tools can detect performance variations before equipment breakdowns occur, helping to prevent costly downtime.

Firms are also testing AI, big data analytics, and quality assurance systems that use digital sensors such as machine vision cameras and LiDAR to identify and remove defective parts from production lines. Some firms interviewed see AI as a "force multiplier" for design and back-office teams, while others are experimenting with generative AI tools to boost efficiency. The most advanced of the Tier 1 parts supplier firms have already adopted AI automation technology into their manufacturing operations through digital dashboards linked to manufacturing execution systems (MESs).

Across all use cases, firms recognize that data itself has become a strategic asset, as data flows enable a full suite of digital technologies to be adopted. Like environmental or workforce performance metrics, operational data needs to be tracked, measured, and maintained throughout production. Finished parts need to be tracked throughout a supply chain for billing, quality control, and supply chain management purposes. According to automotive manufacturing firms interviewed for this research, one of the biggest challenges in digital transformation of their manufacturing enterprises is managing and curating the reams of data being produced and deciding what data to capture and store, and how to get the most value from this data.

Technology Applications in Practice

In Canada's contemporary automotive manufacturing sector, adopting advanced digital technologies is often less about choice and more about company survival, as traditional markets for Canadian automotive parts and finished vehicles are disrupted, foreign competition becomes more capable, and novel digital technologies become more prominent in manufacturing. The need for digital transformation across Canada's automotive manufacturing sector is clear, but effective strategies and best practices on how to do so are less clear—particularly for small- and medium-sized enterprises (SMEs).

As one interviewee put it, "we are investing the time and resources and whatever it takes to go through the transformation, because if we don't, we're dead anyway." Fierce competition means Tier 1 and Tier 2/3 parts suppliers are under immense pressure to automate to stay cost-competitive; if they don't, purchase orders and new contracts can quickly move to rivals who can deliver at lower cost and higher quality.

At the same time, companies face mounting external pressures. As one interviewee explained regarding AI adoption, "it's either going to be driven by your customers, driven by your investors, your board, or it's going to be driven by the regulators. Because this is something that is just like the Internet 30 years ago […] today, your business couldn't function without it—AI is the same thing."

Canadian companies interviewed for this roadmap are not moving at the same pace—each is at a

different stage of its digital transformation journey. One executive explained, "we do digital twinning at the local level, and we do simulations of robotic cells. We're doing more and more simulations of lines. The one thing we don't do is digital twins of full facilities, yet. And this is the next step—ultimately long-term, you'd want to do a digital twin of the entire company and all its operating units."

Different manufacturers embark on their digital transformation journeys from different starting points. For some manufacturers interviewed, particularly OEMs and Tier 1 parts manufacturers, digital technology adoption has been a multidecade endeavor, with the latest crop of advanced digital technologies, such as AI and digital twins, being the next phase in a robust, long-term digital transformation process. For other firms, particularly SMEs covering the Tier 2/3 of the industry, while some digital systems are in use, they are isolated with new technologies being added piecemeal over time.

A piecemeal approach can push a firm slowly towards digitizing their operations over time, to enjoy the benefits of full digital transformation, digital technologies, such as cloud computing, sensors and IoT, and digital twins, should be adopted as technology stacks and integrated together. The most forward-looking firms engaged by ICTC for this roadmap took a proactive, strategic, and integrated approach to their digital transformations.

Cybersecurity

Before exploring how digital technologies such as AI, advanced robotics, and cloud computing are transforming automotive manufacturing, it's important to recognize that cybersecurity is a foundational layer of digital transformation. As production systems become more connected, both operational technology (OT), including machines, robots, sensors, and information technology (IT), such as business and supply chain systems, are exposed to new risks, with cyber risks potentially flowing between IT and OT systems.

A major cyber incident can halt production, compromise intellectual property, and damage customer trust. Indeed, the recent cyberattacks at Jaguar Land Rover in the United Kingdom, which crippled production for several weeks in Fall 2025, show the wide-ranging effects a cybersecurity incident can have on an automotive manufacturing company and across an entire automotive supply chain.[4]

For this reason, cybersecurity must be built into digital transformation plans from the start. SMEs can take immediate steps, such as using multi-factor authentication, isolating shop-floor networks, and regularly updating software, while larger firms are adopting AI-driven monitoring and advanced threat detection. Proactive approaches to cybersecurity such as red team exercises and penetration testing, where teams of cybersecurity professionals are employed to intentionally compromise a network as a way of stress-testing IT and OT systems, can also greatly improve a manufacturing firm's cybersecurity posture.

Cybersecurity doesn't stand alone—it underpins all of the digital tools and systems discussed in the sections that follow.

Artificial Intelligence

For automotive companies, AI is not a singular technology but many different applications that reduce downtime, improve quality, and boost flexibility. From welding robots guided by machine vision systems to digital twins that test production changes virtually, AI is already helping manufacturers enhance cost, speed, and customization.

AI is being deployed across factory floors and back-office functions, driving process optimization and workflow automation. Design teams and in-house developers utilize AI for testing, error detection, and system improvements. Meanwhile, some firms are testing tools like Microsoft Copilot to replace paper-based processes and scattered spreadsheets with centralized, AI-supported systems. Enterprise platforms such as SAP are also being rolled out to replace legacy systems and improve oversight, producing a common operating picture of the manufacturing enterprise.

Generative AI is emerging as tool to modernize outdated workflows and improve workforce productivity. As one business leader noted, "employees need to be aware that it's not going to take your job today, but it's going to make you more productive. So now your output, which could have meant three projects in a week, could potentially be three projects in a day— so that's 15 a week."

Interviewees emphasized the importance of distinguishing between "physical" and "digital" AI

4 BBC News, "JLR could face disruption until November after hack," September 16, 2025, https://www.bbc.com/news/articles/czewlj57e24o.

when understanding how the technology is being incorporated into manufacturing operations. In automotive manufacturing, AI doesn't look the same everywhere.

In some cases, it is used to control the machines and sensors on the shop floor, and in others, it runs behind the scenes in digital models and software that guide decision-making. Physical AI refers to AI integrated into hardware systems, robotics, automation equipment, and IoT devices that act on real-time data in the physical world. Digital AI refers to AI applied in virtual environments and software, such as digital twins, dashboards, and decision-support systems that help plan, test, and optimize processes.

While Canadian firms are steadily embedding AI, they also recognize the global gap Canada's manufacturing sector faces. As one interviewee observed, "China is already building lights-out manufacturing facilities" for manufacturing products such as cell phones and other electronics, "no humans, fully automated." While in Canada, adoption is more gradual and emphasizes flexibility, integration, and measured growth.

Robotics and Industrial Automation

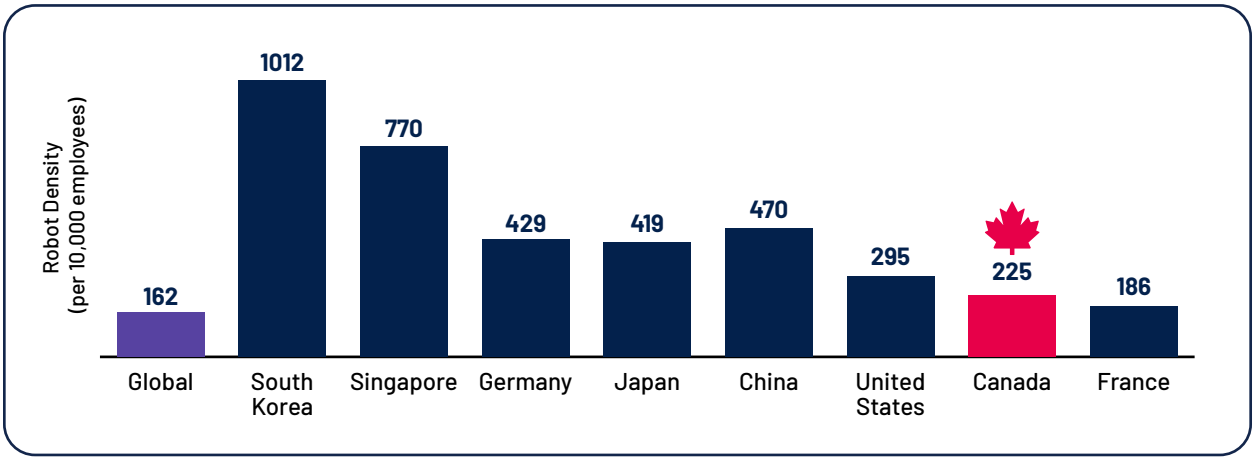
Industrial robots have been a fixture in automotive manufacturing for more than three decades, especially in welding, trimming, and painting. What's different today is that these systems are increasingly AI-powered and connected with IoT sensors, making them more flexible, adaptive, and capable of working safely alongside people.

Advanced robotics platforms, such as cobots and humanoid robots, provide platforms with unparalleled flexibility when compared to the older industrial robots of past decades. While Canada is far from being a global leader in adopting robotics, it does enjoy robotics densities similar to peer economies such as the United States and France, though lags global leaders such as Singapore and South Korea (Figure 10).

Automotive manufacturing firms interviewed for this roadmap reported that robots are already taking on repetitive tasks such as sanding, spraying, and inspection, freeing workers to focus on higher-value activities. As one interviewee explained, "We are starting to bring in automated polishing machines, automated welders, and a concealed paint booth that knows what to paint next. Previously, you'd have to stop and switch colours. Now, with a manifold system, the robot just knows what to paint next."

Robotics are also reducing processing time. One firm interviewed noted that the time spent sanding roof panels dropped 50% on a per-unit basis, from 30 minutes to 15 minutes. As a production manager reflected, "from an ergonomics standpoint, I don't sand panels all day and my back already hurts, it's something that we can absolutely automate, that then allows operators to be repurposed to some other work within the plant." For example, rather than assigning one worker to sand individual panels, the worker can supervise a robot cell that sands multiple panels at once.

Figure 10. Robot Densities in Canada and Select Countries (2023)



Source: International Federation of Robotics, 2024.[5]

5 See: International Federation of Robotics, "Global Robot Density in Factories Doubled in Seven Years (press release)," November 10, 2024, https://ifr.org/ifr-press-releases/news/global-robot-density-in-factories-doubled-in-seven-years.

Robotic inspection is improving as well. LiDAR scanners can be used to scan a full part in 15 minutes and produce detailed digital reports that can be uploaded into enterprise systems. Robots are increasingly compact and flexible, with cobots and welding robots boosting precision and reducing defects, compared to what is possible with a human operator.

Still, cobots introduce new challenges. Safety is paramount in collaborative environments, "if I could touch that robot, I need to know what force is acceptable. And people forget what's on the end of the robot," as one innovation leader shared. While cobots promise new opportunities for closer human-machine interaction, doing so safely is paramount.

Material handling is shifting to autonomous mobile robots (AMRs). As one interviewee explained, "autonomous mobile robots come in different sizes, we're using them in a more dispersed way, with smaller AMRs across a wider variety of activities for all the different small parts, totes, and feed lines, and things of that sort." Some manufacturers interviewed noted that larger AMRs were also being used for plant intralogistics movements of bulky materials.

One interviewee shared how their plant was working with a robotics vendor to implement quadrupedal robots (i.e., "robot dogs") to serve as autonomous roving equipment and facilities inspectors, using sensors to take regular measurements of plant operating conditions.

For many automotive manufacturers interviewed, the real promise of adopting advanced robotics technologies lies in flexibility, "the dream for collaborative applications is for flexibility. You can use the robot for different things depending on your needs. Now we are tackling more difficult tasks, which often the right way to do it is some level of interaction between a person and automation," as one industry leader shared.

Cloud Computing

Cloud computing enables manufacturers to run software, store files, and process large amounts of data without the need for in-house servers. Cloud computing provides scalable storage and processing power, supporting everything from big data analytics platforms to storing large R&D and design files. Cloud technology increasingly serves as the backbone linking AI, advanced robots, and IoT across production sites and supply chain partners. Cloud-based MES and ERP applications are also becoming popular amongst Canadian automotive manufacturers.

Operational and Competitive Outcomes

Automotive manufacturing firms interviewed for this roadmap reported that digital tools are already delivering tangible results. Predictive analytics enable maintenance teams to identify slowdowns before breakdowns occur, while real-time data sharing with OEMs ensures production synchronization and prevents costly stockpiles or shortages.

In welding, AI-driven monitoring reduces defects and scrap, improving throughput. Automation also enhances safety by removing workers from repetitive or hazardous tasks, and quality-control systems are boosting precision, resulting in reduced wastage of materials and less re-work time, producing cost savings.

Yet, a major outcome of adopting advanced digital technologies is greater flexibility along production lines. As one interviewee explained, "what we're looking to do is obviously reduce cost, but I think more importantly is to provide flexibility for our production. The industry is trending towards a customer being able to order a unique product and have it delivered to them as quickly as possible, and basically as close to a build-to-order as possible."

This drive toward mass customization makes automation and technologies, such as product digital twins, central to reducing finished goods inventories while meeting rapidly changing customer demands. As one interviewee observed, "automation helps provide some of that flexibility that we maybe haven't had in our existing operations in the past."

Cost remains a key metric, however. As another interviewee noted, "specific decisions about automating or using a new technology should be driven based on input versus output. How much will it cost us? And what output are we getting?" Overall, the value of digital adoption lies not in transformation for its own sake but in measurable gains to efficiency, cost structures, and competitiveness.

Understanding ROI and Measuring Digital Transformation Results

Calculating the return on investment (ROI) of digital transformation in the automotive manufacturing sector remains a persistent challenge, particularly for smaller manufacturers.

For SMEs, evaluating ROI is often carried out intuitively, rather than being based on traditional cost-benefit criteria. Indeed, SMEs' ability to pursue digital transformation often depends less on traditional ROI models and more on access to financing tools. Leasing programs, government incentives, or vendor-supported pilot projects are often critical enablers of digital tech adoption for SMEs. However, there is an opportunity for SMEs to adopt more formal ROI evaluation metrics to support digital technology adoption decision-making.

Larger Tier 1 suppliers may adopt digital technologies not because the financial case is always clear, but because failing to digitalize risks losing contracts with OEMs. Across the supply chain, a critical consideration in adopting digital technologies is meeting the expectations and needs of customers, which can outweigh strict cost-benefit calculations.

Across the industry, success is often judged by avoided costs and cost savings, improved safety, and enhancing firm competitiveness. As another interviewee explained, "the ROI for digital transformation is there because it will improve your bottom line, it will make you more profitable, it will find the inefficiencies."

Another issue with evaluating ROI for digital transformation is in how digital technologies, such as AI, cloud computing, advanced robotics, or digital twins, tend to be adopted as stacks of integrated technology. For this reason, digital transformation projects should be evaluated systematically, rather than piecemeal. Benefits must be measured at the system level, not just the task level. As one interviewee noted, "what we need to know is the system efficiency and system optimization, not for a small part inside that. Because if you save 5% of material handling time on one process, you can't lay off 5% of a material handler," noting the importance of "looking at it at the system level for the entire facility."

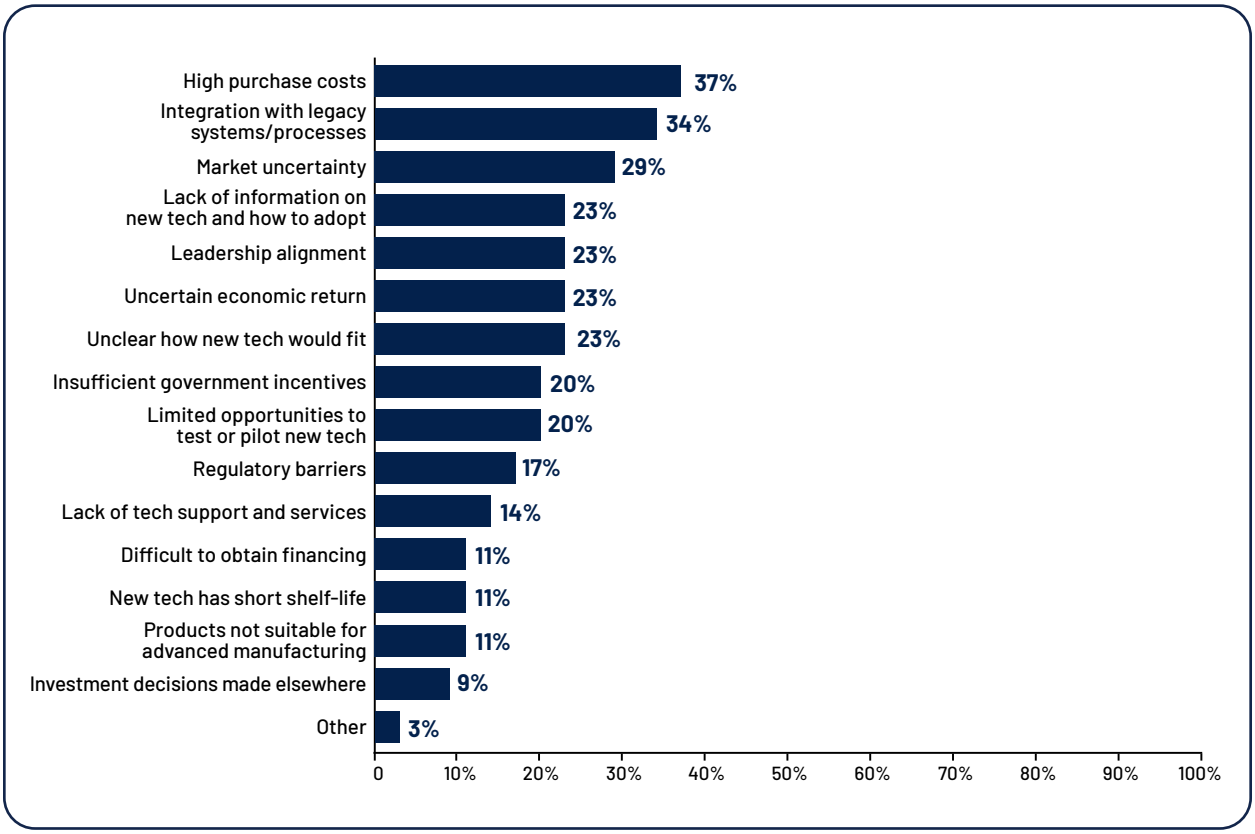
Pilots can play a crucial role in bridging this gap. By testing technologies on a smaller scale, companies can see how they perform in real-world conditions, build familiarity across their teams, and generate practical data from their own facilities—evidence that strengthens the business case for future large-scale adoption. As one technology leader explained, "we want to put it to use on this task for us, we don't necessarily have the ROI use case for it. Not on ergo, not on money, not on anything. But we understand the importance of this type of technology going forward in the future."

Barriers to Adoption

Despite growing accessibility, significant barriers continue to constrain the adoption of advanced technologies in Canada's automotive sector, with implementation limited by company size, internal resources, and market readiness.

Canadian automotive manufacturers report high purchase costs, integration with legacy systems and processes, market uncertainty as major barriers, alongside a lack of information on how to adopt novel digital technologies into manufacturing, leadership alignment, insufficient government incentives, and limited opportunities to test or pilot new digital transformation projects (Figure 11). Numerous business leaders interviewed for this roadmap cited the current trade dispute between Canada and the United States as a significant driver of business uncertainty.

Figure 11. Main Obstacles to Adopting in Digital Technologies – Automotive Manufacturing Sector (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Skill Barriers

Today's vehicles are no longer purely mechanical products but complex technology platforms. With this shift, it is increasingly important for leadership teams to be guided and influenced by technology leaders such as CTOs and CIOs, not just accountants or traditional manufacturing and production engineers.

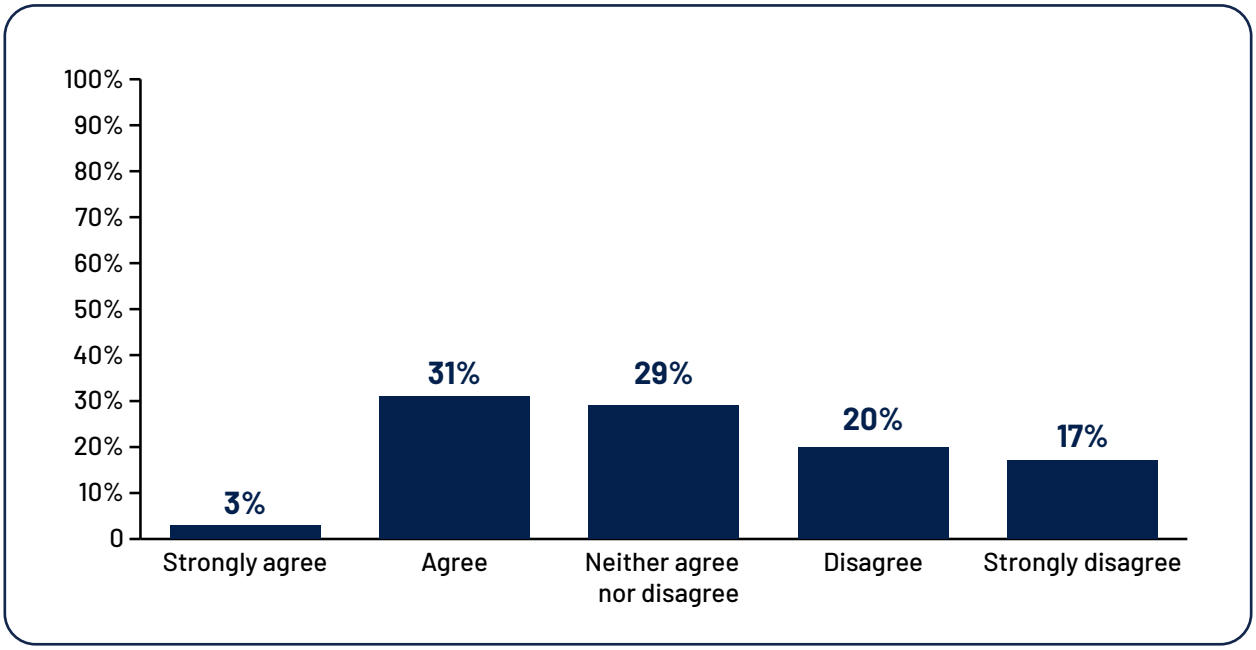
For some firms, the biggest barrier to adopting digital technologies lies not in equipment costs but in workforce capacity. Many firms lack specialists like data scientists, process engineers, or AI/ML experts who can design, maintain, and sustain advanced digital systems. As one interviewee stressed, "we still have too many mechanical engineers and accountants running our OEMs and companies. You've got to bring in the tech people, both software and hardware related." This was particularly true for smaller Tier 2 parts firms, who unless are specifically focused on digital systems, tend to lack requisite technology workforce to support digital transformation.

At the same time, even when automotive manufacturing firms hire tech-skilled employees, such as data scientists, especially recent university graduates, these employees, new to manufacturing, often struggle to apply their expertise in a manufacturing context. Translating advanced big data analytics or AI solutions into production processes requires applied industrial knowledge that is often underdeveloped in traditional academic programs in Canada.

Yet, as another participant explained, "some people think you pull data and it's giving you all the secrets—it's not, it's just a bunch of ones and zeros and you've got to go through it." An elegant digital solution to a manufacturing problem may work virtually but runs into unforeseen issues when applied on a factory floor. The automotive manufacturing industry must foster technology talent, helping to provide new engineering and technology workers with domain expertise in manufacturing.

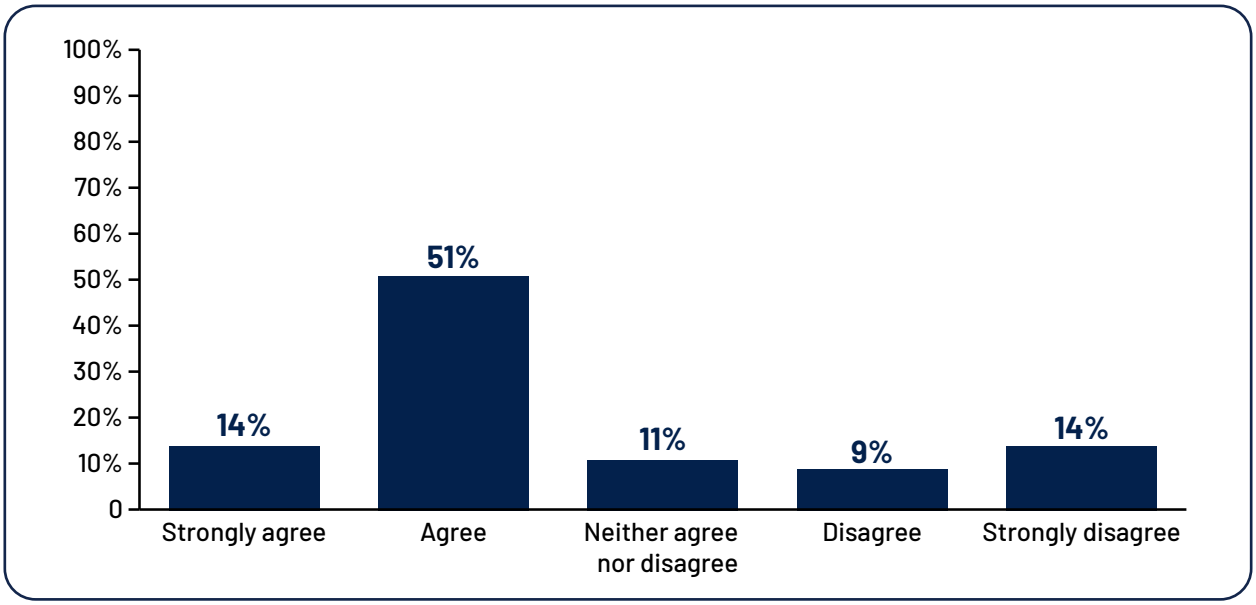
When it comes to supporting staff training and workforce development to support digital transformation efforts in automotive manufacturing, the situation could be improved. While 65% of automotive manufacturers responding to ICTC's digital transformation survey of Canadian manufacturers reported having staff with the digital technology skills needed to adopt technologies, only 34% of automotive manufacturers reported to have a staff training plan to support digital technology adoption (Figures 12 and 13).

Figure 12. Agree/Disagree: My organization has a staff training plan required to implement and adopt new digital technologies – Automotive (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Figure 13. Agree/Disagree: My organization has staff with the digital technology skills required to implement and adopt new technologies – Automotive (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Cost Barriers

Costs were also reported to be a significant barrier. Large manufacturers may budget annually for new equipment as part of their capex budget, but SMEs often rely on ongoing cash flow to finance new technologies. As one technology vendor noted, "for many cases, they don't have budgets prepared. Even when they have the wish to update their equipment, they don't have enough cash to purchase equipment."

Even with falling prices for some digital technologies, such as cobots now costing a fraction of traditional robots, SME business owners may still see the purchase of a cobot as "buying a Ferrari in cash," as one interviewee put it. Cost pressures also shape corporate culture—as one executive put it, when it comes to costs and investments, "it's driven top down, so if it's not broken, why fix it?" Noting how incentive structures can reinforce this hesitancy, "why would I want to risk budgeting a million dollars to implement X, Y and Z, which then comes off my bottom line which therefore affects my bonus, and so why would I do that?"

Solutions to cost barriers that exclude some Canadian manufacturers from adopting advanced digital technologies could include shared innovation hubs and participating in technology user groups to better understand drivers of technology costs and cost saving opportunities, as well as working with vendors to find capex-light solutions such as equipment-sharing programs or leasing options.

Cultural and Organizational Barriers

Hesitancy regarding digital technologies, such as AI and robotics, and mistrust of novel digital tools remain. Employees often worry not only about how data will be stored or used, but also about whether automation could eventually displace their jobs. At the same time, firms must balance these workforce anxieties with the technical risks regarding cybersecurity, intellectual property protection, and compliance with evolving standards and regulations.

Short timeline technology adoption pilot projects and benchmarking with industry peers, as well as consultations such as suppliers and vendors, who have already been successful with digital transformation can help automotive manufacturers accelerate their digital transformation journeys, while also avoiding missteps. Crafting a change management strategy and risk management plan can also help reduce organizational frictions when undergoing digital transformation.

Risk Management

Managing risk in digital transformation means addressing people and culture, and strategic concerns alongside technology risk. Firms emphasized that shifting the ROI lens beyond cost savings—toward readiness, flexibility, and workforce capability—is essential to build buy-in. Without this, even well-funded digital technology adoption initiatives risk stalling.

Technology and Data Risks

Adopting advanced technologies brings risks of system failures, integration errors, or downtime. AI-enabled robotics, if not thoroughly tested, can disrupt production. Some manufacturing technology leaders shared that AI models they were experimenting with were still not reliable enough to introduce into the main manufacturing environment and remained experimental projects for the time being. At the same time, unprecedented volumes of operational data raise cybersecurity risk concerns. Breaches threaten intellectual property, disrupt production operations, and break customer trust, while also risking costly downtime.

Beyond these issues, manufacturers also flag challenges with interoperability and data transformation. Different digital platforms are not always compatible, making it difficult to move data seamlessly across systems for analytics, digital twin, and other applications. These frictions can slow digital transformation and complicate integration across technologies.

Workforce Risks

Fears of job loss remain a major obstacle. Employers need to spend time explaining to employees the benefits of digital transformation, particularly when it comes to AI and advanced robotics adoption. As one interviewee explained regarding AI adoption, "it's not taking jobs, it's making the existing worker's job easier and helping them fulfill more of their daily work." Yet, another interviewee warned, "the whole fear of the robots are going to take over and replace us is going to overwhelm and put a roadblock in front of anything that you're trying to do." Providing workforce upskilling and encouraging employee involvement early on in a manufacturer's digital transformation journey are critical to easing potential concerns.

Vendor Risk

Rapid technological change introduces uncertainty and a degree of risk for manufacturers. As one participant noted, "you will implement a technology that you think is going to work for today, but then the technology changes so fast, you're having technology vendors get acquired or go out of business, things are going obsolete very quickly." This challenge is compounded by vendor reliability, with some manufacturers feeling burned after investing in technology through vendors who failed to deliver sustained support, "we've gone in with them and then find out two, three years later, 'oh, it's obsolete,' that's not the kind of partner we can trust, that we can count on for decades," as one business leader shared.

Strategic Risks and Uncertainty

Market volatility further deepens hesitation, as companies weigh the risks of committing resources amid uncertainty about demand and pricing. In the words of one interviewee, "people have been right on the cusp of buying or committing to projects," yet this interviewee finds the automotive manufacturing industry being haunted by economic uncertainty in Canada, "I don't know what next week looks like, there's a lot of uncertainty in the market." Tariffs, policy shifts, and unclear industrial policy make it harder for firms to commit, as another interviewee noted, "companies are wondering whether Canada is where they should be, investors are wondering what to invest in."

Others stressed the need to avoid sunk costs on expensive digital technology adoption projects during a period of disruption in Canadian automotive manufacturing, "the last thing needed is to go spend money on something that's going to get ripped out," as one executive observed, noting that even if a new technology is successfully adopted on a production line, if the plant closes or needs to be retooled due to changes in market conditions, the return on investment may still be negative.

Considerations for Organizational Change Management

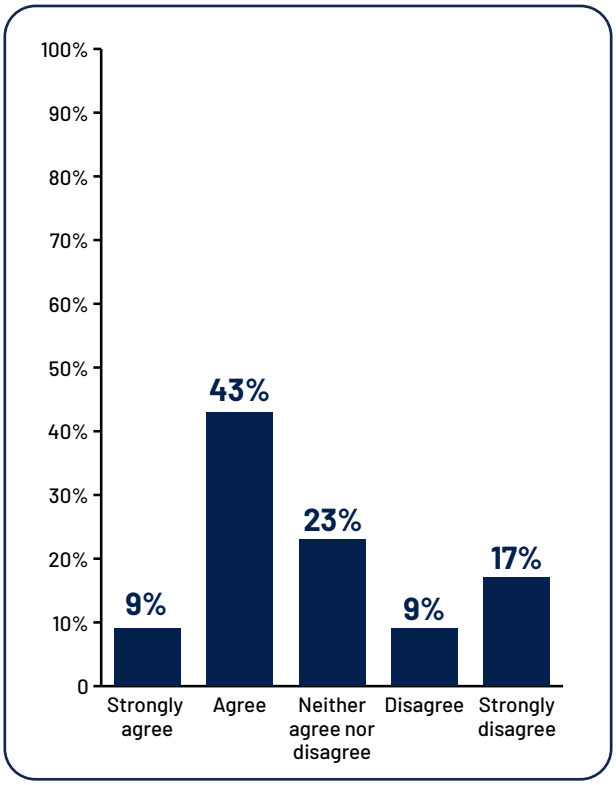
For many firms, the hardest part is not the technology but managing changes brought on by digital transformation throughout a manufacturing enterprise. Pilots and prototypes help build trust and gather valuable data and experience, while training and clear communication reduce workforce fears of technologies such as AI and advanced robotics.

Those who have had the most success tend to work in a collaborative manner, bringing in specialized technology vendors, working with suppliers and customers, and developing strategic partnerships with post-secondary institutions, industry associations, and other ecosystem actors such as technology accelerators and startup incubators. Even the largest OEM and Tier 1 parts suppliers interviewed for this roadmap do not undertake digital transformation on their own.

The most successful companies also take human and organizational factors into account, developing ROI frameworks, along with change management strategies and workforce development and training plans to support their digital transformation journeys. Working in a structured but collaborative manner on digital transformation can help automotive manufacturers reduce risk and uncertainty as they adopt advanced digital technologies into their operations.

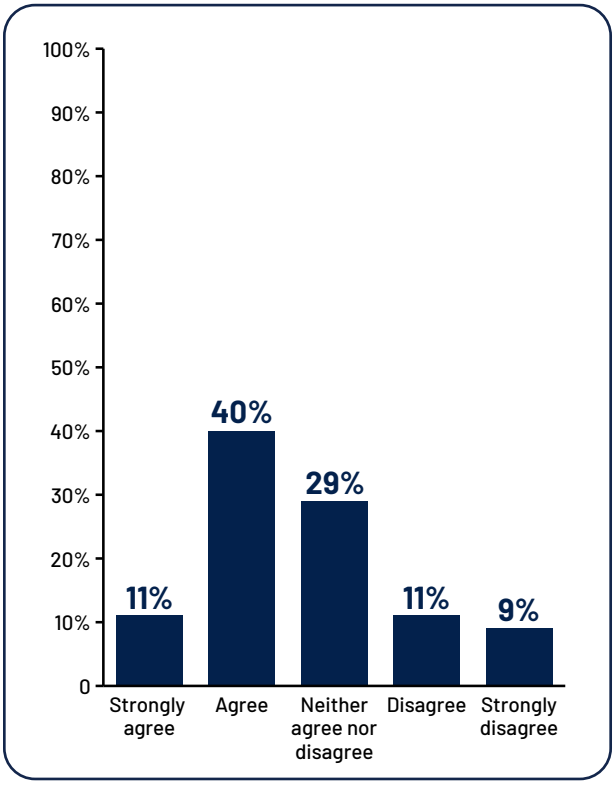
Half of automotive manufacturers surveyed for ICTC's digital transformation survey of Canadian manufacturers reported to engage in both strategic planning and fostering cultures of change across their organizations, with 52% reporting having a comprehensive digital technology adoption strategy and 51% enjoying a culture of change aligned to digital transformation (Figures 14 and 15).

Figure 14. Agree/Disagree: My organization has a comprehensive strategy for digital technology adoption – Automotive (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Figure 15. Agree/Disagree: There is a strong culture of change aligning digital strategy, actions, and structure across the organization – Automotive (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Digital Technology Adoption Horizon

As outlined in this case study, the technical and organizational complexities involved in adopting digital technologies and engaging in digital transformation are immense, yet not overwhelming. Automotive manufacturers should plan digital technology adoptions on a five-year time horizon. Figure 16 outlines digital technology adoption time horizons for automotive manufacturing.

Figure 16. Digital Technology Adoption Horizon

Adoption Phase	Time Horizon	Illustrative Examples
I. Pilots	Years 1-2	Initial cobot cell deployments, adopt AI production scheduling tools, cloud-based dashboards, predictive maintenance pilots.
II. Scaling	Years 3-5	Expand successful pilots across production lines/plants, broaden workforce training programs, increased use of IoT sensors for real-time monitoring.
III. Integration	Years 5+	Integrate digital ecosystems (e.g., AI, IoT, cloud, digital twins) fully, implement enterprise-wide data platforms, share data across supply chain.

Note: This timeline reflects how firms in the case study see their own readiness and adoption pace. Actual timelines will vary by company size, resources, and market conditions.

Digital Technology in Automotive Manufacturing Use Case Matrix

Use cases specify how different digital technologies can be adopted into a manufacturing operation. Figure 17 provides a matrix outlining five example use cases for each of the seven digital technologies covered in this roadmap alongside benefits that can be derived for each use case. As there are likely dozens of different use cases for each of these advanced digital technologies, with specific use cases relevant for specific types of automotive manufacturing operations, the use cases presented are intended to be illustrative, rather than exhaustive.

Figure 17. Digital Technology Use Case Matrix – Automotive Manufacturing

Technology	Example Use Case	Benefit
AI/ML	Predictive maintenance	Decrease risk of unscheduled downtime, reduce incidents of equipment catastrophic failure.
	AI-enabled machine vision inspection and defect detection systems	Increase speed and accuracy of defect detection processes.
	AI-enabled factory floor production dashboard)	Add predictive capabilities to dashboard, automate routine decision-making, automate variance/anomaly detection.
	Weld quality analysis	Analyze welding parameters and identify reasons for substandard welds.
	AI-enabled adaptive process control	Improve quality, increase throughput, reduce downtime, increase energy efficiency, enhance production flexibility.

Technology	Example Use Case	Benefit
Big Data Analytics	Process optimization/root cause analysis	Increase throughput, identify root causes of variance, improve quality, reduce scrap and rework time.
	Tool wear analysis	Analyze manufacturing tools, such as CNC cutting tools, for wear, predict replacement needs.
	Supplier performance dashboards/monitoring	Real-time monitoring of supplier performance, predict supplier performance variance, predict supplier shorts.
	AI/ML training data collection for future AI model building	Collect large volumes of real-world data from production operations to train ML models for future AI implementation.
	Energy consumption monitoring and analysis	Reduce energy consumption/costs, help meet ESG performance targets.
Cloud Computing	Centralized data sharing across facilities/ production sites	Seamless data-sharing across facilities and production sites, more efficient information flow.
	Scalable cloud-based MES/ERP systems	Increase MES/ERP flexibility, reduced risk of digital infrastructure/IT resource bottlenecks, cost savings.
	Cloud-based digital infrastructure for collaboration applications	Enhance design and engineering collaboration across business units and production sites.
	Digital twins hosting and scalable iteration	Host product, equipment, production line, or facility digital twins in cloud environment.
	Cloud-based digital traceability	Enhanced access to digital records and traceability of produced parts.
Cybersecurity (IT/OT)	Intrusion detection and Security Information and Event Management (SIEM)	Real-time detection, analysis, and response to incidents across networks and applications.
	Pen-testing and red ream exercises	Stress-test critical IT/OT networks, identify vulnerability in networks and business processes.
	Cybersecurity standards and best practices (e.g., ISO 27001)	Enhance cybersecurity governance and compliance, reduce cyber risk, adhere to customer (e.g., OEM) requirements.
	Digital forensics	Capture and collect OT/IT network data for forensic analysis after incident and aid law enforcement.
	Secure backups and disaster recovery testing	Reduce risk of catastrophic data loss, improve organizational resilience, enhance business continuity.

Technology	Example Use Case	Benefit
Digital Twins	Virtual prototyping/testing new auto parts	Shortened product development cycles, reduced prototyping time.
	Virtual (VR/XR) equipment operator training	Shortened training time for new hires, reduced time required to train workers on real equipment.
	Production line/facilities layout design/optimization	Shortened retooling time, lower hours needed by skilled trades to relocate equipment.
	Warehouse and materials flow digital twins	Optimize flow of supplies and materials inputs from warehouse storage to factory floor.
	Supply chain scenario planning	Enhanced supply chain resilience, reduced risk of bottlenecks.
Robotics and Industrial Automation	Industrial robots enabled with machine vision for parts/components handling	Increase pick accuracy, reduce worker fatigue, increase parts feed rate.
	Quadrupedal robots (i.e., "robot dogs") for automated facilities/machinery inspection	Identify variance in plant/equipment conditions, decrease risk of unscheduled downtime.
	Robotic welding cells	Reduce worker exposure to welding fumes, reduce sparks, more uniform welds, faster welding speeds.
	Robotic sanding/polishing cells	Reduce worker exposure to dust/vibrations, improve quality, increase output, cell flexibility.
	Autonomous mobile robots (AMRs) for facility intralogistics	Reduced need for human material handling, real-time monitoring of materials flows, agile material flows.
Sensors and IoT	IoT sensors for machine vibration/temperature monitoring	Reduce variance in machinery operations, capture and feed data into operational dashboards.
	RFID-based parts inventory tracking	Enhanced visibility of parts inventory, automated invoicing for shipped finished parts.
	RFID for asset tracking and geofencing	Use of RFID tags to track assets across a manufacturing operation and geofence assets to create alerts if asset leave designated area.
	IoT sensors for equipment and machinery status monitoring and real-time data collection	Capture data for use in big data analytics, asset digital twin development, and AI/ML training.
	IoT sensors and worker wearables for real-time hazard monitoring and detection	Increased worker safety, reduced safety incidents, shorten hazard resolution time.

ROI Measurement Framework

Like other business decisions, investing in digital transformation and the adoption of novel digital technologies should be assessed from a financial lens and should be aligned with strategic objectives, such as cost reduction, revenue growth, risk management, and alignment with high-level corporate strategy (Figure 18).

Figure 18. Digital Transformation Strategic Objectives

I. Reduce Costs	Leveraging advanced digital technologies and undergoing digital transformation to reduce costs, both from an operational perspective, by increasing output efficiencies, and an enterprise perspective, by reducing overheads and inputs.
II. Grow Revenue	Leveraging advanced digital technologies and undergoing digital transformation to support revenue growth, by expanding market access, increasing process and product innovation, and improving output capacity per unit.
III. Manage Risk	Leveraging advanced digital technologies and undergoing digital transformation to better manage operational, enterprise, and market risk, including reducing error and improving quality, retaining customers, and improving workplace safety.
IV. Strategic Alignment	Leveraging advanced digital technologies and undergoing digital transformation in pursuit of long-term corporate vision and enterprise strategic planning, particularly regarding factors such as market access, innovation, workforce development and human resources, and profitability.

Figure 19. Digital Transformation Investment Inputs

Category	Investments/Spend	Illustrative Examples
Digital Technology & Equipment	Robotics (cobots, humanoid/mobile)	UR10, Link 6 Cobot, Boston Dynamics Spot
	IoT/sensors	Sensors, controllers, RFID tags, machine vision cameras
Digital Infrastructure	Networking and connectivity	Industrial ethernet, 4G/5G, ISED NCLL spectrum[6]
	Cybersecurity program (IT/OT)	Firewall, SIEM, end-point protection, pen-testing
	Cloud services subscriptions	AWS, Microsoft Azure, Google Cloud
Software Licensing	IoT/IIoT plaforms	GE Predix, SAP Digital Manufacturing Cloud
	Big data/AI platforms	Siemens MindSphere, IBM Watson, FactoryTalk
	Cloud/hybrid ERP platforms	NetSuite ERP, Odoo, Rootstock, Microsoft Dynamics
	Cybersecurity (IT/OT) platforms	Fortinet OT Security, Microsoft Defender
	Digital Twins platforms	Nvidia Omniverse, Siemens Xcelerator
Human Resources & Workforce Development	Workforce training/development	Employee training, tech. mentorship/coaching
	Digital talent recruitment	Campus recruiting, co-op program participation
	Change management	Internal communications, consultants
	HR management	Union negotiations, job description changes

Note: The software applications and hardware platforms mentioned in this table are intended to be illustrative examples and should not be construed as endorsements nor as procurement recommendations.

Required investments will include hard costs, such as new technology and equipment, underlying digital infrastructure, and software licensing, as well as soft costs, such as training and workforce development, change management, and HR issues (Figure 19).

Figure 20 outlines an ROI framework for adopting digital technologies for a manufacturing enterprise. This ROI framework is categorized into different classes of benefits, including operational efficiencies, workforce and capital productivity, market access, innovation, health and safety, and ESG (environmental, social, and governance), and is cross referenced by digital transformation strategic objectives discussed above.

Detailed ROI calculations will be unique to individual manufacturers, including the specific mixes of digital technologies and their associated use-cases, with the ROI framework presented being intended to help manufacturers navigate ROI assessments and business case development. Like the use case matrix, the ROI framework is intended to be illustrative rather than exhaustive.

6 Innovation, Science and Economic Development Canada (Government of Canada), "Non-competitive local licensing (NCLL)," last update February 19, 2026, https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/licences-and-certificates/non-competitive-local-licensing-ncll.

Figure 20. Advanced Manufacturing Digital Technology Adoption ROI Framework

	Benefits	ROI Metrics	Objective Alignment			
Benefit Types	Potential Benefits	Example Metrics	Reduce Costs	Grow Revenue	Manage Risk	Strategic Alignment
Operational Efficiencies	Increased production	% increase in finished goods/hour		X		X
	Scheduling adherence	% decreased in scheduling variance	X		X	
	Reduced materials wastage	% reduction in material scrap	X			
	Reduced error	% reduction in error rate	X		X	
Workforce Productivity	Task automation	# labour hours saved	X			
	Workforce redeployment	% role revised for higher value tasks	X	X		X
	Enhance employee engagement	% increase in employee engagement				
	Reduce absenteeism	% decrease in absentee hours	X		X	
Capital Productivity	Equipment utilization	% increase in equipment utilization	X			
	Production line flexibility	% reduction in line retool time	X			X
	Reduced equipment downtime	% reduction in equipment downtime	X			
	Efficiency of capital investment	% increase in EBITDA per dollar PP&E	X			X
Market Access	New OEM customers	# new contacts		X		X
	Efficient business development	% bid-to-win rate for new contacts	X	X		
	Customer retention	% of existing customers retained	X	X	X	X
	Digital capability tie-ins	% of RFPs requiring digital capabilities		X		X
Innovation	Reduced product iteration time	% reduction in time to iterate design	X	X		X
	Digital pilot projects launched	# of new digital tech adoption pilots			X	X
	Prototype development time	% reduction in prototype dev. Time	X			X
	Reduce time-to-market	# week reduction time-to-market	X	X		
Health & Safety	Reduced lost-time incidents	% reduction in lost time incidents	X		X	
	Reduced repetitive strain injuries	% reduction in repetitive strain injuries	X		X	
	Fine particulate matter illnesses	% reduction in workplace FPM illness	X		X	
	Reduced WCB premiums	% reduction in WCB premiums	X		X	
ESG Measures	Reduced carbon footprint	% reduction in carbon footprint	X		X	X
	Increased energy efficiency	% reduction in plant electricity use	X		X	X
	Reduced material inputs	% reduction in material input per part	X		X	X
	Reduced water use	% reduction in plant water use	X		X	X

Change Management Checklist

Adopting digital technologies into existing manufacturing operations necessitates careful change management planning. Investing time and resources in a change management strategy in support of digital transformation can improve the likelihood that a project will meet its objectives by seven times, while producing a three-to-one to seven-to-one ROI, according to a 2025 whitepaper by Culture Partners.[7] Likewise, early engagement in change management can increase project ROI by 40-60%.[8]

Change management plans supporting digital technology adoption initiatives should include a project sponsor, outline roles and responsibilities, identify a champion to lead the change, and include internal and external communications planning, as well as a staff training plan. Plans should also include predesigned feedback loops, such as feedback portals, surveys, and staff town halls.

Lastly, they should include measurable goals to and timelines to monitor progress and provisions to celebrate success when achieved, as well as options to scale successful pilots into larger digital transformation projects. Figure 21 below outlines a change management checklist for use in digital technology adoption initiatives.

Figure 21. Digital Technology Adoption Change Management Checklist

I. Pre-Implementation Phase:

- Secure executive leadership commitment and clear digital transformation vision.
- Conduct comprehensive skills assessment and identify training needs.
- Establish dedicated project team with representatives from all affected departments.
- Create communication plan addressing concerns and benefits for all stakeholders.
- Define success metrics and establish baseline measurements for ROI tracking.

II. Implementation Phase:

- Pilot technology with small, manageable scope before full deployment.
- Provide hands-on training for all users, with special attention to production workers.
- Establish feedback mechanisms and regular check-ins with implementation team.
- Address resistance proactively through transparent communication and involvement.
- Document lessons learned and adjust approach based on pilot results.

III. Post-Implementation Phase:

- Measure outcomes against established success metrics and ROI framework.
- Celebrate early wins and recognize team contributions to build momentum.
- Establish continuous improvement processes for ongoing optimization.
- Plan for scaling successful implementations across additional facilities or processes.
- Update training programs based on real-world experience and user feedback.

7 Culture Partners, "Change Management ROI: Measuring Financial Returns and Business Impact," June 10, 2025, https://culturepartners.com/insights/change-management-roi-measuring-financial-returns-and-business-impact/.

8 Culture Partners, "Change Management ROI: Measuring Financial Returns and Business Impact," June 10, 2025, https://culturepartners.com/insights/change-management-roi-measuring-financial-returns-and-business-impact/.

Digital Transformation Phase Gates

When undertaking digital transformation of manufacturing enterprises, a change management plan can be supported by structuring change through phase gates, which are aligned with the digital transformation timeline outlined earlier in this document.

For example, if a Tier 2/3 parts supplier were interested in placing IoT sensors on an existing automated welding cell, Gate 1 could be checking to see if the existing welding equipment were compatible with the new sensors and that connectivity in that area of the factory floor had the needed connectivity for sensors to send data back to a cloud database.

Gate 2 would be to validate if the new IoT sensors were able to capture the data properly over a period of time and if the data were able to provide management with insights into the state of the welding cell. After Gate 2 is cleared, manufacturers should financially validate the pilot to measure ROI and adherence to strategic objectives (i.e., cost reduction, revenue growth, risk management, and long-term strategic alignment). Intermediate financial validation helps firms reduce the chance of falling for sunk costs.

Gate 3 would include staff training for welding cell operators, while Gate 4 would include expanding the technology adoption initiative and adding IoT sensors to all welding operations.

Figure 22 outlines such a phased gate approach to digital transformation in manufacturing, including illustrative examples for each of the seven digital technologies covered in this roadmap.

Figure 22. Digital Transformation Phase Gates

Digital Technology	Gate 1: Tech Readiness Check	Gate 2: Pilot Validated	Intermediate Financial Validation Step	Gate 3: Workforce Trained	Gate 4: Integration Approved
AI/ML	Identify use case (e.g., predictive maintenance)	Pilot AI model on one production line	Predefined ROI metrics mapped to strategic objectives.	Train engineers to interpret outputs	Deploy across facilities
Big Data Analytics	Ensure data capture infrastructure in place	Pilot dashboards for root cause analysis	Predefined ROI metrics mapped to strategic objectives.	Train analysts and operators	Scale to enterprise-level decision-making
Cloud Computing	Assess cloud vendor solutions/ options	Pilot cloud-based MES/ERP on trial basis	Predefined ROI metrics mapped to strategic objectives.	Train IT and plant managers on new system	Fully migrate workflows to cloud MES/ERP
Cybersecurity (IT/OT)	Baseline security assessment	Pilot intrusion detection system	Predefined ROI metrics mapped to strategic objectives.	Train staff on cyber protocols	Certify enterprise-wide compliance
Digital Twins	Develop digital twin for one piece of machinery	Validate twin against real performance	Predefined ROI metrics mapped to strategic objectives.	Train operators with simulations	Expand to line or facility-wide twins
Sensors / IoT	Install sensors on one welding cell	Validate output improvement/ downtime savings	Predefined ROI metrics mapped to strategic objectives.	Train operators to use welding dashboards	Expand across welding line
Robotics	Assess cobot readiness for simple task	Pilot robotic sanding/polishing cobot cell	Predefined ROI metrics mapped to strategic objectives.	Train operators on safety and co-working	Integrate robotics into multiple lines

Managing Risk

As with any new initiative, risk and uncertainty are inherent part of change and should be accounted for in project plans. Figure 23 below provides an example risk register. Such tools can be used to document and specify risks brought on by technology adoption and digital transformation.

Figure 23. Canadian Automotive Manufacturing Example Digital Transformation Risk Register

Risk Category	Specific Risk	Impact	Probability	Possible Mitigation Strategies
Technical	Integration failures	High	Medium	Pilots/testing, vendor partnerships
	Cybersecurity vulnerabilities	High	Medium	Security framework, audits, response
	Legacy compatibility	Medium	High	Assessment, middleware, migration
Financial	Cost overruns	High	Medium	Phased implementation, ROI metrics
	Negative ROI	Medium	Medium	Track ROI metrics
Human Resources	Digital skills gaps	High	High	Training, recruit for digital skills
	Workforce resistance	Medium	Medium	Employee ownership
Operational	Production disruptions	High	Medium	Parallel ops, scheduled downtime
	Supply chain disruptions	High	High	Multi-region sourcing, stockpiling
Vendor Risk	Tech vendor reliability issues	Medium	Medium	Multi-vendor, SLAs, backup plans
	Vendor lock-in	High	Medium	Open standards, portability, exit strategy
Market/ External	Regulatory/policy changes	Medium	Medium	Monitoring, flexible compliance
	Competitive pressure	High	Medium	Market monitoring, agile strategy
	IP theft/cyberattack/data breech	High	Medium	Cybersecurity, IP protection, pentesting

Risk Management Trigger Scenarios

In addition to establishing a risk roster to support enterprise digital transformation, trigger scenarios can be adopted as a risk management tool. Trigger scenarios are indications that a risk is either occurring or is at a heightened probability to occur in the future. Figure 24 below provides illustrative trigger scenarios with early warning indicators and suggested actions, showing SMEs how to spot when a risk is rising and take timely steps to mitigate it.

Figure 24. Example Automotive Manufacturing Trigger Scenarios

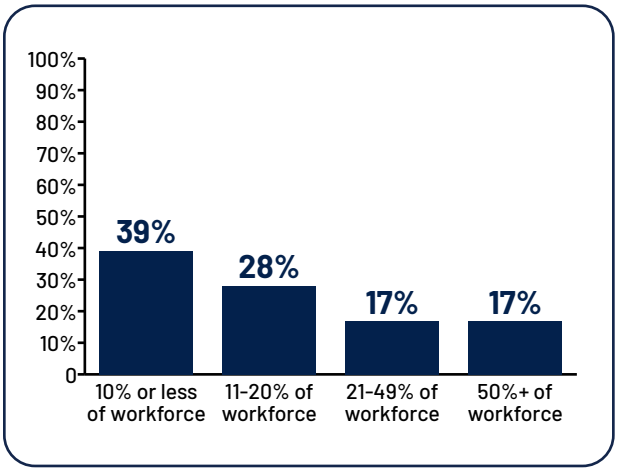
Trigger Scenario	Early Warning Indicator	Potential Action
I. OEM introduces new cybersecurity compliance requirement	Updated IT/cyber clauses in RFQs or supplier contracts.	Review IT/cyber policies; engage managed service provider for gap assessment.
II. Key supplier shows signs of financial distress	Late deliveries, quality slippage, credit rating downgrades.	Identify alternate suppliers; build buffer stock; engage in contingency planning.
III. Workforce turnover spikes in skilled trades	Increase in overtime reliance, exit interviews citing job dissatisfaction.	Launch retention measures; accelerate cross-training; adjust hiring plans.
IV. Equipment reliability declines	Rising unplanned downtime or repeated maintenance calls.	Initiate predictive maintenance pilot; prioritize CapEx replacement schedule.
V. Customer demand shifts suddenly	Drop in firm orders or requests for new product configurations.	Reassess production plan; explore using product digital twins; increase use of flexible automation.

Talent, Workforce Development, and Training

Developing a digitally skilled manufacturing workforce is essential to realize the full potential of digital transformation in Canada's automotive manufacturing sector. The need to accelerate the proportion of the workforce driving digital transformation in automotive manufacturing is acute. ICTC's 2025 survey on digital technology adoption in Canadian manufacturing found that the vast majority of automotive manufacturers had 20% or less of their workforce dedicated to digital transformation (Figure 25).

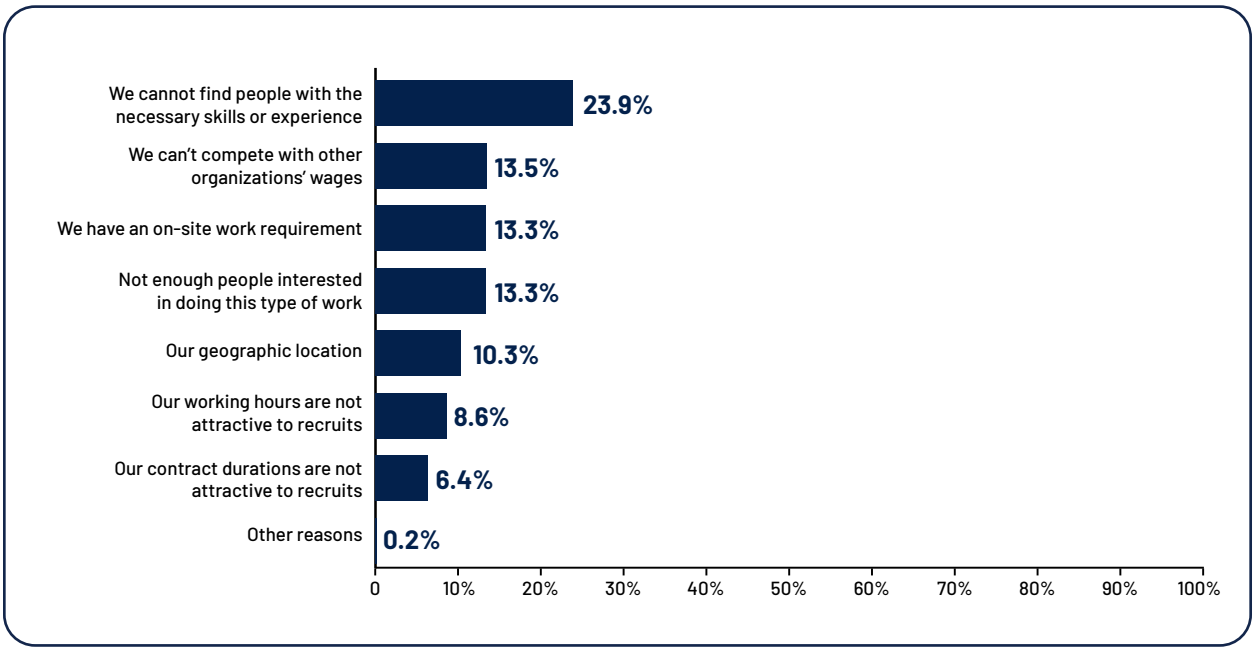
Competition for digital talent in adjacent sectors to manufacturing—such as infrastructure, energy and natural resources, and technology—are immense. Indeed, recruiting technology workers with the required mix of skills and experience was the top recruiting challenge faced by employers across Canada, according to ICTC's 2024 digital economy employer survey (Figure 26).[9]

Figure 25. Workforce Dedicated to Digital Transformation at Canadian Automotive Manufacturers (2025)



Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Figure 26. Canadian Employers' Challenges in Recruiting Technology Employees in Past 12 Months



Source: ICTC's 2024 Digital Economy Employer Survey.

9 Maryna Ivus, Todd Legere, Christopher Lindstrom, Sheldon Lopez, and Faun Rice, "Digital Economy Pulse: Productivity and Employment Trends in Canada," Information and Communications Technology Council (ICTC), 2025, https://ictc-ctic.ca/reports/digital-economy-pulse-productivity-and-employment-trends-canada-august-2025, 22, Figure 9.

On top of recruiting and retaining skilled digital talent to drive digital adoption in Canada's automotive manufacturing sector, there are significant opportunities to invest in upskilling and retraining programs for the existing automotive manufacturing workforce.

Manufacturers adopting digital technologies into their operations as they undergo digital transformation need to establish baseline, essential digital competencies across their workforces This includes the following essential advanced manufacturing digital competencies outlined in Figure 27.

Figure 27. Baseline Digital Competencies for Advanced Manufacturing

Advanced Robotics Interaction	Safely and productivity interacting with advanced robotics in manufacturing environments, including interactions with cobots, autonomous mobile robots, and humanoid robots.
AI and ML Basics	Understanding capabilities and limitations of AI/ML systems and how autonomous systems are being adopted into advanced manufacturing applications.
Cloud Computing Applications	Working with cloud-based manufacturing and enterprise systems such as MES and ERP applications.
Cybersecurity Fundamentals	Basic IT/OT security awareness for manufacturing environments.
Digital Twin Operation	Managing and interpreting virtual representations of physical systems.
Data Analytics and Interpretation	Understanding how to collect, curate, analyze, and act on large volumes of operational data.

Most critically, automotive manufacturers engaging in digital transformation need to create a culture of continuous learning amongst their workforces through deliberate organizational strategies and embracing innovative training models to foster digital talent. Learning should be structured in a practical manner that conveys hands-on knowledge and digital skill development. Figures 28 and 29 outline organizational strategies and training delivery models for fostering digital talent in automotive manufacturing.

10 The Conference Board of Canada, "Building a Digitally Skilled Workforce: Insights from Canadian Employers and Skills Leaders," The Conference Board of Canada and Future Skills Centre, March 2022, https://fsc-ccf.ca/research/building-a-digitally-skilled-workforce/.

Figure 28. Organizational Strategies for Fostering Digital Competencies in Advanced Manufacturing

Integrate Digital Skills into Existing Roles	Integration of digital competencies into existing job roles rather than creating separate digital positions.
Provide Recognition and Incentives	Recognition and incentive systems that reward digital skill development and knowledge sharing.
Develop Internal Digital Skills Training Capabilities	Invest in internal training capabilities to reduce dependence on external providers.
Include Workforce in Pilot Projects	Create cross-functional teams made up of employees throughout manufacturing enterprise to launch technology adoption pilots, document learnings.
Pursue Digital Talent Development Partnerships	Partnerships with post-secondary institutions, technology vendors, and other ecosystem actors for ongoing skills development.

Figure 29. Training Delivery Models for Fostering Digital Competencies in Advanced Manufacturing

Cross-generational Mentoring	Pairing digitally skilled employees with experienced automotive assemblers and other production line workers.
Simulation-Based Learning	Using digital twin environments, coupled with VR/XR for safe, realistic training experiences.
Micro-Learning Modules	Short, focused training sessions that accommodate shifts and production schedules.
Vendor-Supported Training	Leveraging technology supplier expertise for specific system training.
Micro-credentials	Short, skill-focused, and flexible educational programs, often delivered online.

Developing Strategic Partnerships

Canadian automotive manufacturers do not need to undertake their digital transformation journeys alone. Indeed, there are plenty of outside organizations within the manufacturing industry and the public sector that automotive manufacturers can develop strategic partnerships with. These include industry associations, as well as other ecosystem actors, such as industry working groups, industry-led training initiatives, and technology incubators. Post-secondary institutions can also be leveraged to provide workforce training, a pipeline of new talent, through work-integrated learning (WIL) initiatives, such as co-op programs, campus recruiting, as well as joint applied research activities.

Likewise, relationships and preexisting obligations with stakeholders such as customers, suppliers, and technology vendors should be taken into account when undergoing digital transformation. Figure 30 below outlines key strategic partnership and stakeholder management verticals, which should be accounted for when undergoing digital transformation.

Figure 30. Strategic Partnership Verticals

Customers	Vendors and Suppliers	Industry Associations and Ecosystem Groups	Post-Secondary Institutions
› Digital transformation co-investment and cost-sharing programs › Open digital platforms and interoperable data standards › Joint cyber/ information security protocols › Joint digital transformation pilot programs	› Digital transformation co-investment and cost-sharing programs › Open digital platforms and interoperable data standards › Vendor training and technical mentorship/ coaching programs › Joint cyber/ information security protocols	› Industry working groups (e.g., joint digital transformation working group) › Technology/ start-up incubator programs › Industry-led training and workforce development initiatives › Sectoral public affairs and governmental relations initiatives	› Workforce training and talent development › WIL programs (e.g., internships, co-ops practicums) › Campus recruiting (e.g., job fairs, industry nights) › Joint industry-academic research › Industry curriculum advisory councils

Information and Data-sharing for Automotive Manufacturing Strategic Partnerships

In addition to the key partnership verticals listed above, automotive manufacturers should be ready to jointly develop predefined partnership frameworks and agreements up-front between new partners. Co-developing a common understanding of partnership objectives, scope, and timelines is critical to foster successful partnerships. Automotive manufacturers should also understand the types of potentially sensitive non-personal data, such as production, financial, supply chain data, that may be needed to share with partners (Figure 31).

Figure 31. Strategic Partnership Information and Data-sharing Considerations

Strategic Alignment

- Objectives, scope, and partnership timeline
- Business case and ROI expectations (e.g., financial/performance metrics)
- Governance model and decision-making processes (e.g. IP ownership, dispute resolution)
- Knowledge sharing frameworks (e.g., publication agreements, joint workshops, user groups, technology demonstrators, pilots)

Technical Data Requirements

- Manufacturing systems and Process (e.g., enterprise systems and control systems (MES/ERP), machinery/ equipment inventory)
- Facilities connectivity (e.g., 5G, ethernet)
- Non-personal data sharing (e.g., production and process, product/design, quality, financial, safety/ incident, supply chain)
- Interoperability standards and data formats
- Cybersecurity standards/data protection

Safety, Regulation, and Compliance Requirements

- Quality standards
- Health and Safety standards
- Environmental/ESG standards
- IP and confidentiality agreements

Digital Technology Adoption: A Call to Action

Canada's automotive manufacturing sector stands to greatly benefit from increasing digital technology adoption throughout the manufacturing enterprise. Over decades, Canada's automotive manufacturing sector has been at the forefront of technology adoption, such as the early use of industrial robotics, and should continue in this tradition by accelerating its adoption and successful use of advanced digital technologies.

Over the next five to ten years, there are significant opportunities in emerging digital technologies such as advanced robotics, AI, IoT, and digital twins, but digital infrastructure must be continuously upgraded, while the automotive manufacturing workforce needs to be continuously trained and upskilled to get the most out of novel digital technologies on the factory floor. Canadian Tier 2/3 automotive parts SMEs should strive to implement foundational digital infrastructure stacks, which include technologies such as a cloud ERP backbone and a baseline IT and OT cybersecurity program.

Likewise, to get the most out of digital transformation, automotive manufacturers need to understand and rigorously assess opportunities brought about by novel digital technologies and incorporating them into their business plans and long-term corporate strategies, developing business cases, measuring ROI, evaluating risk, managing organizational change, and mapping stakeholders and strategic partners.

Action Steps

Assess	Map your current processes and technological capabilities and identify digital gaps.
Pilot	Start with a small project (e.g., a cobot, predictive maintenance, or AI production scheduling tool).
Train	Involve staff early, build digital change champions on the production floor, recruit digital technology talent.
Partner	Engage with vendors and suppliers, post-secondaries, industry associations and ecosystem groups, and customers for expertise and shared resources.
Scale	Expand proven pilots across lines, plants, or product families.
Integrate	Network successfully scaled technology adoption initiatives into a cohesive technology stack to drive profitability, cost savings, and productivity.
Iterate	Repeat technology adoption cycle as new technologies emerge and markets evolve.

Research Methods

This roadmap for the Canadian automotive manufacturing sector is informed by mixed methods research, including an industry survey of Canadian advanced manufacturers, a series of key informant interviews, an industry roundtable, and a comprehensive literature review.

ICTC carried out an industry survey of Canadian manufacturers (n = 133) from June and July 2025, which included responses from 35 firms from Canada's automotive manufacturing sector, including OEMs and tiered parts suppliers. Due to the wide variety of firm types involved in automotive and automotive parts manufacturing and a relatively small sample size, survey data may not fully reflect the state of all Canadian automotive manufacturers. ICTC also carried out eleven semi-structured key informant interviews with senior executives, technical leaders, and other experts from the Canadian automotive manufacturing sector. ICTC also hosted an automotive manufacturing sectoral roundtable with industry leaders in November 2025.

Prior to carrying out primary data collection, ICTC conducted a comprehensive literature review on digital transformation, digital technology use cases in manufacturing, and the current state of advanced manufacturing in Canada. Insights collected during the literature review helped to inform questions asked to research participants during the industry survey, key informant interviews, and focus groups, as well as design the final roadmap document.