



Digital Technology Adoption Roadmap

Accelerating Digital Transformation in Canada's Aerospace 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 aerospace manufacturing sector. The five-year roadmap details practical steps and considerations for Canadian aerospace firms, 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 aerospace 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:



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 ten-year roadmap details practical steps and considerations for Canadian aerospace manufacturers, particularly small- and medium-sized enterprises, 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 aerospace manufacturing sector, covering barriers, challenges, and solutions to digital transformation. It outlines how aerospace 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 aerospace manufacturers plan and execute their digital transformation journeys, including:

- 1. Digital technology use case matrix:** highlighting practical uses of the seven digital technologies in the aerospace 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 aerospace manufacturing sector and support ongoing digital transformation efforts. Adopting novel digital technologies is critical for continued sectoral success, driving innovation and technology leadership in Canadian aerospace manufacturing, and maintaining the sector's continued global success.



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Acknowledgements

This roadmap was developed in consultation with digital transformation leaders from the Canadian aerospace manufacturing sector, including five expert interviews and an industry roundtable. Representatives from aerospace manufacturers, digital technology vendors with expertise in the aerospace industry, consultants, and other experts all contributed insights towards this roadmap.

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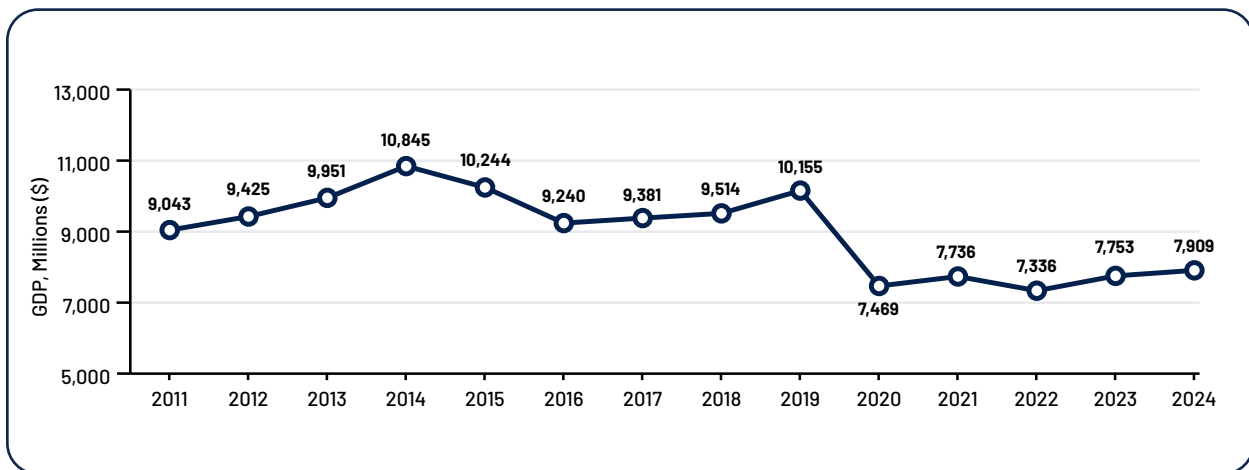
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Why this Roadmap is Needed

Canadian manufacturing is facing notable headwinds from declining productivity, underinvestment, and economic uncertainty stemming from international trade disputes. For the aerospace manufacturing sector, real GDP has faced a notable decline since 2014, but has seen a small resurgence in recent years (Figure 1).

Figure 1. Aerospace Manufacturing Sector GDP Value (2011-2024)



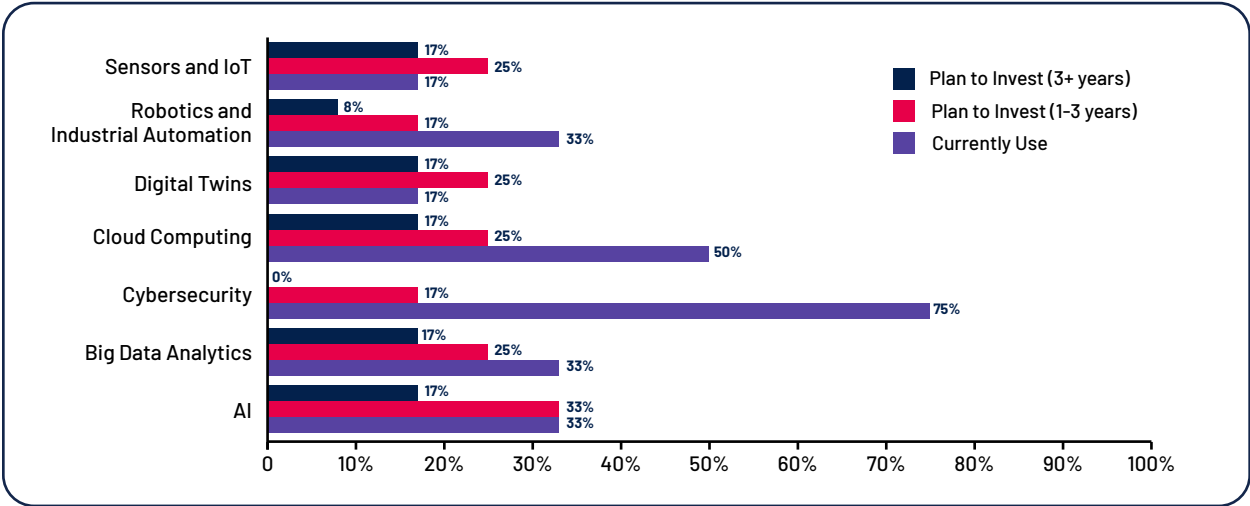
Source: Statistics Canada, Table: 36-10-0434-06 [NAICS 3364].¹

Industry growth has 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 digital infrastructure like cloud computing.

Canadian aerospace manufacturers can increase productivity and accelerate growth by adopting more digital technologies across their manufacturing operations. An industry survey conducted by ICTC finds that while aerospace manufacturers have widely adopted cloud computing and cybersecurity, other critical digital technologies such as artificial intelligence (AI), sensors and IoT technology, and digital twins are much less common (Figure 2).

¹ Statistics Canada (Government of Canada), "Gross domestic product (GDP) at basic prices, by industry, annual average, industry detail (x 1,000,000)," Table: 36-10-0434-06, release date January 26, 2026, <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3610043406>.

Figure 2. Aerospace Manufacturing Digital Technology Adoption (2025)

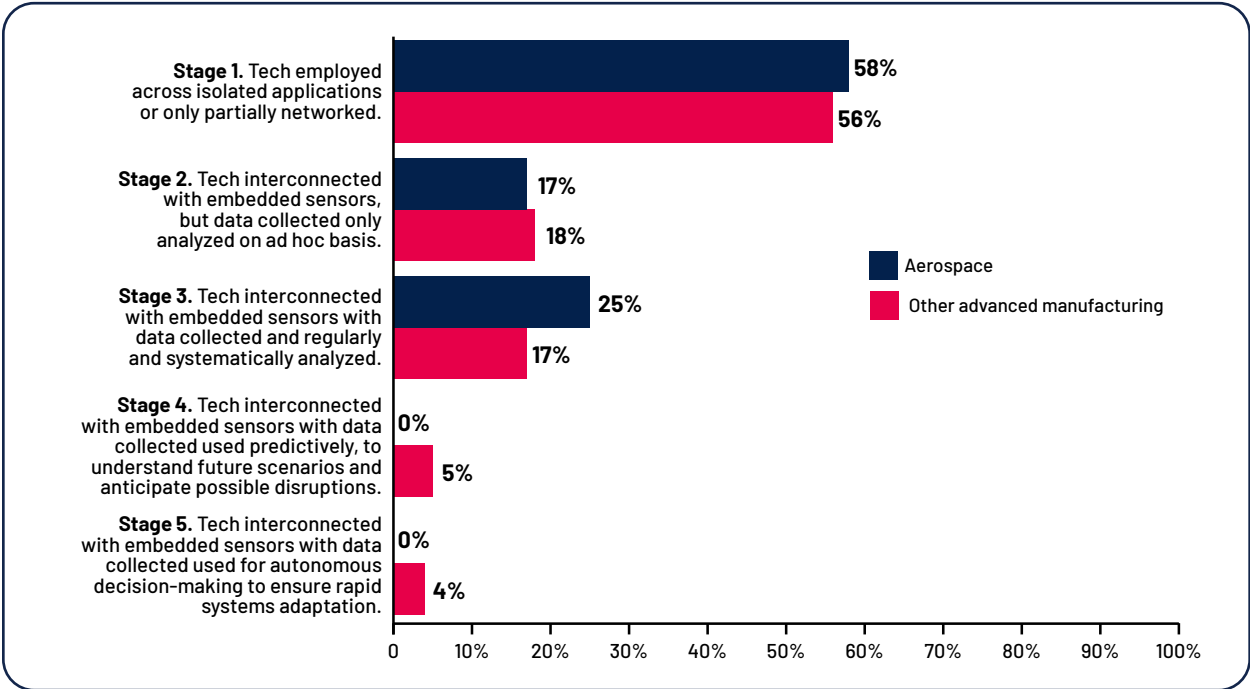


Source: ICTC Canadian Manufacturing Digital Technology Adoption Survey, 2025.

Canadian manufacturing technology adoption shows mixed progress across industries. Within the Canadian aerospace manufacturing sector, ICTC’s Canadian manufacturing digital technology adoption survey found that 58% of aerospace manufacturers employed digital technology piecemeal, as isolated applications or only partially networked, 17% employed interconnected digital

technology but only analyzed collected data on an ad hoc basis, while 25% employed interconnected digital technology and analyzed collected data regularly and systematically. Furthermore, no aerospace manufacturer ICTC surveyed reported to use data collected from networked sensors for predictive analytics nor autonomous decision-making (Figure 3).

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



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

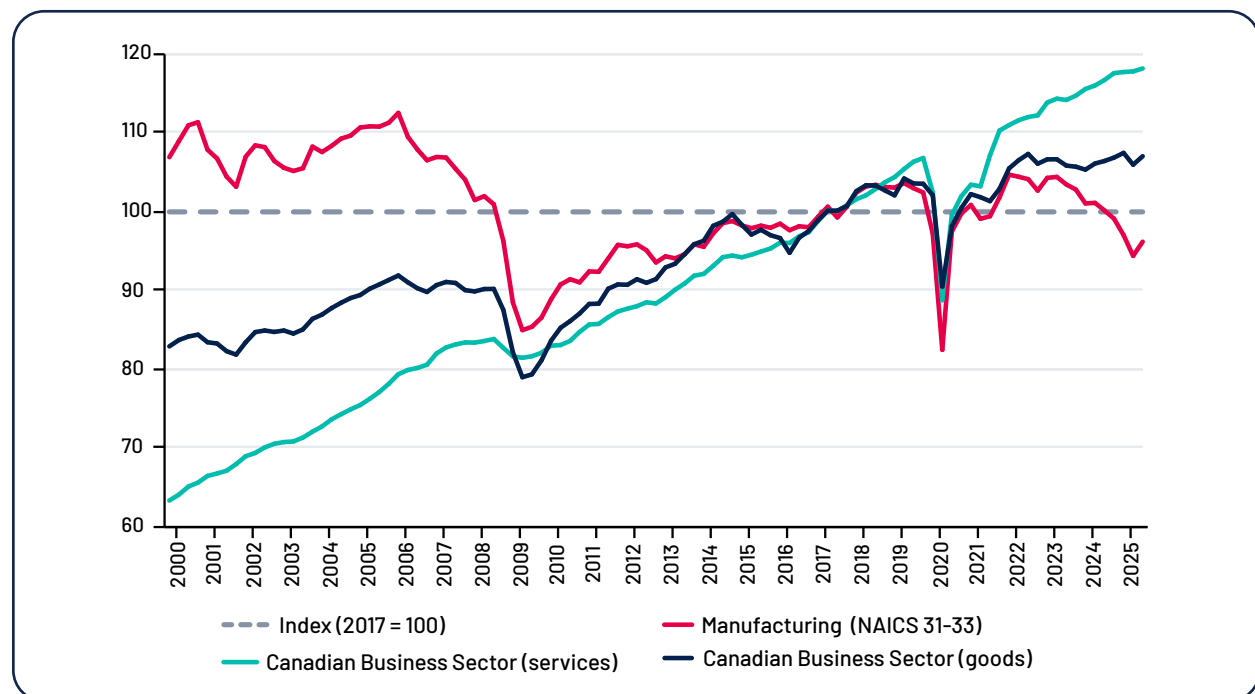
Further leveraging networked digital technologies towards integrated, autonomous operations across a manufacturing process, or even an entire manufacturing enterprise, could have a positive effect on labour productivity in Canada's manufacturing sector (Figure 4). This would be a welcome development,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

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 aerospace Tier 2 or Tier 3 supplier 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.

Figure 4. Index on Canadian Manufacturing Labour Productivity (2000 to Q3 2025)



Source: Statistics Canada, Table: 36-10-0207-01.³

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>.

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 Aerospace Manufacturing

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

Figure 5. Seven Key Digital Technologies Essential for Canadian Manufacturing

Artificial Intelligence (AI) and Machine Learning (ML)	AI-enabled systems can quickly parse large volumes of data, helping to optimize processes and predict outcomes, and 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, off-site 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 encompasses protecting both information technology (IT), such as networks and data, and 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)	Machinery, sensors, and other electronic devices can be interconnected 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	Automation technologies have long been used in aerospace 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. Aerospace 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, on its own, be 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 an aerospace manufacturing operation, or across an entire manufacturing supply chain, with significant gains in operational excellence, productivity, safety, product innovation, and market responsiveness.

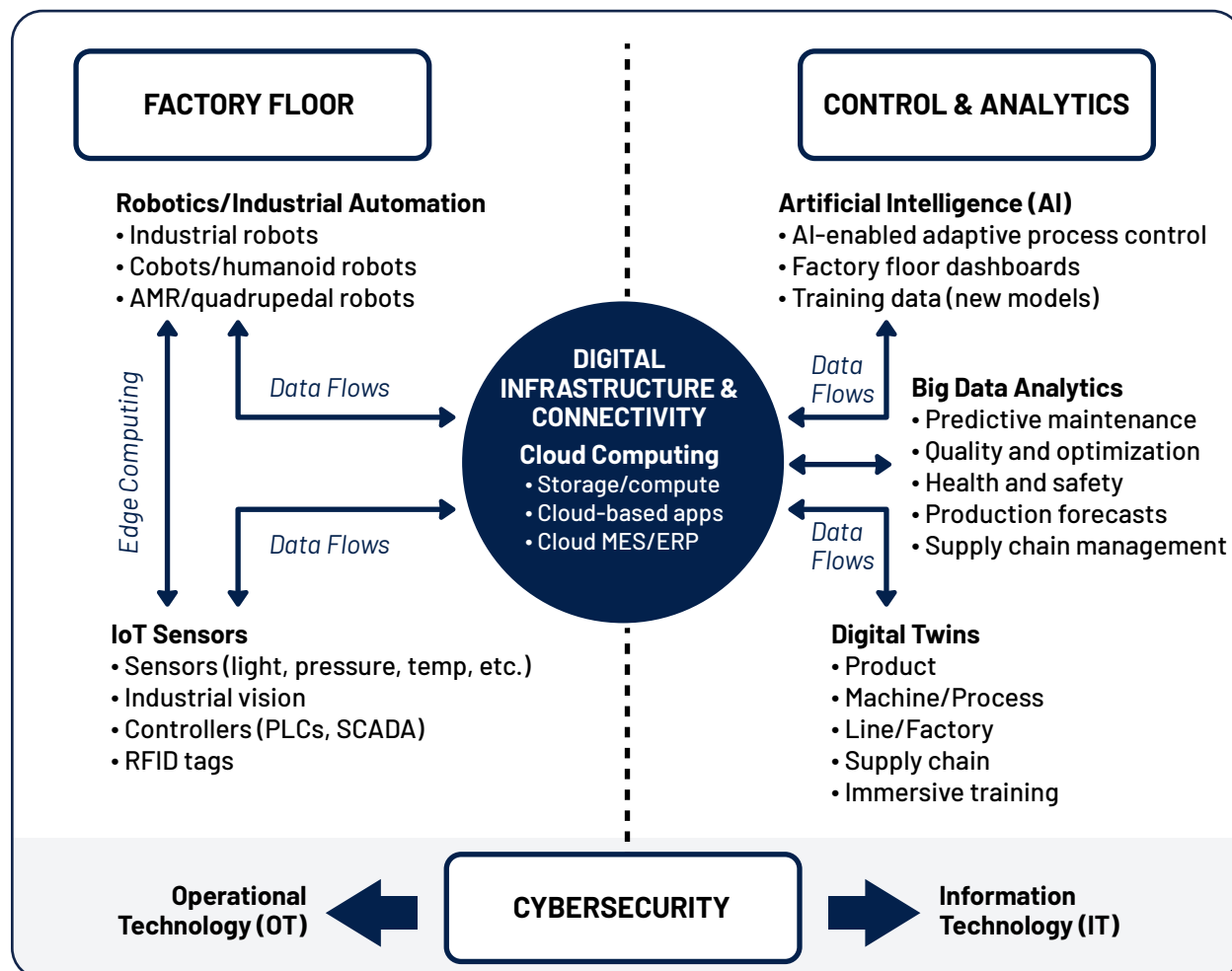
For example, sensors deployed across a manufacturing operation, on industrial robots and other production equipment, can collect significant amounts of real-time data (i.e., big data) that can be

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, products, 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 production floor and across an enterprise in the aerospace manufacturing sector.

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

Figure 7. Advanced Digital Technology in Manufacturing Integration Model



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 aerospace manufacturers adopting novel digital technologies, such as AI, digital twins, or advanced robotics, for the first time, it can take years to derive the full value from the investment and get the most out of the new technology.

A phased, five-year timeline provides aerospace manufacturers, including those undergoing a digital transformation project for the first time, with a realistic timeline for effectively adopting digital

technologies. Due to the large capital costs involved, significant time horizons, and aircraft and parts certification cycles, timelines may even be stretched beyond five years. This is in comparison to other advanced manufacturing sectors which can adopt digital technologies—moving from pilot projects to scaling at a quicker cadence.

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, or more, scaling successful pilots across their manufacturing operations and beginning digital integration with other manufacturing and enterprise systems.

Digital Technology Adoption in Canada's Aerospace Manufacturing Sector

This case study synthesizes insights from companies operating across Canada's aerospace and space ecosystem, ranging from advanced robotics and inspection technology providers to aerospace manufacturer OEMs and parts manufacturers, including defence contractors, and space systems firms. These organizations span civil aviation, defence, maintenance and overhaul, and space-adjacent infrastructure, reflecting the breadth and complexity of the sector. Large multinational firms, as well as small- and medium-sized enterprises were engaged to create this case study.

Aerospace manufacturing activities in Canada include aircraft assemblies and parts such as fuselage, wings, and tail assemblies, aircraft engines and engine components, aerospace product prototypes, flight simulators, avionics, helicopters and propellers, as well as space-related products including space systems and telecommunications satellites and components.

Industry Overview and Context

Aerospace is one of Canada's most innovation-intensive manufacturing industries. In 2024, the industry invested CAD \$1.2 billion dollars in research and development and maintained the number one research and development ranking among Canadian manufacturing industries. Its research intensity and share of STEM employment were more than 2.8 times higher than the manufacturing average. The aerospace workforce is innovation-

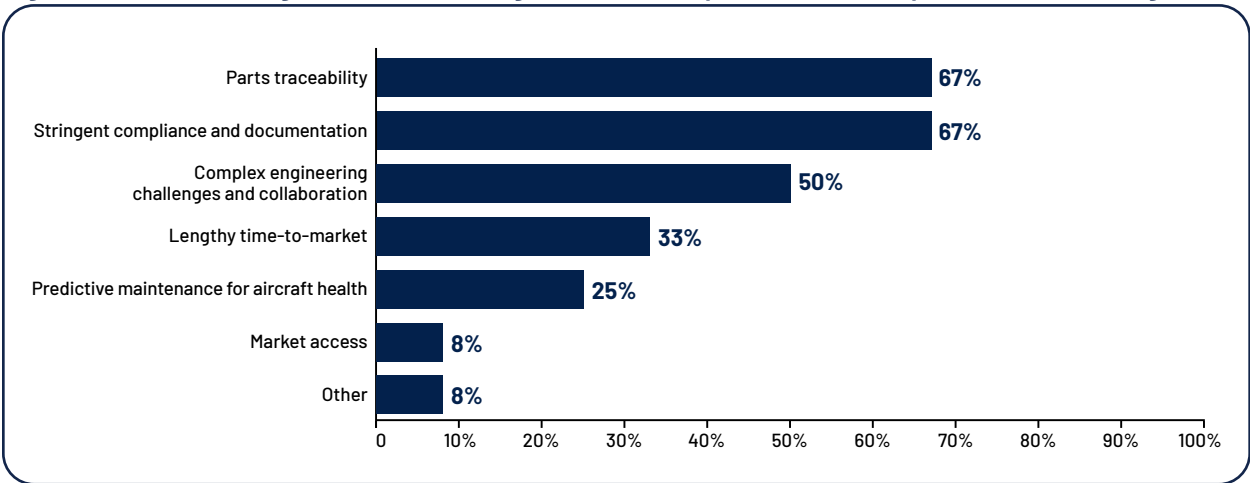
focused and earned close to 25% more than the Canadian manufacturing sector average in 2024. While Canada's aerospace sector is primarily civil-oriented, defence remains an important component, representing 17% of total Canadian aerospace revenues in 2022.⁴ With the February 2026 release of the Canada's Defence Industrial Strategy, the defence segment of the aerospace industry will become increasingly important.⁵

Canada's aerospace sector is poised to greatly benefit from increased digitalization across its manufacturing enterprise. Driving aerospace manufacturers' digital transformation is a need to solve practical business problems, including parts traceability, meeting stringent compliance and documentation requirements, collaborating on complex engineering, and lengthy time-to-market for aerospace products (Figure 8).

⁴ Aerospace Industries Association of Canada, "About Canada's Aerospace Industry," accessed February 9, 2026, <https://aiac.ca/about/about-canadas-aerospace-industry/>.

⁵ Department of National Defence (Government of Canada), "Canada's Defence Industrial Strategy," February 2026, <https://www.canada.ca/en/department-national-defence/corporate/reports-publications/industrial-strategy/security-sovereignty-prosperity.html>.

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



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

Strategic Approaches to Digital Technology Adoption

Across aerospace manufacturers, the approach to adopting digital technologies was described by industry leaders interviewed for this roadmap as deliberate, phased, and constrained by security and regulatory realities. Firms generally start by making sure the basics are in place, meaning connectivity, secure access, and systems architecture. Firms then focus on proving value through targeted use cases rather than pursuing full integration all at once.

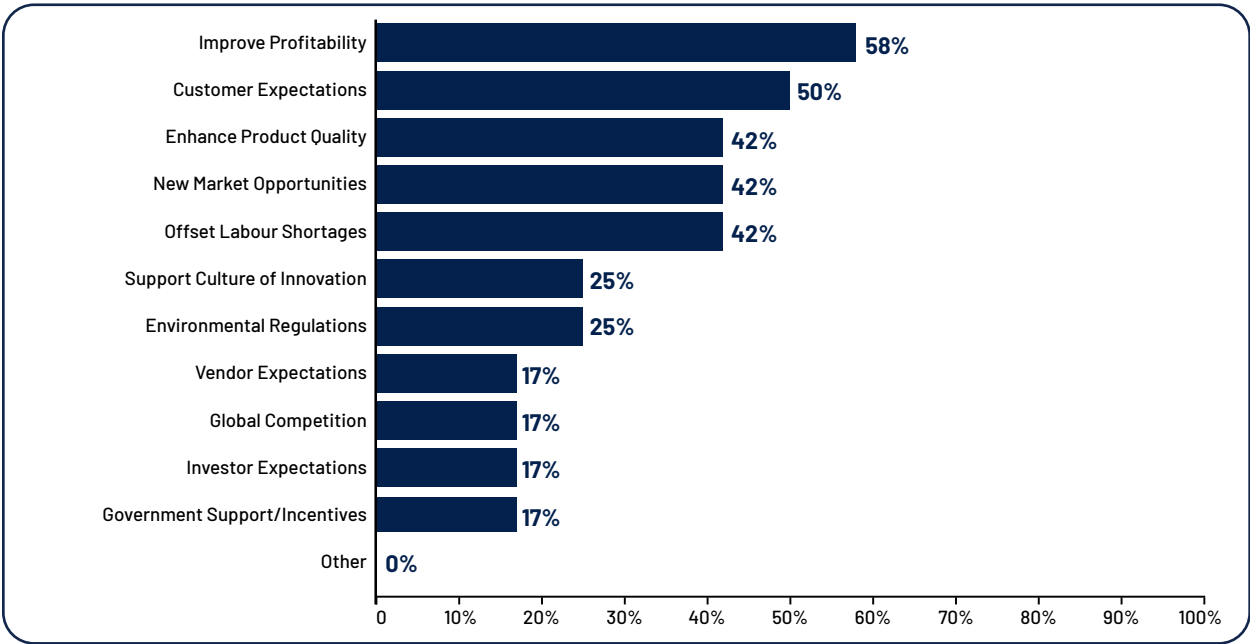
Aerospace leaders also described adoption as requiring “getting people over the hump” from legacy tools, where decision-makers may ask for “a faster spreadsheet” rather than rethinking how data, systems, and users interact. Put simply, the adoption approach is to secure the environment first, prove value through bounded use cases second, and then scale toward deeper integration and more advanced systems once governance, trust, and operational fit are established.

At its core, the digital transformation in Canada’s aerospace industry is about defensibility, reliability,

control, and predictability. Technologies that enhance process visibility, reduce uncertainty, and facilitate compliance in safety-critical applications are given top priority.

Furthermore, aerospace leaders stressed the need to balance top-down and bottom-up approaches to digital technology adoption. Enterprise-wide digital initiatives and capital investments were described as necessary to modernize infrastructure, integrate systems, and scale adoption across sites and business units. Yet at the same time, these leaders stressed that frontline teams need room to experiment with new digital tools and updated ways of working, particularly where specialized process knowledge and operational realities shape what is feasible on the production floor. What constitutes “strategic” adoption varies by context, but major strategic goals of digital technology adoption include improving profitability, meeting customer expectations, enhancing product quality, responding to new market opportunities, and offsetting labour shortages (Figure 9).

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



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

Technology Applications in Practice

At a foundational level, across Canada’s aerospace manufacturing sector, core digital infrastructure, including cloud computing is regarded as the backbone for consolidating operational data streams into usable, decision-ready views, and a way to pull information together so it can be accessed, shared, and acted on across teams and sites.

One digital technology provider with extensive experience providing cloud solutions to aerospace firms described their model as fully cloud-delivered and noted “we’re all cloud based. You don’t download any software,” emphasizing browser-based access while noting that adoption still has to work within “security and the VPNs,” including practical constraints of “internal VPNs” in high security environments, such as the defence sector.

For one firm that develops advanced robotics, AI, and space-based infrastructure technologies designed to support autonomous operations, predictive maintenance, and distributed computing in orbital and deep-space environments, cloud computing was extended into a more future-oriented discussion about edge-computing and distributed, cloud-like capability beyond Earth,

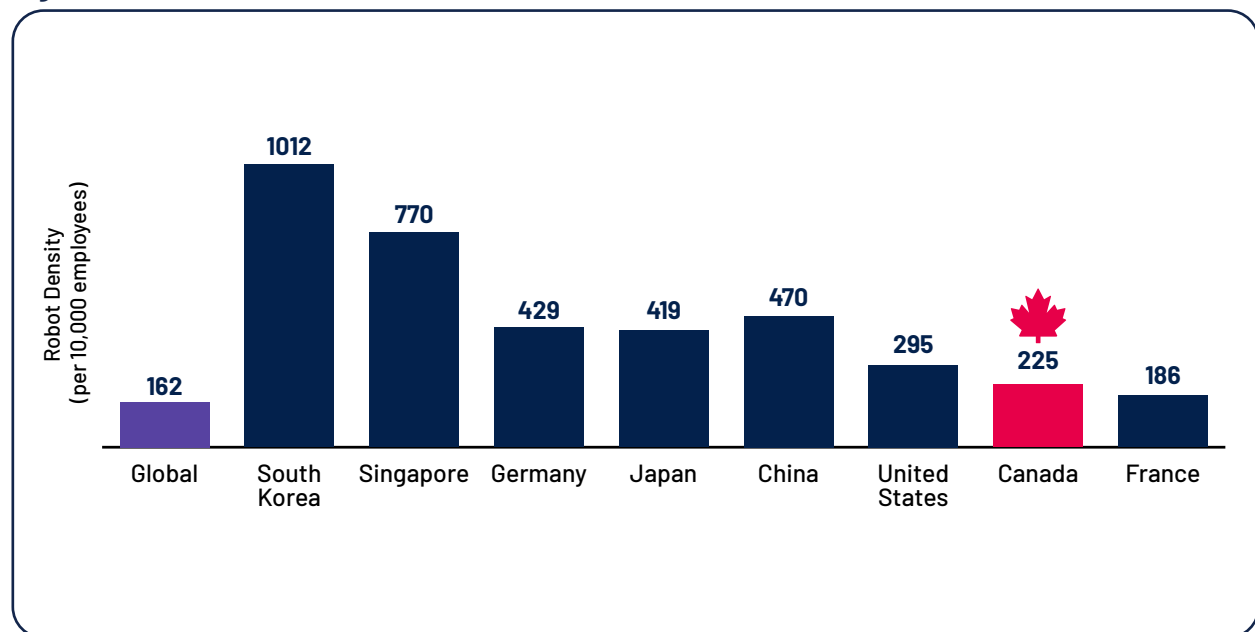
particularly when bandwidth limits and latency reduce reliance on terrestrial data centres. One aerospace industry leader described how advances in computing now make it possible to move capability “to the edge and decentralized, not relying on the large data centers.”

Industrial Automation and Robotics

Automation and robotics were described as tools to stabilize production under conditions of labour scarcity, process variability, and occupational risk, rather than as simple productivity upgrades. This framing also aligns with the roundtable discussion, where participants emphasized that aerospace adoption decisions are shaped less by volume-driven efficiency gains and more by the realities of high-reliability production, strict compliance expectations, and constrained pathways for scaling.

While Canada enjoys robot densities above the global average in its manufacturing sector and compares well with peer economies such as France and the United States, it lags behind leaders such as South Korea and Singapore (Figure 10).

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



Source: Statistics Canada, 2024; Info Institute, 2023; National Center for Science and Engineering Statistics, 2022; McKinsey & Company, 2022.⁶

For one firm specializing in robotic automation for aerospace manufacturing, particularly for engine components and MRO, automation is positioned as a response to highly variable, fatigue-intensive finishing work. This firm described customers relying on “between 10 and 70 manual polishers or blenders” who “all day long polish parts” to meet surface finish requirements and remove residual material.

Because forging and casting introduce part-by-part variation, this work has traditionally depended on skilled human operators. Their approach is to replicate that adaptability through robotic systems that can “adapt from part to part to adjust the process,” delivering consistent outcomes while reducing reliance on manual labour. Importantly, this was framed as a workforce sustainability strategy as much as a productivity one, given that “there are less and less young people that want to work in a workshop for twenty- or thirty-years polishing parts.”

For this firm, the goal was not to replace operators with robotics specialists, but to make robotics usable on the shop floor by “humanizing” it through software that embeds process knowledge so operators do not need to become robot programmers.

In another example, a major aerospace and defence firm acts as a defence sustainment coordinator, managing a supplier network that manufactures and delivers spare parts for a legacy platform while ensuring sensitive technical drawings and data are handled securely. For them, “digital readiness” is less about in-house automation and more about secure, controlled sharing and management of design information across the supply chain.

Robotics, whose adoption is tightly governed, appears primarily through the supply base rather than in-house manufacturing. Suppliers use robotics mainly for welding and, in some cases, repair and overhaul activities. Automated welding processes must follow approved procedures, undergo qualification testing, and meet strict traceability requirements. The emphasis is not on speed, but on control, auditability, and compliance, illustrating that in aerospace and defence contexts, automation is only viable when it can be formally validated.

Similarly, in low-volume aerospace environments, the case for automation is often quality and compliance driven rather than purely economic, and new systems must be credible on first use because shop-floor workers are unlikely to tolerate tools that slow them down or fail to perform reliably during early rollout.

⁶ 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>.

Sensors and Internet of Things (IoT)

Across firms, sensors and IoT are understood not just as “one more technology” but as core digital infrastructure for aerospace manufacturing. Aerospace companies described sensors as the layer that makes inspection, traceability, predictive maintenance, procedural compliance, and broader digital integration all possible. Indeed, for Canadian aerospace manufacturing firms embarking on a digital transformation journey for the first time, sensors and IoT infrastructure integrated into an ERP system can act as a starting point for further digitalization of manufacturing operations.

Sensor-driven inspection emerged as one of the most mature and clearly operationalized use cases in aerospace manufacturing. One manufacturer ICTC interviewed for this roadmap described a workflow that mirrors human inspection but increases repeatability and creates more usable digital evidence through layered sensing. In this inspection workflow, a 2D grayscale camera rapidly images component surfaces to flag potential “relevant indications” such as scratches, dents, or surface irregularities. Those preliminary flags are then followed by 3D scanning, which measures defect geometry to determine whether the flaw exceeds engineering tolerances.

More broadly, aerospace companies suggested that machine vision is moving upstream, embedded directly into production workflows reducing reliance on downstream manual checks. In MRO settings in particular, vision systems were also discussed as a compliance layer, supporting adherence to strict procedures by verifying that steps are completed correctly and in sequence.

Finally, sensor data is increasingly framed as the backbone of predictive maintenance, because it enables teams to detect issues early, monitor change over time, and plan interventions rather than relying on reactive fixes. One interviewee highlighted the practical logic of predictive maintenance as tracking change over time, allowing teams to avoid unnecessary work, focus attention where conditions are actually deteriorating, and intervene only when it’s warranted.

Artificial Intelligence (AI)

Across the aerospace firms engaged for this roadmap, AI was not positioned as a substitute for safety-critical judgment or a path to completely automated production decision-making, but rather as a support layer for quality, compliance, and quicker access to technical information across all enterprises.

The most specific use cases were found in maintenance and repair, where participants explained how AI may improve task standardization and decrease manual compliance work. In real-world settings where mistakes are expensive and process compliance is unavoidable, artificial intelligence (AI) is more about enhancing consistency, documentation, and audit preparedness than it is about automating judgments. Aerospace firms ICTC interviewed for this project did not use AI technologies towards decision autonomy in safety critical functions.

One automation firm with extensive aerospace experience described using AI selectively and conservatively, noting that “most of the detection algorithms are classical algorithms,” rather than true AI because classical methods are easier to explain and defend when acceptance decisions carry safety implications. For this firm, AI supports narrower tasks such as character recognition and helping generate inspection or processing “recipes,” acknowledging that the aerospace sector has a structural data constraint compared to other domains because defect examples are relatively rare when compared to other manufacturing industries.

Another organization involved in the aerospace manufacturing sector described strong interest in AI but a deliberately limited approach to its use. According to this organization, AI could be used “for information purposes” but not to “write things for you” or be relied on, pointing to a preferred pathway through a secure internal chatbot system, a “GPT tool that only looks at your data and is not connected to the internet.” Such a chat bot tool can be queried directly to speed up interpretation, search internal technical documentation, and support technical specifications across standards while limiting the risk of uncontrolled data exposure.



Another compelling example involved AI-enabled smart glasses worn by technicians. Using built-in cameras and AI, the system observes maintenance work as it happens, confirming each step is completed correctly and in the right order. As technicians progress through a maintenance process, the tool can automatically validate and check off tasks against standard operating procedures.

Overall, across Canada's aerospace manufacturing industry AI adoption is advancing fastest where it improves workflow speed and traceability without introducing opaque decision logic, and where deployment models can meet safety, security, and confidentiality expectations.

Digital twins

For Canada's aerospace manufacturing industry, digital twin use ranged from full 3D, data-rich virtual replicas to earlier-stage approaches such as visualization suites and "single pane of glass" operational views. Digital twins for aircraft and parts visualization was the most common way the aerospace manufacturing firms ICTC engaged with for this roadmap utilized digital twins in their operations.

Across firms, digital twins were treated as a practical bridge between design data, production floor activity, inspection, and downstream maintenance decisions, helping make complex aerospace systems easier to design, test, monitor, and maintain, and to complement physical testing and manual inspection. One robotics and inspection supplier described being "digital twin ready," explaining that because "all our systems are generating data," which is "related back to the CAD file of the part."

Digital twins were especially valued in space-adjacent contexts, such as space satellite production, where testing is expensive and operating conditions are extreme. One interviewee stressed the need to "replicate the environment in space" with enough reliability that regulators can confidently depend on the results. This interviewee described running a digital twin "in parallel" with real space missions to see where the digital twin deviates from observed conditions and update models quickly. Digital twins were also positioned as tools to "monitor deviations in systems health in real time," especially when paired with telemetry data.

Other aerospace firms ICTC interviewed framed this as part of a broader shift toward integrated environments that consolidate and fuse multiple

data sources. One technology provider argued that "digital twins was kind of like yesterday," pointing instead to "industrial metaverses" that bring "everything into a single place." Others described earlier stepping stones, such as a room-sized visualization suites where engineering teams can visualize aircraft designs and identify issues as designs evolve. Overall, adoption appears to follow a maturity pathway from visualization toward deeper integration with live operational, inspection, and maintenance data.

Cybersecurity

Cybersecurity was described as a must have for doing business in Canada's aerospace manufacturing sector. It is not simply a compliance requirement but a core operating condition that determines what data can move, where it can be stored and hosted, who can access it, and which technologies can be integrated under certifications and export control regimes.

One firm involved in the defence sector explained that bringing in new digital tools can be "tougher because we need to meet these certifications and this criteria for security purposes." In this context, the security layer is not a supporting detail of digital transformation—it shapes the extent that digital transformation is possible and how quickly it can proceed.

One automation firm with extensive experience in the aerospace sector explained that cybersecurity concerns can shape how aerospace firms configure and support robotic systems used on the production floor. In some cases, customers keep robots and connected equipment disconnected from the public internet to reduce exposure to cyberattacks. In these cases, robots are deliberately air-gapped, meaning they are isolated from the internet and other networks to make them less vulnerable to cyberattacks, like ransomware incidents.

This choice has practical implications for how digital tools are deployed and maintained. The same supplier noted that keeping equipment offline can limit the use of internet dependent support features, such as embedded conversational tools, because "a lot of customers isolate the machine from the internet so we're not able to communicate."

Firms also highlighted the close link between cybersecurity and data sovereignty. One company pointed to the infrastructure reality that "the cloud players are American," and emphasized the



absence of a shared standard. There is “no one body” defining sovereignty in practical terms, no “here’s your checklist.” As a result, companies adopt inconsistent approaches. Some try to keep “metadata in Canada” while allowing encrypted files to move through U.S. infrastructure. Concerns about American legal reach including the Patriot Act reinforced the view that control is not only technical through encryption and access permissions, but also jurisdictional and contractual.

When firms were asked what matters most to protect, the conversation focused heavily on intellectual property and controlled products. One firm argued that it must protect “technology and intellectual properties,” emphasizing that “the product itself is export controlled.” The risk, therefore, is not limited to downtime or ransomware. It also includes unauthorized access to sensitive designs and data products that carry regulatory and national security implications.

Understanding ROI and Measuring Digital Transformation Results

Across aerospace and space firms, measuring digital transformation results and return on investment (ROI) was described as both necessary and evolving. Companies emphasized that transformation must translate into operational visibility, risk reduction, efficiency gains, and defensible compliance. However, the way results are measured often reflects where a firm sits on its digital maturity curve.

Operational Visibility and Performance Monitoring

Increased visibility is the first quantifiable outcome of digital technology adoption for many aerospace firms. Aerospace manufacturers strive to integrate operational data so that managers and supervisors can view performance problems, asset health, or workflow bottlenecks in real time, as opposed to depending on static reports or post-event summaries.

This visibility facilitates quicker decision-making and more transparent accountability in manufacturing and MRO contexts. Performance tracking is altered by the shift from disjointed spreadsheets to integrated dashboards.

Predictive Maintenance and Risk Reduction

A second major outcome highlighted by aerospace manufacturing firms ICTC engaged with towards this roadmap was the ability to reduce unplanned downtime through predictive monitoring. Industry leaders described environments with “massive

sensor arrays,” where transformation results are visible in the consolidation and interpretation of machine and system data.

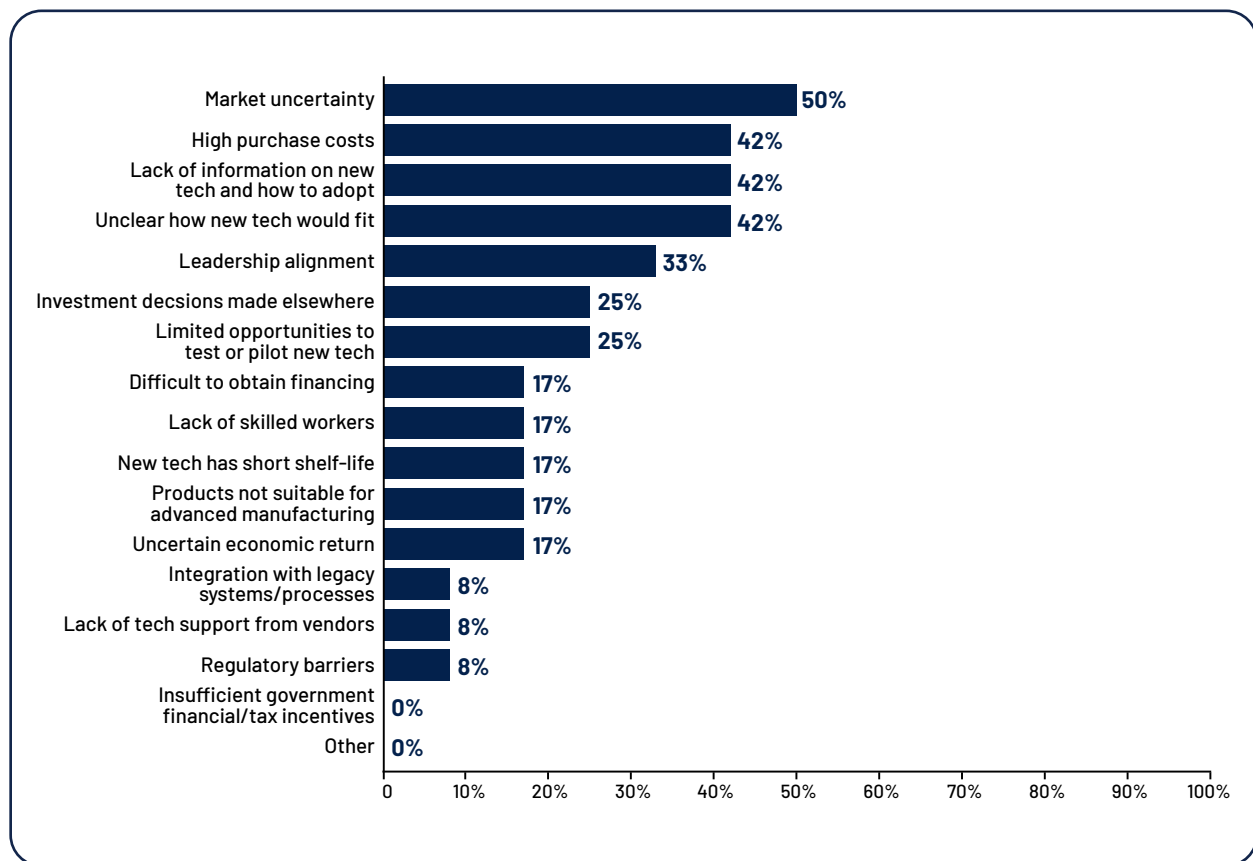
Aerospace firms emphasized that every “unanticipated event” is more costly than an anticipated production outage, making predictive capability a measurable risk-reduction outcome. In these cases, transformation success is measured through fewer surprises, better scheduling, and improved system reliability rather than through strict output metrics alone.

Compliance, Traceability, and Audit Readiness

The quality of documentation and audit defensibility are also used to gauge transformation outcomes in the aerospace sector. According to firms interviewed, advanced digital systems must function within “these certifications and this criteria for security,” meaning that being able to clearly and consistently demonstrate compliance is a necessary component of success for aerospace digital transformation initiatives.

Protecting “technology and intellectual properties” is a transformation benchmark in and of itself for aerospace enterprises that deal with export-controlled goods. A system is deemed a measurable improvement if it facilitates export compliance and fortifies control over sensitive data and IP. In this case, digital maturity is demonstrated not only by speed and automation but also by lower compliance risk and more transparent process control.

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



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

Barriers to Adoption

Across Canadian aerospace firms, barriers to adopting digital technologies were described as less about whether the technology exists and more about whether organizations can effectively absorb it into their manufacturing enterprise. Aerospace manufacturers ICTC interviewed for this roadmap repeatedly pointed to a mix of legacy systems, slow decision cycles, security constraints, and uneven capacity to navigate export controls and data governance. In many cases, the barrier was not a single blocker, but the combined friction of integration, compliance, and organizational readiness to engage in widespread digital transformation.

ICTC's Canadian Manufacturing Digital Technology Adoption Survey found that aerospace manufacturers reported market uncertainty, high purchasing costs of acquiring new technologies, lack of information on what new digital technologies are available and a lack of clarity on adopt them into aerospace manufacturing operations (Figure 11).

Legacy tools and processes

A recurring barrier was that decision-makers often frame modernization as an incremental improvement to existing tools, rather than a change in how information is organized and used. This challenge is amplified in complex environments where existing systems are deeply embedded and replacement feels even riskier. Even when firms see the potential, adoption is slowed by uncertainty about whether a new system will be "applicable" and whether it will actually improve work rather than "annoy" users. Firms described adoption as a decision to retire old processes and accept new ones, and that shift depends on confidence that the new tools will work reliably. The underlying barrier is not only technical performance but also whether organizations trust the system enough to change routines that already feel safe.

Slow procurement and limited appetite for rapid change

Canadian aerospace firms also described long decision timelines and slow procurement cycles as practical barriers, especially when working with governmental bodies and regulators. One company noted that even when organizations have resources, they “don’t go fast” and it can often be “a year or later” to move new technology into a production environment. This slow movement was framed as a core reason why adoption feels stalled even when there is strong demand for digitalization.

Similarly, aerospace manufacturers described a tendency to default to integration on top of existing systems rather than structural change. The result is that modernization becomes an add-on project rather than a redesign, extending timelines and raising the risk that pilots never fully scale.

Security requirements, certifications, and operating inside restricted environments

As noted above, cybersecurity and defence requirements surfaced as early, foundational barriers that shape both what digital technologies can be adopted and how quickly. Firms described security as the guardrail for the entire adoption pathway, setting the conditions for where data can be hosted, how systems connect, and who can access them. Even when a solution is built to be lightweight and easy to deploy, these constraints do not disappear. They still determine the pace, the approvals required, and the form adoption can realistically take.

Export controls, data sovereignty, and uncertainty about what is allowed

Several firms described export controls and data sovereignty as barriers that slow adoption by creating hesitation, delays, and uneven approaches across organizations. One aerospace SME noted that smaller teams often cannot afford to build internal infrastructure, but relying on external platforms can introduce governance uncertainty. As the firm’s leadership put it, “we don’t have a big team that understands all the export challenges,” which makes them “hesitant to jump in to use some of these tools, which delays innovation.”

Firms also stressed that the problem is not only regulatory burden, but the lack of clear, shared guidance on what compliance and sovereignty should look like in practice. Without consistent standards, aerospace manufacturers large and small interpret risk differently, adopt different workarounds, and move forward at different speeds even when they are trying to solve similar problems.

Organizational capacity, incentives, and the adoption ownership problem

Firms also described a structural barrier inside organizations because new adoption work often falls between roles. One technology provider argued that workers in the aerospace sector are “busy doing their jobs” and focused on making current tools “go faster,” while few people are responsible for evaluating new systems at most aerospace manufacturing firms. This creates an ownership gap where end users are measured on KPIs and throughput, and innovation groups may exist but can be disconnected from the people who actually use the digital tools on the production floor.

Access barriers for startups and smaller vendors

Finally, smaller firms described market access itself as a barrier. One technology startup explained that it is “very hard” to engage potential aerospace customers to even pitch new technology and that without intermediaries “it’s very, very hard to reach out to those people.” Another firm reinforced that ecosystem groups can help open doors, but that early traction depends on being introduced in a trusted way.

At the same time, there were examples of larger companies helping close the access gap. One major aerospace OEM talked about helping small and medium-sized enterprises within its supply chain with digital transformation projects. This support lowered the cost and risk of adopting new technology for smaller suppliers that lacked internal resources to engage in largescale digital transformation. It also supported the OEM’s effort to digitize its supply chain by improving data sharing and processes among partners. This served to make future integration easier. For SME suppliers, the benefits included practical gains in productivity, such as less manual work, better documentation, quicker quality checks, and smoother handoffs during production and inspection processes.



Workforce and Skills Barriers

Workforce development and training were seen as essential to successful digital transformation in the Canadian aerospace sector. Aerospace manufacturers ICTC interviewed for this roadmap stressed that digital transformation requires a clear investment in skills and building internal capacities.

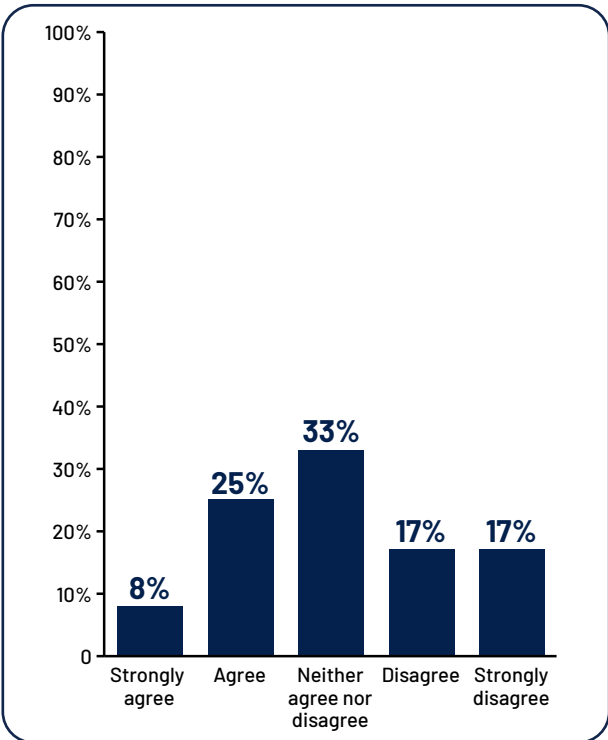
In many cases, aerospace firms pointed out that adoption relies on “getting people over the hump,” not just technically, but also culturally, especially when teams are used to established workflows and tools. Training focuses not only on how to use new systems but also on helping employees understand why workflows are changing and how digital tools enhance traceability, compliance, and improve decision-making.

When it comes to staff training and workforce development to drive digital transformation, 67% of Canada’s aerospace manufacturers surveyed by ICTC reported having staff with the digital skills

required to adopt new digital technologies. Only 33% of aerospace manufacturers reported having formalized staff training plans for adopting and implementing new digital technologies (Figures 12 and 13).

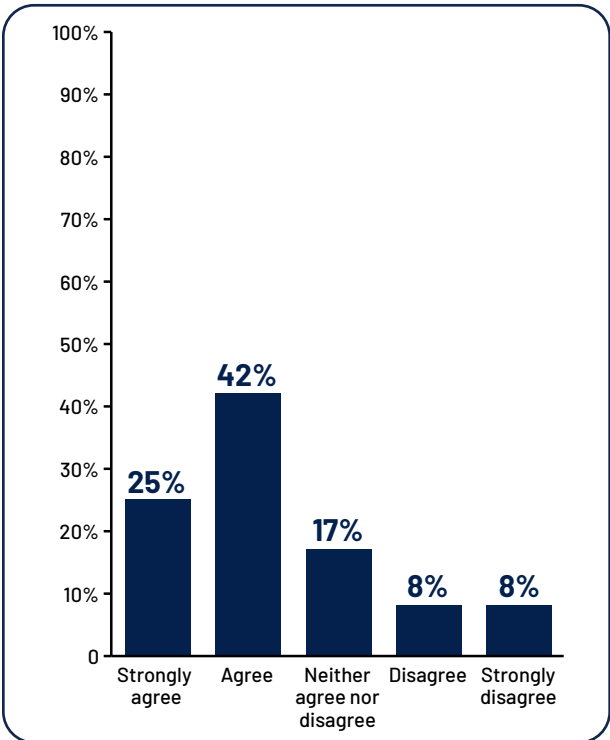
Manufacturing firms in Canada are aware of labour shortages and limited internal capacity, particularly in specialized aerospace manufacturing environments. Because of this, successful adoption strategies often aim to reduce dependence on scarce technical specialists by embedding process knowledge directly into software and interfaces. The goal is to make advanced systems usable for existing production workers without requiring them to become programmers or data scientists. In highly regulated settings, training also includes reinforcing procedural discipline and cybersecurity awareness, ensuring that employees understand export control obligations, data handling requirements, and documentation standards.

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



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

Considerations for Organizational Change Management

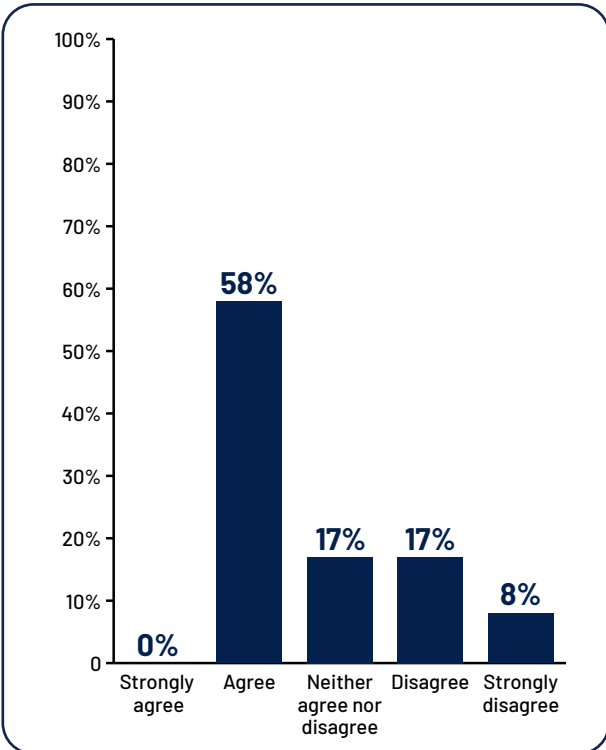
Aerospace manufacturing firms interviewed by ICTC for this roadmap emphasized that well thought out and resourced organizational change management programs can help ensure digital transformation initiatives translate into business wins, rather than remaining as isolated pilots, or even failed technology adoption initiatives. Maintaining aircraft and parts certifications can be a key change management consideration for aerospace manufacturers.

Given the sector’s high reliability requirements and tightly regulated operating environment, industry leaders emphasized that When it came to developing comprehensive digital technology adoption strategies and supporting a strong culture of change when supporting digital transformation, 58% aerospace of manufacturers reported having a comprehensive digital technology adoption strategy and 59% enjoyed a culture of change aligned to digital transformation (Figures 14 and 15).

Likewise, strategic partnerships were also identified by Canadian aerospace leaders as a practical way aerospace firms are accelerating digital adoption, especially when the goal is to modernize beyond a single facility and strengthen capabilities across the entire Canadian ecosystem.

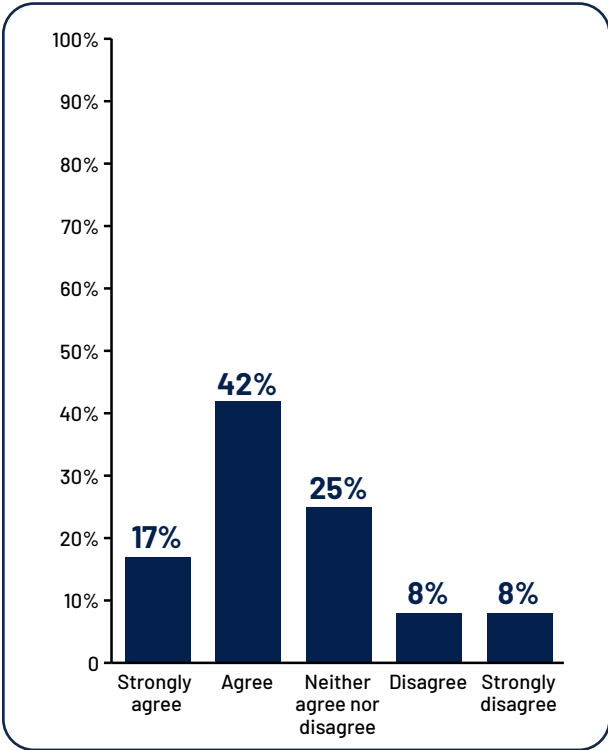
One interviewee pointed to Downsview Aerospace Innovation and Research in Toronto as a useful Canadian example of a consortium model that helps bring firms together around innovation and technology uptake. Japan Aircraft Development Corporation was identified by interviewees as a collaborative approach Canada could learn from, describing it as a model where aerospace companies align on shared civilian aircraft technology priorities and advance them through joint R&D initiatives. Together, these examples underscore how ecosystem initiatives can help de-risk adoption, coordinate experimentation, and support wider diffusion of digital tools across the sector.

Figure 14. Agree/Disagree: My organization has a comprehensive strategy for digital technology adoption – Aerospace (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 – Aerospace (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 implementing digital transformation are immense yet not overwhelming. Aerospace manufacturers should plan digital technology adoption over at least a five-year horizon. Though large-scale, enterprise-wide digital transformation projects in aerospace can easily surpass five years. Figure 16 outlines the time horizons for digital technology adoption in the aerospace manufacturing sector.

Figure 16. Digital Technology Adoption Horizon

Adoption Phase	Time Horizon	Illustrative Examples
I. Pilots	Years 1-2	Initial small-scale production automation experimentation, 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 Aerospace Manufacturing Use Case Matrix

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

Figure 17. Digital Technology Use Case Matrix – Aerospace Manufacturing

Technology	Example Use Case	Benefit
AI/ML	Production technology predictive maintenance	Decrease the risk of unscheduled downtime and reduce incidents of equipment catastrophic failure.
	Maintenance/troubleshooting chat bots	Reduce production equipment downtime by making maintenance and troubleshooting quicker.
	Compliance and technical documentation automation	Automate production of finished product documentation, such as material test reports.
	AI-enabled adaptive process control	Improve quality, increase throughput, reduce downtime, increase energy efficiency, and enhance production flexibility.
	AI-enabled computer vision inspection and defect detection systems	Increase speed and accuracy of defect detection processes.

Technology	Example Use Case	Benefit
Big Data Analytics	Process optimization/root cause analysis	Increase throughput, identify root causes of variance, improve quality, and reduce materials wastage.
	Demand forecasting and inventory optimization	Increase market responsiveness, reduce scrap, and optimize production scheduling.
	Supplier performance dashboards/monitoring	Real-time monitoring of supplier performance, predicting supplier performance variance, and predicting supplier shortages.
	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.
	Tool wear analysis	Analyze manufacturing tools, such as CNC cutting tools, for wear, predict replacement needs.
Cloud Computing	Product traceability and lifecycle management	Digital records to support product traceability and lifecycle management.
	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, reduce risk of digital infrastructure/IT resource bottlenecks, and achieve cost savings.
	Digital twins hosting and scalable iteration	Host digital twins of the product, equipment, production line, or facility in a cloud environment.
	Cloud-based digital infrastructure for collaboration applications	Enhance design and engineering collaboration across business units and production sites.
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 team exercises	Stress-test critical IT/OT networks, identify vulnerabilities in networks and business processes.
	Cybersecurity standards and best practices (e.g., CPCSC, CMMC, ISO 27001)	Enhance cybersecurity governance and compliance, reduce cyber risk, adhere to national security requirements.
	Air-gap OT assets (e.g., industrial robots)	Reduce risk of cyber incidents directed at key OT assets, such as ransomware attacks, at the expense of network integration.
	Secure backups and disaster recovery testing	Reduce the risk of catastrophic data loss and enhance business continuity.



Technology	Example Use Case	Benefit
Digital Twins	Production tooling digital twins	Predict machine tool wear based on historical usage and production schedule.
	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 technicians to relocate equipment.
	Aerospace product digital twin for visualization	Detailed digital model of aerospace products to enhance program management, engineering design, and marketing/customer relations.
	Digital twins for spacecraft testing in extreme environments	Virtually test spacecraft and their ability to operate safely and effectively in extreme environments, such as Earth orbit.
Robotics & Industrial Automation	Robotic welding cells	Reduce worker exposure to welding fumes, reduce sparks, more uniform welds, faster welding speeds.
	Robotic aerospace parts polishing cells	Reduce worker exposure to dust, debris, vibrations; improve polishing quality, increase output.
	Industrial robots/cobots enabled with machine vision for parts/materials handling	Increase pick accuracy, reduce worker fatigue, increase parts feed rate.
	Autonomous mobile robots (AMRs) for facility intralogistics	Reduced need for human material handling, real-time monitoring of material flows, agile material flows.
	Quadrupedal robots (i.e., “robot dogs”) for automated facilities/machinery inspection	Identify variance in plant/equipment conditions, decrease risk of unscheduled downtime.
Sensors & IoT	Acoustic, temperature, vibration sensors on production equipment, etc.	Monitor variance in production equipment parameters for predictive maintenance.
	Sensor-driven inspection	Increase speed and accuracy of parts and aircraft inspection.
	Machine vision for compliance adherence	Increase compliance adherence by using machine vision cameras to monitor compliance checks and detect variance.
	RFID tags for supply chain and inventory tracking	Track products, materials, and assets within the production environment to reduce the risk of asset or inventory loss.
	IoT sensors and worker wearables for real-time hazard monitoring and detection	Increase worker safety, reduce safety incidents, and 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 errors 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, human resources, and profitability.

Figure 19. Digital Transformation Investment Inputs

Category	Investments/Spend	Illustrative Examples
Digital Technology & Equipment	Robotics (cobots and industrial robots)	UR10 cobot, ABB GoFa, OTTO AMR
	IoT/sensors	Sensors, controllers, RFID tags, machine vision cameras
Digital Infrastructure	Networking and connectivity	Industrial ethernet, 4G/5G, ISED NCLL spectrum ⁷
	Cybersecurity program (IT/OT)	Firewall, SIEM, endpoint protection, pen-testing
	Cloud services subscriptions	AWS, Microsoft Azure, Google Cloud
Software Licensing	IoT/IIoT platforms	ABB Ability, Siemens MindSphere, GE Predix
	Big data/AI platforms	Dassault DELMIA Apriso, Databricks
	Cybersecurity platforms (IT/OT)	Microsoft Defender, Splunk, FortiGuard OT Security
	Cloud/hybrid ERP	Rootstock Cloud ERP, JobBOSS, Epicor
	Quality management systems	eQMS, QT9 QMS, SAP Quality Management
	Product lifecycle management systems	Dassault 3DEXPERIENCE, Siemens Teamcenter
	Configuration management tools	Autodesk Fusion Manage, SolidWorks PDM, Git
	Secure file-sharing platforms	Exostar, OpenText CoreShare, MOVEit
	Maintenance, Repair, Overall (MRO)	Ramco MRO, Veryon MRO, Trax
Human Resources & Workforce Development	Workforce training/development	Employee training, tech. mentorship/coaching
	Digital talent recruitment	Campus recruiting, apprenticeships, co-op 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 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 with the digital transformation strategic objectives discussed above.

Detailed ROI calculations will be unique to individual manufacturers, including specific mixes of digital technologies and their associated use cases, and the presented ROI framework is 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.

⁷ 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 products/day		X		X
	Scheduling adherence	% decreased in scheduling variance	X		X	
	Reduced materials wastage	% reduction in materials waste	X			
	Increased quality	% reduction in error/variance 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	X		X	
	Reduce absenteeism	% decrease in absentee hours	X		X	
Capital Productivity	Equipment utilization	% increase in equipment utilization	X			
	Production line/cell flexibility	% reduction in line/cell 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 clients/customers	# new contracts		X		X
	Efficient business development	% bid-to-win rate for new contacts	X	X		
	Client/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 designs	X	X		X
	Digital pilot projects launched	# of new digital tech adoption pilots			X	X
	Product development time	% reduction in product 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	
	Reduced near-miss frequency	% reduction in near-miss incidents	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 facility electricity use	X		X	X
	Reduced material inputs	% reduction in material input per unit	X		X	X
	Reduced water use	% reduction in facility 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 to support digital transformation can increase the likelihood that a project will meet its objectives by a factor of seven, while producing a three-to-one to seven-to-one ROI, according to a 2025 whitepaper by Culture Partners.⁸ Likewise, early engagement in change management can increase project ROI by 40-60%.⁹

Change management plans supporting digital technology adoption initiatives should include a project sponsor, a clear delineation of roles and responsibilities, identification of a champion to lead the change, and internal and external communication planning, as well as a staff training plan. Plans should also include pre-designed feedback loops, such as feedback portals, surveys, and staff town halls.

Lastly, they should include measurable goals and timelines to monitor progress, provisions to celebrate success when achieved, and 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.

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/>.

⁹ Ibid.



Digital Transformation Phase Gates

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

For example, if an aerospace manufacturer were interested in adopting a suite of IoT sensors for its production equipment, Gate 1 could verify that the equipment is compatible with the new sensors and that the area the production cell is placed in has required connectivity for the sensors to transmit data to a cloud-based database and that OT cybersecurity measures can be implemented to cover this new sensor suite.

Gate 2 is to validate whether the new IoT sensors reliably capture data over time and whether the

data provides management with useful insights into the state of the production process. 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 all production workers and engineers, while Gate 4 would expand the technology adoption initiative and add IoT sensors to other areas of the production floor. 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 cell	Predefined ROI metrics mapped to strategic objectives.	Train maintenance technicians to interpret outputs	Deploy across facilities
Big Data Analytics	Ensure data capture infrastructure is in place on target production process.	Pilot dashboards for root cause analysis	Predefined ROI metrics mapped to strategic objectives.	Train data analysts, production team members	Scale to enterprise-level decision-making
Cloud Computing	Assess cloud vendor solutions/options	Pilot cloud-based MES on a trial basis	Predefined ROI metrics mapped to strategic objectives.	Train IT staff and managers on the new system	Fully migrate workflows to cloud ERP/MES
Cybersecurity (IT/OT)	Baseline security assessment	Pilot intrusion detection system	Predefined ROI metrics mapped to strategic objectives.	Train production staff on cyber protocols	Certify enterprise-wide compliance
Digital Twins	Develop a digital twin for one piece of machining equipment	Validate the twin against real performance	Predefined ROI metrics mapped to strategic objectives.	Train production staff and engineering teams using simulations	Expand to line or facility-wide twins
Sensors / IoT	Install sensors on one machine cell	Validate output improvement/downtime savings	Predefined ROI metrics mapped to strategic objectives.	Train production staff and engineering team to use new technology	Expand across production facility
Robotics	Assess cobot's/robot's readiness for production task	Pilot cobot on parts polishing	Predefined ROI metrics mapped to strategic objectives.	Train production team members on safety and cobot training and co-working	Integrate robotics into multiple polishing cells

Managing Risk

As with any new initiative, risk and uncertainty are inherent to 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 associated with technology adoption and digital transformation.

Figure 23. Canadian Aerospace 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, and exit strategy
Market/ External	Regulatory/policy changes	Medium	Medium	Monitoring, flexible compliance
	Competitive pressure	High	Medium	Market monitoring, agile strategy
	Export control audit failure	High	Low	Incorporate export control rules into ERP

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 aerospace manufacturers how to spot when a risk is rising and take timely steps to mitigate it.

Figure 24. Example Aerospace Manufacturing Trigger Scenarios

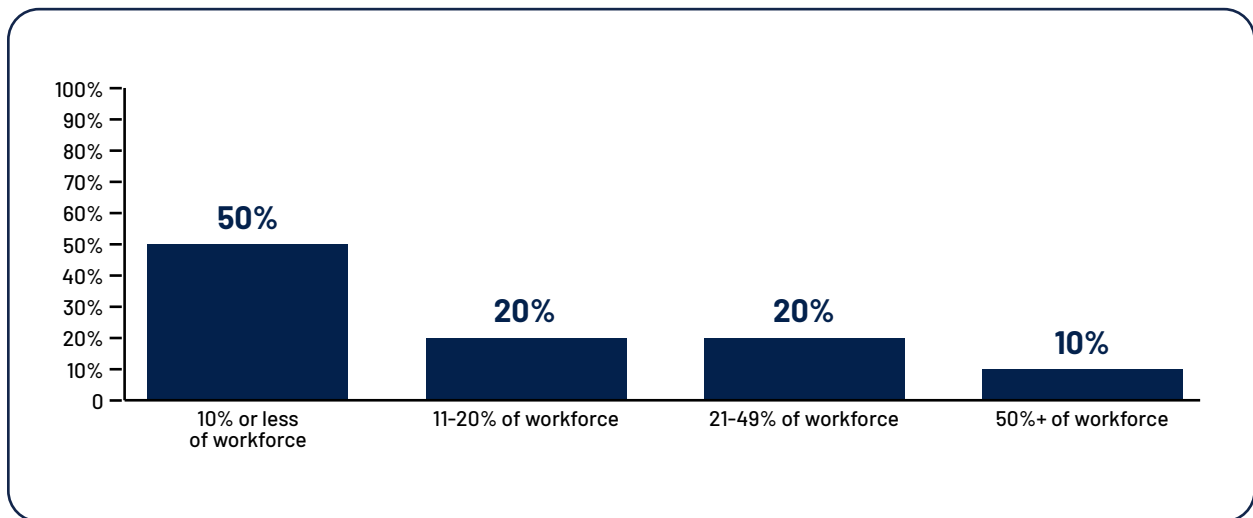
Trigger Scenario	Early Warning Indicator	Potential Action
I. Aerospace/defence sector cybersecurity standards (e.g., Canada: CPCSC, United States: CMMC 2.0) introduced	Calls for sectoral/industry consultation, coming changes mentioned at industry events, industry association issue guidance.	Update IT/OT cybersecurity stack to meet new standards; work with compliance/legal team to interpret coming standards; engage with regulator during consultations or calls for comment.
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 production and skilled trades workforce	Increase in overtime reliance, exit interviews citing job dissatisfaction.	Launch retention measures; accelerate cross-training; adjust hiring plans; increase campus recruitment for new graduates.
IV. Equipment reliability declines	Rising unplanned downtime or repeated maintenance calls.	Initiate predictive maintenance pilot; carry out root-cause analysis of downtime; prioritize Capex replacement schedule.
V. Peer company experiences a cybersecurity incident or data breach	Alerts and advisories issued from Canadian Centre for Cybersecurity.	Increase cybersecurity posture; issue firm-wide communication to employees calling for vigilance; conduct enhanced threat-hunting within network; audit IT/OT stack to ensure all security updates have been applied.



Talent, Workforce Development, and Training

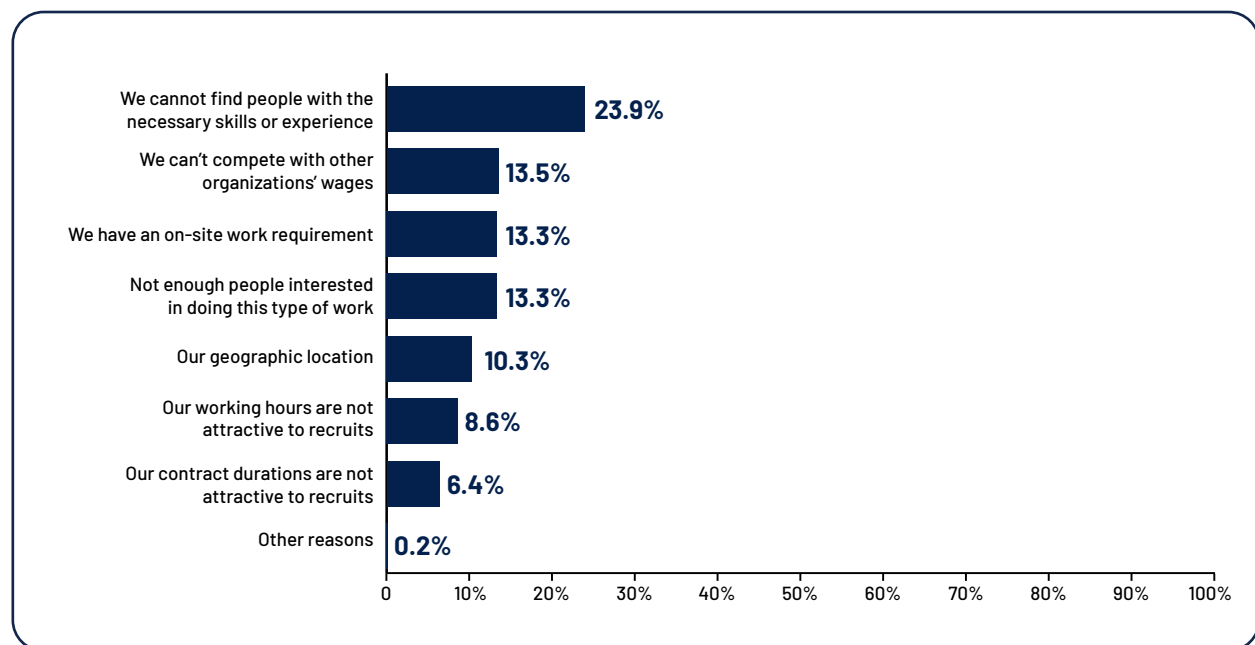
Developing a digitally skilled manufacturing workforce is essential to realize the full potential of digital transformation in Canada's aerospace manufacturing sector. The need to accelerate the proportion of the workforce driving digital transformation in aerospace manufacturing is important to sustain continued growth. ICTC's 2025 survey on digital technology adoption in Canadian manufacturing found that 50% of aerospace manufacturers surveyed devote 10% or less of their workforce to digital transformation efforts (Figure 25).

Figure 25. Workforce Dedicated to Digital Transformation at Canadian Aerospace 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.

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 needed 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).¹⁰

On top of recruiting and retaining skilled digital talent to drive digital adoption in Canada's

aerospace manufacturing sector, there are significant opportunities to invest in upskilling and retraining programs for the existing 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.

¹⁰ 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.

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.
AI and ML Basics	Understanding capabilities and limitations of AI/ML systems and how autonomous systems are being adopted into aerospace 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 aerospace 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, aerospace 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.¹¹

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 aerospace manufacturing.

¹¹ 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 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 engineers, technologists, and other production staff.
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 aerospace 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 aerospace 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 tech 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 apprenticeships and co-op programs, campus recruiting, and joint applied research activities.

Likewise, relationships 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 › OEM digital supply chain initiatives	› 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., apprenticeships, co-ops practicums) › Campus recruiting (e.g., job fairs, industry nights) › Joint industry-academic research › Industry curriculum advisory councils

Information and Data-sharing for Fabricated Aerospace Manufacturing Strategic Partnerships

In addition to the key partnership verticals listed above, aerospace manufacturers should be ready to jointly develop predefined partnership frameworks and agreements upfront between new partners. Co-developing a common understanding of partnership objectives, scope, and timelines is critical to foster

successful partnerships. Aerospace manufacturers should also understand the types of potentially sensitive non-personal data, such as production and process, controlled drawings, financial, supply chain data, and export-controlled 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 processes (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, IP/trade secrets, quality, financial, safety/incident, supply chain)
- › Sensitive data (controlled drawings, export-controlled technical data, etc.)
- › 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 aerospace manufacturing sector stands to benefit from increasing digital technology adoption throughout its production enterprise. The sector is playing an important role in Canada’s economy and national sovereignty, as a significant locus of production of aircraft, space craft, and other aerospace technology.

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 Canada’s aerospace manufacturing workforce needs to be continuously trained and upskilled to get the most out of novel digital technologies on the production floor.

Likewise, to get the most out of digital transformation, aerospace 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 lab automation, predictive maintenance, or AI production scheduling tool).
Train	Involve staff early, build digital change champions on the lab 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, labs, 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 aerospace 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 12 firms from Canada's aerospace manufacturing sector. Due to the wide variety of firm types involved in aerospace manufacturing—from OEMs to tiered suppliers—and a relatively small sample size, survey data may not fully reflect the state of all Canadian metals manufacturers. ICTC also carried out five semi-structured key informant interviews with senior executives, technical leaders, and other experts from the Canadian aerospace manufacturing

sector. ICTC also hosted an aerospace manufacturing sectoral roundtable with industry leaders in January 2026.

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.

