

CM & E

CANADIAN
MANUFACTURERS
& EXPORTERS

EMBRACING CHANGE:

Industry 4.0 and Canada's
Digital Future in Manufacturing



WHO WE ARE

ABOUT CANADIAN MANUFACTURERS & EXPORTERS

Since 1871, we have made a difference for Canada's manufacturing and exporting communities. Fighting for their future. Saving them money. Helping manufacturers grow.

The association directly represents more than 2,500 leading companies nationwide. More than 85 per cent of CME's members are small and medium-sized enterprises. As Canada's leading business network, CME, through various initiatives including the establishment of the Canadian Manufacturing Coalition, touches more than 100,000 companies from coast to coast, engaged in manufacturing, global business, and service-related industries.

CME's membership network accounts for an estimated 82 per cent of total manufacturing production and 90 per cent of Canada's exports.

CME would like to recognize and thank Mike Holden for his contribution on this report.

CME-MEC.CA

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Thank you to our Premier Partners



Royal Bank

Thank you to our Industry Partners





MARGARET STUART

Country Manager, Salesforce Canada

Most manufacturing executives understand that we are entering a period of industry disruption so sweeping that it has already earned the weighty title Fourth Industrial Revolution. The source of this disruption is a wide range of new and emerging digital technologies that have the ability to radically transform processes and even render them obsolete.

As Canadian manufacturers contemplate the challenges facing their industry, they would do well to remember mark Twain's quip: "Everybody talks about the weather, but nobody does anything about it." If manufacturers are to count themselves among the survivors of the fourth industrial revolution, it won't be enough for them merely to talk about it – they too must do something about it.

The manufacturing world is putting on a new face, and the makeover it is receiving from powerful new technologies has the potential to help Canada reaffirm its position as one of the world's leading manufacturing countries and win back work that has migrated to low-cost countries. Canada is currently ranked as the world's tenth largest manufacturer, but maintaining or improving that position will largely depend on whether or not the industry seizes the opportunities provided by new technologies to transform processes, reduce costs, build better ecosystems, spur innovation, and attract highly skilled workers.

With these new technologies available to all, Canada cannot afford to be a laggard in their uptake. Globalization makes the world a far too competitive place for that. However, 55% of our manufacturers have not yet invested in advanced manufacturing technologies and one in five does not intend to do so in the next five years. And in spite of our reputation as a leader in artificial intelligence, Canada ranked last out of ten countries in its implementation, with only 31% of firms claiming successful AI deployment. Simply put, that's not enough. We must do better.

There is much work to be done. Canadian manufacturers are already in catch-up mode, and the competition is fierce. Asia, Europe, and the U.S. will aggressively surge forward with digital transformation. We must do the same. To help ensure success, organizations need to prepare for a transformation of their business models. Leaders also need to focus on evolving the workforce to be more digital and to nurture a company culture that embraces change.

This is no small feat. Companies will need all hands on deck in order to thrive. The industry has spent a lot of time talking about the Fourth Industrial Revolution. The time to start doing something about it is now.



Royal Bank

GREG GRICE

Executive Vice-President, Business Financial Services, RBC

The Canadian manufacturing sector continues to be an important driver of our economic prosperity, representing more than 10% of our national GDP. But consumer expectations are rapidly evolving, creating a new frontier of opportunities and challenges for businesses in this sector. Canadian manufacturers are increasingly facing consumer and competitive pressures to drive down costs, uphold the gold standard of quality and safety, and improve speed to market while remaining accountable to the stewardship of environmental sustainability. In this landscape, advanced digital technologies play a critical role in helping manufacturers unlock greater value for customers and their own organizations by way of increased productivity, cost efficiency, accountability and waste reduction, among other benefits.

With the rapid evolution of advanced, Industry 4.0 technologies, the sector's potential for growth and innovation leadership on the domestic and global stage looks bright. Technologies such as artificial intelligence, blockchain, data analytics solutions, cloud computing and others serve as powerful tools to create a more productive and profitable sector, which in turn can fuel a higher cyclical demand for Canadian production and exports.

Despite the strong case for investments in advanced manufacturing technologies, adoption by companies is unfortunately still more of an exception than the norm. Canada remains one of the worst OECD countries when it comes to making critical investments in manufacturing machinery, equipment and digital innovation over the last five years. It's certainly not for lack of interest on the part of Canadian manufacturers to innovate and transform. A deeper awareness around the available technologies, and more cross-sector collaboration to make these solutions and capital financing more accessible are key to overcoming the common barriers of adoption.

In an effort to move the needle, RBC recently partnered with Microsoft to offer Canadian manufacturers a turnkey suite of market-leading digital technologies, innovation financing solutions and industry-tailored advice under RBC's Go Digital™ program. It's one of the many ways in which RBC is working with industry leaders to help businesses in the manufacturing sector embrace digital transformation, and manage and grow their operations.

Sustaining the momentum and accelerating a lasting, widespread change requires a collaborative and integrated effort between private and public sectors, industries and regulatory bodies. RBC remains committed to supporting the advancement of the Canadian manufacturing sector on this journey and we're proud to partner with Canadian Manufacturers & Exporters (CME) on this report, which highlights the critical actions needed to help the industry embrace, invest in and realize the benefits of advanced technologies.

We look forward to collectively exploring and leveraging these opportunities in an effort to build a more competitive and thriving sector that stands to be the gold standard for manufacturing innovation around the world.

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EXECUTIVE SUMMARY

Industry 4.0 is transforming the world of manufacturing. The convergence of digital, biological and physical innovations are lowering operating costs, increasing flexibility and responsiveness, reducing waste and improving product quality. These technologies are opening new doors for innovative, risk-taking companies and threatening to leave slow adopters behind.

Unfortunately, Canada lags other industrialized countries when it come to digitization and the adoption of advanced manufacturing technologies. Our record on capital investment over the last five years is one of the worst in the entire OECD. Instead of increasing, spending on machinery, equipment and intellectual property products in Canadian manufacturing was about 21 per cent lower in 2017 than it was in 2005.

Canada's poor investment record is directly affecting the competitiveness of our manufacturing sector. Capital investment allows businesses to make more with less through more efficient use of inputs, fewer hours of labour, and by generating less waste. But because our manufacturers underinvest in new technologies, they innovate less and they fail to realize these gains. As a result, our productivity growth is among the slowest in the OECD, while productivity in the US has grown more than three times faster than our own over the last 15 years.

Why are our manufacturers underinvesting in new technologies if the benefits are so clear and the need so great? It is not for a lack of desire to do so. A range of barriers are limiting manufacturers' ability to invest in their own success. Some of the factors that come into play include economic conditions, business culture, and the overarching policy environment.

That said, there are three specific obstacles that need to be addressed if these investment and productivity trends are to be reversed:

- **A lack of information and testing opportunities.** Businesses are more likely to invest in new technologies if they have a clearer sense of the benefits those technologies offer.
- **High purchase costs and uncertain ROI.** New equipment and technologies can be expensive and businesses are effectively taking a leap of faith when they invest in technologies that disrupt established production methods.
- **Labour and skills shortages.** Businesses lack the skilled workers needed to take full advantage of the opportunities presented by digitization.

These barriers are interconnected and must be addressed holistically and simultaneously if they are to be overcome. This report identifies 10 recommendations that are at the core of the solution to Canada's lagging record on digitization and technology adoption in manufacturing. Action in these areas will help propel Canada to the forefront of technology investment, and position us as a global leader in manufacturing competitiveness, growth and prosperity.

LIST OF RECOMMENDATIONS

OBSTACLE 1: LACK OF INFORMATION AND TESTING OPPORTUNITIES

Recommendation 1: The federal government should provide financial support to facilitate technology demonstration tours and site visits for Canadian manufacturers that showcase cutting-edge machinery, equipment and technologies. The Innovation Insights program in BC is a model that could be extended nationwide.

Recommendation 2: Using NAIT's Productivity and Innovation Centre as a model, the federal government should fund a series of technology demonstration and testing hubs across Canada that give manufacturers the opportunity to learn about and test new and emerging technologies.

Recommendation 3: The federal government should work with CME to develop an online technology adoption roadmap. Available to all manufacturers in the country, the roadmap would allow businesses to learn about the various stages of technology adoption, assess their own progress in moving towards Industry 4.0, and get information on the steps needed to advance to the next level.

OBSTACLE 2: HIGH PURCHASE COSTS AND INVESTMENT RISK

Recommendation 4: The federal and provincial governments should work together to introduce a shared 20 per cent investment tax credit on the purchase of new machinery, equipment and technologies, including software. The federal component would be achieved by extending the 10 per cent Atlantic Investment Tax Credit, making it available to businesses across the country. The provinces would provide a matching 10 per cent credit on the same base as the federal program.

Recommendation 5: The federal government should support the creation and delivery of a nationwide SMART program modelled after the initiative formerly delivered in Southern Ontario. The SMART program would:

- Offset the cost of technology assessment and diagnostic services; and
- Provide support for advanced manufacturing technology adoption/adaptation initiatives for SMEs.

Recommendation 6: The federal government should work with industry associations to develop an awareness campaign that demonstrates the benefits of technology adoption in manufacturing by:

- Highlighting and celebrating Canadian success stories; and
- Examining the challenges and issues in technology adoption and implementation.

OBSTACLE 3: LABOUR AND SKILLS SHORTAGES

Recommendation 7: The federal and provincial governments should work with the manufacturing community to:

- Develop more vocation-focused education streams at the secondary level;
- Provide more information to secondary students about career options in manufacturing;
- Create more opportunities for students to participate in "open doors" programs that allow them to visit local manufacturing facilities; and
- Focus the above efforts on recruiting more women and under-represented groups to manufacturing-related fields.

Recommendation 8: The federal government should fund the development of local Workforce Planning Consortia across the country. These consortia would bring together major employers, their supply chains, and local secondary and post-secondary institutions on a regular basis to discuss current and future workforce needs, and to drive curriculum planning and career counselling to meet those needs.

Recommendation 9: The Atlantic Immigration Pilot should be made permanent and extended to the rest of Canada.

Recommendation 10: The federal government should expand and improve the Canada Job Grant by:

- Making it permanent and increasing its funding envelope;
- Allowing for the funding of multi-year training and expanding the range of eligible on-the-job training; and
- Speeding up approval times.

INTRODUCTION

A revolution is underway in manufacturing. New advanced manufacturing and digital technologies are sparking a dramatic leap forward in innovation, productivity and efficiency. Computers and machinery are becoming increasingly interconnected through cyber-physical systems, the Internet of Things, cloud computing and other digital advances. By creating and sharing massive amounts of information, these technologies are helping manufacturers optimize production processes, reduce waste, and proactively identify problems before they happen. They are opening doors for innovative, risk-taking companies and threatening to leave slow adopters behind.

FOUR INDUSTRIAL REVOLUTIONS

INDUSTRY 1.0

Mechanization (c. 1780)

INDUSTRY 2.0

Electrification, mass production (c. 1870)

INDUSTRY 3.0

Automation (c. 1970)

INDUSTRY 4.0

Digitization (today)

This is the story of Industry 4.0 – the convergence of digital, biological and physical innovations. Industry 4.0 can be either a threat or an opportunity. Businesses that embrace advanced manufacturing technologies and analytics will enjoy dramatically lower production costs, quicker product development times, and the flexibility to create innovative new products to meet changing customer demands. Those that do not will find it ever more difficult to meet the quality, cost and operational requirements of their customers.

Embracing this revolution is critical to the long-term success of Canadian manufacturing. Digital technologies could allow Canadian businesses to compete with anyone in the world. However, we are being left behind.

Canada has one of the worst records in the entire OECD when it comes to machinery and equipment investment in manufacturing. This has a direct bearing on technology adoption. While Canada is home to a number of dynamic, early-adopting companies, on the whole, we typically lag our international competitors in this area.

This needs to change. The opportunities are too great to pass up and the consequences of being a late adopter are too serious to ignore.

Recognizing these realities, Canada has taken some significant steps over the past several years to alter course. CME has worked with the federal government to introduce measures such as the Accelerated Cost of Capital Allowance (ACCA), the Innovation Superclusters Initiative, and the Strategic Innovation Fund which are all aimed at investment and technology adoption. Federal and provincial governments have also stepped up to increase support for training to help close the significant skills gap that undermines companies' efforts to adopt and deploy new technologies.

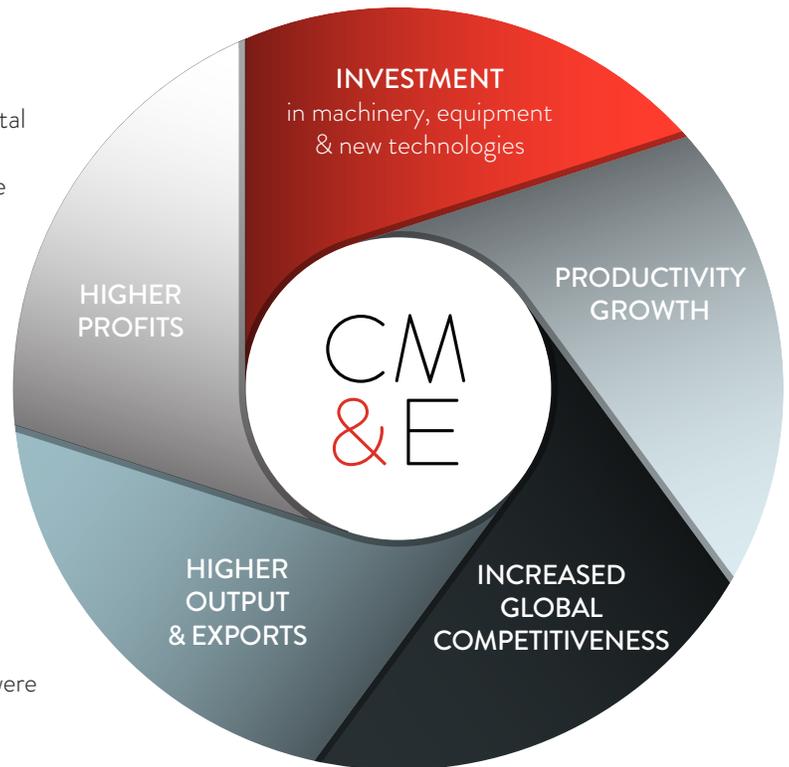
While they are all steps in the right direction, these measures are too narrowly focused on specific issues and are insufficient to overcome the barriers to technology adoption in this country. Canada needs a new urgency and a broader-reaching plan to get back in the game and accelerate growth in our manufacturing sector. The heart of this strategy must focus on demystifying technology for risk-adverse Canadian industry; de-risking and supporting technology investment; and training the workforce of today and tomorrow with the skills necessary to get the most out of those investments.

BENEFITS OF TECHNOLOGY ADOPTION

Investing in digitization and new technologies offers considerable benefits to Canadian manufacturers. According to a BDC study, businesses that invest in digital technologies have a considerably better growth outlook than their non-adopting counterparts.¹ At the end of the day, these technologies can result in a wide range of potential benefits:

- **Lower operating costs.** Digitization opens the door to the collection of data that can be mined to identify efficiencies in existing operations, decrease downtime, and monitor and guide production activity.
- **Increased product quality.** Advanced technologies can help to root out errors and deficiencies in production, boost quality control, and lead to overall improvements in the production process.
- **Higher innovation capacity.** Technologies like 3D printing and electronic prototyping lower innovation costs and can unlock new abilities and capacity that were previously unavailable to producers.
- **Increased customer satisfaction.** Digitization and advanced technology use can increase customer satisfaction by decreasing response times, creating more specialization and customization opportunities, and improving product quality.

These specific benefits all contribute to the most important overarching outcome: higher productivity. Productivity growth is the key to the long-term future of manufacturing in Canada. It allows our companies to compete successfully in domestic and foreign markets. That, in turn, attracts more production mandates to Canada, resulting in higher output and exports. Finally, higher output leads to greater firm profitability, which leaves businesses with more money to invest in their future success. In other words, technology-induced productivity growth can open the door to a virtuous cycle of continuous investment, competitiveness and growth.



¹ Industry 4.0: The New Industrial Revolution. Available at https://www.bdc.ca/EN/Documents/analysis_research/bdc-etude-manufacturing-en.pdf?utm_campaign=manufacturing-2017--Studies--EN&utm_medium=email&utm_source=Eloqua

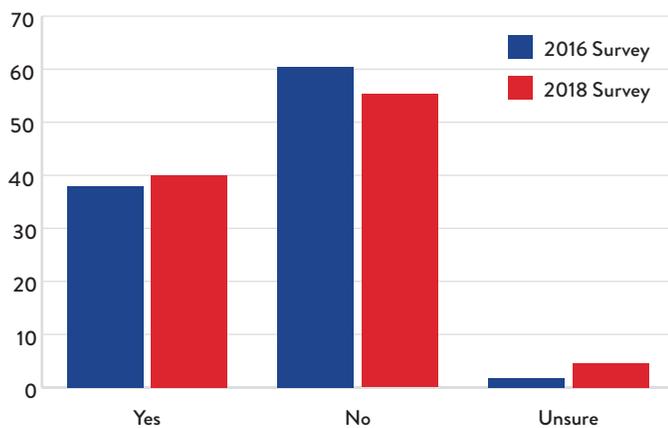
STATE OF ADVANCED TECHNOLOGY ADOPTION IN CANADIAN MANUFACTURING

Canada is home to many dynamic manufacturing businesses who are on the forefront of digitization and technology adoption. These companies are benefiting from lower costs, greater efficiencies, and increased capacity to deliver innovative and, in some cases, more customizable products. As a result, many are seeing rapid growth in their business.

Indeed, a growing number of Canadian manufacturers are embracing Industry 4.0 and are investing in digitization and advanced technologies. According to CME's 2018 Management Issues Survey (MIS), 40.1 per cent of respondents presently use advanced manufacturing technologies. That's up slightly from 37.9 per cent in our 2016 survey. More importantly, more than half of 2018 respondents said that they plan on investing in those technologies within the next three years.

DOES YOUR COMPANY PRESENTLY USE ADVANCED MANUFACTURING TECHNOLOGIES?

(% of respondents)

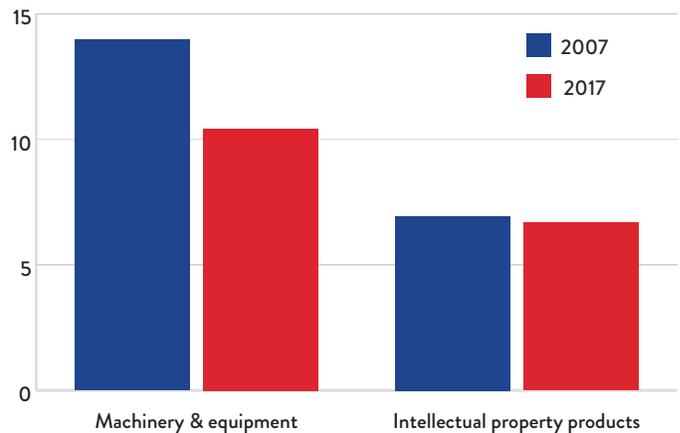


Source: CME Management Issues Survey

However, on the whole, advanced technology adoption is still more the exception than the rule. The fact remains that more than half of Canadian manufacturers are not investing in advanced technologies today and close to half have no immediate plans to do so. Data show that real spending on machinery, equipment and intellectual property products in Canadian manufacturing was about 21 per cent lower in 2017 than it was in 2005. And investment levels have not grown at all since 2010.

CAPITAL INVESTMENT IN MANUFACTURING

(billions of 2012 dollars)

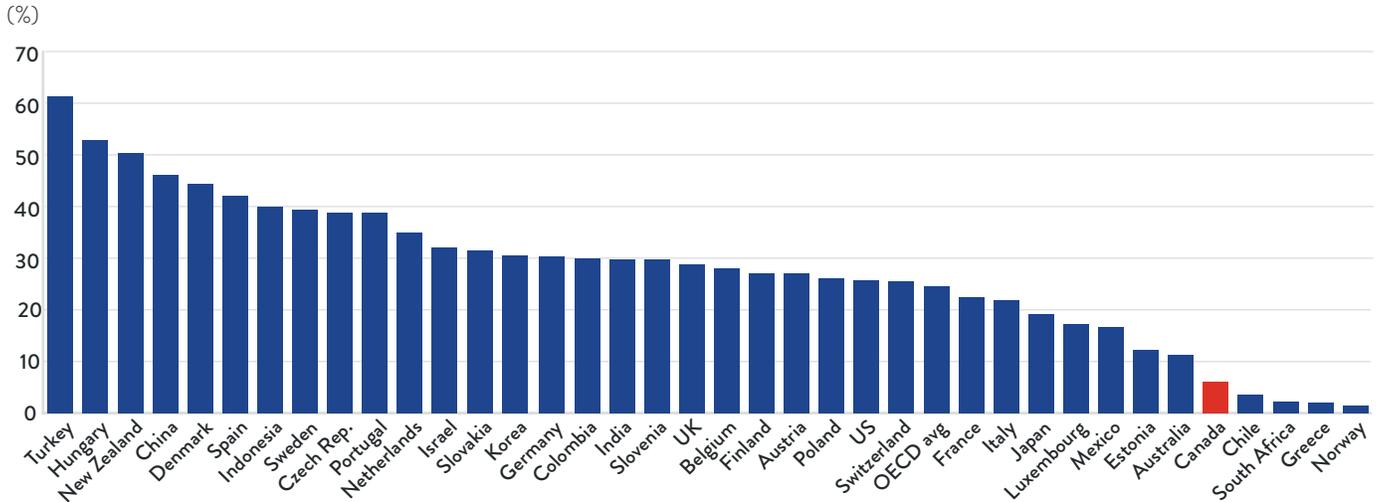


Source: Statistics Canada

A 2017 report by BDC, Industry 4.0: The New Industrial Revolution, suggests that, while digital technologies are gaining traction in Canada, our manufacturing sector is still in the very early stages of embracing Industry 4.0. According to that study, only three per cent of businesses have fully implemented Industry 4.0 projects, and another 36 per cent are partway through the process. Meanwhile, 42 per cent of businesses said they had done nothing at all.

As a result, Canadian manufacturers, on average, lag their international counterparts when it comes to investing in new machinery, equipment and technologies. Data from the OECD suggest that we're close to the bottom of advanced economies in terms of capital investment growth over the last five years. Canadian gross fixed capital formation (GFCF) has risen by 6.0 per cent over the last five years. That's well below the OECD average of 24.6 per cent. The US growth rate was 26 per cent. The EU's was 30 per cent. And in countries like Ireland and Iceland, GFCF has more than doubled in the last five years.

GROWTH IN BUSINESS CAPITAL INVESTMENT - MOST RECENT FIVE YEARS



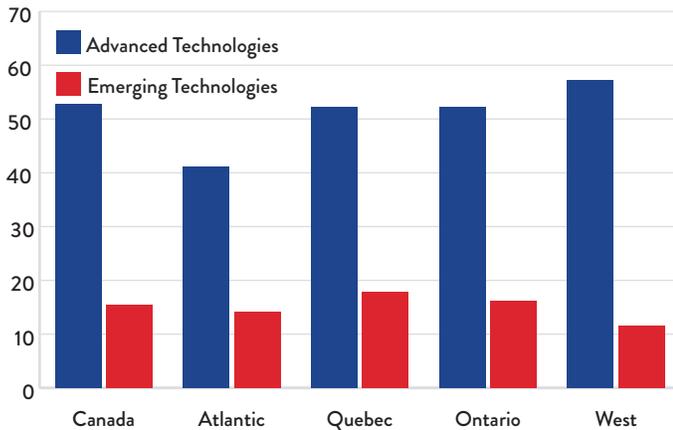
Source: OECD

Within Canada, there are also notable variations in technology adoption rates by region, by company size and by industry. Beginning at the provincial/regional level, according to Statistics Canada’s Survey of Innovation and Business Strategy, technology adoption tends to be somewhat higher in western Canada than it is elsewhere in the country. About 58 per cent of manufacturers in Manitoba and points west use advanced or emerging technologies² in their operations compared to the national average of 54.7 per cent. Thanks to the importance of the aerospace sector (see below), Quebec is the next largest adopter, at 54.8 per cent, followed closely by Ontario, at 53.8 per cent. Meanwhile, technology adoption in Atlantic Canada lagged the rest of the country by a fairly wide margin – it was about 43 per cent.

² According to the Survey of Innovation and Business Strategy, advanced technologies include material handling, supply chain or logistics technologies; design or information control technologies; processing or fabrication technologies; clean technologies; security or advanced authentication systems; and business intelligence technologies, among others. Emerging technologies include nanotechnology, biotechnology, geomatics or geospatial technologies, artificial intelligence (AI), integrated Internet of Things (IoT) systems, and blockchain technologies.

USE OF ADVANCED/EMERGING TECHNOLOGIES IN MANUFACTURING - BY REGION

(% of companies)



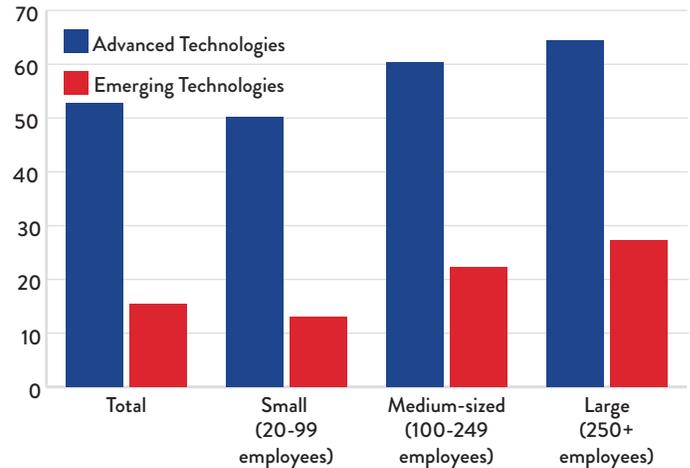
Source: Statistics Canada

While the western provinces lead the way in overall technology adoption, the story is a little different when it comes to emerging technologies – a category which includes things like artificial intelligence, the Internet of Things and blockchain technologies. In those cases, it’s Quebec companies that lead the way with about 17.8 per cent of manufacturers reporting that they have already incorporated those technologies into their operations. Ontario businesses follow, with an adoption rate of 16.2 per cent. Meanwhile, the Atlantic and western provinces lag behind with adoption rates of 14.2 per cent and 11.5 per cent, respectively.

The variance in tech adoption rates is more pronounced when it comes to business size. In general, large companies are far more likely to have introduced new advanced or emerging technologies in their operations. According to that same Statistics Canada survey, about two thirds of large businesses (those with more than 250 employees) presently use those technologies, while the same was true for just 52 per cent of small companies (those with 20-99 employees).

USE OF ADVANCED/EMERGING TECHNOLOGIES IN MANUFACTURING - BY COMPANY SIZE

(% of companies)



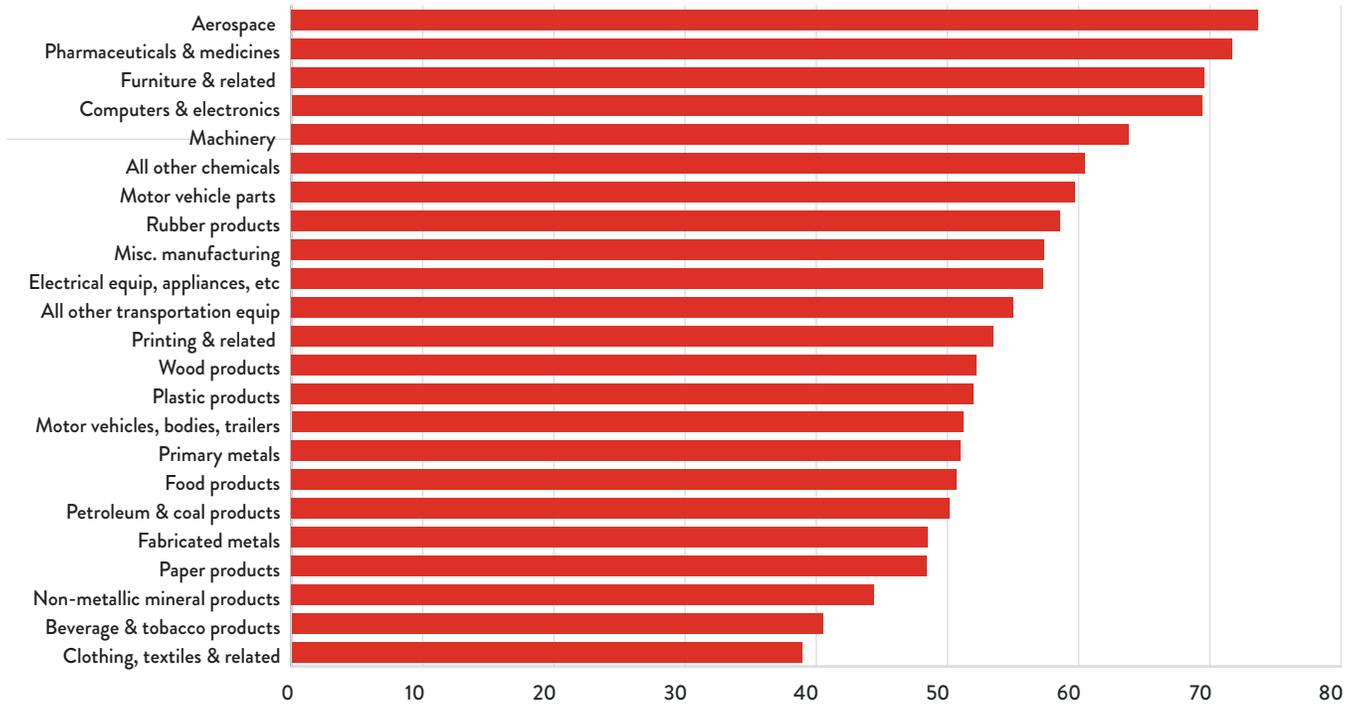
Source: Statistics Canada

The widest difference is in the use of emerging technologies. Only about 13 per cent of small businesses report using these technologies compared to 27 per cent of large companies.

Finally, the degree of technology adoption also varies considerably depending on the business that manufacturers are in. Canada’s industry leader for technology adoption is the aerospace sector where, according to Statistics Canada, nearly three quarters of businesses use those technologies already. Other cutting-edge adopters include the pharmaceuticals and medicines industry (72 per cent of businesses), as well as producers of furniture (70 per cent), computers and electronics (69 per cent), and machinery (64 per cent).

USE OF ADVANCED/EMERGING TECHNOLOGIES IN MANUFACTURING - BY INDUSTRY

(% of companies)



Source: Statistics Canada

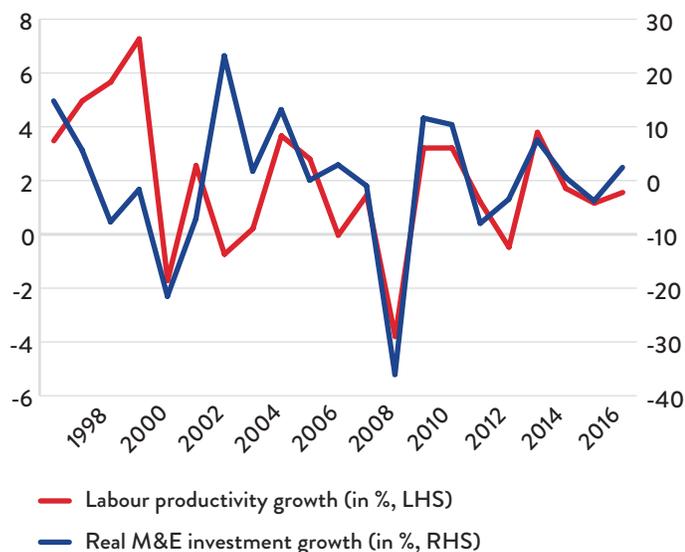
At the other end of the spectrum, even though Canada is home to some world-leading clothing businesses, the industry as a whole is a low adopter of advanced manufacturing technologies. Just 39 per cent of businesses report using them. Other low adopters include the beverage and tobacco industries, non-metallic minerals, paper, and fabricated metals.

TECHNOLOGY ADOPTION AND CANADA'S LAGGING PRODUCTIVITY RECORD

Canada's poor record on investment in machinery, equipment and new technologies is directly affecting the competitiveness of our manufacturing sector. Capital investment allows businesses to make more with less through more efficient use of inputs, fewer hours of labour, and by generating less waste. But because Canadian manufacturers underinvest in new technologies, they innovate less and they fail to realize these gains.

The link between machinery and equipment spending on the one hand, and labour productivity on the other, is shown in the chart below. Except for the immediate aftermath of the tech bubble collapse in the early 2000s, there is clearly a tight relationship between the two.

RELATIONSHIP BETWEEN M&E INVESTMENT AND PRODUCTIVITY GROWTH IN MANUFACTURING



Source: CME calculations using Statistics Canada data

The problem is that since Canadian businesses underinvest in new manufacturing equipment and technologies compared to our global competitors, our productivity growth is lagging as well. Over the last 15 years, labour productivity in Canadian manufacturing has increased by about 20 per cent. Meanwhile, productivity in the US has grown by nearly 50 per cent, and it has more than doubled in locations like South Korea, Taiwan and Eastern Europe. In fact, since 2002 Canada has the poorest record in manufacturing productivity growth of any country in the G-7, save Italy.

BDO

This Technology Adoption Paper lays down a stiff challenge for us as a Canadian manufacturing community: How will we close the gap in advanced manufacturing?

It is a gap that continues to grow. Canada is close to the bottom of advanced economies in capital investment growth over the past five years. The gap has developed gradually and from a mix of causes. Meeting the challenge demands a response in kind: step by step and multi-layered.

Our friends at CME have continued their fine work to address this gap by recommending 10 steps for federal and provincial governments. These steps address three specific obstacles to investment: a lack of information on Industry 4.0; high purchase costs and uncertain return on investment; and labour and skills shortages.

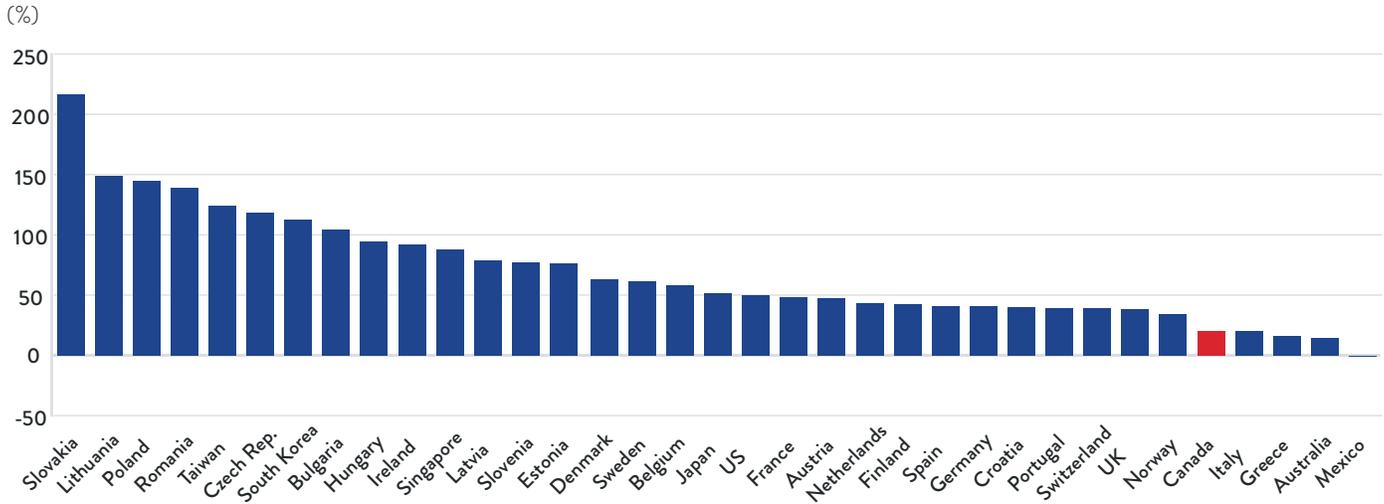
BDO Canada applauds the recommendations presented in this paper. BDO sees these obstacles daily when advising small and medium-sized manufacturers as they adopt advanced manufacturing. Manufacturers need support to compete on "the global stage."

Manufacturers can also do their part by nudging their mindset from short to long term.

Adopting Industry 4.0 is a journey, not a one-time investment to generate quick returns. It is a plan that addresses how manufacturers can improve competitiveness for the future. It is a strategy that yields profitability and efficiency. At its heart, Industry 4.0 is a bet on a company's future success.

Canadian manufacturers have met business challenges in the past. We look forward to seeing manufacturers meet the advanced manufacturing challenge head-on – supported by government support, strategic vision, and the Canadian capacity for global leadership. BDO.CA

MANUFACTURING PRODUCTIVITY GROWTH - 2002-2017

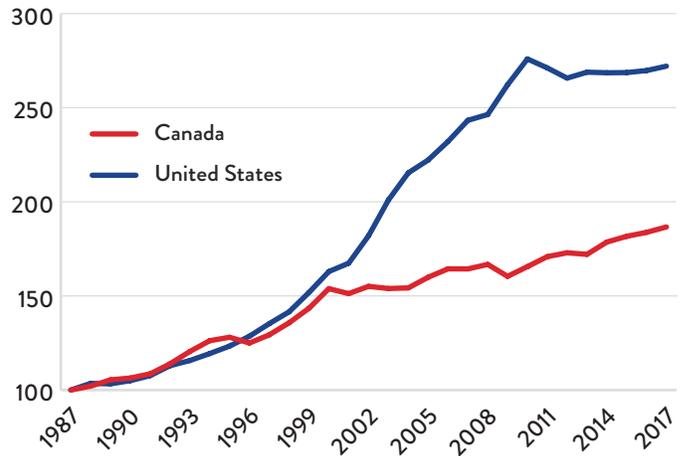


Source: Conference Board

Because of our closely-integrated economies and the ease with which investment can flow across the border, the most concerning productivity gap is between Canada and the United States. Taking a longer-term view of the issue, manufacturing productivity in the United States has risen by 172 per cent over the last 30 years, compared to just 87 per cent in Canada. Most of that gap emerged over a 10-year period in the early 2000s. The silver lining for Canada is that US manufacturing productivity has been stagnant since about 2010 while it continues to grow slowly here at home. However, there remains a wide difference in manufacturing productivity levels between the two countries. Historically, while US businesses have leveraged capital investment to drive competitiveness and output growth, Canadian businesses have often relied on a low exchange rate.

LABOUR PRODUCTIVITY IN MANUFACTURING

(Index: 1987=100)



Source: Statistics Canada, US Census Bureau

BARRIERS TO INVESTMENT

If the benefits of digitization and new technologies are so evident – and the need so critical to long-term business success – then why aren't more Canadian manufacturers investing in them?

There is no single answer to this question. Overarching economic conditions play a role. So too do corporate leadership, customer demand and local business culture.

At the end of the day, however, there are three basic steps in the process of successful technology adoption in manufacturing: identifying the right technology in which to

invest; ensuring that the expected benefits of investment outweigh the costs; and training the existing workforce to be able to operate and integrate the new technology with minimal disruption and maximal effectiveness. There are barriers in each of these areas that are preventing Canadian manufacturers from maximizing the potential from digitization and technology investment.

These must all take place in the broader context of a competitive business and policy environment – one that promotes investment, growth and economic success.

A CLOSER LOOK AT THE CHALLENGES FACING SMALL BUSINESSES

CME's 2018 Management Issues Survey results point to a significant gap in tech adoption rates between small and large companies. According to the survey, only 26 per cent of small businesses say that they presently use advanced manufacturing technologies. That share rises to 61 per cent for large companies.

Similarly, small companies are less likely to invest in those technologies in future. When asked if they were considering making such investments within the next three years, 40 per cent of small businesses answered in the affirmative. However, more than three quarters of respondents from large companies had such investment plans.

The survey also offers some clues as to why this gap exists. We asked businesses about their main barriers to technology adoption. Small companies were far more likely to say that their business had no immediate need for such technologies – 39 per cent of respondents, compared to just 10 per cent for large companies. They also were more likely to point to the high cost of doing business as a barrier. Nearly 44 per cent of small-business respondents

said that the rising cost of doing business left their company with no money with which to invest. Only 29 per cent of large-company respondents felt the same way.

There were other key differences as well. Smaller companies were more likely to believe that governments were not creating a supportive investment and growth environment; and they were more likely to believe that government tax and regulatory policies have been growing less supportive over the past three years.

These findings speak to the need for specific policy solutions tailored to small manufacturers. In particular, the fact that many SMEs do not believe they need to invest in advanced technologies speaks to the need for better options when it comes to learning about and testing new technologies. Small businesses also want governments to provide investment incentive programs that are better-suited to their needs; and policy measures that promote growth and reduce the cost of doing business in Canada.

OBSTACLE 1: LACK OF INFORMATION AND TESTING OPPORTUNITIES

The first step in the process of technology adoption is making an informed choice about which new technologies are the best fit and the highest priority. When asked about their main barriers to technology adoption, 30 per cent of MIS respondents said that their business have no need for such technologies, and 32 per cent said that it is unclear how new technologies would fit into existing operations. These results suggest that many businesses lack information about the potential benefits these technologies offer. They are also supported by Statistics Canada's Survey of Innovation and Business Strategy, which found that the main reason manufacturers don't adopt new technologies is because they don't consider those technologies necessary for continuing operations.

The technology information gap has three broad components:

- A lack of awareness about the machinery, equipment, software or other technologies that are available;
- An incomplete understanding of how specific technologies could benefit their operations; and
- The inevitable disruption that comes from incorporating new technologies into existing processes.

These obstacles are especially pronounced for small businesses, which typically lack the resources needed to research and implement new technologies.

SOLUTIONS AND RECOMMENDATIONS

Businesses are more likely to invest in new technologies if they have a clear idea of the benefits those technologies offer. Technology assessment programs, demonstration tours and testing opportunities are all good ways to demystify technologies and give manufacturers a better understanding of their potential value, and how they could fit into – or transform – existing operations.

Technology assessment programs are especially valuable to small businesses that typically do not have the time or resources needed to fully explore the investment options available to them. These involve site visits by qualified professionals that examine a company's performance and recommend how advanced manufacturing technologies could be implemented. The Atlantic Canada Opportunities Agency (ACOA) offers such a program in the Atlantic region, while the SMART program in Ontario offered similar services in that province.

A nationwide SMART program would be of great value to businesses – especially SMEs – because it would lower the cost of technology assessments; and would provide financial incentives to adopt those new technologies (see Recommendation 5, below).

Another important way to improve awareness of digitization and new technologies is for businesses to see them in action. One way to accomplish this goal is to promote direct, first-hand exposure by facilitating site visits for technology demonstration tours. In that vein, CME operates a program in BC called Innovation Insights – an event series that, through tours and practical demonstrations, showcases innovative technologies and manufacturing processes on-site in a leading manufacturing facility in the province.

Recommendation 1: The federal government should provide financial support to facilitate technology demonstration tours and site visits for Canadian manufacturers that showcase cutting-edge machinery, equipment and technologies. The Innovation Insights program in BC is a model that could be extended nationwide.

In addition, manufacturers would benefit from increased opportunities to test new and emerging technologies. Technology demonstration and testing hubs located across the country would help businesses familiarize themselves with those technologies, better understand their capabilities, and learn how they might benefit from applying them to their own operations. The Northern Alberta Institute of Technology (NAIT) operates a Productivity and Innovation Centre (PIC) in Edmonton that performs this function, with funding from the federal government's now-expired Post-Secondary Institutions Strategic Investment Fund.

Recommendation 2: Using NAIT's Productivity and Innovation Centre as a model, the federal government should fund a series of technology demonstration and testing hubs across Canada that give manufacturers the opportunity to learn about and test new and emerging technologies.

Finally, successful technology adoption begins with an investment plan and a guide to help the process along. A technology roadmap that sets out a path and a process to move a business from a traditional manufacturing setup to fully embracing Industry 4.0 can be an invaluable tool to help manufacturers invest with confidence and purpose while avoiding costly mistakes.

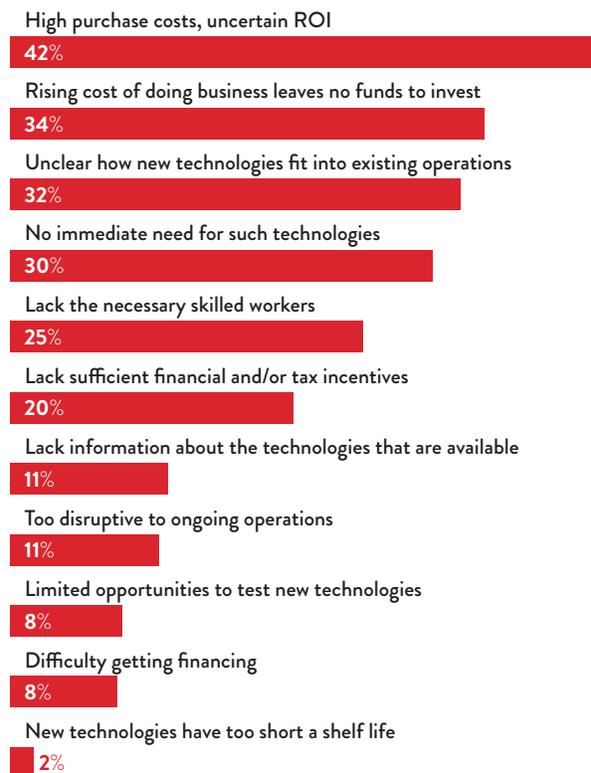
Recommendation 3: The federal government should work with CME to develop an online technology adoption roadmap. Available to all manufacturers in the country, the roadmap would allow businesses to learn about the various stages of technology adoption, assess their own progress in moving towards Industry 4.0, and get information on the steps needed to advance to the next level.

OBSTACLE 2: HIGH PURCHASE COSTS AND INVESTMENT RISK

New equipment and technologies can be expensive. The way they fit into existing operations is not always obvious, and businesses are effectively taking a leap of faith when they make the decision to invest in technologies that disrupt established production methods. For these reasons, manufacturers report that the largest barrier to investing in new technologies is that the purchase cost of those goods and services is high and the return on investment (ROI) is too uncertain.

WHAT OBSTACLES PREVENT YOUR COMPANY FROM INVESTING MORE IN ADVANCED TECHNOLOGIES?

(% of respondents)



Source: 2018 Management Issues Survey

Note: Respondents were asked to select their top three choices.

Other factors come into play as well. One is that many new technologies must be imported from other countries. In these cases, already-high purchase costs can be magnified by movements in the exchange rate. As the value of the Canadian dollar has fallen since 2008, the average cost of imported machinery and equipment has soared, rising by 42 per cent in just 10 years. Another barrier is that many businesses require a projected two-year payback in order to pull the trigger on a major new investment. But if companies are not running at full capacity, they may not be able to use the new technology often enough to achieve that two-year ROI.

MACHINERY AND EQUIPMENT PRICES FOR MANUFACTURERS

(Index: Q1 2000=100)



Source: Statistics Canada

Finally, there is the question of whether Canadian businesses are, on average, simply too risk averse relative to their global competitors. According to the World Economic Forum, Canada ranks 31st in the world when it comes to business appetite for entrepreneurial risk, and 28th when it comes to companies' willingness to embrace risky or disruptive business ideas. By comparison, the United States ranks second and first in those two areas, respectively.

SOLUTIONS AND RECOMMENDATIONS

Businesses need help with offsetting the cost and risk of investing in new technologies. At the same time, steps need to be taken to move the yardsticks on business culture in Canada by better rewarding companies that do take risks, celebrating Canadian success stories, and sharing best practices.

The simplest way for governments to incentivize and de-risk business investment in new technologies is through the tax system – by allowing businesses to use strategic investments to do two related but separate things: lower their taxable income; and lower their tax payable.

In the first case, the policy solution is an accelerated capital cost allowance. Businesses lower their taxable income by depreciating their assets faster, allowing them to deduct more expenses in the current year. Canada has made considerable progress in this area already. The federal government recently improved its capital cost allowance incentive program, allowing manufacturers to immediately write off all qualifying capital expenditures in the year in which they were made.

The second approach is to provide businesses with a tax credit on the purchase of new machinery, equipment and technologies. In this case, businesses could claim a certain percentage of their investment costs directly against their tax payable. For example, if a company had access to a 10 per cent tax credit on the purchase of a \$10,000 piece of technology, it would be able to lower its tax payable by \$1,000.

The federal and provincial governments offer several personal and corporate tax credits designed to incentivize certain kinds of behaviour. Perhaps the most relevant example is the Atlantic Investment Tax Credit (AITC), which allows Atlantic Canadian businesses to claim a tax credit equal to 10 per cent of qualifying capital expenses.

The combination of the accelerated capital cost allowance and an investment tax credit like the AITC is a solid foundation for technology investment policy in Canada. It would lower the cost and risk of business investment, it would be available to businesses (and investments) of all sizes, and it would be cheap and simple for governments to administer. With the ACCA already in place, the remaining step is to expand the AITC outside the Atlantic region.

Recommendation 4: The federal and provincial governments should work together to introduce a shared 20 per cent investment tax credit on the purchase of new machinery, equipment and technologies, including software. The federal component would be achieved by extending the 10 per cent Atlantic Investment Tax Credit, making it available to businesses across the country. The provinces would provide a matching 10 per cent credit on the same base as the federal program.

There is also a need to improve the supports available for small-scale technology adoption – especially for small- and medium-sized enterprises. The former SMART program delivered through FedDev Ontario (and discussed earlier) is a useful model in this regard. The SMART program had two basic components: it provided support to conduct technology assessments by qualified professionals; and it offered financial support for advanced technology adaptation and adoption. Re-introducing this program and applying it across Canada would not only help SMEs with the unique technology-adoption barriers they face, but would also help improve awareness of the technologies that are available. We recommend:

Recommendation 5: The federal government should support the creation and delivery of a nationwide SMART program modelled after the initiative formerly delivered in Southern Ontario. The SMART program would:

- Offset the cost of technology assessment and diagnostic services; and
- Provide support for advanced manufacturing technology adoption/adaptation initiatives for SMEs.

These steps will help reduce the cost and uncertainty of investing in new digital and advanced manufacturing technologies. However, they do not address the issue of risk aversion in Canada. To be sure, the idea that Canadian businesses are risk averse is a blanket generalization. There are myriad examples to the contrary. At the same time, this is clearly an issue that requires policy attention.

Risk aversion leads businesses to underestimate the ROI of any given initiative. To the extent that this is generally true of Canadian businesses, it causes our companies to hesitate while those in the US and elsewhere take the plunge.

Addressing this issue requires action that helps to increase business risk tolerance. One way to do this is by showcasing and celebrating Canadian success stories. Few things are as motivating as seeing what success looks like. If Canadian businesses can see examples of successful technology adoption in their own backyard, it will drive their own desire to invest.

Recommendation 6: The federal government should work with industry associations to develop an awareness campaign that demonstrates the benefits of technology adoption in manufacturing by:

- Highlighting and celebrating Canadian success stories; and
- Examining the challenges and issues in technology adoption and implementation.

OBSTACLE 3: LABOUR AND SKILLS SHORTAGES

Manufacturers are struggling to find the workers they need. According to our MIS results, 69 per cent of businesses face labour shortages today and nearly three quarters expect to do so within the next three years. In fact, labour/skills shortages were identified as the single most pressing concern facing Canadian manufacturers today.

These shortages are also a major barrier to technology adoption in Canadian manufacturing. At a basic level, labour shortages prevent businesses from operating at optimal levels. This impacts competitiveness and profitability, which, in turn, leaves businesses with less money with which to invest.

Similarly, skills shortages impact every step of the process of technology investment: from selecting the right technology to integration, customization, operation, troubleshooting, and maintenance and repair. Each of these steps require workers with specialized and specific skills.

However, the most important issue is that new digital technologies are turning innovation, design prototyping and other manufacturing operations on their head. Consider the process of developing prototypes: traditionally, these were done through a process of subtractive manufacturing – removing material from a larger object until the model was created. Today, that process can be done through additive manufacturing – printing a three-dimensional object by adding layers until it is complete. Leveraging the opportunities of additive manufacturing requires a completely different mindset and skillset compared to what students have traditionally been taught.

In other words, technology and skills are fundamentally interconnected. Without access to a skilled, innovative workforce, the economic case for investing in technology adoption evaporates.

SOLUTIONS AND RECOMMENDATIONS

To prevent labour and skills shortages from continuing to limit technology adoption in manufacturing, action is needed in four broad areas:

The first is to increase the size of the labour supply pipeline for manufacturers by encouraging more young students and under-represented groups to consider manufacturing-related education programs. Without higher enrolment in these fields – not to mention expanding the capacity of post-secondary schools to accommodate those students – skills shortages will continue to plague the sector and limit both economic growth and technology adoption. To achieve this goal, the following steps are necessary:

Recommendation 7: The federal and provincial governments should work with the manufacturing community to:

- Develop more vocation-focused education streams at the secondary level;
- Provide more information to secondary students about career options in manufacturing;
- Create more opportunities for students to participate in “open doors” programs that allow them to visit local manufacturing facilities; and
- Focus the above efforts on recruiting more women and under-represented groups to manufacturing-related fields.

Getting more young Canadians to consider a career in manufacturing is only the first step. The second is to ensure that existing post-secondary education programs are a good match for the skills that businesses are looking for. This was one of the key findings from our 2018 MIS. Businesses told us that the most important thing governments can do to address labour and skills shortages is to work with post-secondary institutions to develop education and training programs that more closely meet business’ needs.

Doing this right means the manufacturing community itself must play a central role. Manufacturers know best the skills that are needed in their operations and those that are lacking in their recent hires.

Recommendation 8: The federal government should fund the development of local Workforce Planning Consortia across the country. These consortia would bring together major employers, their supply chains, and local secondary and post-secondary institutions on a regular basis to discuss current and future workforce needs, and to drive curriculum planning and career counselling to meet those needs.

Increasing the size and quality of the education pipeline is an important long-term solution to skills shortages, but it does little to help manufacturers in the short term. Businesses cannot afford to wait several years for the education system to provide the workers they need.

The solution to this problem lies in the immigration system. Specifically, in 2017 the federal government introduced the Atlantic Immigration Pilot – an employer-driven program designed to bring more skilled workers into the Atlantic region. This pilot project has proven effective at filling important skills gaps in those provinces. A similar program would be of immense value to manufacturers in other parts of the country.

Recommendation 9: The Atlantic Immigration Pilot should be made permanent and extended to the rest of Canada.

Finally, on-the-job and workforce training is a critical component of skills development – especially in an environment of fast-paced technological change. In our 2018 MIS, businesses stated that one of the most valuable things governments could do to alleviate skills shortages is to provide more direct funding to support workforce training.

Recommendation 10: The federal government should expand and improve the Canada Job Grant by:

- Making it permanent and increasing its funding envelope;
- Allowing for the funding of multi-year training and expanding the range of eligible on-the-job training; and
- Speeding up approval times.

CONCLUSION

Industry 4.0 is revolutionizing manufacturing around the world. Companies that embrace digitization and advanced manufacturing technologies will realize extraordinary improvements in efficiency, lower operating costs, and greater flexibility and adaptability. These, in turn, lead to higher productivity, greater customer satisfaction. And those result in higher profits, more investment, and growth.

Canada is lagging other countries when it comes to implementing Industry 4.0 technologies. This trend needs to be reversed if we are to maintain a competitive manufacturing sector into the future. Our report identifies three broad barriers that are limiting technology adoption in Canadian manufacturing:

- **A lack of information about the technologies that are available**, preventing companies from making confident, informed strategic decisions;
- **High purchase costs and uncertain ROI**, which cause businesses to hesitate on pulling the trigger on making new investments; and
- **Labour and skills shortages**, which prevent manufacturers from optimizing the use of those technologies.

These barriers are interconnected. The specific issues identified in each must be addressed holistically, simultaneously and as part of a comprehensive policy strategy if they are to be overcome. Doing so will help propel Canada to the forefront of digitization and technology adoption in manufacturing, and position Canada as a global leader in manufacturing competitiveness, growth and prosperity.

R3D

R3D International assists clients in their transition to digital manufacturing. We understand the challenges of Canadian manufacturing companies locally and globally. Thanks to a very pragmatic and efficient approach, our consultants will assist you in putting together a digital manufacturing roadmap, adapted to your global strategy. Once you have your roadmap in place, the real work begins, and we are expert at speeding up the process. Regardless of the size of your operation or where you are located we can assist you with your transition. Our clients' testimonies speak for themselves:

- *“R3D understands that time to market is key, we need efficient solutions, implemented fast.”*
- *“R3D’s methodology helped us to implement solutions in several plants in record time.”*

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