



INTELLIGENT INDUSTRIALIZATION: THE NEXT WAVE

SERIES ON EMERGING SUB-SECTORS

INFORMATION AND COMMUNICATIONS TECHNOLOGY COUNCIL (ICTC)

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FOREWORD

The global push to remove mundane repetitive tasks, boost productivity, and increase profits and market share has created demand for automation in Canada and abroad. As aging workers enter retirement, the manufacturing sector will require a steady pipeline of technologically skilled professionals that can contribute to a fast paced sector. Automated processes offer a stop gap measure; however for sustained growth in automation, finding workers to operate the automated systems and work on the “smart” processing lines will require employers to develop attractive employment programs to recruit young workers faster and smarter. Educational curriculums will need to encompass how the employment landscape is changing with merging Information and Operational Technologies heightened by the Internet of Things (IoT).

The automation sector has the opportunity to expand beyond the main subsectors of industrial manufacturing with the dramatic growth of eCommerce. This trend is creating demand for innovative automated systems and solutions integrated with intelligence to increase production flexibility, improved time to market, and improved asset utilization. In response to growing consumer demand in emerging markets, automation solutions will require a combination of Information Technology (IT), Operational Technology (OT), industrial robotics, and the connectivity of the IoT to deliver information on demand that operators can act upon in real time.

Barriers exist for companies that develop automated solutions and for companies that adopt automation on their production lines, which challenges future growth in the automation and robotics sector in Canada. For companies that develop automation solutions, greater access to funding and a streamlined application process with respect to SR&ED could greatly enhance innovation and reduce financial uncertainty for risk adverse companies. Implementing a tiered SR&ED program aligned to company size, product innovation and industry sector will enable small and medium sized companies to participate in the program with less cumbersome requirements providing them the opportunity to focus energy and effort on commercialization.

As digitization continues to expand, so does the need for industrial manufacturing companies to find skilled labour such as software engineers, instrumentation and control professionals, IT support technicians, and design and production engineers motivated to work in an evolving manufacturing sector. Many companies are experiencing difficulty attracting talent due in part because many young people (post-graduates) entering the workforce perceive manufacturing as “Blue Collar.” Limited skills to manage automation equipment and processes may inhibit companies’ ability to adopt automation. Educating youth about the opportunities available in manufacturing can help promote a steady pipeline of talent to automation companies and high-tech industrial manufacturers.

In order for Canadian companies to succeed, they need to make strong inroads in the global arena, especially in emerging markets where demand for industrial automation is growing rapidly. Canadian companies face barriers to competing globally in advanced and emerging markets partly due to limited funding opportunities and hooks for ownership of intellectual property. Encouraging Trade Commissioners to develop programs to attract foreign and Canadian companies to learn about Canadian product innovations will help promote adoption and investment in automation. Programs that address trade agreements to encourage cross border cooperation will further enhance Canadian companies’ ability to compete globally, as will the development of a data base that matches industrial Canadian companies with foreign companies for commercialization opportunities.

In closing, profiling the Canadian automation and robotic industry through a multimedia platform to foreign companies collectively with an incentive program will further stimulate Canadian innovation growth.



EXECUTIVE SUMMARY

For more than half a century Canadian manufacturers have relied on advances in technology to boost productivity, redistribute labour resources, and enhance profitability. Advances in industrial automation, a concept used to refer to a set of interrelated technologies that monitor, control, and expedite the production of goods and services, have greatly improved manufacturing by introducing repeatability, waste management, quality controls, and end-to-end business integration.

The proceeding study explores the impact of industrial automation and robotics on Canadian goods producers, especially the manufacturing sector, which is the biggest end-user market for automation technologies in Canada. The study also examines the competitive landscape of Canadian automation companies with the aim of understanding the size of the Canadian market, barriers to adoption, and avenues for growth.

Below is a snapshot of the key findings of the study.

Canada's industrial automation industry

Canada is home to a small cluster of industrial automation companies (i.e., developers) operating in specialized ICT industries across the country. Developers are companies that design, manufacture, and install industrial automation and robotics equipment.

- Canada's industrial automation sector, which includes Canadian and foreign-based developers operating in Canada, generates an estimated \$2 billion in revenues annually.
- One half (49 percent) of industrial automation companies are based in Ontario, one quarter in the Western provinces and more than one-fifth (23 percent) in Quebec.
- Canadian developers face growing competition from international vendors; 73 percent of Canada's end-user market turns to suppliers outside of Canada for their automation equipment.

Canada's end-user market

Canadian businesses rely on industrial automation technologies for manufacturing/product assembly, product packaging, product testing, and to perform hazardous work. Automation has had a significant impact on productivity, business expenditure, and employment.

Productivity

- Seventy percent of businesses indicated their use of automation changed significantly over the past ten years. Of these businesses, two-thirds (68 percent) report production costs have decreased as a result, and 90 percent say productivity has increased.
- Two-thirds of these businesses said the integration of industrial automation reduced production costs. Nearly half of companies (42 percent) said production costs fell between 10 percent and 29 percent as a result of automation.

Expenditure

- For more than half of Canadian businesses (55 percent), automation expenditures account for between 5 percent and 49 percent of total operational expenditure.
- Canadian businesses routinely source automation equipment internationally because foreign suppliers have greater experience and more advanced equipment that can fulfill very specific functions.



Employment

- Although most companies indicated a relationship between industrial automation and staffing levels, no clear trend emerged. Among businesses that said their usage of automation had increased over the past decade, about one quarter (29 percent) said the adoption of automation reduced overall employment. About the same (30 percent) said industrial automation led to higher employment in the company.
- Canadian businesses are staffing automation services locally. Almost half (45 percent) of businesses say they rely exclusively on Canadian sources for professional services.
- While businesses tend to currently only have a fraction of their staff using industrial automation, this is likely to change significantly in the next three-to-five years. Most businesses do not anticipate their automation-related employment levels will increase this year, but most believe they will increase within five years. Very few businesses expect to reduce the number of workers who are using automation.
- More than half (57 percent) of businesses said they always or sometimes experience difficulty recruiting qualified automation-related talent.

Supporting Canada's Industrial Automation Industry

Given that manufacturing is by far the biggest end-user market for industrial automation, Canada's automation industry operates in a much smaller domestic market. In order to compete, Canadian developers must expand internationally to tap into strong manufacturing economies in Asia and Europe. A series of recommendations have been suggested by industry to strengthen Canada's industrial automation and robotics sector.

Supportive Trade Policies:

- A major hurdle for Canadian developers is accessing the US market. Refining trade agreements to include how cross border interaction between companies are handled should be considered. Policymakers should offer foreign companies incentives to buy Canadian. One way this can be accomplished is by supporting innovations that result in intellectual property that can be supported and protected in Canada. ICTC firmly believes that the adoption of a "patent" box approach that rewards businesses for the commercialization of intellectual property should be considered. This will not only boost the pool of capital available to Canadian companies, it will allow them to sell patented products and licence out patent rights to the international market. Bringing Canadian innovations to the international market is a critical step to increasing national prosperity not just in the industrial automation and robotics sector, but in the rest of the digital economy.
- Trade Commissioners should consider playing a bigger role in developing programs to attract foreign businesses to Canada through incentives. Other programs that help Canadian companies broker foreign partnering, licensing or reseller agreements may also help boost Canadian visibility abroad.

Increasing Funding Opportunities:

- Building off the "patent" box, policymakers should consider expanding direct funding opportunities to innovative technology companies that may lack marketing expertise. Such a program would not be limited to a certain technologies, but would be open all sub-sectors that could have a positive impact on the end-user market.
- Policymakers should consider providing businesses with a larger investment fund (e.g. equity financing, investment from angel groups, direct funding) to commercialize their intellectual property with favourable lending terms on the basis their commercial product would yield large returns in the market (for example, AVAC Ltd., Alberta).

Maximizing SR&ED:

- Policymakers should consider developing an accompanying program that provides assistance in the commercialization process. This program can help ensure that SR&ED recipients receive the business support they need to succeed in the marketplace. This will also help streamline the SR&ED program toward business growth, as companies will be required



to demonstrate how their research will be linked to business growth and commercialization goals. Such a program would help companies compete internationally and ensure that businesses capitalize on their SR&ED-based research.



1. INTRODUCTION

For the past six decades information and communications technology (ICT) has created new possibilities for the manufacturing sector. Advances in automation have made goods production far more productive, streamlined, and profitable. Industrial automation redefined the division of labour by introducing repeatability, waste management, enhanced quality control, and end-to-end business integration. This in turn has resulted in labour reduction in certain fields, but has created more opportunities in other, more advanced areas.

As a result, Canada's goods-producing industry contributes nearly half a trillion dollars to gross domestic product on an annual basis. The manufacturing sector alone contributes more than \$174 billion annually.

Outside the manufacturing sector, several high profile industries are taking advantage of automation, robotics, computer control methods, hydraulics, and pneumatics to conduct R&D, introduce efficiencies, and boost productivity. Robotic automation is being leveraged in aeronautics, agriculture, transportation and warehousing, and retail trade. However, very little is known about the economics of automation and robotics in Canada, its talent needs, and growth trajectory.

The direct contribution of automation on the goods-producing economy warrants further elaboration and examination. While automation is playing an increasingly important role in various sectors of the economy, it has single-handedly transformed the goods-producing industry and impacted its productivity, employment, and competitiveness. The justification to study the role of automation in goods production was validated through secondary research, primary data collection, and industry consultations.

Automation is the creation and application of technology to monitor, control, and expedite the production and delivery of goods and services. Automation encompasses many vital processes and job functions that make up today's economy, and is used in facility operations in all levels of production.¹ Specific tasks in industrial automation are also performed by robots, which are multipurpose manipulators that are automatically controllable and reprogrammable in three or more axes, and can be used in either a fixed location or for mobile use.²

The Canadian economy has witnessed a substantial uptake in industrial automation. Companies across Canada report improved productivity and cost savings associated with the adoption of these technologies, which are used for product assembly, product packaging, and hazardous work. Canada has a relatively high adoption rate of industrial robots at 118 per 10,000 manufacturing employees. This is more than double the global average, but well below industrialized leaders such as Germany, Japan, South Korea, and the United States.

Canadian businesses have noted a direct relationship between the adoption of automation and increased productivity. Over 90 percent of businesses say the adoption of industrial automation has boosted productivity over the last ten years. Two-thirds of companies (68 percent) say industrial automation has reduced production costs. The overall impact of automation on employment, however, is less clear, with some companies reporting greater employment as a result of lean manufacturing and others reporting a reduction of workers. Technology-driven change is nothing new in the Canadian economy. Certainly within the manufacturing sector industrial automation has been a mainstay for several decades, and has only in the last 20 years approached critical mass. What is noteworthy, however, is the growing uptake of robotic automation in sectors such as mining, construction, and healthcare.³

Advances in the digital economy will continue to push the boundaries of lean manufacturing. Already today we are witnessing a wide scale proliferation of the Internet of Things (IoT), a broad computing concept that describes a scenario where everyday objects

¹ Automation Federation. What is Automation?

http://www.automationfederation.org/Content/NavigationMenu/General_Information/Alliances_and_Associations/The_Automation_Federation/About1/What_is_Automation/What_is_Automation.htm

² International Federation of Robotics. Industrial robot as defined by ISO 8373. <http://www.ifr.org/industrial-robots/>

³ The Canadian Chamber of Commerce (2013). March of the Robots: Policy Brief – October 2013. *The Canadian Chamber of Commerce*. <http://www.chamber.ca/media/blog/131031-the-march-of-the-robots/>



are connected to the internet and able to communicate with other devices. The emergence of cloud computing, digital platforms, and mobile technologies represent only a cusp of the IoT revolution.

According to IoT experts, the biggest challenge in realizing an IoT ecosystem is “modelling of information ... To enable every device to communicate and to co-operate with all other devices.”⁴

Advances in IoT will streamline automation processes by making industrial machinery, equipment, and other objects accessible remotely. This environment will enhance machine-to-machine networks and boost communication channels throughout an organization.

⁴ Tessel Renzenbrink (6 December 2012). “The Internet of Things: Robots, RFID & Co-operation.” *Tech the Future*. <http://www.techthefuture.com/technology/the-internet-of-things-robots-rfid-co-operation/>

2. METHODOLOGY

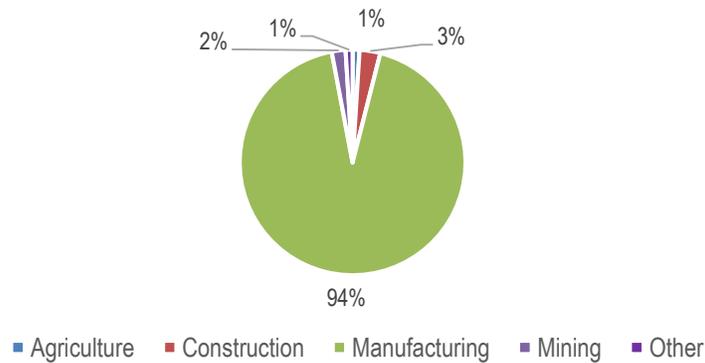
ICTC's research approach and methodology addresses several interrelated elements of the industrial automation sector and its end-user market. ICTC's evidence-gathering methodology combines both quantitative and qualitative research approaches to expertly mine, analyze, and report on both publicly-available and proprietary data. In developing the study, ICTC employed a mixed approach that included a literature review, key informant interviews (KIIs), working groups, and market research. Below is a snapshot of the research approach with an accompanying timeline:



ICTC's field phase consisted of three interrelated approaches: KIIs, market research, and validation. Between May and September ICTC conducted KIIs with industry leaders representing companies in the industrial automation industry. Companies were initially vetted through Industry Canada's database, as well as through secondary research conducted by ICTC. A total of 15 KIIs were completed over this period. ICTC engaged executives at these companies to gauge the trends of the industry, identify the opportunities and challenges, and to operationalize definitions that would be used in the market research. These KIIs would eventually form ICTC's Automation and Robotics Advisory Committee, which provided key inputs and validation in the finalization of the study. The Advisory Committee met three times between September and November 2014 to validate the research findings and provide key recommendations for strengthening the automation industry in Canada.

ICTC engaged a third-party market research firm between June and August 2014 to study industrial automation consumption trends in Canada. The market research firm interviewed 410 automation user companies (i.e., companies that have integrated automation technologies into their workflow) from across Canada. Below is an industry breakdown of the companies involved in the market research:

Figure 1. Industry breakdown of market research participants

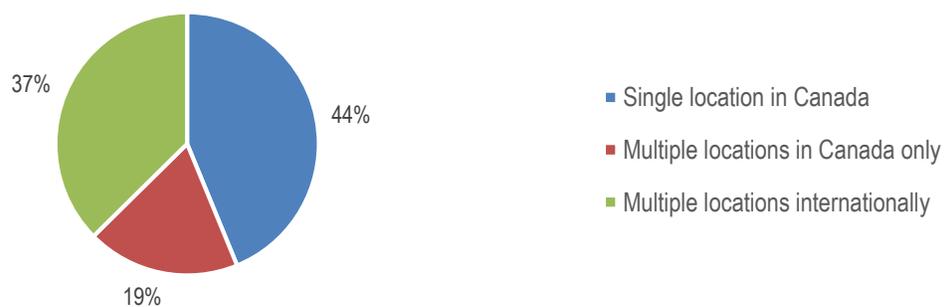


Source: ICTC (2014).

As figure 1 clearly demonstrates, the vast majority of respondents were drawn from the manufacturing sector, which reflects the results of the pre-survey screening phase. Among manufacturers, the strongest representation came from steel products, machinery, and food, beverage and tobacco products.

The screening phase, launched before the official survey was deployed, helped ICTC screen out non-users of industrial automation. ICTC was surprised to learn that, among other things, industrial automation is used only minimally in Canada’s oil and gas sector, but was much more prevalent in food manufacturing. One possible reason for this could be that the definition of automation used in the study screened out users of other industrial technologies such as heavy machinery. Figure 2 outlines the organizational structure of the companies that participated in the study.

Figure 2. Organizational structure of study participants



Source: ICTC (2014).

The results of the market research were validated by 31 companies that completed the survey. These results, among others, were presented to ICTC’s Advisory Group between September and November for further validation. A draft version of the report was provided to the Advisory Committee for final feedback and validation. Their input was incorporated into the final report presented below.

3. INDUSTRIAL AUTOMATION IN A GLOBAL CONTEXT

Industrial automation is a growing industry not just in Canada, but internationally as well. According to Sandler Research, the global market for industrial automation will grow at a compound annual growth rate of 6.87 percent through 2018. The penetration of wireless sensor networking solutions is one of the defining trends in the end-user market, as organizations rely on these new technologies to overcome the limitations of centralized architecture.⁵

The end market value of industrial automation in terms of revenue is worth more than \$150 billion annually, divided almost evenly between factory automation (\$72 billion) and process automation (\$83 billion).⁶ Key end markets for factory automation include automotive and packaging. Key markets for process automation include the pharmaceutical and natural resource sectors. As the world's largest manufacturer, China is considered a major growth driver for industrial automation.

Emerging markets present a large growth opportunity for industrial automation; they account for 50 percent of global manufacturing output, but are behind developed economies in industrial robot density. According to Credit Suisse, industrial automation penetration in emerging markets is still considered weak, with only seven industrial robot installations per 10,000 manufacturing employees. By contrast, industrial robot density in developed markets is 149 per 10,000 manufacturing employees.

The adoption of industrial automation and robotics is highest in developed economies where manufacturing is prevalent, such as Japan, Germany, and South Korea. Manufacturing output represents a large segment of GDP in these countries, so they are more likely to integrate industrial automation.

Japan, which has the highest adoption rate of industrial robots in the world at more than 300 per 10,000 manufacturing employees,⁷ has a large manufacturing sector that accounts for nearly one-fifth of GDP.⁸ Japan is closely followed by South Korea, where industrial robot density is less than 300 per 10,000 manufacturing employees. Manufacturing output accounts for 31 percent of South Korea's economy.⁹ Germany, where manufacturing accounts for 22 percent of GDP, is third on the list of industrial robot density at around 250 per 10,000 manufacturing employees.^{10,11}

2013 witnessed the largest ever increase in industrial robotics sales, according to the International Federation of Robotics (IFR). Industrial robot sales increased 12 percent to 178,123, led by the automotive, chemical and rubber plastics, and food industries. China became the biggest robot maker with a 20 percent share of the global production pie.

China is now considered the biggest international market for industrial robotics, overtaking Japan last year with a total of 37,000 purchases, according to the IFR. However, at 96,000, China still lags considerably behind other nations in the number of industrial robots in use. The United States and Japan, by contrast, have 168,000 and 310,000 industrial robots in use, respectively.¹²

In contrast to manufacturing powerhouses such as Japan and Germany, Canada has a smaller manufacturing sector at approximately 11 percent of GDP.¹³ Unlike Germany, Japan, and South Korea, Canada has a rich natural resources sector that

⁵ Paul Nelson (2014). Global Industrial Automation Control Industry Latest Report 2014-2018.

https://www.academia.edu/6181649/Global_Industrial_Automation_Control_Industry_Latest_Report_2014-2018

⁶ Credit Suisse (2013). Global Industrial Automation. https://doc.research-and-analytics.csfb.com/docView?language=ENG&source=emfromsendlink&format=PDF&document_id=994715241&extdocid=994715241_1_eng_pdf&serialid=hDabUewpvOqQcRiLxK7rxIQJZ8TPLDrYHs47S97OOI%3d

⁷ Ibid.

⁸ The World Bank (2014). Manufacturing, value added (% of GDP). <http://data.worldbank.org/indicator/NV.IND.MANF.ZS>

⁹ Ibid.

¹⁰ Credit Suisse (2013). Global Industrial Automation. https://doc.research-and-analytics.csfb.com/docView?language=ENG&source=emfromsendlink&format=PDF&document_id=994715241&extdocid=994715241_1_eng_pdf&serialid=hDabUewpvOqQcRiLxK7rxIQJZ8TPLDrYHs47S97OOI%3d

¹¹ The World Bank (2014). Manufacturing, value added (% of GDP). <http://data.worldbank.org/indicator/NV.IND.MANF.ZS>

¹² China Labour Bulletin (19 June 2014). "China now the world's largest market for industrial robots." *China Labour Bulletin*. <http://www.clb.org.hk/en/content/china-now-world%E2%80%99s-largest-market-industrial-robots>

¹³ Statistics Canada (2014). Gross domestic product at basic prices, by industry (monthly). <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gdps04a-eng.htm>



accounts for 14 percent of GDP. Untransformed natural resources, which strip away manufacturing activity that transform resources into intermediate goods, represent nearly 11 percent of GDP.¹⁴ When you factor in other industries tied directly and indirectly to natural resources, the sector's contribution to GDP is 20 percent.¹⁵ Natural resources and related industries account for 50 percent of Canada's nearly \$480 billion export market.¹⁶

GLOBAL INNOVATION POLICIES

In 2013 approximately 70 percent of total robot sales were concentrated in five countries: Japan, China, the United States, Korea, and Germany.¹⁷ Innovation is high on the policy agenda in these countries. Governments are placing greater emphasis on R&D, innovation, industry partnerships, and talent development while promoting their national innovation strategies to the globe.¹⁸

In 2011 the US government launched *A Strategy for American Innovation*, a blueprint for a private sector-led innovation strategy focusing on digital skills, research, physical infrastructure, and developing a strong ICT ecosystem. By prioritizing market-based innovation, the strategy seeks to harness innovation to attain sustainable growth and create quality jobs following the 2007-08 financial crisis. The blueprint laid out several priority areas, including a wireless initiative to boost high-speed wireless access, patent reform to boost the production of innovative goods, an improved K-12 education program, the development of clean technology, and encouraging entrepreneurship across the country.¹⁹

The government of Japan has long emphasized science and technology as a means to boost the resource-poor country's high standard of living. This emphasis is shared by the private sector and general public, which increasingly look to technology to overcome the challenges of an ageing population and increased global competition. The Basic Law on Science and Technology is considered the linchpin of Japanese innovation policy. Enacted in 1995, the strategy produces five-year plans designed to drive innovation in science and technology. The fourth plan, covering the 2011-2016 period, "proposes the internationalization of [the] Japanese science and technology system."²⁰

Germany is supported by the High-Tech strategy, which was initially adopted in 2006 and ratified in 2009 and 2010. While the bulk of government funding has gone to post-secondary institutions, "Demand-side innovation policies are gaining increasing attention in Germany," according to the European Commission.²¹ The current scheme has prioritized five key areas: climate/energy, health and nutrition, mobility, safety, and communication.²²

Germany's high uptake of industrial robots, which is by far the highest in Europe, is due largely to its robust automotive market, particularly among motor vehicle suppliers. All other industries decreased automation investments in 2013 with the exception of the pharmaceutical and primary metals industries.²³

¹⁴ National Bank of Canada. Canada: The importance of natural resources in the economy. *National Bank Financial Markets*.

<https://www.nbc.ca/content/dam/nbc/en/rates-and-analysis/economic-analysis/special-report-22/jul2013.pdf>

¹⁵ Government of Canada (2014). Responsible Resource Development and Jobs. <http://actionplan.gc.ca/en/backgroundunder/r2d-dr2/responsible-resource-development-and-jobs>

¹⁶ Ibid.

¹⁷ International Federation of Robotics (2014). Industrial Robot Statistics: World Robotics 2014 Industrial Robots. <http://www.ifr.org/industrial-robots/statistics/>

¹⁸ Christian Rammer (2011). Mini Country Report/Germany under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012). *European Commission*. http://ec.europa.eu/enterprise/policies/innovation/files/countryreports/germany_en.pdf

¹⁹ The White House (2011). *A Strategy for American Innovation*. *The White House*. <http://www.slideshare.net/whitehouse/a-strategy-for-american-innovation>

²⁰ Kazuyuki Motohashi (2011). Innovation Policy Challenges for Japan: An Open and Global Strategy. *Centre for Asian Studies*.

²¹ Christian Rammer (2011). Mini Country Report/Germany under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012). *European Commission*. http://ec.europa.eu/enterprise/policies/innovation/files/countryreports/germany_en.pdf

²² Research in Germany (2013). The High-Tech Strategy for Germany. <http://www.research-in-germany.de/dachportal/en/Research-Landscape/R-and-D-Policy-Framework/High-Tech-Strategy.html>

²³ International Federation of Robotics (2014). Industrial Robot Statistics: World Robotics 2014 Industrial Robots. <http://www.ifr.org/industrial-robots/statistics/>



China is witnessing higher adoption rates across a wide spectrum of emerging technologies, including cloud computing, mobile technology, high performance computing (HPC), and industrial robots. Naturally, production costs are much lower in China than they are in Canada and other advanced industrialized nations, which means the world's second-largest economy could become the main destination for robotics companies.

China has become the world's largest market for industrial robotics, adding another layer of challenges for Canadian businesses looking to expand their market. China's supply of industrial robots increased approximately 36 percent annually between 2008 and 2013, giving China one-fifth of the global supply market. A total of 36,560 industrial robots were sold in China in 2013, of which about 9,000 were installed by Chinese developers.²⁴ International developers increased their sales in China by 20 percent in 2013, feeding a country that is set to outstrip the second and third largest robot markets combined in a few years' time.²⁵

²⁴ Ibid.

²⁵ Tanya Powley (1 June 2014). "China becomes largest buyer of industrial robots." *Financial Times*. <http://www.ft.com/intl/cms/s/0/a5cca8c0-e70c-11e3-aa93-00144feabdc0.html#axzz3G8B9ujtE>



4. MAPPING CANADA'S INDUSTRIAL AUTOMATION INDUSTRY

Automation and robotics is a relatively new phenomenon for most businesses. Over 90 percent of the businesses consulted by ICTC indicated they started using automation after 1984, even though more than half (61 percent) of the total businesses surveyed were established before that period. Among those who have been using automation for at least a decade, 70 percent say their use has significantly changed in the past ten years.

According to the IFR, industrial robot sales in Canada increased by 29 percent in 2013, well above the global average of 12 percent. A total of 2,250 industrial robots were sold in Canada in 2013, which is well below peak levels of around 3,000 robots between 2005 and 2007.²⁶ Canada represented approximately 1.3 percent of global industrial robot sales in 2013.

Canada has a relatively high penetration of industrial robots per 10,000 manufacturing employees at 118,²⁷ well above the global average of more than 50, but well below industrial powerhouses such as the United States, Japan, and Germany.²⁸

Canada is home to a small cluster of industrial automation companies (i.e., developers) operating in specialized ICT industries across the country. Developers are companies that design, manufacture, and install industrial automation and robotics equipment. Not all of these companies are based in Canada; some are foreign-owned companies that manufacture industrial automation equipment in Canada. These companies operate in traditional ICT, advanced materials, aerospace and defence, automotive and transportation (including aftermarket exporters), bio-industries, consumer products, health industries, manufacturing and processing technologies, metals and mineral processing, nanotechnology, and solutions for advancing manufacturing.

Canada is home to a small, innovative cluster of industrial automation companies that generate approximately \$2 billion annually in revenues from Canadian and international sources.

Source: ICTC (2014).

On the basis of industry research and secondary data, ICTC estimates that Canada's industrial automation sector, inclusive of Canadian and foreign developers operating in Canada, generates approximately \$2 billion annually in revenues from domestic and international sources.

Given that the global end-user market is valued at more than \$150 billion, Canada's industrial automation enterprises are bringing in approximately 2 percent of global revenues.

Separately, Canada represents approximately 1 to 2 percent of the global end-user market for industrial automation and robotics. This means Canadian developers are relying not only on domestic end-markets, but on international demand. ICTC's consultations with Canadian industrial automation developers confirmed a large and growing international market, with some firms conducting the majority of their business with overseas clients.

the estimated annual revenue generated by Canada's industrial automation sector, including Canadian and foreign developers operating in Canada, is approximately \$2 billion. As industrial automation processes continue to increase and Canadian firms have greater access to international markets, this market is expected to grow over the next several years.

On the basis of secondary data collected through Industry Canada and other sources, ICTC estimates that one-half of Canadian industrial automation companies are based in Ontario (49 percent). One quarter are based in the Western provinces and more than one-fifth (23 percent) are based in Quebec (see figure 3).

²⁶ International Federation of Robotics (2014). Industrial Robot Statistics: World Robotics 2014 Industrial Robots. <http://www.ifr.org/industrial-robots/statistics/>

²⁷ Ibid.

²⁸ Credit Suisse (2013). Global Industrial Automation. https://doc.research-and-analytics.csfb.com/docView?language=ENG&source=emfromsendlink&format=PDF&document_id=994715241&extdocid=994715241_1_eng_pdf&serialid=hDabUewpyOgQcRILxK7rxIQJZZ8TPLDyYHs47S97OOI%3d

Figure 3. Breakdown of Canadian industrial automation companies by region



Source: ICTC; Industry Canada (2014).

Canadian businesses need to go abroad for their automation equipment (see figure 4). All of the most commonly cited suppliers are foreign companies, though some, such as Fanuc, Mazak, and Motoman have operations in Canada.

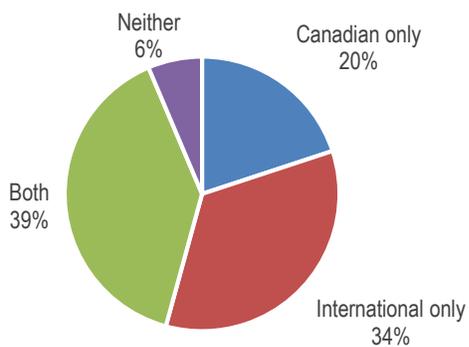
The most commonly used suppliers, per survey respondents:

- ABB (Switzerland)
- Allan Bradley / Rockwell Automation (USA)
- Amada (Japan)
- Fanuc (Japan)
- Mazak (Japan)
- Motoman (Japan)
- Panasonic (Japan)
- Toshiba (Japan)

73% of Canadian businesses turn to suppliers outside of Canada for their automation equipment, and 34% rely exclusively on non-Canadian suppliers.

Source: ICTC (2014)

Figure 4. Proportion of automation equipment purchased from Canadian vs. international sources



Source: ICTC (2014).

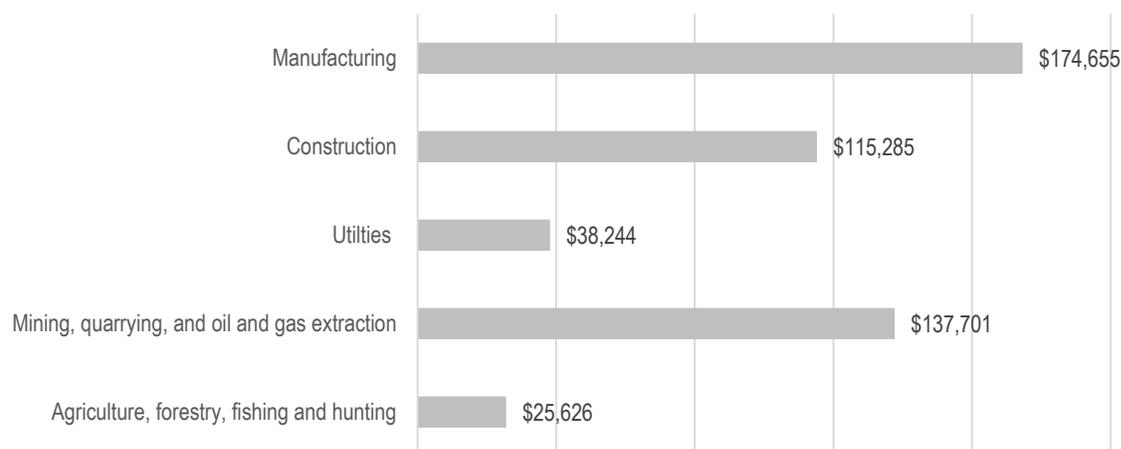
As the next section illustrates, the manufacturing sector is the biggest user of industrial automation, especially the steel, automotive, machinery and food products sub-sectors.

5. INDUSTRIAL AUTOMATION IN CANADA'S GOODS-PRODUCING SECTOR

Automation is a key catalyst of industrial production in the goods-producing industry, which include sectors such as manufacturing, construction, utilities, mining, agriculture, and others.²⁹ This sector is a key driver of Canada's export market and contributes approximately 30 percent to national gross domestic product.

Below is a breakdown of Canada's five goods-producing industries and their corresponding contribution to GDP.

Figure 5. GDP contribution of goods-producing industries, July 2014, in millions of chained dollars (2007)



Source: Statistics Canada (2014). Gross domestic product at basic prices, by industry (monthly). <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gdps04a-eng.htm>

Industrial production in Canada increased at an annual rate of 4.8 percent in July 2014, and has averaged approximately 1.1 percent annually since 1998.³⁰ Manufacturing output, which accounts for a key component of industrial production, has rebounded in 2014 after experiencing a broad slowdown the previous year that resulted from generally weak international trade.

Canada's manufacturing industry has been in expansion mode since April 2013, as higher levels of output and new orders continue to support domestic producers, according to the Royal Bank of Canada's monthly purchasing managers' index (PMI). Manufacturing output reached a nine-month high in August, which supported the fastest rate of jobs growth in nearly one year. Total output eased slightly in September, but the rate of growth was enough to give Canadian manufacturers their strongest quarter of growth since the third quarter of 2013.³¹

Goods-producers, year-on-year growth

Manufacturing: +4.7%
 Construction: +1.6%
 Utilities: -3.1%
 Mining, quarrying, and oil and gas extraction: +7.2%
 Agriculture, forestry, fishing and hunting: -11.1%
Total: +3%

Source: Statistics Canada (2014).

²⁹ Industry Canada (2013). Goods-Producing Sectors of the Canadian Economy. https://www.ic.gc.ca/eic/site/cis-sic.nsf/eng/h_00007.html

³⁰ Trading Economics (2014) Canada Industrial Production. <http://www.tradingeconomics.com/canada/industrial-production>

³¹ Markit Economics/Royal Bank of Canada (2014). Manufacturing business conditions continued to improve in September. <http://www.markiteconomics.com/Survey/PressRelease.mvc/82c1e4bb37d84a51914bda389b113879>



Canada's export sector is a heavy user of industrial automation. In 2013, Canadian exports were valued at more than \$479 billion.³² Motor vehicles and parts, industrial machinery, aircraft, telecommunications equipment, timber, natural gas, and crude petroleum are just some of the major goods Canada exports.

Businesses operating in these and other industries rely heavily on industrial automation to streamline process, enhance efficiencies, and increase production output. This is especially the case for manufacturers, who based on ICTC's survey, allocate significant resources to boost productivity and reduce costs. To gauge the impact of automation on Canadian industry, ICTC considers how companies today are using automation for:

- Accessibility
- Construction
- Hazardous work
- Equipment repair
- Product assembly
- Product packaging
- Product testing
- Product transportation
- Resource harvesting

As discussed in Section 4, Canadian businesses began integrating industrial automation into their workflow relatively recently. Businesses generally adopted industrial automation in a piecemeal fashion, beginning with the automation of minor components of their operations before automating major elements of their operations. Businesses generally had machines they considered "automated," such as CNC machinery (e.g., automated lathe, press, cutter), while fewer had "robotics" (e.g., welding arms, pick-and-place machines). There was general consensus that CNC technology was the entry-level technology among automation equipment, and that industrial robotics were more advanced.

PRODUCTIVITY

Automation is a labour saving innovation that is widely believed to increase labour productivity. This is especially true in manufacturing, where automation has replaced repetitive tasks such as product assembly and packaging. Automation has also increased productivity by reducing human involvement in hazardous work, which reduces the likelihood of severe injury. Figure 6 illustrates the general and specific uses of industrial automation in Canadian industry.

As we will see in the employment section, automation has had a big impact on employment. For some companies, automation greatly increases employment whereas for others the introduction of lean manufacturing has removed the need for certain types of workers. These competing forces arise from the fact that automation reduces labour intensity, which results in higher levels of productivity and a reduction workforce. However, the savings associated with this process – that is, the reduction in overall marginal costs – leads to higher levels of output and greater job opportunities in other fields.³³

Among those that have been using automation for at least a decade, 70% indicated their use of automation **"changed significantly over the past ten years."**

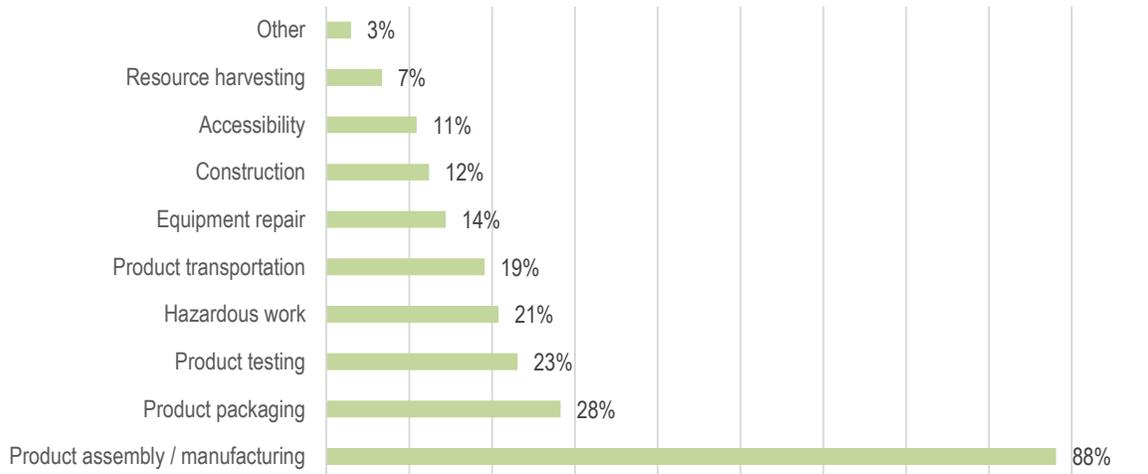
Of these businesses, two-thirds (68%) report production costs have decreased as a result, and nine-tenths (90%) say productivity has increased.

³² Statistics Canada (2014). Imports, exports and trade balance of goods on a balance-of-payments basis, by country or country grouping.

<http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gblec02a-eng.htm>

³³ Lene Kromann, Jan Rose Skaksen and Anders Sorensen (2011). Automation, labor productivity and employment – a cross country comparison. *Aim-Projekt*. <http://www.aim-projekt.dk/files/robot-employment.pdf>

Figure 6. Specific Functions of industrial automation in Canadian business

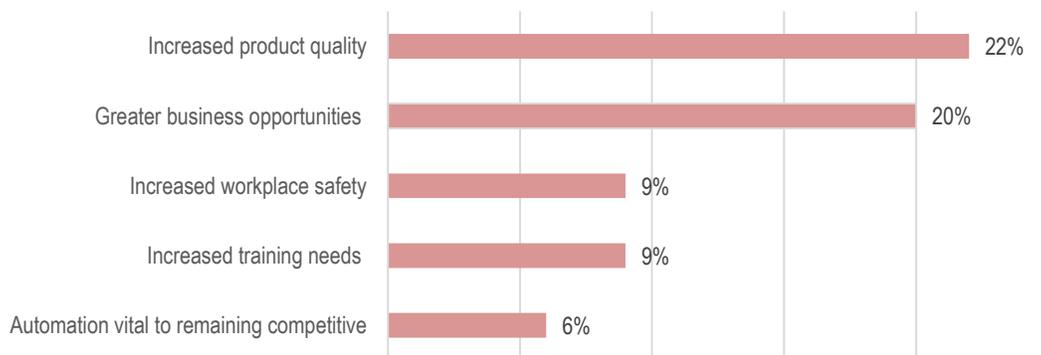


Source: ICTC (2014).

Among businesses that began using industrial automation within the last ten years or indicated their automation use has changed significantly in the past decade, an overwhelming majority (90 percent) said the integration of automation increased productivity. More than half (52 percent) noted productivity gains of between 10 percent and 29 percent.

Increased productivity as a result of industrial automation also reduces overall production costs, as predicted by the literature. Two-thirds of these businesses said the integration of industrial automation reduced production costs. Nearly half of companies (42 percent) said production costs fell between 10 percent and 29 percent as a result of automation.

Figure 7. Other impacts of industrial automation



Source: ICTC (2014).



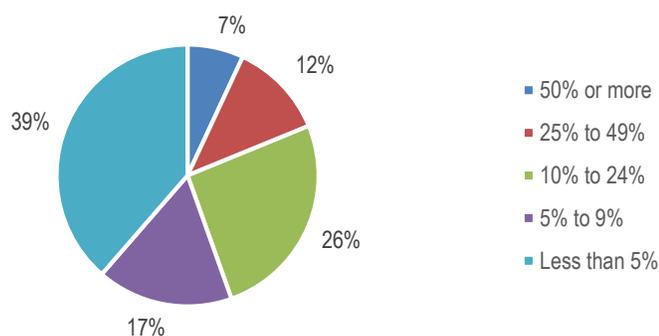
Canadian businesses acknowledged several other practical and economic benefits of industrial automation processes, including improved product quality and increased workplace safety. Figure 7 illustrates other perceived benefits of automation adoption.

EXPENDITURE

Canadian automation companies generate approximately \$2 billion annually in revenues, although this only scratches the surface of total expenditures on industrial automation technologies. As discussed previously, the total end-market value of the global automation industry is \$152 billion – a figure expected to grow more than 6 percent annually.

For the most part, automation-related expenditures account for between 5 percent and 49 percent of companies' total operating expenditures. Fifty-five percent of companies fall into this category. For a further breakdown, see figure 8.

Figure 8. Percentage of total operational expenditure spent on industrial automation



Source: ICTC (2014).

Thirty-nine percent of companies indicated they spend less than 5 percent of total operating expenditures on automation equipment and processes. By contrast, only 7 percent of the companies surveyed said 50 percent or more of operational expenditures are devoted to industrial automation.

Businesses noted that automation-related equipment was not readily available from Canadian suppliers, forcing them to search internationally. Some equipment was manufactured in Canada but by foreign-owned companies. Businesses said that foreign suppliers have greater experience, which allowed them to produce more advanced automation equipment that fulfilled very specific functions. Even then, some businesses have had to modify their equipment to fulfill product-specific functions (e.g., food processing). This may have required bringing on consultants to assist with this process.

EMPLOYMENT

There are competing views about the impact of automation on the labour market and whether advances in lean manufacturing result in more job losses or increased job opportunities in the rest of the economy. The popular myth that surrounds automation is that it takes away jobs and results in downsizing labour. Our research indicates that that instead of replacing jobs, automation displaces jobs. In other words, automation reduces the need for monotonous tasks and lower skilled jobs, while increases demand for more cognitive tasks with digital literacy. Also, higher productivity and lean manufacturing generally lead to increased sales and expansion of business in scale and scope, resulting in additional employment potential.

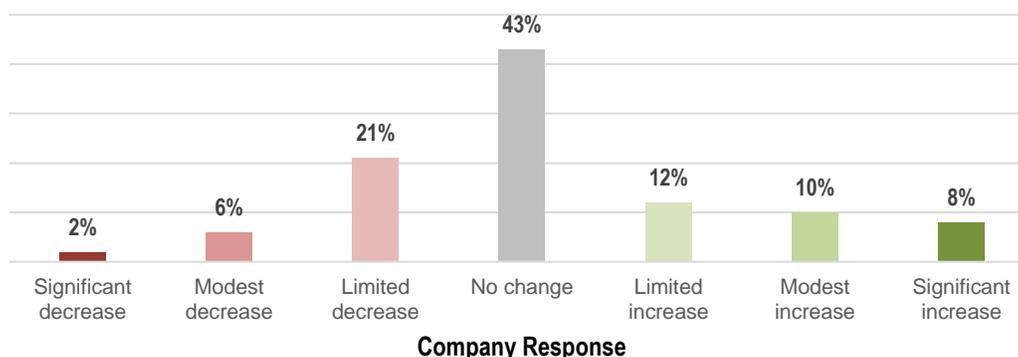
While historical trends clearly indicate that automation will inevitably impact employment trends over time, this impact is not always predictable.³⁴ Automation has been shown to reduce labour input per unit of output, which results in higher levels of productivity, but also a reduced workforce. However, automation has also been proven to reduce the marginal costs of production, which leads to higher output levels that often lead to increased employment.³⁵

Companies interviewed by ICTC were virtually split evenly on the overall impact of automaton on the workforce. Although most companies indicated a direct relationship between industrial automation and staffing levels, no clear trend emerged. Among businesses that said their usage of automation had increased over the past decade, about one quarter (29 percent) said the adoption of automation reduced overall employment. About the same (30 percent) said industrial automation led to higher employment in the company (see figure 9).

ICTC's research found that the introduction of automation certainly reduces demand for certain types of workers, but also increases demand for other professionals as a result of higher productivity and increased cost savings. In the latter case, costs savings are redistributed back into the economy via lower prices, higher wages for remaining employees, and increased profits for successful business.³⁶ In other words, automation enables companies to boost productivity without increasing costs, which leads to greater prosperity. More prosperous firms expand their operations and purchase new equipment in order to grow. These practices support job creation over the long-run, although the exact nature of these jobs – technical vs. non-technical, highly skilled vs. low skilled – varies considerably among businesses and industries.³⁷

In the declining demographics context of Canada lean manufacturing is helping boost productivity, even with a minimal labour force. This is a huge benefit for regions where finding skilled ICT workers is a huge challenge. However, this puts added pressure on skilled workers tied to the manufacturing industry whose skills may no longer be as relevant due to industrial automation.

Figure 9. Impact of industrial automation on staffing over the last decade (2004-2014)



Source: ICTC (2014).

Automation-related positions can be any ICT occupation directly involved in the development or maintenance of automation workflow, software or processes. These workers typically have a background in information technology, engineering, or a related field. In addition to these ICT-specific roles, ICTC's survey results identified four additional automation-related jobs whose skills

³⁴ Oliver Balch (3 September 2014). "Will robots take over the world? The social impact of automation." *The Guardian*. <http://www.theguardian.com/sustainable-business/2014/sep/03/robots-take-over-world-social-impact-automation>

³⁵ Ben Miller and Robert D. Atkinson (2013). "Are Robots Taking Our Jobs, Or Making Them?" *The Information Technology & Innovation Foundation*. <http://www2.itif.org/2013-are-robots-taking-jobs.pdf>

³⁶ Ibid.

³⁷ David Greenfield (1 September 2011). "Automation's Effects on Jobs." *Automation World*. <http://www.automationworld.com/batch-manufacturing/automations-effect-jobs>



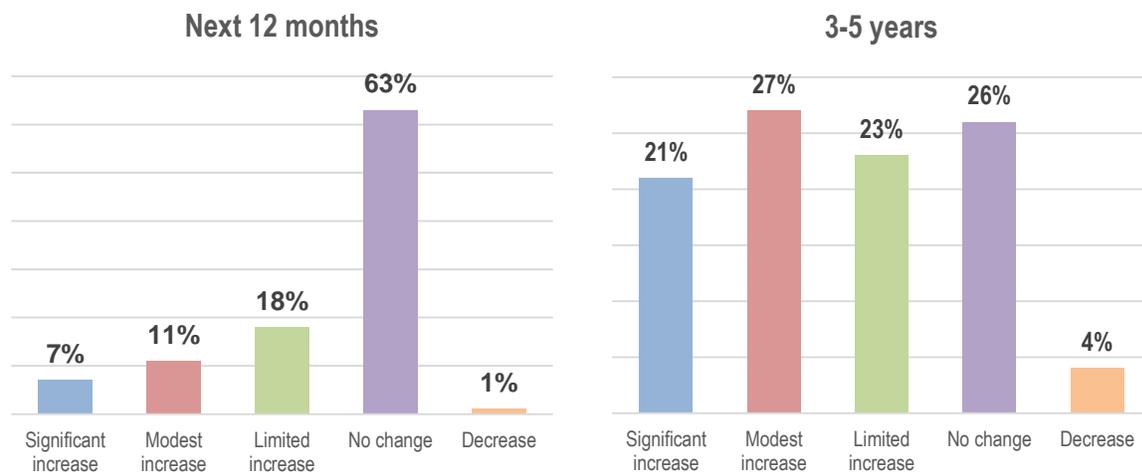
are vital to businesses: mechanical engineers, machinists, welders, and electricians. Below is a breakdown of automation-related occupations and the percentage of businesses that employ them:

Field	Occupation	%
ICT	Technologists	48%
	Systems technicians	46%
	Computer programmers	45%
	Electrical and electronics engineers	39%
	Computer engineers	24%
	Software engineers	21%
	Software developers	21%
	Software testers	18%
Non-ICT	Mechanical engineers	73%
	Machinists	73%
	Welders	68%
	Electricians	64%

Generally speaking, Canadian businesses are staffing automation services locally, but relying more on foreign sources for automation equipment. For instance, almost half (45 percent) of businesses say they rely exclusively on Canadian sources for industrial automation professional services, but only a fifth (20 percent) rely exclusively on Canadian sources for automation equipment.

While businesses tend to currently only have a fraction of their staff using automation, this is likely to change significantly in the next three-to-five years. Most businesses do not anticipate their automation-related employment levels will increase this year, but most believe they will increase within five years. Very few businesses expect to reduce the number of workers who are using automation (see figure 10).

Figure 10. Industrial automation staffing outlook



Source: ICTC (2014).

Figure 10 compare the number of businesses that expect their automation and robotics-related staff numbers to increase, decrease, or not change over the short-term (12-months) and long-term (three-to-five years).

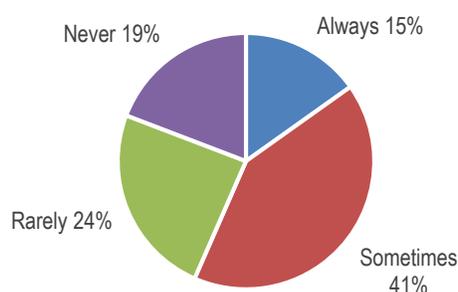


As the figure on the left shows, nearly two thirds of businesses expect no change in automation-related employment over the next 12 months. Among those who do expect growth, their estimates are generally modest. The figure on the right shows that most businesses do anticipate significant change within the next three-to-five years. A fifth of businesses expect to increase their automation-related employment by 20 percent or more. This does not necessarily mean businesses will have to take on more staff. Rather it could include retraining existing staff to use new equipment and processes.

Whether businesses plan to bring on new employees to use industrial automation, or retrain the employees they already have, they may have some difficulty maintaining a skilled workforce. About half of businesses said they always or sometimes experience difficulty filling their industrial automation-related positions (57 percent). Figure 11 illustrates this point.

A small pool of available talent and challenges retaining staff were the two biggest employment-related challenges companies faced. Regional issues, industry competition, and a dearth of post-secondary programs specializing in industrial automation exacerbated these challenges.

Figure 11. How often businesses face difficulty recruiting talent for automation operations



Source: ICTC (2014).



6. SUPPORTING CANADA'S INDUSTRIAL AUTOMATION INDUSTRY

Industrial automation has expanded the frontiers of Canadian manufacturing capability, which has resulted in a bigger and more prosperous sector. As a world leader in natural resources, Canada stands to benefit significantly from increased adoption of lean manufacturing.

Industrial automation companies are capitalizing on growing demand for efficient technologies that can boost productivity and create leaner production operations that are more consistent and of higher quality. In this vein, developers can seize a growing market that extends far beyond the manufacturing sector to include oil and gas, healthcare, construction, defence, transportation, and warehousing.³⁸

Canadian developers are typically prosperous firms that generate millions of dollars in annual revenues. In order to maximize business success automation companies require additional policy supports, funding opportunities, and access to international markets to keep pace with players in the competitive global arena. This section provides a summary of the key recommendations posited by industry to strengthen Canada's lean manufacturing capability.

A major barrier to growth continues to be a stagnant domestic economy. Canada's economy is operating below capacity, according to several economic indicators including employment, exports, and industrial production. As a result, Canadian automation businesses are finding it more difficult to expand nationally, which may limit their willingness to invest in the short-term.

The Canadian economy expanded 2 percent in 2013, and is expected to grow at a similar rate in 2014, according to the International Monetary Fund. The economy is forecast to pick up only gradually in 2015, a sign spare capacity will persist over the next two years.³⁹ According to the Bank of Canada, the economy will operate below capacity until the middle of 2016.⁴⁰

The outlook is not all gloom and doom, however. A weaker Canadian dollar combined with a stronger US recovery have boosted Canadian exports, which resulted in faster economic growth in the second quarter of 2014. Canada's gross domestic product expanded 3.6 percent annually in the second quarter, the biggest gain in nearly three years. The economy maintained a solid growth pace in the third quarter, expanding 2.8 percent year-on-year.⁴¹

A faster recovery south of the border will help create a bigger market for Canadian exports. A consensus of companies interviewed by ICTC identified the United States as a key export market.

SUPPORTIVE TRADE POLICIES

Like in other advanced industrialized economies, Canada has witnessed a gradual decline in manufacturing output over the decades, as producers shifted their production lines overseas to take advantage of cost savings. In the process Canada lost much of its manufacturing backbone, which was gradually replaced by a knowledge-based professional services economy. Given that Canada has a relatively small manufacturing sector in absolute size and as a percentage of GDP, Canadian automation companies must succeed internationally in order to remain competitive.

³⁸ The Canadian Chamber of Commerce (2013). March of the Robots: Policy Brief – October 2013. *The Canadian Chamber of Commerce*.

<http://www.chamber.ca/media/blog/131031-the-march-of-the-robots/>

³⁹ International Monetary Fund (October 2014). World Economic Outlook. *International Monetary Fund*.

<http://www.imf.org/external/pubs/ft/survey/so/2014/NEW100714A.htm>

⁴⁰ Julian Beltrame (16 July 2014). "Bank of Canada downgrades Canadian economy." *MacLean's*. <http://www.macleans.ca/economy/bank-of-canada-downgrades-canadian-economy/>

⁴¹ John Clinkard (12 December 2014). "Heading into 2015, U.S. and Canadian economic indicators are pointing up." *Journal of Commerce*.

<http://www.journalofcommerce.com/EconomicNews/2014/12/Heading-into-2015-US-and-Canadian-economic-indicators-are-pointing-up-1004633W/>



Robotics penetration in China is less than half of the global average at 23 industrial robots per 10,000 manufacturing employees. China and other emerging economies, therefore, should not be considered inhibitors but accelerators of growth. With the right framework, Canadian businesses can tap into this lucrative market.

Given Canada's growing trade liberalization efforts with several countries, businesses have greater incentive to conduct cross border business with traditional trade partners like the United States and other economic hubs like the European Union, Middle East, and Asia-Pacific. ICTC's research on industrial automation and robotics clearly indicates that Canadian companies must increase their international reach in order to boost Canada's presence in the fast paced global digital economy.

Recommended actions:

- A major hurdle for Canadian developers is accessing the US market. Refining trade agreements to include how cross border interaction between companies are handled should be considered. Policymakers should offer foreign companies incentives to buy Canadian. One way this can be accomplished is by supporting innovations that result in intellectual property that can be supported and protected in Canada. ICTC firmly believes that the adoption of a "patent" box approach that rewards businesses for the commercialization of intellectual property should be considered. This will not only boost the pool of capital available to Canadian companies, it will allow them to sell patented products and licence out patent rights to the international market. Bringing Canadian innovations to the international market is a critical step to increasing national prosperity not just in the industrial automation and robotics sector, but in the rest of the digital economy.
- Trade Commissioners should consider playing a bigger role in developing programs to attract foreign businesses to Canada through incentives. Other programs that help Canadian companies broker foreign partnering, licensing or reseller agreements may also help boost Canadian visibility abroad.

INCREASING FUNDING OPPORTUNITIES

The majority of industrial automation businesses in Canada are small- and medium-sized enterprises (SMEs) that are looking for increased funding opportunities to innovate and expand production. In a sector that relies heavily on innovation and fast R&D cycles, greater funding opportunities can help bring to market competitive products and services needed to compete in the global arena.

Companies interviewed by ICTC agreed almost unanimously that more funding opportunities are needed to help Canadian businesses compete internationally. Current funding programs (public and private) need to be expanded to help companies deal with longer sales cycles.

Recommended actions:

- Building off the "patent" box, policymakers should consider expanding direct funding opportunities to innovative technology companies that may lack marketing expertise. Such a program would not be limited to a certain technologies, but would be open all sub-sectors that could have a positive impact on the end-user market.
- Policymakers should consider providing businesses with a larger investment fund (e.g. equity financing, investment from angel groups, direct funding) to commercialize their intellectual property with favourable lending terms on the basis their commercial product would yield large returns in the market (for example, AVAC Ltd., Alberta).

BOOSTING ADOPTION IN CANADIAN INDUSTRY

Canada has a strong adoption rate of industrial automation when compared to the global average and given that manufacturing accounts for only 11 percent of national GDP. Like with virtually every emerging technology, there is a considerable gap between early adopters and the rest of the market. Typically businesses are reluctant to invest in technology they do not understand. ICTC



believes that it is up to the industry to communicate the economic benefits of automation in non-traditional sectors outside manufacturing.

According to the International Federation of Robotics, the potential growth of industrial automation and robotics “is based on huge potentials of further penetration of the industrial segments like electronics or food and on the ongoing industrialization of the emerging countries.”⁴²

Recommended actions:

- Greater industry advocacy for automation and robotics is strongly needed in Canada. Canada’s automation industry lacks a collective voice that can spearhead adoption in potential high growth sectors such as construction, mining, electronics, and oil and gas. In turn, user industries do not have the required knowledge to make informed decisions about whether to adopt automation technologies.

MAXIMIZING SR&ED

The Scientific Research and Experimental Development (SR&ED) tax incentive program is heavily relied upon by domestic developers. SR&ED incentivizes and supports research and development (R&D), which is critical for the prosperity of the automation and robotics sector.

SR&ED has been leveraged with varying success in Canada’s automation and robotics sector. While most businesses agree that SR&ED is an excellent program for research and development, they require greater commercialization support to ensure their products succeed in the marketplace. An accompanying program that helps businesses commercialize their innovation is strongly desired. According to our Advisory Committee, SR&ED does an excellent job in the innovation process; what is needed after the initial development is a commercialization program that can boost business growth.

Recommended actions:

- Policymakers should consider developing an accompanying program that provides assistance in the commercialization process. This program can help ensure that SR&ED recipients receive the business support they need to succeed in the marketplace. This will also help streamline the SR&ED program toward business growth, as companies will be required to demonstrate how their research will be linked to business growth and commercialization goals. Such a program would help companies compete internationally and ensure that businesses capitalize on their SR&ED-based research.

⁴² International Federation of Robotics (18 September 2013). “The robotics industry is looking into a bright future.” IFR Press Release. <http://www.ifr.org/news/ifr-press-release/the-robotics-industry-is-looking-into-a-bright-future-551/>



7. CONCLUSIONS

Industrial automation and robotics is a highly competitive market that is witnessing a huge uptake in advanced and emerging markets. The growth and widespread adoption of emerging technologies, such as the Internet of Things, will continue to blur the lines between the physical and digital worlds, and create bigger demand for smart machines.

In Canada, adoption of industrial automation is above the global mean, but is significantly below industrial leaders like Japan, Germany, and South Korea, where manufacturing represents a larger component of GDP. By contrast, Canada's manufacturing sector accounts for approximately 11 percent of GDP. Canada's reliance on natural resources, which overtook manufacturing as a percentage of real GDP for the first time in 1997, offers some insights about the relative decline in manufacturing output. Where manufacturing is not prevalent, demand for industrial automation is lower.

A combination of policy and industry initiatives are needed to internationalize Canada's existing automation sector and boost adoption domestically. A more predictable SR&ED program, increased funding opportunities, and improving global visibility can help Canada's automation sector tap into a highly lucrative global market.



ABOUT ICTC

The Information and Communications Technology Council (ICTC) is Canada's leading not-for-profit centre of expertise conducting research, policy development, and creating talent solutions for the digital economy.

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