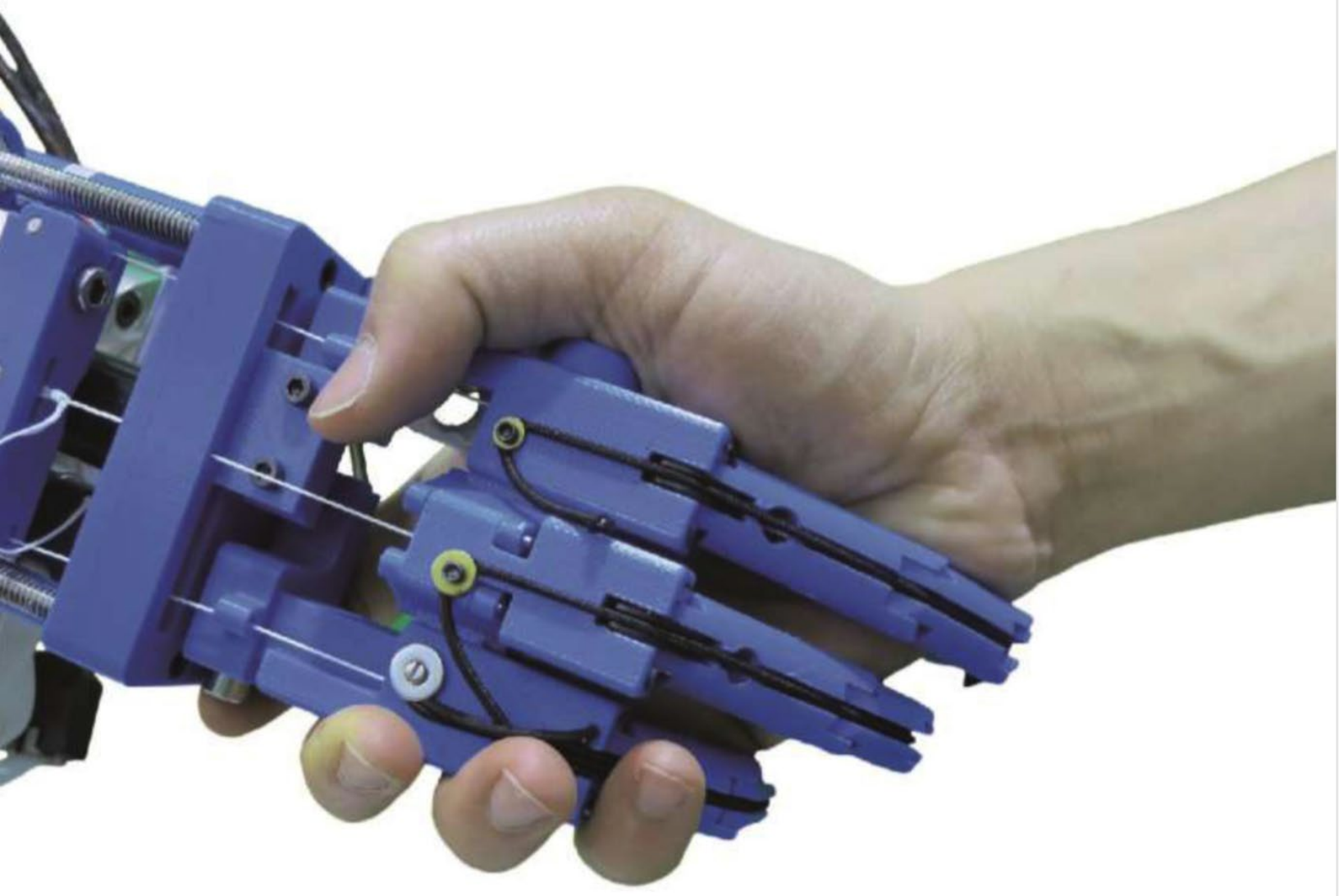
Advanced Manufacturing Sector

Initiative on the Automation of the Manufacturing Sector in Canada



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Acronyms

CNC	Computer Numeric Control
CSA	Canadian Standards Association
C-TPAT	Customs-Trade Partnership Against Terrorism
CRIQ	Quebec Industrial Research Center (CRIQ).
ETS	Public engineering school
ISO	International Organization for Standardization
OEM	Original Equipment Manufacturer
CMM	Coordinate measuring machine
OPC UA	Object Linking and Embedding for Process Control - Unified Architecture
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
PRECARN	Pre-Competitive Applied Research Network
QME	Quebec Manufacturers and Exporters (a branch of Canada Manufacturers and Exporters)
SCADA	Supervisory Control And Data Acquisition

Figures

Executive Summary

Manufacturing in Canada appears to have stopped its decline. The relocation of activities to Asia or Latin America seems to be offset by domestic industry creation. But it is not a return of the companies of the past.

Around the world, a highly automated, state-of-the-art enterprise is emerging with connected equipment in a centralized IT system. Manufacturing is fast becoming a high-tech sector.

China has become the country with the highest number of robots in 2016, ahead of Japan and the United States. On the other hand, the country with the highest density of robots is South Korea. Canada is well above the world average of 69 robots per 10,000 employees, but with 136 robots, it lags behind the US (176 robots per 10,000 employees).

As Professor Gosselin explains in his preface, Canada is a world leader in robotic research thanks to massive injections of money into R&D in the 1990s and the adventure of the Canadarm and Canadarm2 robotic arms for the International Space Station. On the other hand, the manufacturing sector is still falling behind the other industrialized nations.

The challenge today is to translate the benefits of Canadian scientific research into commercial applications.

The Canadian Manufacturing Sector

The CATA Alliance / Sciencetech survey revealed the lack of skilled labor as the number one problem facing Canada's manufacturing industry. This shortage is one of the reasons why companies want to automate their production.

> While manufacturing jobs are high-paying, high-technology jobs, individual career choices are often based on an obsolete view of manufacturing.
> *Advanced Manufacturing, Executive Office of the President of the United States, 2016*

Innovation is omnipresent in the manufacturing sector, but it covers a different reality from R&D. Indeed, only product innovation requires an effort in R&D. Instead, process innovation relates to the management and marketing of the business.

The rise of US protectionism is not perceived as a threat by two thirds of companies. Analysis of responses indicates a certain lack of knowledge of macroeconomic realities. If new tariff or non-tariff barriers are created at the US border, it is clear that the Canadian government will have some information work to do.

Level of automation in Canada

Automation is very widespread in Canada's manufacturing sector, with an estimated 26,000 robots, representing an investment of $ 5.2 billion. More than two-thirds of this amount is attributable to installation, engineering and programming costs and the purchase of peripherals. If the robots are imported in almost all cases, the related costs are paid to a large extent to local integrators. Indeed, Canada has a dynamic integration industry. These companies have recently formed a trade

association, the Group of Experts in Automation and Robotics (GEAR) under the aegis of Canadian Manufacturers & Exporters (CME).

In addition to robots, automation includes multiple systems (CNC machines, 3D printers, visions systems, lasers, sensors, etc.). In total, it can be said that 70% of Canada's manufacturing companies use some form of automation.

Nevertheless, the minority of non-automated companies does not plan to automate in the future. Some could do so through government assistance, but they are a small number. There is an irreducible core which considers that their production is not automatable and that no form of government assistance is required.

The main reason for automation is cost reduction, and if we add similar reasons such as workforce reduction and productivity gains, this predominance becomes overwhelming. The following reason is quality control.

Precisely, the main effect of automation is the reduction in production costs. There is therefore a perfect match between the displayed intention and the result obtained. The next two effects are increased production volume and quality control. The increase in the volume of production is clearly a surprise since it was only marginally cited as one of the reasons for automation.

The decrease in the volume of the workforce is little mentioned under the effects of automation. This finding contradicts those who perceive automation as a major cause of unemployment.

Only a small number of non-automated companies plan to equip themselves with robots and other automated equipment. On the other hand, the majority of already automated companies plan to acquire additional equipment. Eighty-five per cent of companies that are ready to buy robots or other automated equipment are already automated companies: companies that are renewing their equipment or completing it.

Preface: The Robotic Revolution is Nearing

Prof. Clement Gosselin, Laval University
Director of the Robotics Laboratory
Canada Research Chair
in Robotics and Mechatronics

Robotics has existed for decades, especially among automotive manufacturers, where it has been given the most repetitive (and dangerous) tasks such as welding and painting. Today, everything changes, because there is a convergence of several factors.

First, manufacturing companies want to reshore activities that had been delocalised to Asia or Latin America, or even to retain their domestic activities. In order to manufacture in an industrialized country, where the labor force is relatively well-paid, the production chain must be automated. To this purely economic reason one must add awareness among business leaders that the link between design and manufacturing is more important than had been imagined in the past. Even when you keep the design in Canada, if you make it elsewhere, there is something that is lost. What is more, foreign subcontractors who manufacture Canadian-designed products have access to all industry secrets. It should not be surprising if they end up taking over the design and continue to manufacture for their own account.

Then, the arrival of collaborative robots is changing the nature of automation. General Motors plants had two sections: one where classic robots were assembling body parts without the help of anyone; and one where all the work was manual. In recent years, Laval University's robotics lab has been involved in the introduction of collaborative robots in the part of GM where work is done manually to solve ergonomic problems, increase efficiency, facilitate the agility of production, etc. We have arrived in a transitory phase where the robot and the human collaborate to do all the refinishing operations of automotive building. We still need someone to guide the robot, at least partially. Eventually, the goal is for the robot to become more autonomous and do all the work itself.

What is new at the present time is this convergence between the rehabilitation of production activities and the discovery of robots capable of working with humans. Let us add the arrival of artificial intelligence and we have all the ingredients for a major change in our ways of working.

Industrial robotics and service robotics

Let us take the example of autonomous cars: they have already traveled thousands of kilometers under real driving conditions. This means that the boundary between industrial robotics and service robotics is becoming increasingly blurred. Collaborative robots used in the industry are closer to service robots. Service robots used in domestic applications are the cousins of industrial robots. With all the problems of demography that we face, we can predict the arrival of service robots in a horizon not too far.

I see two great fields of application in the line of sight of service robotics: first transport and then healthcare. Why transport first? If we have seen the autonomous cars develop so quickly, it is because the mechanical part was already developed. We have been making cars for more than a century. It is sufficient to add intelligence. We are always referring to autonomous cars, but I rather see the first commercial applications developing in the field of public transport: tram, bus, train, etc. There is room for many automation possibilities. Already, the metro is largely automated: the

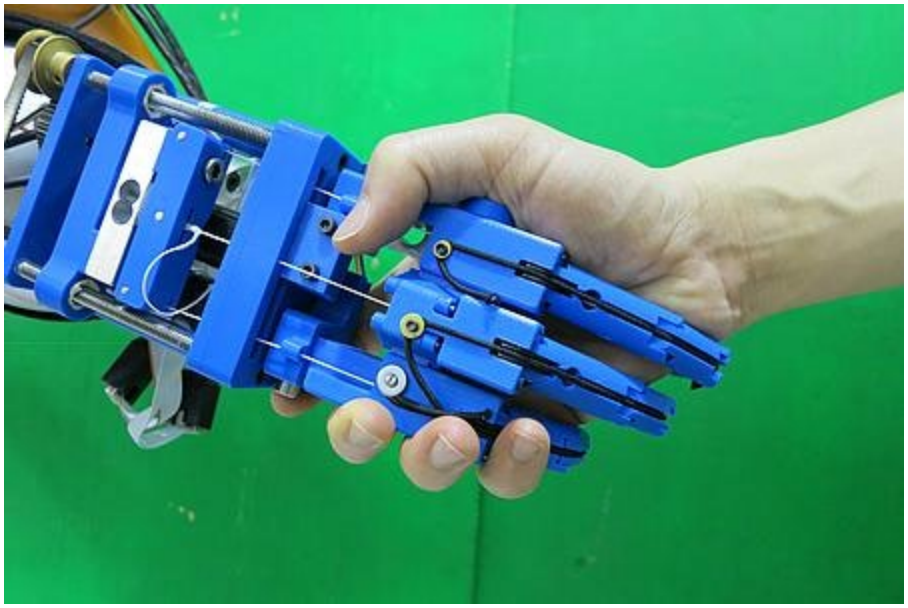
driver's presence is meant to check that everything is running and to intervene only in case of anomalies.

Healthcare robots will take longer to become popular, as a whole range of mechanical applications must be developed that do not yet exist. To help someone at home, for example, we want the robot to be able to do a high-precision job, but at the same time, that it is incapable of hurting a person, etc. This, we do not know yet how to do, from a mechanical point of view. This is a double challenge: besides artificial intelligence, there is also the mechanical challenge.

Ainsi, le laboratoire de robotique de l'Université Laval essaie de développer des systèmes pour l'assistance de personnes handicapées avec le concours du Centre interdisciplinaire de recherche en réadaptation et intégration sociale (CIRRIS). Nous avons développé un système de robot interactif pour les thérapeutes qui doivent évaluer la capacité d'une personne à manipuler les charges. On utilise un environnement de réalité virtuelle : la personne porte un casque et peut voir dans l'espace des boîtes qui n'existent pas physiquement. Grâce à la programmation, on peut changer la masse de la boîte, la friction, les obstacles, etc. Non seulement le système permet au thérapeute d'acquérir des données précises sur les capacités du patient, mais il permet à celui-ci de faire un entrainement à la réadaptation.

The Laval University Robotics Laboratory is trying to develop systems for the assistance of disabled people with the help of the Interdisciplinary Center for Research in Rehabilitation and Social Integration (CIRRIS). We have developed an interactive robot system for therapists who must evaluate a person's ability to handle loads. We use a virtual reality environment: the person wears a helmet and can see boxes that do not exist physically in the space. By programming, you can change the mass of the box, friction, obstacles, etc. Not only does the system allow the therapist to acquire accurate data about the patient's abilities, but it allows the patient to do rehabilitation training.

FIG. 1 – ROBOTIC HAND DEVELOPED BY THE ROBOTICS LABORATORY



There is still a lot of work to do before the robots can be used in residential and long-term care centres, but it is certain that in the medium and long term, this is going to grow. A robot could perform all sorts of tasks to free the nursing staff. The first commercial applications are likely to go

to the institutional sector before entering the home. What is happening in the industrial field is going to happen in the healthcare field: the human will have to learn to live with the robots.

The Canadian Advantage

The race for winning applications is well underway and will require very different talents from traditional skills. Countries that have successfully integrated robotics into their production capacity (Germany, Japan and South Korea) will not necessarily be the robotic giants of tomorrow. Collaborative robotics was born in Denmark thanks to the success of Universal Robots. The big players in the robotics of tomorrow could come from any industrialized country and why not from Canada?

Indeed, Canada is a good figure on the international scene in robotic research: it has top-notch human skills. When GE Aviation wanted to create a new global R&D center in robotics, automation and instrumentation, it chose Bromont, Que. This lab develops advanced robotics processes, software applications and intellectual property components that are exported to GE Aviation facilities around the world. Why did you choose Canada? Precisely, because the company is more likely to find robotic skilled people here than in the US or elsewhere in the world.

This Canadian advantage stems from investments in university research during the 1990s - I am thinking in particular of the PRECARN consortium[1], which was a network dedicated to robotics and intelligent systems. People who was trained then did not necessarily go to robot manufactures or integrators because there were very few of them at that time. Large numbers joined high-tech companies in Canada, bringing their advanced robotics skills.

There was also all of Canada's space research, with programs designed to develop the Canadarm and Canadarm2 robotic arms for the International Space Station. These programs have generated a lot of research in universities. In total, Canada has many leading-edge skills in robotics and innovation.

On the other hand, where the problem lies, it is at the level of manufacturing companies. In this area, my impression is that we are perhaps below the average of the industrialized countries. Many manufacturing companies are relatively small and, until recently, they perceived automation as something beyond their reach. This view is changing. But there is a gap to be filled in terms of automation in companies.

There is an opportunity for Canada. We have the skills to develop new technologies in robotics that could be used in our companies and also in our exports. The government is injecting money into businesses today, which is a good thing, because it allows them to automate. But if we do that, we will encourage the purchase of mostly foreign equipment.

In order to have a complete robotics program, it is also important to consider injecting money into universities and research centers, not to increase the volume of research, but to link up with the commercial phase. We have excellent research results in robotics, now they have to be transformed into commercial products. There, I think there is a leverage effect that could be really interesting for the government.

The model that we must follow is the one given by Lévis-based Robotiq, which is a spin-off from Laval University. This company manufactures a robotic hand that is exported to some thirty

[1] PRECARN hosted the Institute for Research on Intelligent Systems (IRIS) and provided a pre-competitive platform for member companies. PRECARN research and development funding has developed an impressive record of bridging the innovation gap between research and commercialization, thus, helping entrepreneurs and innovators bring forward their ideas to the global market and acquire a competitive edge.

countries. There is also Clearpath in Kitchener, which is a spin-off from the University of Waterloo. This company manufactures mobile robots that are also very well positioned in international markets. In both cases, we have models of what can be done to turn an innovation into commercial success in specific niches.

Canada's chance is that students who are doing advanced work at the master's and doctoral levels are much more aware of the transition to the commercial phase than we were at the time. Many of the students who have passed through the Laval University robotics lab have started their own businesses and marketed products, and I am convinced that the phenomenon is the same in other universities. There are seeds that are ready to grow, but they should be watered!

1. Introduction: Study Objectives, Methodology and Acknowledgements

The battle to maintain an industrial base in Canada is underway. It operates on several fronts. In 2011, we developed a profile of the embedded systems industry. The goal was to make the products "made in Canada" smarter to compete internationally. Today, in this same perspective, we are studying the automation market in the manufacturing sector.

The survey was conducted through a questionnaire of 2,420 Canadian companies. 465 companies replied: 63 by email and 402 by telephone follow-up.

Almost 3/4 of the respondents are automated companies using robots or other advanced systems (CNC machines, 3D printers, sensors, Internet objects, etc.).

The survey was complemented by 21 personalized interviews with businesses, universities and not-for-profit organizations.

This survey was funded by the CATA Alliance, the Ministry of Economy, Science and Innovation (MESI) and the Quebec Industrial Research Center (CRIQ).

1.1 Why This Study?

Everyone is convinced of the need to maintain an industrial base in Canada. Two models are open to us: Germany, where the manufacturing sector accounts for about 30% of the value added produced by the country and that of Canada, where it represents about 12% of value added.[2]

Now, the engine of the industry today is the automation of the production line. Concretely, this automation takes two forms:

- ✓ industrial robots and other automated systems (CNC machines, sensors, lasers, vision systems, 3D printers, etc.);
- ✓ the integration of all these equipments in an intelligent system of Industry 4.0 type or Industrial Internet of Things (IIoT).

All industries are engaged in a speed race to automate their production. While pure robotics is still used by a minority of companies, a majority of them use other automated systems.

The companies that will survive and flourish tomorrow in Canada are the ones that will have automated their production. The others will have disappeared.

Definition of industrial robot

An industrial robot is automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.

The industrial robot includes:

— the manipulator, including actuators;
— the controller, including teach pendant and any communication interface (hardware and software).

Excerpt from the International Standard ISO 8373 (2012)

1.2 Structure of the automation market

The manufacturing sector needs targeted and ongoing investments in automation to meet the challenge of global competitiveness – and become, strictly speaking, the "advanced manufacturing".

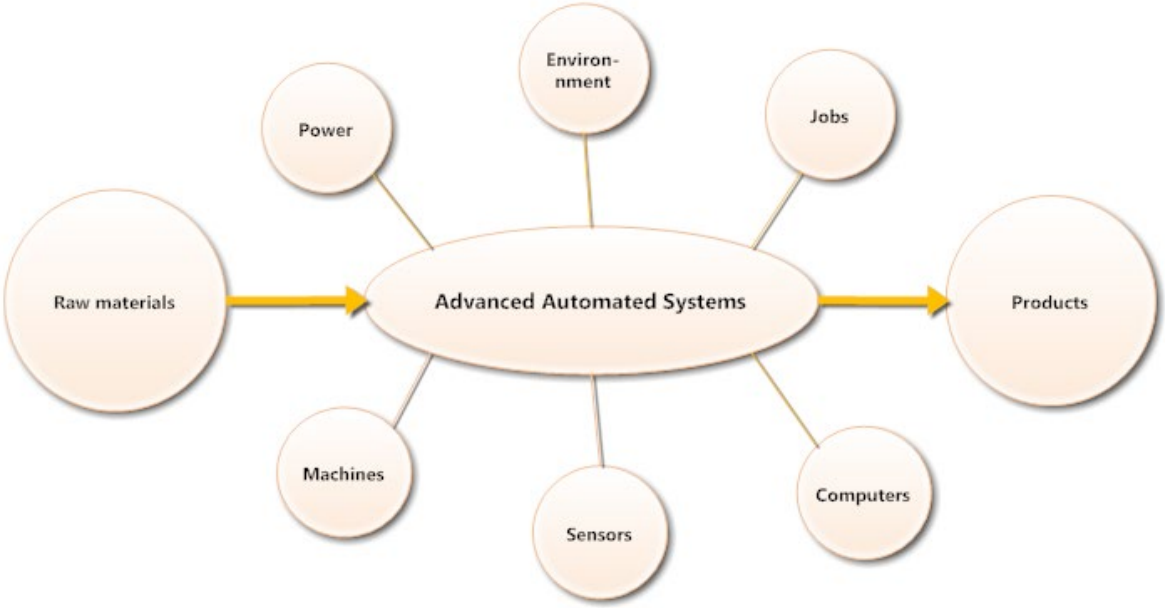
Instead, the years 2000s saw the decline of the sector, which saw whole sectors outsource to Asia and, to a lesser extent, Latin America. The result is that the share of the manufacturing sector in Canada's gross domestic product (GDP) fell by more than a third between 2000 and 2014, from 20% to 14%.

According to our estimate, the global market for industrial robots was more than US $ 38 billion in 2016, including peripheral costs as well as installation and maintenance costs.[3]

[2] World Bank national accounts data, and OECD National Accounts data files, value added (% of GDP), data for 2014. - http://data.worldbank.org/indicator/NV.IND.TOTL.ZS.

[3] The IFR analysts assessed the world market to $ 35 billion at the end of 2015, a 9.2% change compared to 2014. If we assume an identical increase in 2015, we obtain an amount of $ 38.2 billion by the end of 2016.

FIG. 2 – ROBOT MARKET AND OTHER AUTOMATED EQUIPMENT ECOSYSTEM



Source: CATA Alliance/Sciencetech Communications

1.3 Methodology

The study on manufacturing automation is based on three sources of information: a compilation of existing secondary information, mainly the annual data provided by the IFR. The bulk of the study comes from primary information, a survey of manufacturing industry and a series of personal interviews with industry, university and not-for-profit organizations stakeholders.

1.3.1 References

An exhaustive list of the documents consulted would be both long and tedious. On the other hand, some key documents have influenced our overall research. These are:

Title	Organization	Country	Date	Pages
A future that works: automation, employment and productivity	McKinsey Global Institute	United States	2017	135
World Robotics 2016 : Industrial Robots	International Federation of Robotics (IFR)	Germany	2016	482
The Talented Mr. Robot: The impact of automation on Canada's workforce	The Brookfield Institute for Innovation	Canada	2016	47
The Robotics Revolution: The Next Great Leap in Manufacturing	Boston Consulting Group	United States	2015	24

Robot Revolution – Global Robot & AI Primer	Bank of America et Merril Lynch	United States	2015	304
Robots at Work	Centre for Economic Performance	United Kingdom	2015	54
Innovation: the future of the manufacturing sector in Canada	Canadian Chamber of Commerce	Canada	2014	28
Ontario Made: Rethinking Manufacturing in the 21st Century	Mowat Centre	Canada	2014	75
Positive Impact of Industrial Robots on Employment	International Federation of Robotics (IFR)	Germany	2013	66
The Future of Employment: How Susceptible Are Jobs to Computerisation?	University of Oxford	United Kingdom	2013	72
SME Manufacturers in Quebec: Adding Services to Boost Competitiveness and the Bottom Line	McGill University and the Conference Board of Canada	Canada	2012	26
The Canadian Manufacturing Sector: Adapting to Challenges	Statistics Canada	Canada	2009	55

The following magasines suivants were systematically consulted and dome of them contacted for advice:

- *Canadian Manufacturing*
- *Canadian Metalworking*
- *Design Engineering*
- *Manufacturing Automation*
- *Plant*

Other secondary sources that we have consulted and used on an ad hoc basis are listed in the footnotes.

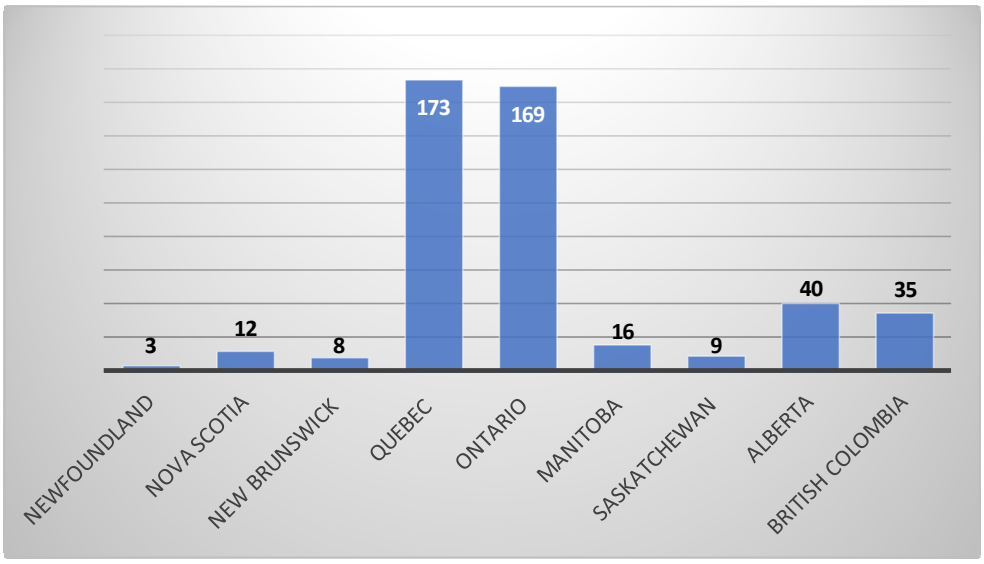
1.3.2 Survey

The quantitative survey covered a population of 2,420 firms. A questionnaire (see Appendix II) was sent by e-mail in December 2016, which received 63 responses. A telephone follow-up was carried out in January 2017 by the Altus Group, which received 402 responses. A total of 465 companies responded.

There are 22,727 firms with 10 or more employees in the Canadian manufacturing sector.[4]

[4] Statistique Canada, Tableau CANSIM 552-0004, Canadian business counts, location counts with employees, by employment size and North American Industry Classification System (NAICS), Canada and provinces, June 2016.

FIG. 3 – THE SURVEY



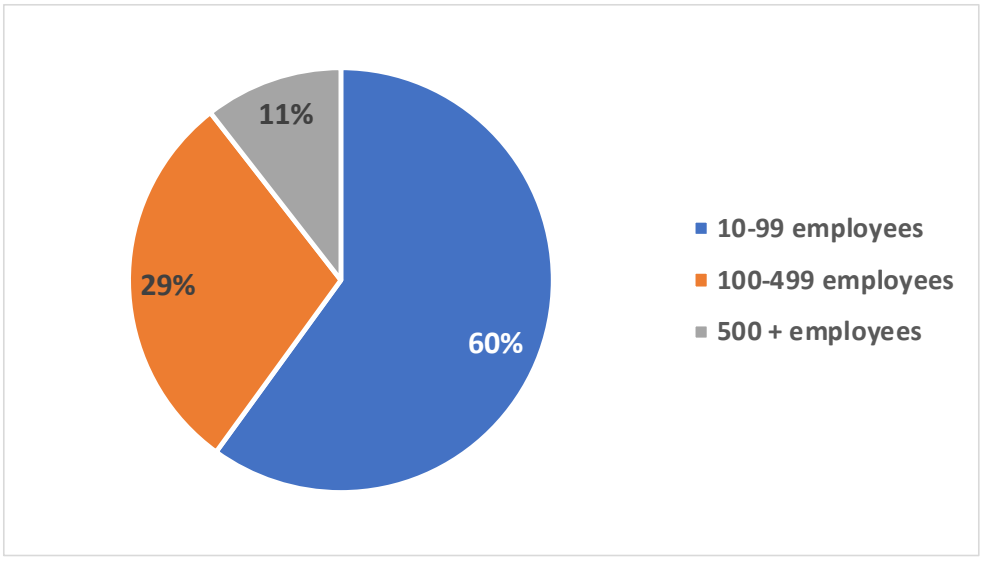
Source: Survey CATA Alliance/Sciencetech communications – December 2016-January 2017

1.3.3 General Characteristics of Respondents

Small businesses and medium-sized enterprises are under-represented, while large firms are over-represented. We have therefore weighted the results to obtain absolute figures that accurately reflect reality.

FIG. 4 – SIZE OF THE COMPANIES

Total number of employees working in the Company – in Canada only



Source: Survey CATA Alliance/Sciencetech communications – December 2016-January 2017

> One of the biggest challenges in Canada, both at exporters and at the government level, is to create more of these medium-sized businesses that are ready to invest in the next stage and are ready to export. If we really want to strengthen our economy, particularly our manufacturing economy, that is where we need to go.
>
> *Eric Tetrault, Quebec Manufacturers and Exporters*

Similarly, we have classified firms according to their NAICS code. The survey was structured to respect the relative weightings of each category, so that the distribution of the results is fairly accurate to the industrial reality.

FIG. 5 - BREAKDOWN OF RESPONDENTS BY CATEGORY OF ACTIVITY

Subsector	NAICS Code	Cies #
Food manufacturing	311	25
Beverage and tobacco product manufacturing	312	6
Textile mills	313	14
Textile product mills	314	4
Clothing manufacturing	315	11
Leather and allied product manufacturing	316	3
Wood product manufacturing	321	33
Paper manufacturing	322	11
Printing and related support activities	323	17
Petroleum and coal product manufacturing	324	6
Chemical manufacturing	325	26
Plastics and rubber products manufacturing	326	30
Non-metallic mineral product manufacturing	327	9
Primary metal manufacturing	331	15
Fabricated metal product manufacturing	332	81
Machinery manufacturing	333	52
Computer and electronic product manufacturing	334	27
Electrical equipment, appliance and component manufacturing	335	20
Transportation equipment manufacturing	336	36
Furniture and related product manufacturing	337	14
Miscellaneous manufacturing	339	20
Machinery, equipment and supplies merchant wholesalers	417	1
Professional, scientific and technical services	541	3
Educational services	611	1
Total		465

Source: Survey CATA Alliance/Sciencetech communications – December 2016-January 2017

1.3.4 Interviews and Roundtable

The qualitative aspect of the study is based on a customized series of interviews and a roundtable. Some of these interviews led to a case study (see Appendix I), all served to clarify and enrich the statistics provided by the survey.

A°) One-to-one Interviews

Twenty-one interviews were conducted (17 companies, two universities, one association and one non-profit organization). The interviews were conducted face to face or by telephone, and all respondents are in Canada.

21 ONE-TO-ONE INTERVIEWS

AGT Robotics	Louis Dicaire, General Director	February 21, 2017
Quebec Manufacturers and Exporters (QME)	Éric Tétrault, President	February 22, 2017
Siemens Canada Engineering and Technology Academy (SCETA)	Tom Murad, Director	February 23, 2017
Deloitte	Louis Duhamel, Strategic Advisor	February 24, 2017
La Petite Bretonne	Serge Bohec, President and CEO	February 27, 2017
Vestshell	Joseph Laflamme, President and CEO	February 28, 2017
Medtronic	David R. Lee, Executive Director	March 01, 2017
Polytechnique Montréal	Lionel Birglen, Professor and Director of the Robotics Laboratory	March 01, 2017
Festo	Patrice Charlebois, Industry Segment Manager - Food & Beverage, Biotech/Pharma	March 02, 2017
Labplas	Alain Périard, Director of Operations and Benoit Brouillette, Deputy Executive Director	March 03, 2017
Précinov	Mathieu DeBlois, President and CEO	March 06, 2017
Génik	Donald Turcotte, President and CEO	March 06, 2017
Vêtements SP	Serge Bérard, President and CEO	March 07, 2017
Symbotic	Nicolas Durand, Sales Director	March 07, 2017
Etalex	Jean-François Rousseau, Director of Operations	March 15, 2017
APN	Yves Proteau, Co-President	March 16, 2017
Lantic	Bob Copeland, Vice President Operations	March 17, 2017
Centre de recherche industrielle du Québec (CRIQ)	François Gingras, Director Productivity and Industrial Systems	March 17, 2017
Cisco	Rick Huijbregts, Vice President Digital Transformation and Innovation	March 22, 2017
Bombardier Recreational Products (BRP)	Gilles Blais, Directeur Manufacturing Strategy and Joël Bombardier, Director Systems and Technology	March 23, 2017
Laval University	Clément Gosselin, Professor, Director of the Robotics Laboratory, Canada Research Chair in Robotics and Mechatronics	March 23, 2017

B°) The Roundtable

The gross results of the survey were presented to an evening roundtable on February 15, 2017 in the facilities of the Industrial Research Center of Quebec (CRIQ) in Montreal before 40 representatives of the manufacturing sector and the automation industry. The presentation was followed by an hour and a half lively debate that was duly compiled and included in this study.

1.4 Production Team, Funding for the Study and Acknowledgements

1.4.1 The Team

The 2017 study on the robotics and other automated systems industry in Canada was led by Jean-Guy Rens, Vice President of the Canadian Advanced Technology *Alliance* (CATA) and Senior Partner of ScienceTech Communications Inc., in collaboration with Huguette Guilhaumon, also Senior Partner of ScienceTech Communications.

John Reid, President of the CATA*Alliance* oversaw the financing and administration of the study in collaboration with Cathi Malette, Executive Manager.

1.4.2 Financing

The constitution of the database and the completion of the overall study were funded by the CATA Alliance and by sales of the study.

A first survey limited to the Quebec-based robotics and other automated systems industry was funded by the Ministry of Economy, Science and Innovation (MESI) and the Industrial Research Center of Quebec (CRIQ). The Quebec data were combined with the broader all-Canadian results in order to produce this report.

1.4.3 Acknowledgements

Together CATA and ScienceTech Communications would like to especially thank Prof. Clément Gosselin, Director of the Robotics Laboratory, Canada Research Chair in Robotics and Mechatronics, for his intellectual contribution to the study, which took the form of a preface.

We want as well to thank Martin Joncas, advisor in industrial development at MESI who provided his help throughout all along the development of the initiative on robotics and other automated systems industry. Similarly, Denis Hardy, president of the CRIQ, has trusted us from the first day and is entitled to a special recognition.

Finally, we express gratitude for all the following people who helped us to identify automation stakeholders who should be interviewed:

Samuel Bouchard	Robotiq
Patrice Charlebois	Festo
Louis Duhamel	Deloitte
Dikran Husseindjian	Robotiq
Luc Vanden-Abeele	Symbotic

We are finally indebted to the people working in the voluntary sector. Several of them did not hesitate to give us their advice and their time, from the questionnaire to the analysis of the answers. Their input has been invaluable.

François Borrelli, Vice President	PROMPT
Daniel Deschamps, General Director	Grouping of Suppliers in Industrial Automation (REAI)
Louis Dicaire, Vice President Marketing & Associate	AGT Robotics
Sâadia Lakehal, General Director	Association of Inter-Industries of Montreal (AIIM)

Disclaimer:

The CATA Alliance and the ScienceTech team assume responsibility for any error and omission in this study on the advanced manufacturing sector in Canada. Neither the many people who generously contributed to this project nor the partners nor the clients that put their trust in us can be held responsible for the content of this study.

2. Technological & International Environment

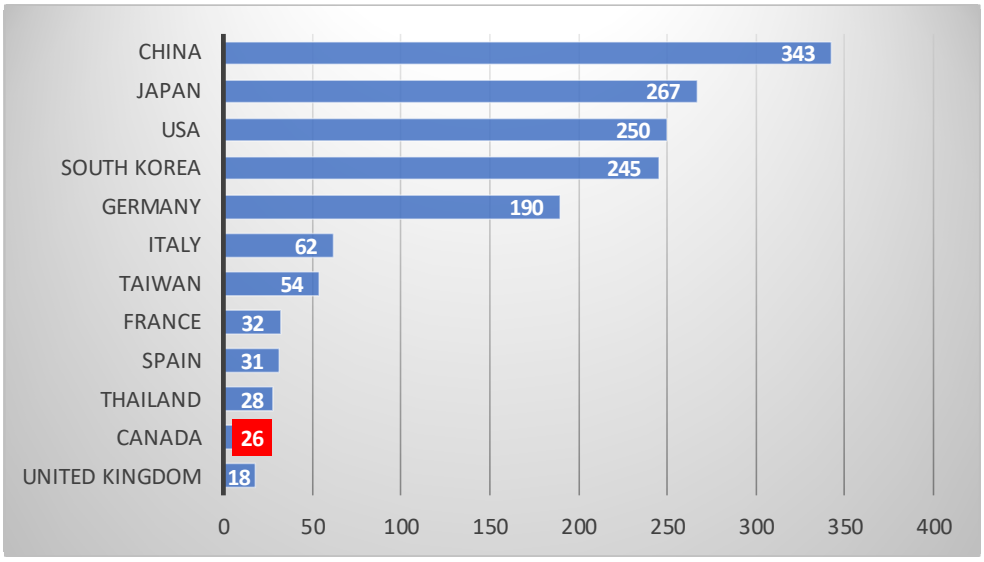
2.1 International Environment

China bought 90,000 of the 240,000 robots sold worldwide in 2016. This is by far the largest buyer of robots. Its installed base of robots amounted to 343,000. In 2016 it became the first automated country in the world, ahead of Japan and the United States.[5]

Not only is China being automated at high speed, but it has the ambition to become a world leader in the production of robots. Already, nearly one third of the robots sold in China are produced locally. On the international scene, Chinese investors have entered a buying frenzy: the German giant Kuka was bought in 2016 by the Chinese group Midea. Shortly before, another German manufacturer, KraussMafei, was purchased by ChemChina – KraussMafei was previously owned by the Toronto-based investment fund Onex. The U.S.-based Paslin was bought by Wanfeng.[6]

Is China an isolated case among emerging countries? Not at all. South Korea, Taiwan, Indonesia and Thailand are also automating their manufacturing sectors. Some of these countries do so because their wages have risen sharply – making them less competitive in the global market. Others do so to meet the quality standards of developed countries.[7]

FIG. 6 - NUMBER OF ROBOTS IN THE MOST AUTOMATED COUNTRIES IN 2016 (THOUSANDS)



Source: "World Robotics 2016: Industrial Robots", International Federation of Robotics (IFR), 2016. Our assessment out of the data for 2015.

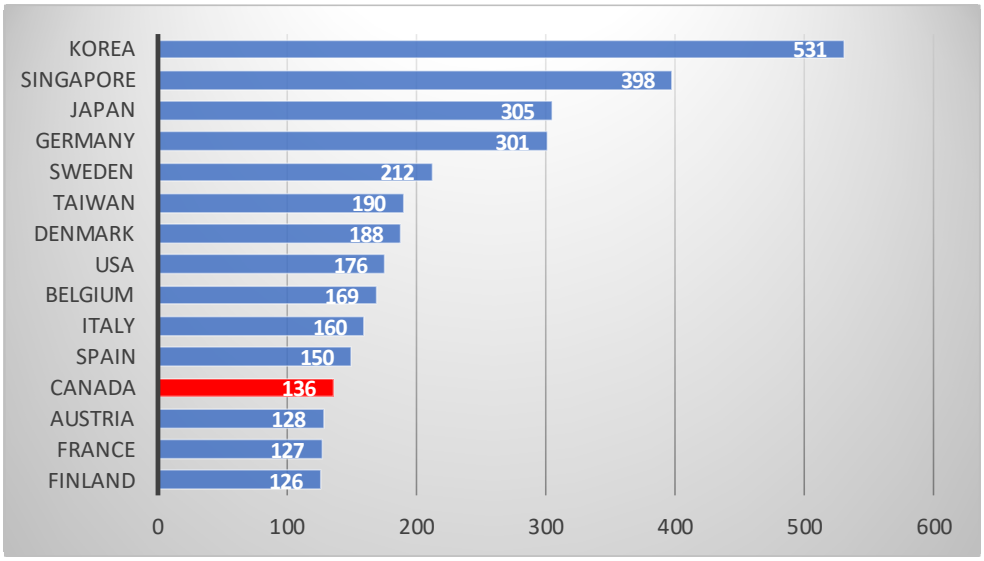
Those who think that the competition of the emerging countries in the manufacturing sector is coming to an end are exposed to serious disappointments. Competition from these countries has only just begun, with automation taking over from cheap labor as a comparative advantage. There was an estimated 1.8 million robots worldwide by the end of 2016. However, more than 70% of the

[5] "World Robotics 2016: Industrial Robots", International Federation of Robotics (IFR), 2016. Cf. pp. 18-9.
[6] Frank Tobe, "What's happening in robotics? Five trends to watch", *The Robot Report*, June 27, 2016..
[7] "The Robotics Revolution", Boston Consulting Group, September 2015. Cf. pp. 16-7.

global stockpile is concentrated in five countries: China, Japan, the United States, Korea and Germany.[8]

If we consider the density of robotics in the world, we see a very different map. Density equals the number of robots per 10,000 employees. Korea is by far the most automated country in the world. China disappears from the picture, which shows that this country is still in the process of being equipped. Its massive purchases of robots are expected to continue for years to come, while the traditional robotic champion, Japan, has seen its density stagnate over the last decade.

FIG. 7 – ROBOTS DENSITY IN THE MOST AUTOMATED COUNTRIES IN 2015 (NUMBER OF ROBOTS PER 10,000 EMPLOYEES)



Source: "World Robotics 2016: Industrial Robots", International Federation of Robotics (IFR), 2016.

Canada is well above the world average of 69 robots per 10,000 employees, but with 136 robots, it lags behind the US. Often cited as a good student of robotics, Canada can not remain sub-automated in relation to its main competitor and customer. It is absolutely necessary to close this gap and for that it will be difficult to avoid developing a national strategy.

2.2 Technological Environment

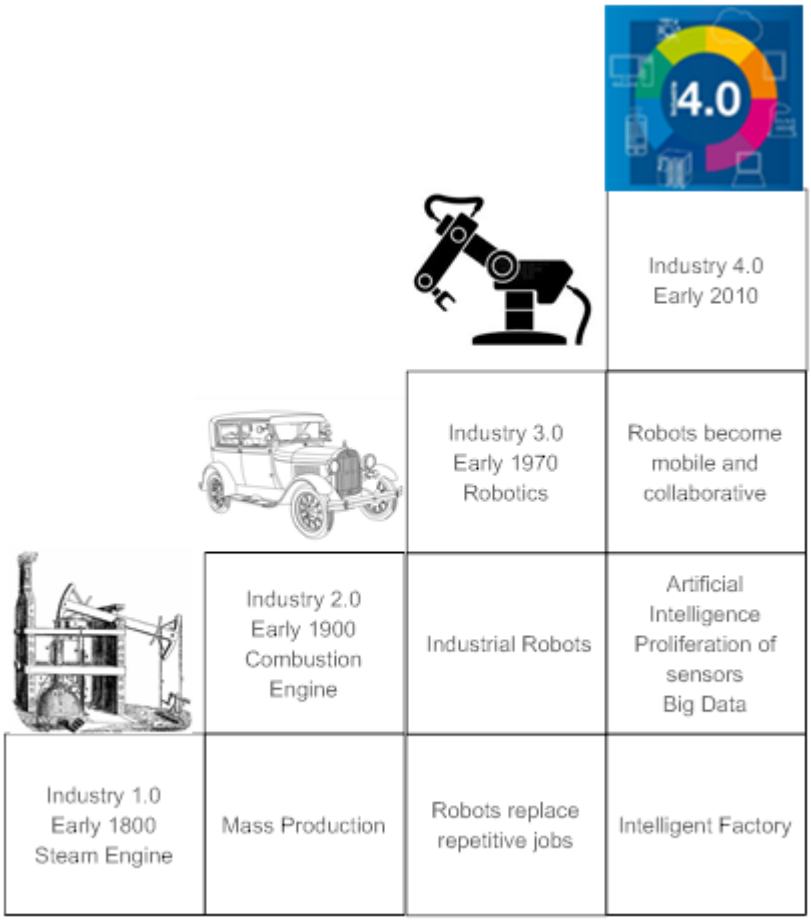
The arrival of robots in the economy is not new. The first robots were installed in the Trenton (New Jersey) plant of General Motors in 1961.[9] They were fixed robots at the time dedicated to a single task (welding or painting) and at prohibitive cost. These robots were separated from the workers by wire cages to avoid any risk of accidents. The first industrial sector to be equipped was the automobile because of the repetitive nature of certain tasks and the economies of scale that manufacturers could achieve on mass production. Industry 3.0 is then spoken of to highlight the importance of the revolution that occurred - after the introduction of the steam engine in the 19th century and the appearance of mass production at the beginning of the 20th century.

[8] "World Robotics 2016: Industrial Robots", International Federation of Robotics (IFR), 2016. Cf. p. 48. The number of robots was in the range of 1.6 million to 1.9 million in 2015, 11% more than in 2014. We took the low end of the IFR assessment and applied to 2016 the same increase rate as the previous year.
[9] V. Daniel Hunt, *Understanding Robotics*, Academic Press, San Diego, 1990, 285 pages. Cf. p. 12.

The price of these robots decreases year after year - the average price is currently about $ 60,000 per unit, which together with installation, software and engineering costs amounts to about $ 200,000.[10] Today a new generation of mobile robots, equipped with highly sensitive sensors, are easy to program and can take their place alongside the workers on the assembly line. They can be reprogrammed by non-specialists to change tasks. We are talking about collaborative robots or cobots.

Competition from emerging countries, as well as lower costs for robots and other automated systems, have caused the robotic shock that we are currently seeing in Canada. While the automotive sector still accounts for 40% of the world's robotic fleet, all industrial categories are automating their production. Even sectors previously considered to be less automated, such as agri-food, can be equipped with robots that handle perishable goods, which are soft to varying shapes. Meat and fish processing companies are increasingly using robots.

FIG. 8 – ÉVOLUTION DE LA TECHNOLOGIE INDUSTRIELLE À TRAVERS LE TEMPS



Today, the networking of the robots allows to have an instantaneous view of what happens in the factory. Increasingly, these robots are extended by a series of sensors. The whole is connected to the systems of suppliers and customers. The CAD/CAM systems implanted massively at the end of the 20th century already gave a digital image of the products, but statically. Now, the entire

[10] The $ 60,000 figure comes from the IFR data (converted from US $ 44,000); the $ 200,000 figure is derived from the CATA / Sciencetech survey responses.

production cycle is digitized. This allows managers to track, monitor, and control production in real time as required by vendors and customer needs. Each company analyzes the "big data" generated by its equipment, including, of course, the robots, and modulates production so as to ensure the integrity of the product, regardless of the hazards at the level of the inputs or the exploitation of the " factory. This is referred to as Industry 4.0 or the Industrial Internet of Things (IIoT).

> The Internet of things will be ubiquitous to understand what is going on in the factory. The good news is that there are all kinds of small products coming out. As an example, the Worximity equipment manufacturer sells a cheap solution that allows to put sensors on different machines in the factory. In this way, the company manager can follow in real time all sorts of things, such as machine speed, ambient temperature, etc. He can be quiet in his office, even in a hotel room in another country and thanks to the analysis of the "big data", he knows more about what is going on in the factory than the on-site director of operations.
>
> *Louis Duhamel, Deloitte*

2.3 Political Environment

2.3.1 Federal Government

The Government of Canada does not have a strategy for manufacturing automation. There is, however, a Factory of the Future initiative to support Canadian industries by providing the technologies and innovations necessary to remain competitive globally in current and future markets. Launched in 2014, the program includes three sites (Montreal, London and Winnipeg) worth $ 70 million.

A Roundtable on Advanced Robotics and Intelligent Automation was held in Mississauga in November 2016 at the instigation of Innovation, Science and Economic Development Canada (ISDE). The ministry concluded that it was necessary to mobilize industry to seize the opportunities offered by Industry 4.0 and the Internet of industrial objects. With this in mind, the department says it wants to support the ongoing work of the Group of Experts in Automation and Robotics (GEAR) launched last year through the Canadian Manufacturers and Exporters (CME) and inform the rest of the government.[11]

2.3.2 Government of Ontario

The Ontario government, in partnership with agencies FedDev Ontario and FedNor launched the SMART program in 2008 to increase SME productivity projects and improve energy efficiency. Each project can receive 50% of the required investment up to a maximum of $ 50,000. Continually renewed, the program directly funded more than 1,400 manufacturing projects in Ontario for a total value of $ 80 million. In 2016, the program was modified to adopt an ecological approach - this is known as SMART Green.

The originality of the SMART program is that it was administered by an association and not by the government. With more than 10,000 members, Canadian Manufacturers & Exporters (CME), the association selected, is the largest industry association in Canada.

[11] Round table on advanced robotics & intelligent automation, Mississauga, November 5, 2016, Innovation, Science and Economic Development Canada (ISDE), 24 pages.

2.3.3 Government of Quebec

In April 2016, Dominique Anglade, Minister of Economy, Science and Innovation and Minister responsible for the Digital Strategy, announced, together with the President and CEO of Invest Quebec, Pierre Gabriel, the allocation of $ 500 million over three years, to support the innovative manufacturing sector throughout Quebec.

Based on a process of in-depth consultation with industry, the so called Innovative Manufacturer action plan offers a term loan of up to $ 250,000 to finance the implementation of innovative projects (innovation process or marketing of an innovative product). Access to the program has been simplified and administrative procedures reduced. It is a lightweight program.

To ensure that this action plan is followed, a "manufacturing team" made up of representatives from Invest Quebec, the Ministry of Economy, Science and Innovation (MESI), Solidarity FTQ[12], STIQ[13], Quebec Manufacturers and Exporters, the Quebec Business Association, the Quebec Federation of Chambers of Commerce and Deloitte, traveled all over Quebec, meeting thousands of Leaders of SMEs.

> The action plan "Innovative Manufacturer" is the equivalent of what the Germans call "Industry 4.0" and the Americans "Connected Enterprise". It focuses on manufacturing processes such as collaborative robots, the development of high-tech products, marketing where diversification of exports is required, training of human resources in order to overcome skills gaps.
>
> *Louis Duhamel, Deloitte*

2.4 Robot manufacturers and integrators

Almost all robots used in Canada are imported. There are 200 robotic equipment manufacturers in the world. The top 15 of them account for 60% of industry revenues. Among the best known are ABB (Switzerland), Mitsubichi Electric (Japan), Kawasaki Heavy Industry (Japan), KUKA (Germany), Fanuc (Japan) and Motoman (Japan). Some of these companies display their colors as standards, to distinguish themselves: red for ABB, orange for KUKA, bright yellow for Fanuc...[14] To these giants must be added newcomers like the Danish Universal Robots and the American Rethink Robotics who are the leaders of collaborative robotics and are at the origin of the current robotic wave.

In Canada, the most known company is Ontario-based Clearpath Robotics, which specializes in mobile robots to perform hazardous tasks in factories. Mention should also be made of four small Quebec-based companies: Robotics Design manufactures modular robots, Mecademic and Kinova manufacture small robotic arms, and Robotiq produces adaptive hands. In all cases, it is a very young and expanding industry, which occupies niche markets.

In a completely separate category, there is a start-up in Vancouver founded in 2014 and named Kindred, which developed a robot combining artificial intelligence based on quantum computing to robotics. Thanks to US venture capital funding (Google is an investor), Kindred has already produced some fifty android prototypes that can do everything in principle from palletizing in a

[12] The largest development capital network in the province, Solidarity FTQ was created on the initiative of the FTQ, Québec's largest central labour union.
[13] STIQ is a multi-industry association of Quebec-based manufacturers whose mission is to improve the competitiveness of manufacturing supply chains in order to promote the development of our economy.
[14] "Old and new at Automate 2013", Frank Tobe, *Robohub*, January 29, 2013.

warehouse to the direction of a symphonic orchestra... Of course, the Kindred multifunction robots are still experimental.[15]

There is a well-established automation industry in Canada, which specializes in the installation, programming and maintenance of robotics systems. When we know that more than two-thirds of the cost of an investment in robotics comes from these activities, we measure the importance of this industry.

This sector is so dynamic that in November 2016, Canadian Manufacturers & Exporters (CME) launched GEAR a national network of excellence dedicated to the adoption and development of automation and industrial robotics in Canada. GEAR (group of experts in automation and robotics) comprises private, public, academic, and non-profit entities. The network covers a broad range of automation and robotics system specialists, including Original Equipment Manufacturers (OEMs), providers of customized automation systems, academic institutions and government entities with robotics and automation laboratories, as well as end-user manufacturers interested in learning more on the benefits automation and robotics can offer to their processes.

Part of GEAR is the Quebec-based Regroupement des équipementiers en automatisation industrielle or Grouping of Suppliers in Industrial Automation (REAI), a group of close to 100 companies founded in 2005. Most of its members are equipment manufacturers, and manufacturers and suppliers of specialized components to the automation and robotic industries.

[15] Gerrit De Vynck, "Secretive Canadian Company Teaches Robots to Be More Like People", *Bloomberg*, October 26, 2016.

3. Industry Profile

3.1 Nature of the Companies

The vast majority of respondents define themselves primarily as Original Equipment Manufacturer (OEM). Among those who reported "other" activities, there were 18 companies reporting that they were contract manufacturers, two answered they were in the raw material sector.

FIG. 9 – COMPANY'S PLACE IN THE PRODUCTION LINE

Main activity	Cies #
OEM (provider of parts or subsystems)	362
Product designer	39
Distributor	15
Other	49
Total	465

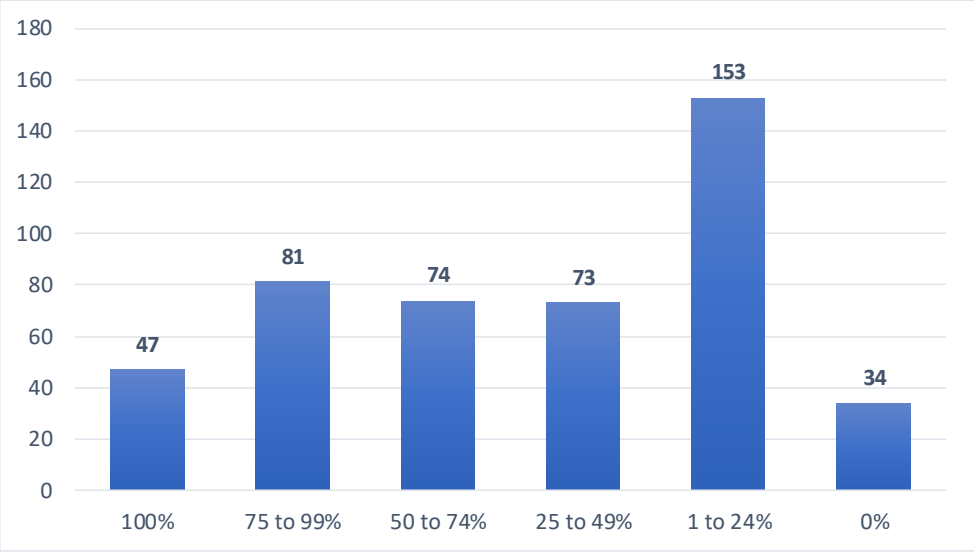
Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.2 Where Are Located Your Clients?

3.2.1 Shipments Within the Home Province

Manufacturing firms primarily serve the external markets. Two hundred and sixty, or 56%, sell most of their production outside their home province. At the extreme of this trend, there are 34 companies that sell 100% of their production outside their home province. In most cases, these are high-tech, highly automated companies.

FIG. 10 – SHIPMENTS WITHIN THE HOME PROVINCE

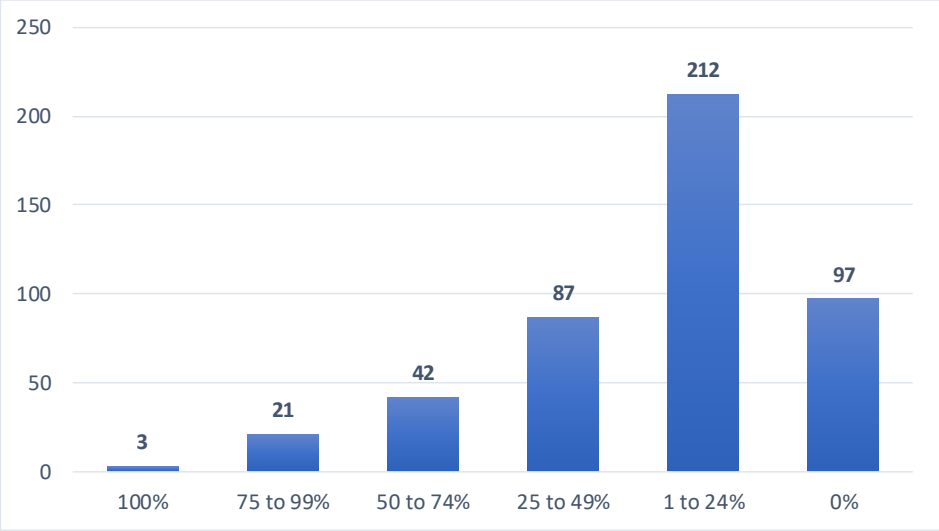


Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.2.2 Shipments Elsewhere in Canada

Nearly 80% of businesses sell in other Canadian provinces. This high response rate should not hide the fact that for many of these companies, the Canadian market remains marginal (1 to 24% of sales).

FIG. 11 – SHIPMENTS ELSEWHERE IN CANADA

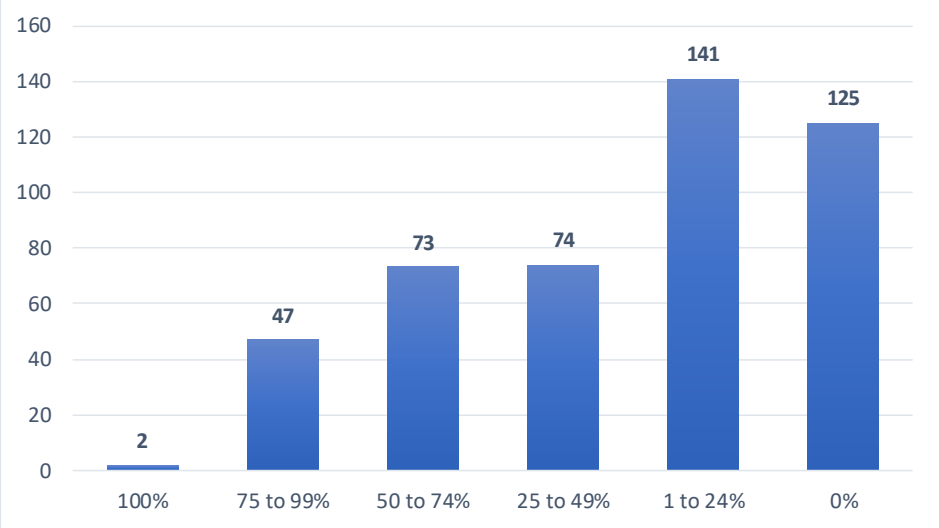


Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.2.3 Shipments to the United States

Nearly ¾ of the respondents sell in the United States. But only a minority sells the bulk of its production in the United States (50 to 100% of sales).

FIG.12 – SHIPMENTS TO THE UNITED STATES



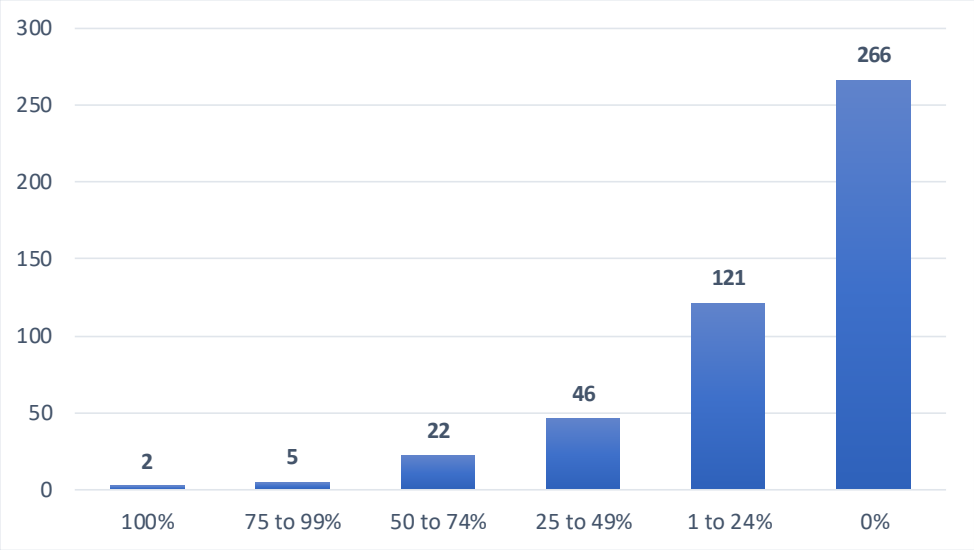
Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.2.4 Shipments to Foreign Countries

Firms exporting to the rest of the world are a minority and only 29 of them export the bulk of their turnover - even so, let us notice the presence of two companies that realize their total turnover in the rest of the world.

The destinations of these exports are varied: 13 companies claim to sell all over the world. Thirty-four companies cite Europe, 19 Asia and 22 Oceania. Otherwise, the two individual countries that are most often mentioned are Mexico and China - 40 respondents sell in each of these two countries.

FIG. 13 – SHIPMENTS TO FOREIGN COUNTRIES



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

> We have to talk about the Comprehensive Economic and Trade Agreement (CETA) with Europe, which will change the situation for Canada's economy, possibly as much or more than NAFTA 30 years ago. For the manufacturers, it is extraordinary. But is the degree of preparedness there? The answer is no. We are the only ones in the world who will pay 0% customs to access the European market. The Americans will pay 14% customs and also all of the others, whether they are Asians, Australians, Latin Americans.
>
> *Louis Duhamel, Deloitte*

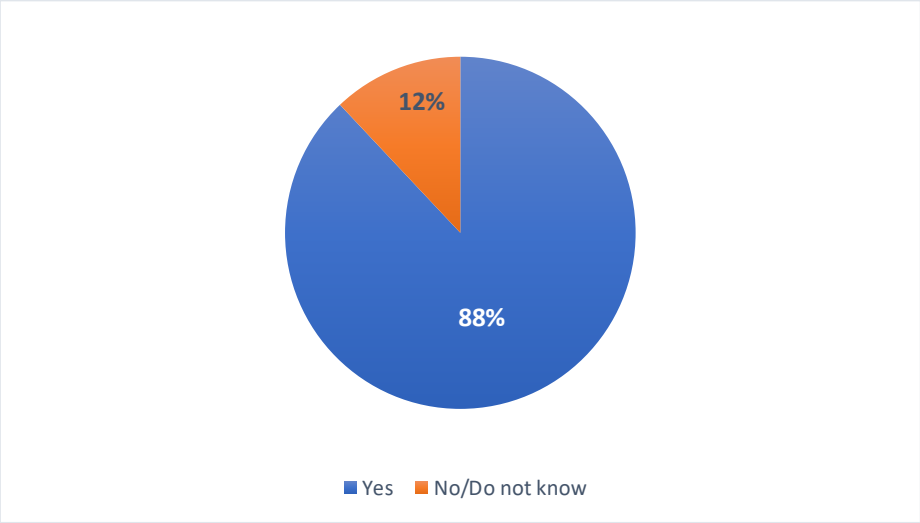
3.3 Innovation Strategy

To export, you have to innovate. To check the innovation potential of Canada manufacturing companies, we asked them if they had an innovation strategy. Almost all companies, or 88% of respondents, say they have an innovation strategy.

Interestingly, most companies without an innovation strategy are medium-sized companies. Large and small companies seem to know more about where they are going. Similarly, the majority of these companies do not export abroad. When they export, they are subsidiaries with parent companies outside Canada.

It goes without saying that innovation is a very broad concept. To simplify, we can distinguish between two main types of innovation: process innovation, which concerns, above all, business management and product innovation, which is more technological in nature.

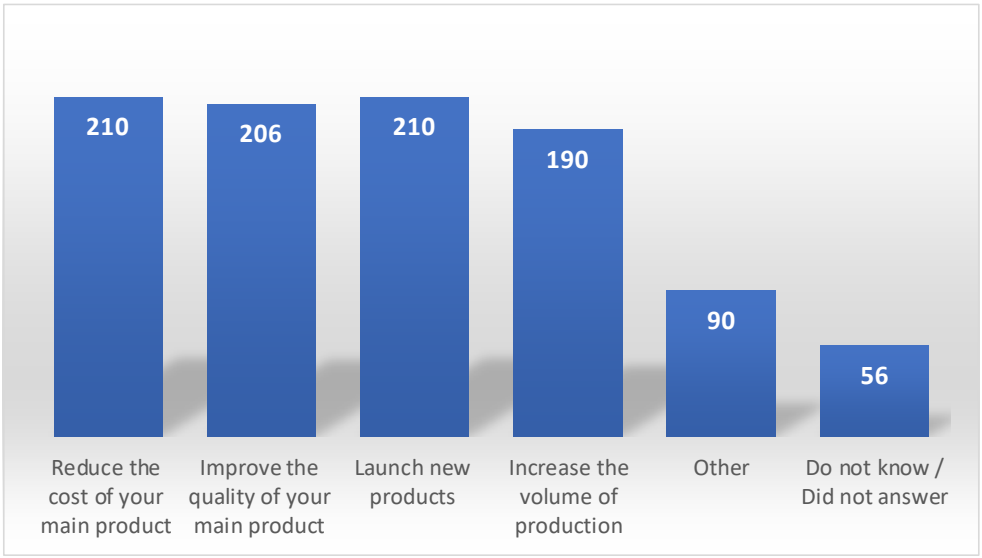
FIG. 14 – DO YOU HAVE AN INNOVATION STRATEGY?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

Asked about the nature of their innovation strategy, the majority of companies responded to reduced production costs. Among the companies that answered "Other", it should be noted that several stated that they wanted to "stick" to customer needs (20) or increase sales or develop new markets (13). Improving productivity is also mentioned by several companies (6). Training of labor is less frequently cited (2).

FIG. 15 - WHAT ARE THE MAIN OBJECTIVES OF YOUR INNOVATION STRATEGY?



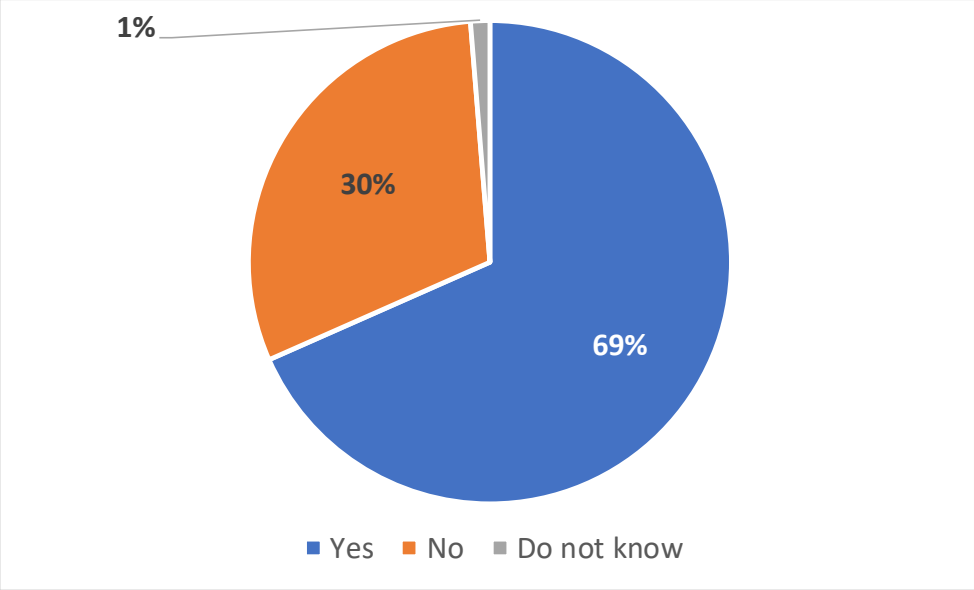
Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.4 – Research and Development (R&D)

The vast majority of manufacturing firms do R&D (69%).

However, 88% of companies reported having an innovation strategy. Innovation and R&D are not synonymous. If we distinguish between process innovation and product innovation, it is obvious that it is primarily companies that launch new products and improve existing products that need to do R&D. In other cases, it is a matter of modifying processes in order to reduce costs, increase production or meet customer needs, so there is less need for R&D.

FIG. 16 - DOES YOUR ORGANIZATION CONDUCT R&D?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.5 Main Obstacles Facing the Manufacturing Sector

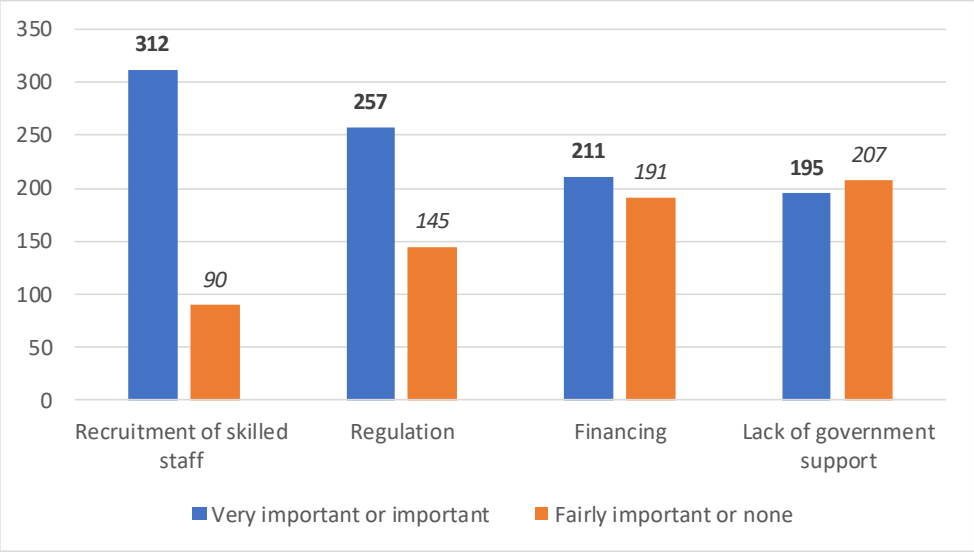
The recruitment of skilled personnel is the number one problem in the manufacturing industry. Regulation comes a long way behind. Funding and lack of government support are often mentioned, but many companies consider these issues to be of little or no concern (191 for funding and 211 for government support).

In order to put these barriers into perspective, it should be noted that eight companies consider that Canadian manufacturing industry does not face any particular barriers.

Among the obstacles not mentioned in the survey questionnaire, respondents cited:

- ✓ Electricity rates in Ontario.
- ✓ Environmental laws.
- ✓ Unfair competition from emerging countries.

FIG. 17 - WHAT ARE THE MAIN OBSTACLES FACING THE MANUFACTURING INDUSTRY TODAY?

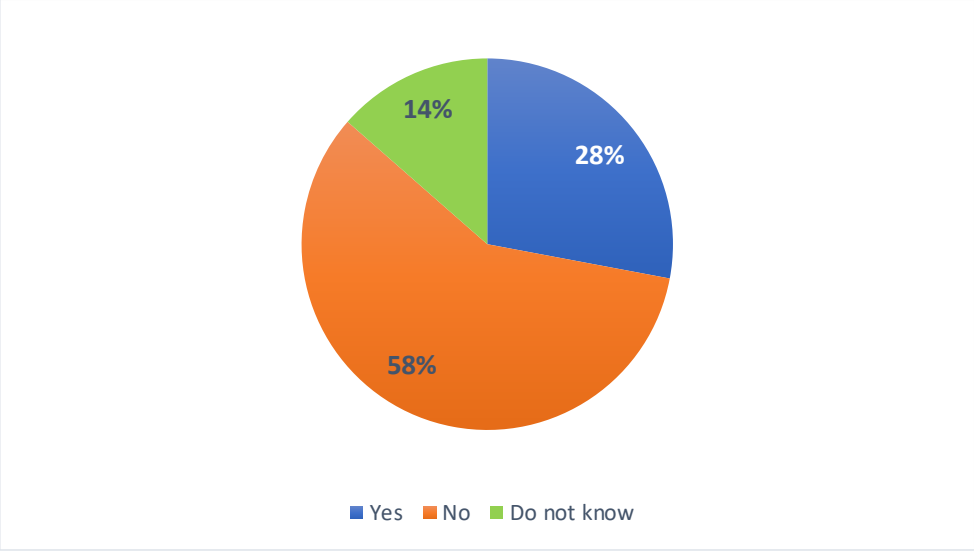


Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.6 - Current Issue: The election of Donald Trump as President of the United States

As we prepared our survey, Donald Trump's election to the US presidency over a protectionist program that was hostile to the North American Free Trade Agreement (NAFTA) prompted us to ask, "The United States intends to increase its protectionist policies. Do you foresee a negative impact on your sales?"

FIG. 18 - DO YOU FORESEE A NEGATIVE IMPACT ON YOUR SALES?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

Less than 30% of respondents believe that US protectionism will have a negative impact on sales, which is little. When asked to state their opinion, companies that answered "yes" and anticipate a negative impact justify their opinion:

- ✓ A company that realizes 95% of its sales in its home province believes it will still be affected, as its own customers are exporting to the United States.
- ✓ Three companies even plan to close their doors in the event of protectionist measures (accounting for more than 40% of their turnover in the United States).

Companies that answered "no" to the question and do not believe that their turnover will suffer from US protectionism, justify their optimism:

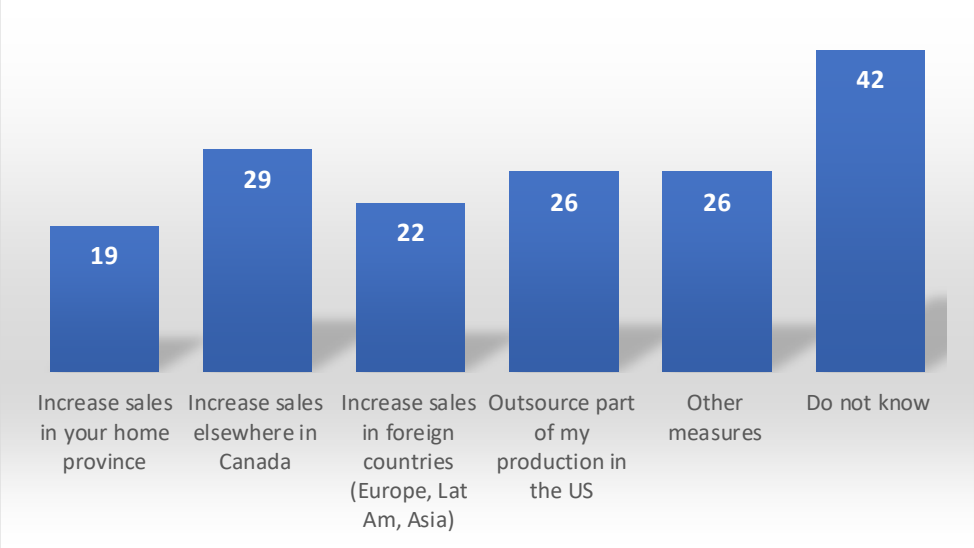
- ✓ It does not affect us because we make 100% of sales in Canada.
- ✓ The Americans already have protectionist measures and we are used to it.
- ✓ Our product is unique and the Americans will continue to source from us.
- ✓ Our product is covered under the NAFTA agreement, we are not worried.

Other companies claim that President Trump policies will not have a bad impact on Canada ...

One company even argued its C-TPAT (Customs-Trade Partnership Against Terrorism) accreditation to explain why American protectionism will not affect it. In general, we see that there is a kind of denial among Canadian manufacturing companies. They do not believe that international affairs can affect them.

Respondents who apprehend the impact of US protectionism on their sales, consider two types of strategies to remedy this. The majority intend to increase sales in their home province, elsewhere in Canada or around the world. On the other hand, a minority intends to relocate all or part of its production to the United States. Again, indecision remains important as almost all companies that responded "other measures" actually admit that they do not have an alternative strategy. Only one company says it plans to launch new products to fight against the new American protectionism.

FIG. 19 - DO YOU HAVE A CORPORATE STRATEGY TO GET ROUND THE IMPACT OF AMERICAN PROTECTIONISM?



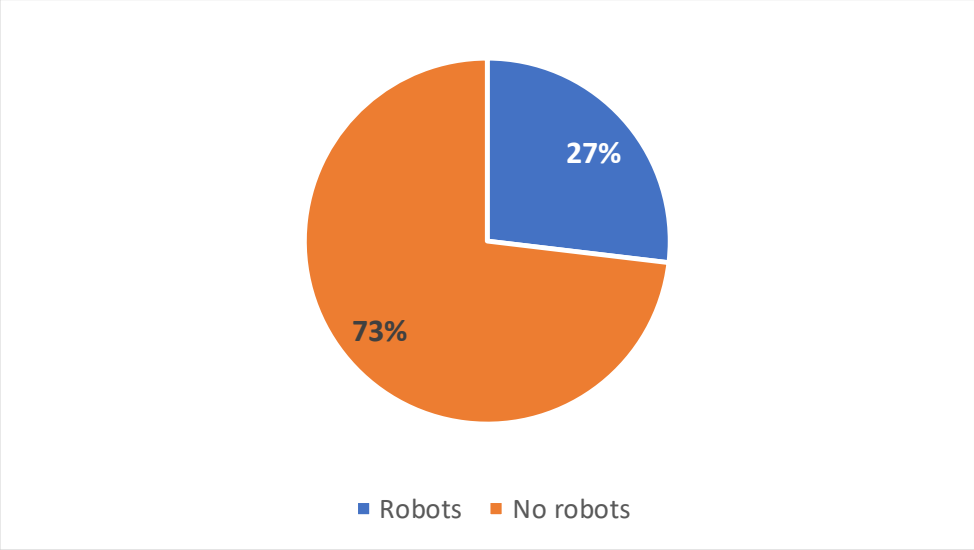
Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.7 Level and nature of automation

3.7.1 Robots

The heart of this study is the level of automation in the Canadian manufacturing sector: 27% of companies have robots. Translated into real numbers, this means that the Canadian manufacturing industry has about 26,000 robots. We have seen above that this figure ranks Canada 11th among the most automated countries.[16]

FIG. 20 - WHAT TYPE OF ADVANCED TECHNOLOGY IS CURRENTLY BEING USED BY YOUR ORGANIZATION?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.7.2 Other Automated Systems

If we add companies that use robots and companies that use other automated equipment, we get an automation rate of 69%.

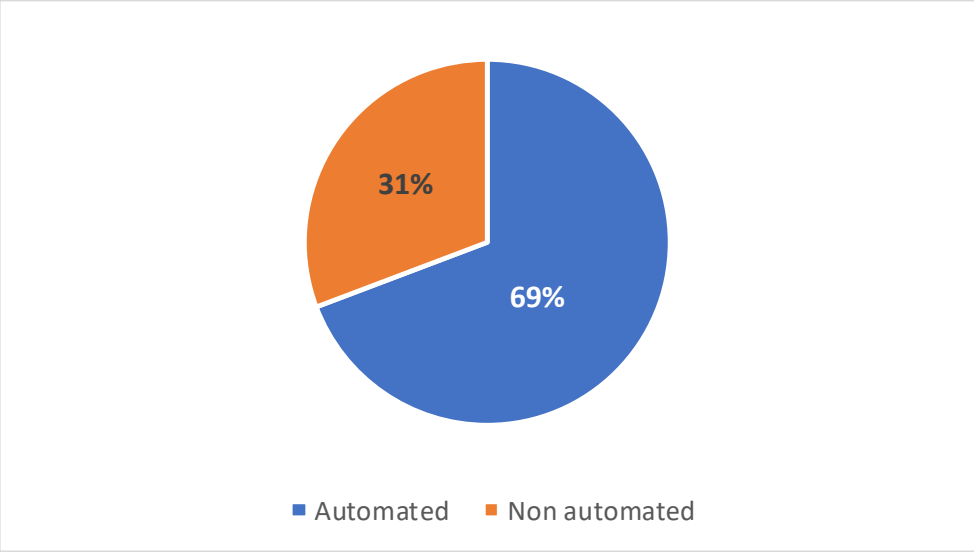
But what do we call "other automated systems"? Companies that answered this question say they use the following equipment:

- ✓ Numerical control machines: 172 companies
- ✓ 3D printers: 43 companies
- ✓ Sensors: 39 companies
- ✓ Internet of things: 23 companies
- ✓ Laser: 11 companies
- ✓ Vision systems: 7 companies

It should also be noted that 83% of companies using robots also use other automated systems.

[16] The IFR data indicated 23,300 robots by the end of 2015. As the Canadian robotics increase grew by 11% in 2014-15, we assumed a similar rate for 2015-16. "World Robotics 2016: Industrial Robots", International Federation of Robotics (IFR), 2016. Cf. p. 122.

FIG. 21 - TOTAL AUTOMATION RATE IN THE CANADIAN MANUFACTURING SECTOR



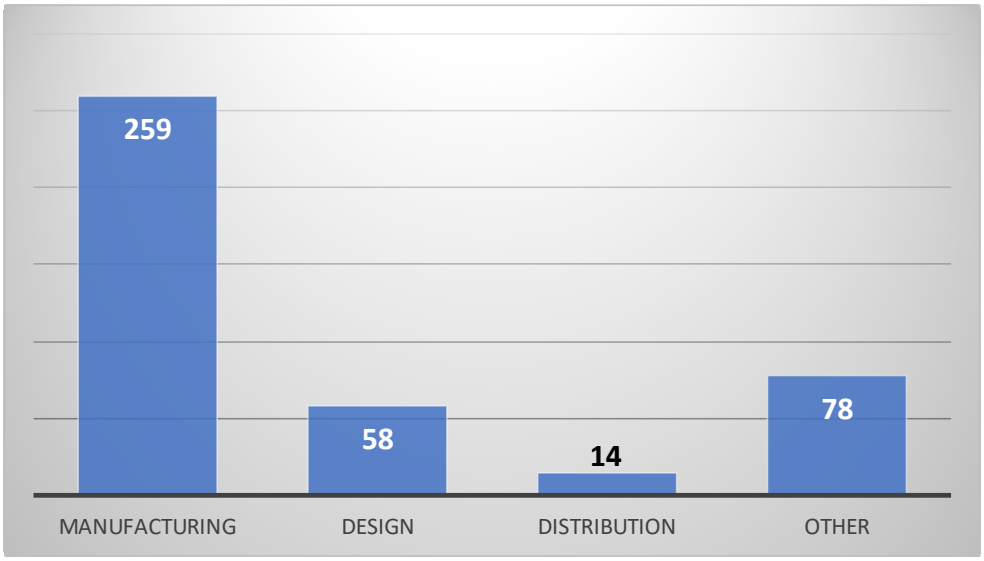
Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.7.3 Nature of Automated Activities

Manufacturing is obviously the main automated activity, followed far behind, from design / design. This absolute domination of manufacturing clearly indicates that it is the core of industrial activity that is automated.

Other activities mentioned sometimes refer to manufacturing specialities (machining, welding and cutting). Otherwise, packaging or testing and control activities are mentioned.

FIG. 22 - WHAT PROCESSES ARE AUTOMATED



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.7.4 Value of investments in robotics

According to survey respondents, robots have a unit price that can range from $ 15,000 to $ 2 million. The big difference is due to installation, engineering and programming costs as well as peripherals, which vary greatly depending on the industrial context. The average price is $ 200,000 for a robot installed.

It should be noted that a robot costs an average of just under $ 60,000, according to IFR data at the international scale. More than two thirds of the automation costs come from related costs (installation, engineering, programming and peripherals). That's where the integrators industry comes in, which is Canadian.

If we have 26,000 robots in Canada at $ 200,000 on average, that means we have an installed base of close to $ 5.2 billion.

> The sum of peripherals may cost more than the robot. In your study, you estimate that a robotic cell costs an average of $ 200,000 with installation, security costs. But if you do the detail, the cost of the robot is probably only a quarter of that amount. Everything around the robot including the design of the cell and its programming is what is expensive.
>
> *Pr Lionel Birglen, Polytechnique Montreal*

Such a calculation is impossible to do with the other automated systems, as the costs vary even more than for robots. They range from $ 1,000 to several million dollars. It goes without saying that setting up a digital control system for the entire operation of a company can entail significant investments. In addition, in many cases, the cost of other automated systems is included in that of robots as peripherals.

It is difficult to know the brand of robotic and related equipment used in Canada. The majority of respondents consider this information to be confidential. Those who did responded mentioned Fanuc and ABB among their main suppliers. But reliable statistics can not be derived from the low level of respondents. Robotic equipment is treated as central information to the company's business strategy.

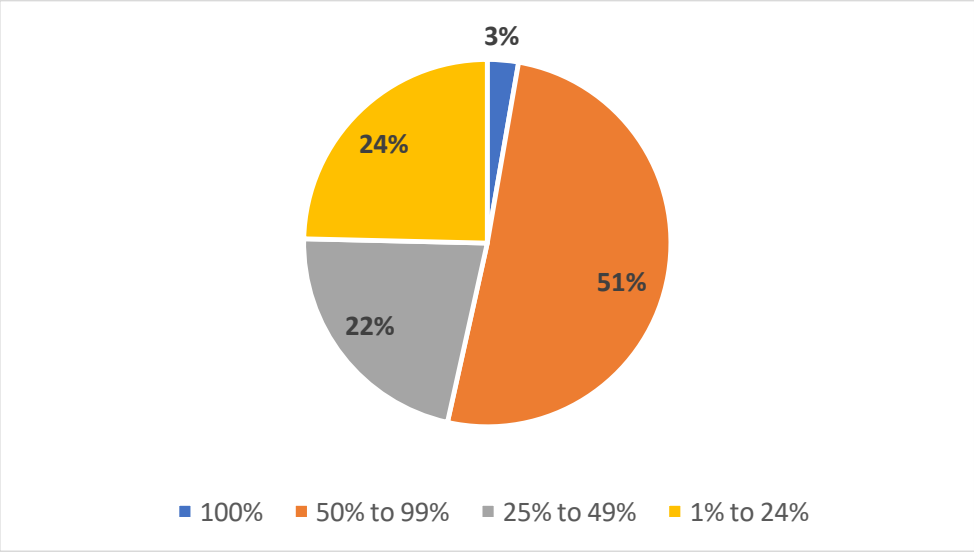
3.7.5 Level of Automation

Among the companies that say they are automated, we find that few of them are fully automated, but a large block is mostly automated. Considering that only companies with 50% or more of their automated activities actually adopted the industrial automation paradigm, this means that only 54% of Canadian companies are in this situation.

Nevertheless, 46% of these enterprises are not very automated or even marginally automated.

If we look at the geographic distribution of firms that have fully embraced the new industrial paradigm, we see that they are concentrated in Ontario. Conversely, Quebec has a large number of weakly automated businesses.

FIG. 23 - WHAT PART OF YOUR PRODUCTION IS AUTOMATED?

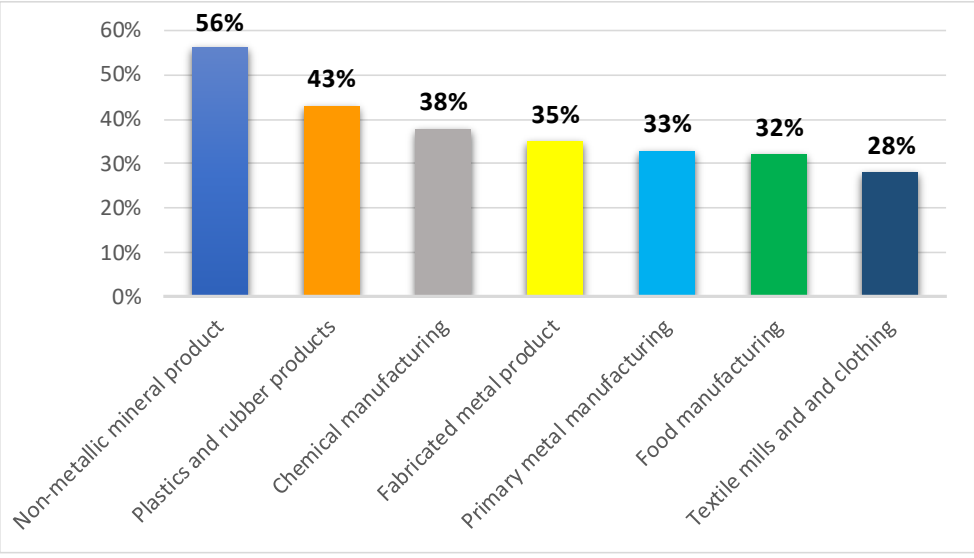


Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.7.6 Inequalities in the level of automation

Among survey respondents, non-metallic mineral manufacturing firms are the most automated: 56% of non-metallic mineral manufacturing companies are more than 50% automated. Otherwise, the good performance of the metal manufacturing industry (35% of companies are automated to more than 50%) is much more predictable. That is the basis of the Canadian manufacturing sector.

FIG. 24 - INDUSTRIAL SUB-SECTORS WITH MORE THAN 50% AUTOMATION



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

The automation of the food processing sector is less obvious. This is a difficult sector to automate technologically because of the delicacy of foods and their changing shapes. The automation of the

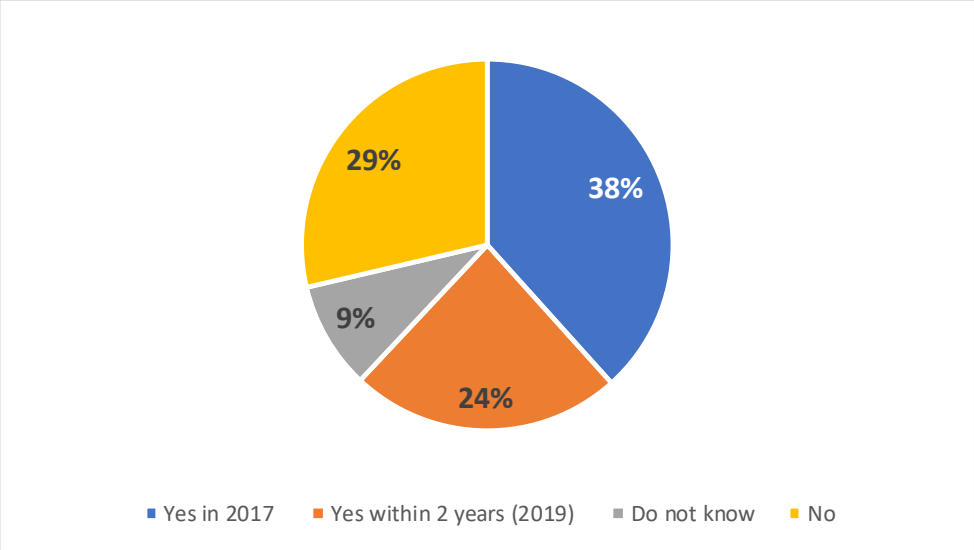
Canadian food processing sector proves that it has acquired the latest robots (collaborative and equipped with ultra-sensitive sensors).

The relatively high automation of the textile sector leads us to rethink the soft sector concept of the economy to which this industry is generally associated. It is true that this sector has been affected for twenty years. Many companies have closed or relocated to Asia.[17] However, the small group of remaining textile companies are equipped with advanced technologies.

3.7.7 Anticipated automated equipment purchases

Companies that are already automated answer 62% that they intend to purchase additional equipment in 2017 or within two years. It should be noted that in the case of already automated companies, it is rather a replacement of equipment.

FIG. 25 - DOES YOU COMPANY INTEND TO PURCHASE MORE ROBOT SYSTEMS OR OTHER AUTOMATED EQUIPMENT?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

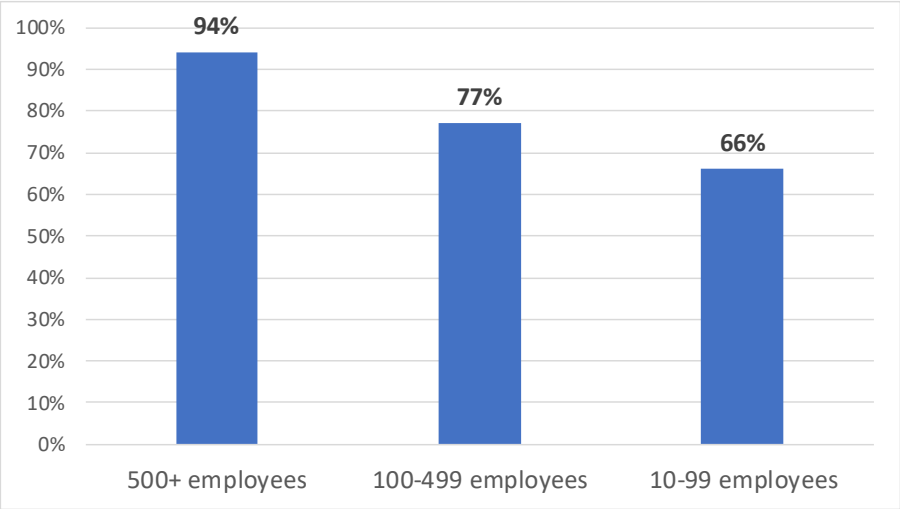
3.7.8 Portrait of the automated company

If we consider the size of the company, almost all large companies (500 employees or more) are automated and their activities are generally automated to more than 50% (only one large respondent was marginally automated). The few large companies that are not automated say their production is too customized to be automated.

Seventy-seven percent of medium-sized businesses are automated, well above the Canadian average (69%). Small business, on the other hand, is automated in only 66% of cases. There is therefore a correlation between the size of the company and automation.

[17] The number of textile companies in Canada has decreased from 4,465 in 2001 to 2,696 in 2013, a decrease of almost 40%. Kristian Behrens, Brahim Boualam, Julien Martin, "The resilience of the Canadian textile industries and clusters to shocks, 2001-2013", Cirano, 86 pages. Cf. p. 29.

FIG. 26 - AUTOMATION ACCORDING TO THE SIZE OF THE COMPANY

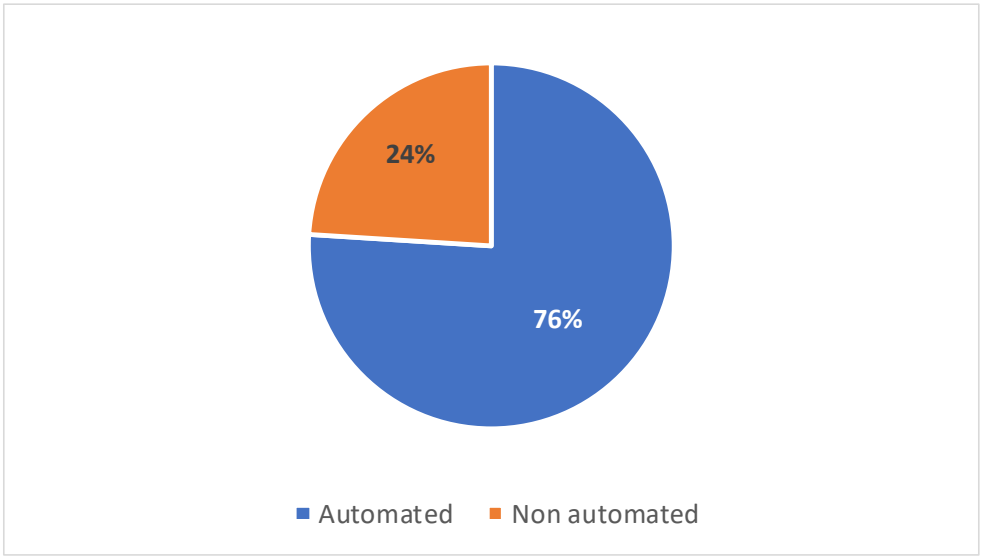


Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

The same goes for exports. All large companies export. We thus have a perfect correlation: large firms = automation = export. But apart from the great enterprise, the link is not absolute. There are automated SMEs that do not export and non-automated SMEs that export.

Seventy-six percent of the companies that export are automated. This is well above the Canadian manufacturing average (69%). In addition, the more automated the firms, the more they export. 83% of firms that are more than 50% automated are exporting companies.

FIG. 27 – AUTOMATION BY EXPORT



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.8 Reasons and Impacts of Automation

3.8.1 Reasons of Automation

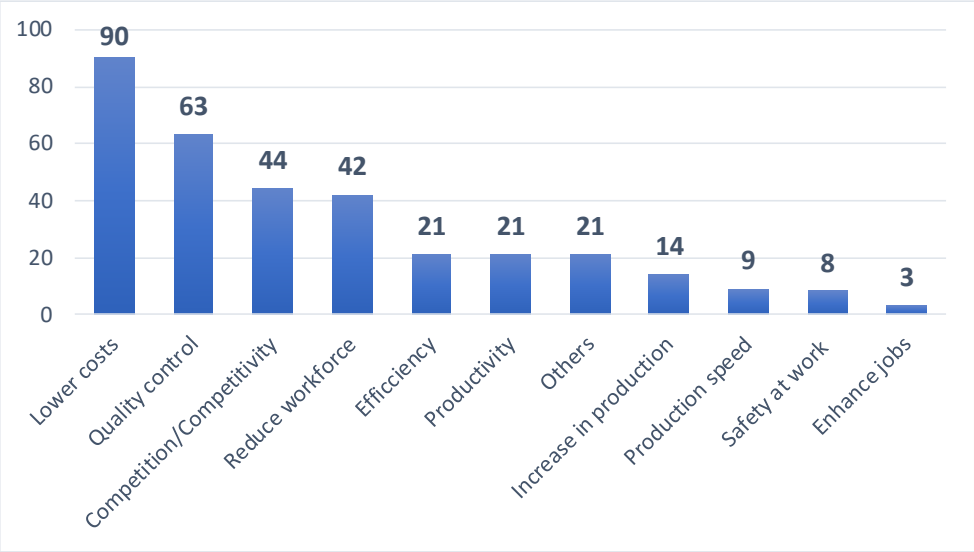
Lower production costs are by far the main reason for automating the business. This reason would be even more ubiquitous if we added those who responded they wanted to enhance productivity.

Quality control comes second, far ahead of competitiveness and the need to reduce the volume of labor. As this question was open, we end up with a large dispersion of responses.

> For too long, the Government of Canada has shifted away from manufacturing jobs. Manual labor has been devalued. It is the opposite of Germany where manual labor has always been the object of all the attention of the government. The result is that Canada has many good engineers, but a chronic shortage of technicians.
>
> *Patrice Charlebois, Festo*

Reducing the volume of the workforce comes in two different ways: some companies want to reduce the number of their employees to lower the total payroll. The result is a further increase in the ranks of those who want to limit their production costs. But in some cases, companies are automating because they have difficulty recruiting skilled labor.

FIG. 28 - WHAT IS THE MAIN REASON WHICH INCITED YOU TO AUTOMATE YOUR COMPANY?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.8.2 Impacts of Automation

It is always interesting to compare the reasons why one automatizes and the results obtained: namely the impacts of automation. The three main impacts (lower production costs, higher production volumes and higher quality) are almost equal.

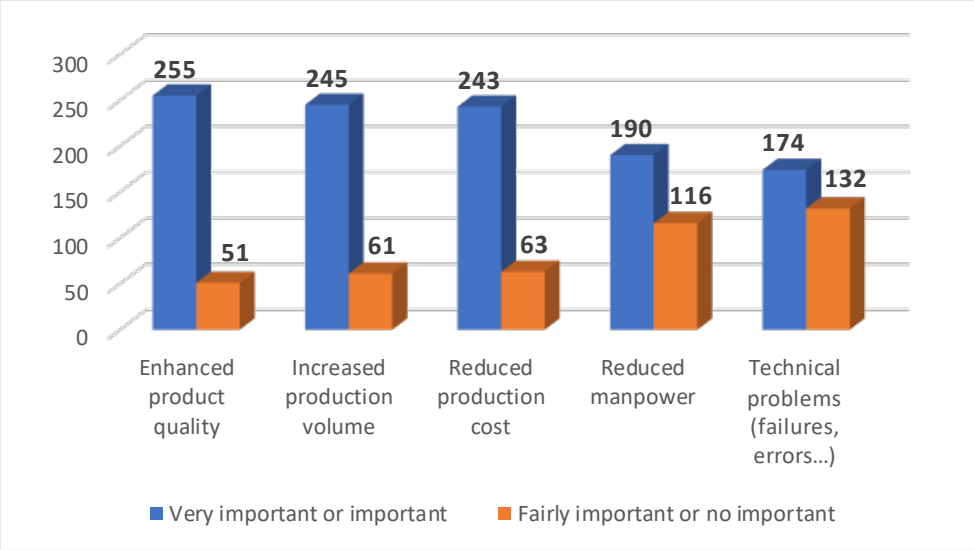
In this regard, we find almost perfect match between the first two reasons for automation, namely lower costs and quality control, which are among the three main impacts noted.

Very different is the second impact mentioned by the respondents: the increase in the volume of production. This was only a marginal reason for automation. This is a "surprise" that companies seem to have discovered after engaging the automation process.

As expected, the desire to reduce the volume of labor appears to have had only a limited effect. The number of firms with a significant or moderate decline was significantly lower (190) than the number recorded for the three main impacts. Above all, the number of respondents who report little or no impact is considerable (116).

Not only are technical problems not very numerous, but several respondents noted in "others" a suppression of manufacturing errors. Other impacts noted in "others" include improved product traceability, increased safety and reduced risk of accidents.

FIG. 29 - SINCE YOU INTRODUCED ADVANCED TECHNOLOGIES IN YOUR COMPANY, DID YOU MEASURE ANY POSITIVE OR NEGATIVE CHANGES?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

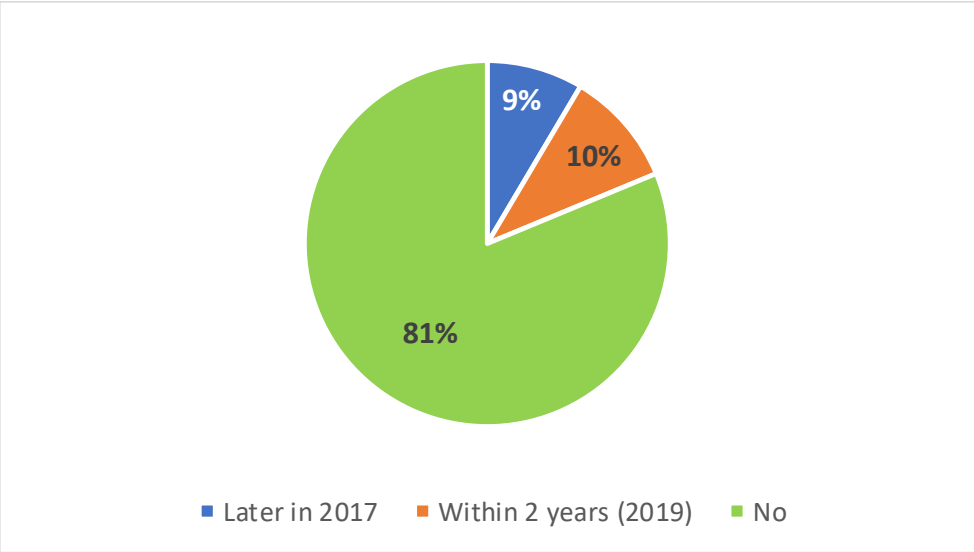
3.9 What About Non-Automated Companies?

Non-automated firms represent a minority of Canadian manufacturing firms. It is also necessary to take into account those which intend to automate in the short or medium term. For example, 19% of non-automated companies intend to acquire robots or other automated equipment – 9% in the course of 2017 and 10% intend to do so within two years.

This means that 81% of non-automated companies do not intend to automate. So, there is an irreducible core in Canada that does not want to automate itself.

> These are the SMEs that would be the perfect customer for process automation, because the giants are already in it. But for SMEs, it is still too expensive, they are suppliers, they do not necessarily see a return on investment for three or four years, the cash flow is not the same as in a large company, Risk is higher, it is often a family business.
>
> *Éric Tétrault, QME*

FIG. 30 - DOES YOUR ORGANIZATION INTEND TO EQUIP ITSELF WITH ROBOTS OR OTHER AUTOMATED SYSTEMS?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

The reasons for this refusal to automate can be reduced to two trends: the costs and the volume of production. Only three companies declare themselves opposed to automation for reasons of principle (we want to remain artisanal).

- ✓ Production is not automatable (36 companies)
- ✓ Automation costs are too high (19 companies)
- ✓ The company is too small or the volume of production is too small (13 companies)
- ✓ Customized production (9 companies)
- ✓ We want to stay artisanal (7 companies)
- ✓ Lack of information on return on investment (6 companies)

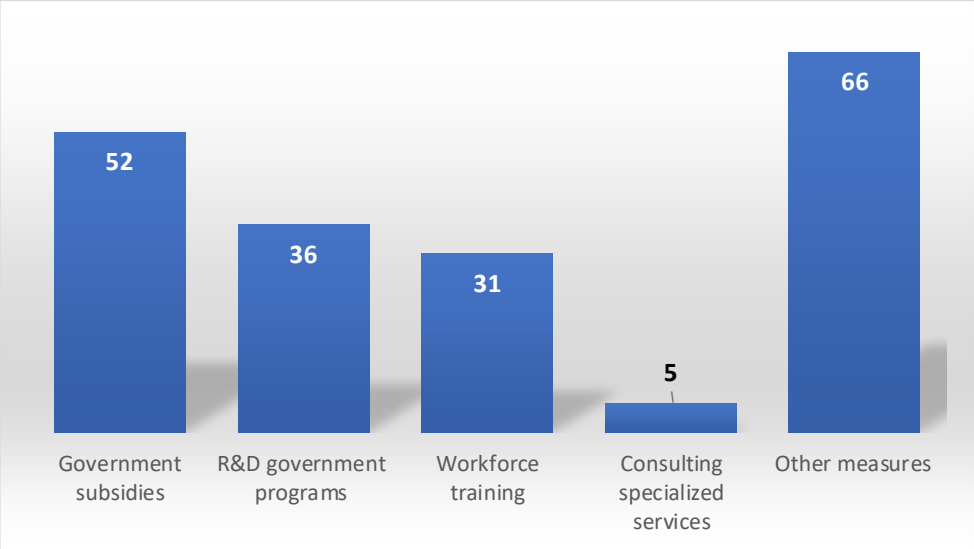
Is there a way to automate this minority of non-automated businesses? We have considered several scenarios of government action:

- ✓ Targeted government grants for the purchase of automated equipment
- ✓ Government R & D Programs
- ✓ Manpower training
- ✓ Specialized consulting services on automation

Not surprisingly, it is the scenario of targeted government subsidies that would be most likely to convince companies to automate. Contrary to what one might think, the provision of specialized consulting services on automation does not seem to interest companies. It is therefore not the lack of information or skilled personnel that hinders automation.

Of the companies that responded "other measures", most felt that the government could not facilitate the automation of the manufacturing sector, some of them even mentioning that it was not its role.

FIG. 31 - HOW CAN THE GOVERNMENT ACCELERATE THE DEPLOYMENT OF AUTOMATION IN YOUR ORGANIZATION?



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

3.10 Where is the Automation Market?

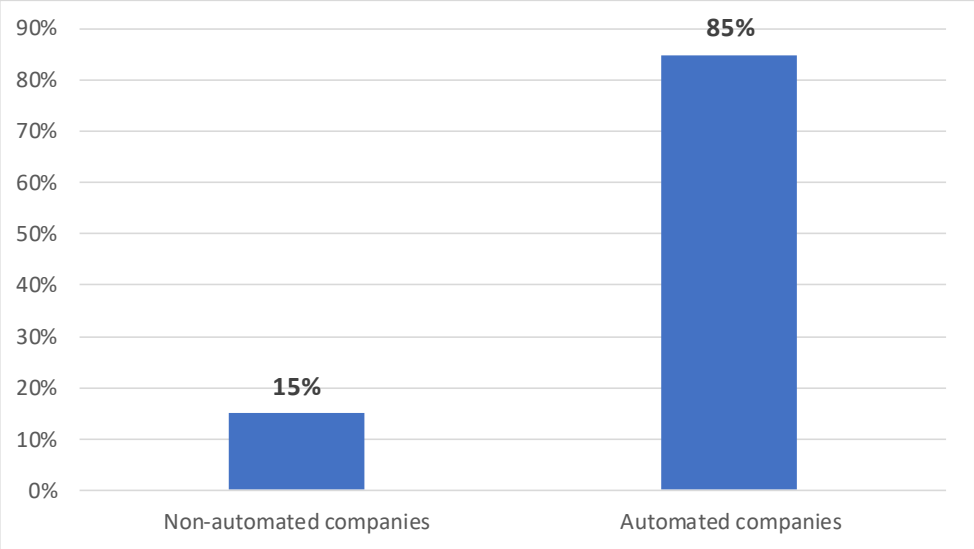
If we compare the already automated companies that intend to acquire additional equipment (section 3.7.7 - Anticipated automated equipment purchases) to non-automated companies intending to do the same (section 3.9 - What About Non-Automated Companies), we realize that the bulk of the future purchases of equipment will come from the former.

Eighty-five per cent of the companies that intend to purchase robots or other automated systems in the next two years are partially automated companies that complete their fleet.

It is therefore probable that in the future it will not be so much the number of automated companies that will be growing, but rather the density of automation. It is a strong trend that is welcome because only highly automated companies can take full advantage of the new paradigm of advanced manufacturing and switch to Industry 4.0.

Large purchases of robots and other automated equipment must therefore be expected to come from already automated companies.

FIG. 32 - THE BULK OF THE AUTOMATION MARKET IS COMPOSED OF PARTIALLY AUTOMATED COMPANIES THAT COMPLETE THEIR FLEET



Source: Survey Alliance CATA/Sciencetech communications – December 2016-January 2017

4. Main Trends, National Policies and Practical Approaches

4.1 Main Trends

- Manufacturing tends to become a high technology sector.
- Integrators control about two-thirds of the automation market and are essentially a Canada-based industry.
- Robots are acquiring vision (sensors, lasers, vision systems ...). They require less and less set-ups, which simplifies the installation of the robotic cell. In addition, robotics is becoming more collaborative (cobot). The cobot works at reduced speed when the human being approaches, it accelerates when the human being moves away.
- Artificial intelligence is being massively integrated into robotics. Thus, new generation robots learn when human beings manipulate them - which eliminates many programming activities.
- Automation is facilitated by the prior penetration of CAD-CAM systems into Canadian companies. Most of the parts used in a plant have already been digitized in 3D, which makes it easy to program the robot by mere downloading.
- Applications of robotics to low volume production lines are multiplying. More and more SMEs are equipping themselves with robotics. It is symptomatic that SMEs without expertise in engineering or even in technology, are equipped with robots.

4.2 Robotics National Policies

The Chinese government is continuing to implement its "Made in China 2025" strategy to boost China's industrial fabric. This effort is part of a longer-term plan to radically transform Chinese plants by 2049 so that they are more sophisticated than their counterparts in Japan, Germany and the United States. Why 2049? Because it is the 100th anniversary of the Chinese revolution of Mao Zedong.

The Chinese competition that already seems intense today is therefore expected to exert increasing pressure in all areas of industry in the years to come.

Moreover, China is not the only country to have a policy of forced automation. The US launched its National Robotics Initiative in 2011 ($ 50 million) as part of the $ 500-million Advanced Manufacturing Partnership to respond to the 2008 financial crisis that shook the manufacturing sector. The purpose of this R&D initiative was to encourage the emergence of collaborative robots (cobots) capable of working in symbiosis with human beings. Five years later, an NRI version 2.0 was announced in order to work on the robots' adaptability and networking. Work on the preparation of NRI 2.0 is currently underway.[18]

In Europe, the SPARC project was launched in 2014 by the European Commission in cooperation with a consortium called euRobotics that includes 180 private companies and research centers. This R&D project aims to promote the development of robots that meet the needs of the manufacturing, agricultural, health and hygiene, transport, civil security and home automation sectors. A budget of € 2.8 billion has been earmarked (€ 700 million from the European Commission and € 2.1 billion from euRobotics). This project aims to create 75,000 direct jobs in the robotics sector as well as 140,000 indirect jobs in the services sector.[19]

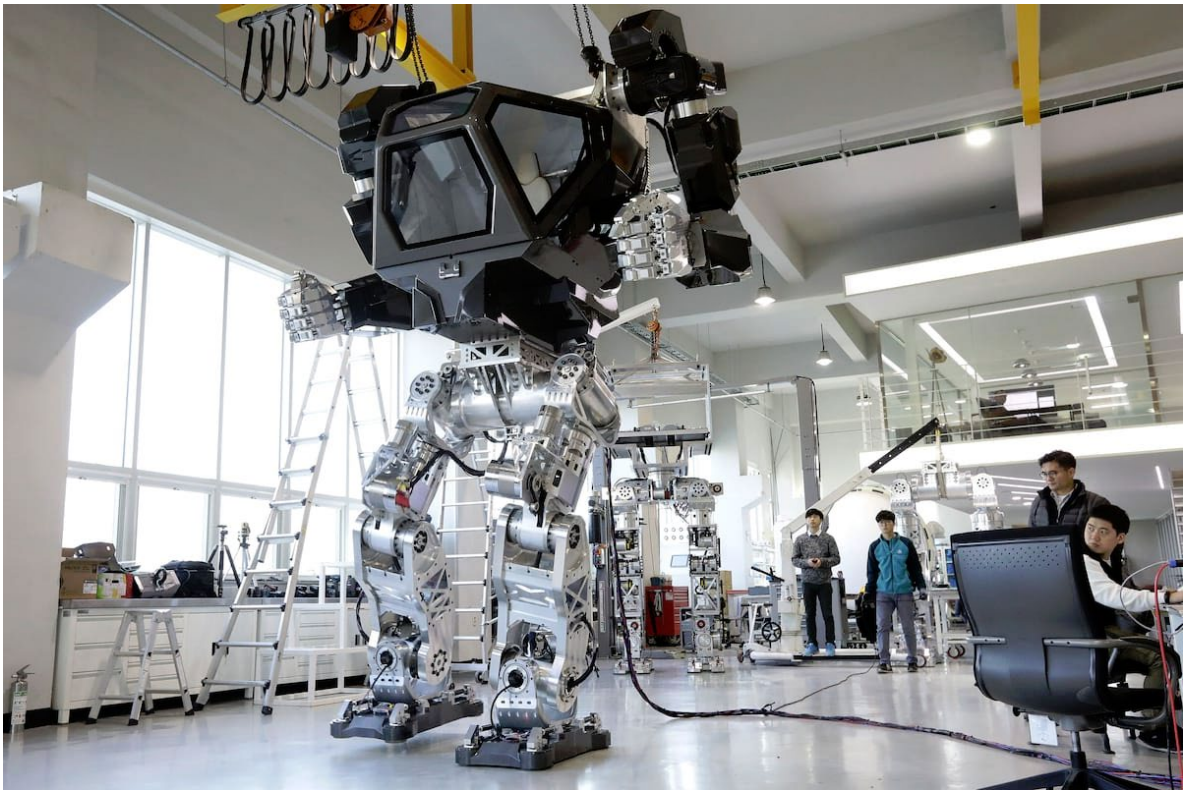
Long the undisputed leader in terms of number of robots, Japan launched in 2015 a Robot Revolution initiative as part of its revised strategy for the revitalization of the economy. The aim of

[18] National Robotics Initiative 2.0: Ubiquitous Collaborative Robots (NRI-2.0), National Science Foundation, https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503641
[19] Jack Schofield , "European Union launches $4bn project to innovate in robotics", *ZD Net*, June 3, 2014.

this initiative is to prepare for the doubling of the number of robots in the Japanese manufacturing sector and to increase it by 20 times in the rest of the economy (in particular services, agriculture, health, communications and construction). Japan intends to respond to both the Chinese challenge and the aging of its population. To this end, the 5th Science and Technology Basic Plan was launched in April 2016 with the aim of setting up a "Society 5.0", an ultra-intelligent society that would benefit most from the opportunities offered by digital technologies In order to revitalize the industrial sector.[20]

In 2012, the South Korean government announced an investment of nearly $ 316 million over 10 years to boost its robotics industry, which, as in Japan, spans both the manufacturing and services sectors. The considerable investment in robotics quickly transformed Korea into a country with the highest number of robots per 10,000 employees in the world. Encouraged by this success, the government launched a second plan for the development of robots (2014-2018) with an additional $ 2.7 billion over five years. As part of this enormous effort, we should mention the creation of a 1.5-ton, giant, humanoid robot that is expected to be marketed by the end of 2017.

FIG. 33 – KOREA HAS DEVELOPED A TERMINATOR-LIKE GIANT ROBOT…



In addition to these national efforts, it is important to note the commitment of private companies that grouped together in international associations. Among the most interesting for automation is the Industrial Internet Consortium (IIC) and Plattform 4.0. The IIC was founded in March 2014 by AT&T, Cisco, General Electric, IBM, and Intel. It now has more than 270 members, including universities. The goal of the IIC is to create an ecosystem for the advanced manufacturing sector based on interoperability, security and open standards. A reference architecture model was released in June 2015.

[20] New Robot Strategy, Vision, Strategy, Action Plan, The Headquarters for Japan's Economic Revitalization, February 2015, 90 pages. Cf. pp. 18-9.

Plattform Industrie 4.0 was founded in 2013 as a joint project of the German industry associations (BITKOM, VDMA and ZVEI)[21] to implement the German government's Industry 4.0 strategy. It involves applying the Internet of objects and other digital services in industrial processes. In September 2016, IIC and Plattform Industrie 4.0 put together their expertise. Both organizations want to ensure compatibility between reference architectures developed in North America and Europe and provide their members with access to test environments.

> The guys who run the operations, who run the factory floor, have typically had a pretty closed-loop, tight working environment for years. The last thing they would ever want is to let an IT guy in the middle of it.
>
> *Aider Mitchell, Vice President, Arrow Electronics*
> *(cited by Mary Del Ciancio, « Entering the IIOT », Manufacturing Automation, March/April 2017)*

4.3 Robot Fear

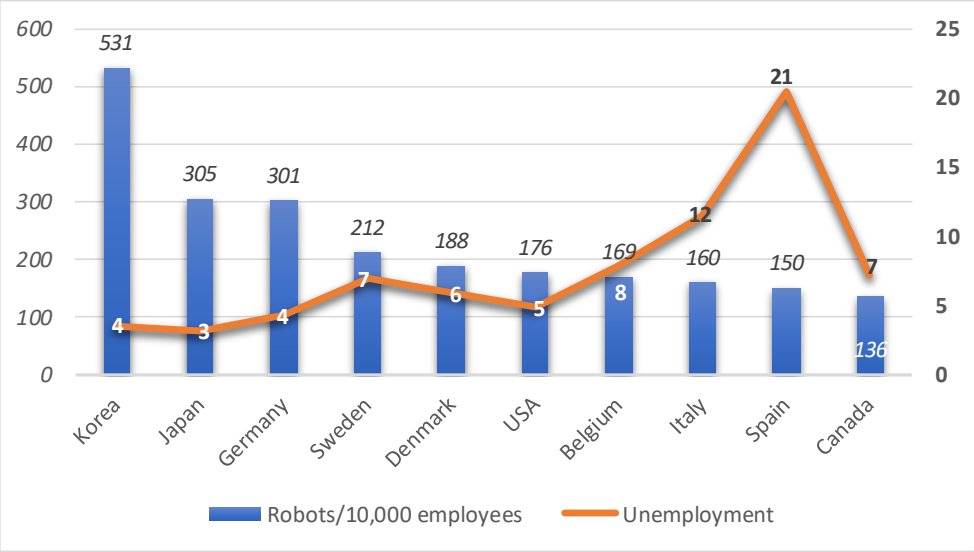
4.3.1 Automation And Unemployment

The popular wisdom is that robots cause unemployment. It is logical to consider that the jobs lost in the manufacturing industry resulted in an increase in the unemployment rate. Yet this logic is false as shown in the table "Robotic Density and Unemployment". The three countries with the highest density of robots per 10,000 employees, namely Korea, Japan and Germany, are precisely the countries with the lowest unemployment rate as a percentage of the labor force.

The only countries that deny this trend are Italy and Spain, which have an average rate of automation and a high rate of unemployment, respectively 11.5% and 20.5% - this "anomaly" points to an exogenous cause to automation (rigidities of the labor market, inadequacy of globalization, etc.).

[21] BITKOM has 1,350 members and represents the ICT and new media industry in Germany; Verband Deutscher Maschinen- und Anlagenbau (DDMA) has 3,200 members, mainly SMEs working in the field of mechanical engineering; Zentralverband Elektrotechnik- und Elektronikindustrie (ZVEI) has 1,600 members who are electrical and electronic manufacturers.

FIG. 34 - ROBOTIC DENSITY AND UNEMPLOYMENT



Sources: "World Robotics 2016: Industrial Robots", International Federation of Robotics (IFR), 2016 for robots' density. OECD, Harmonised unemployment rate (HUR) for unemployment data.

Jobs being eliminated by automation are direct and highly visible, while those created are more difficult to identify. Automation creates jobs (in small numbers) upstream in the manufacture of robots and in integration and maintenance. It also creates jobs (in large numbers) downstream in the marketing, sales and distribution of manufactured goods. For example, the work of analyzing the data generated by the 4.0 devices. In addition, new services are about to be created, which by definition are beyond the scope of statistics.

> The public remembers images of plants closing in the Great Recession and is skeptical about believing manufacturing is alive again or on the road to thriving. But the technology is tempting. Robotics, laser technology, machine learning, 3D printing, data science, virtual reality and global sensor tracking are reality. It's a science geek's wonderland, a gamer's real-life version of Minecraft, a millennial's ultimate collaborative and social engineering experience. Manufacturers need those young people who live technology, breathe social media, and instinctively know how to collaborate and build consensus among groups.
>
> *Mark Humphlett, « Why manufacturers and suppliers must train the next generation », Manufacturing Automation, March/April 2017.*

An econometric report published by the Centre for Economic Performance (CEP) of the London School of Economics and cited in the 2016 version of the US President's Economic Report shows that robots accounted for about one tenth of the increase in the industrial countries GDP between 1993 and 2007 and increased labor productivity by more than 15%. According to the authors of the report, these figures are comparable to those reflecting the impact of steam engines on the growth of British labor productivity in the 19th century.

Is this growing at the expense of work? The authors show that wages increase as the use of the robot increases. While the number of hours worked remains broadly constant, they calculate that this number increases for highly skilled workers, but decreases for low- and moderate-skilled workers.[22]

[22] George Graetz et Guy Michaels, "Robots at work", Centre for Economic Performance (CEP), March 2015.

Conversely, the Toronto Brookfield Institute for Innovation + Entrepreneurship (BII + E) estimates that 42% of employment in Canada is at risk of disappearing in 10 to 20 years as a result of automation in both manufacturing sector and services.[23] This thesis is echoed by Dominic Barton, managing partner of McKinsey and Chair of the Advisory Council on Economic Growth of Federal Finance Minister Bill Morneau. He recently said that nearly 40% of existing jobs in Canada will disappear over the next 10 years. It should be noted that, according to the McKinsey study, to which he refers, only 5% of jobs will be eliminated, the rest will be redefined and will see certain tasks only disappear.[24]

In either case, it is assured that the ongoing automation will have a significant impact on society. Even under the "optimistic" hypothesis of CEP researchers, where the level of the workforce remains stable, the nature of the work is expected to change dramatically and job shifts will have to take place between low and highly skilled jobs. In addition, in an environment where robotics seep into most activities, the human being will have to learn to deal with machines on a daily basis.

> In some cases, it is certain that robots will replace human positions, especially in the low-skilled or unskilled workforce. But better educated, better trained human resources will have more interesting positions. It's not going to be people who put products in boxes, a stupid job all day long. No, it will be people who are going to be programming, people who will work side by side with robots. With the advent of Industry 4.0, the robot will have sensors that detect the human, who will be able to work with it, so that's a good thing. We will always need humans, but humans who will have to be more qualified, who will have to be recycled.
>
> *Louis Duhamel, Deloitte*

4.3.2 A Fashionable Idea: Taxing Robots

The Legal Committee of the European Parliament adopted a resolution by Luxembourg MEP Mady Delvaux in February 2017 defining robots as "electronic people" with specific rights and obligations. The text which refers in a lyrical way to "Mary Shelley's Frankenstein's Monster to the classical myth of Pygmalion, through the story of Prague's Golem to the robot of Karel Čapek, who coined the word", and proposes the establishment of a system of registration for robots to ensure that they are legally responsible. On top of that, it states that companies must declare how much money they saved in social security contributions by replacing the labor force with robots.

However, the European Union rejected the section of the resolution which called for a tax on robots to finance a general basic income for all human beings. According to the International Federation of Robotics, "a robot tax would have had a very negative impact on competitiveness and employment."[25] The opposition was particularly strong in Germany, where the automotive industry is wholly dependent on intensive automation. Taxing the production tool was considered an economic heresy - one can tax income or consumption, but never production, exclaimed the employers' organizations.

The principle of a tax on robots was resumed in February 2017 by Bill Gates in an interview with the Quartz website. He advocated that a robot that took the place of a worker be taxed in proportions comparable to the person being evicted, in order to slow down the current wave of automation. On the other hand, the founder of Microsoft is not in favor of universal income. He believes that the robot tax should be used to finance the training and employment of people in areas where human

[23] Craig Lamb, "The Talented Mt. Robot: The impact of automation on Canada's workforce", Toronto, June 2016.
[24] Geoff Johnson, "How do we prepare kids for changing jobs?", *Times Colonist*, February 28, 2017.
[25] Georgina Prodhan, "European parliament calls for robot law, rejects robot tax", Reuters, February 16, 2017.

beings can not be replaced. He cited, in particular, education and assistance to the elderly, where an increase in staff numbers and resources could be welcome.

This reflection begun in the turmoil of political or economic news is called to develop over time.

4.3.3 Robots and Security

There is also a more irrational fear of robots due to science fiction. Who has not seen movies or read books on the subject of robot revolt? In practice, the safety that surrounds the robots has always been maximal. Traditional robots like those used in the automotive industry are always surrounded by a safety fence. To approach such robots in order to carry out maintenance operations, you must first stop them and disconnect them. Accidents involving robots are exceedingly rare.

The arrival of collaborative robots or "cobots" should not alter this state of affairs. A "cobot" slows down its gestures as soon as a human being approaches it and stops when the latter is nearby. It is thus possible to move it or to handle it without danger. Of course, precautions must be taken according to the peripherals of which the "cobot" is equipped: torch in the case of welding or laser activity in the case of a cutting activity. Precautions are needed and new work habits will have to be taken.

Killed by a Robot

In July 2015, in a Volkswagen factory near the German city of Kassel, a robot became uncontrollable and killed a man. During assembly, the robot's automatic arm seized the 21-year-old worker and crushed it against a metal plate.

The first man killed by a robot was a Ford worker in January 1979. The robot was carrying parts in a warehouse. As it was working too slowly, the man entered the warehouse to take a part manually when he was hit in the head.

In July 1981, a Japanese engineer from Kawasaki Heavy Industries was killed by a robot he repaired. He had omitted to disconnect it entirely and was thrown into a grinding machine by the hydraulic arm of the robot.

At full speed, these collaborative robots, whether Universal Robots or Rethink Robotics, if they hit you, you will feel it pass. They stop if they touch you, but can give you a black eye! They will not kill you however.

Prof. Lionel Birglen, Polytechnique Montréal.

4.4 Conclusion and Discussion

4.4.1 Promotion of the Manufacturing Industry

For too long unloved of economic activity, manufacturing industry must be rehabilitated by all available means.

There is an urgent need to systematically promote the manufacturing industry. It is meaningful to note that the in the United States, a National Manufacturing Day was founded in 2012 as a first step to acknowledge the importance of manufacturing to the economy. It is a grass-roots movement that lets manufacturers tell the story of today's manufacturing right on the shop floor. It's a chance to show off the innovative culture, safe environment, and advanced technology of the plant the community's students, prospective employees, educators, and government officials via an open house format.

▶ National Manufacturing Day.

A series of events should be organized at the Canadian level with the help of the provinces and municipalities. Thus, open houses can be organized by companies for schools to familiarize students with the trades of the manufacturing industry. The preparation of the Manufacturing Day in schools must take on a festive and educational character.

A Manufacturing Industry Day has already been organized in Quebec since 2015 by STIQ, a multi-industry association of manufacturers with the support of various other associations.

A Manufacturing Day on the Hill was organized in 2016 in Toronto which was a great success. In total, representatives of the Coalition and manufacturing executives met this week with 98 MPs and senior government representatives.

There is a need to multiply such initiatives and to give it a more popular dimension.

Approach 1:
It is proposed that the federal government provide its support for the launching of a Canadian Manufacturing Day in various cities in each province.

▶ Best Practices.

As a matter of priority, government support to automation must target SMEs either partially or marginally automated. Indeed, we have seen that this is the weak point in Canada: 46% of Canadian firms that claim to be automated, are weakly automated (see 3.7.5 - Level of Automation). It is also these companies that are most willing to buy robots (see 3.10 - Where is the Automation Market).

Approach 2:
It is recommended that the government, in partnership with associations representing the manufacturing sector, collect examples of the introduction of robotics in SMEs and disseminate them, in the form of case studies, as best practices.

By targeting this group of marginally automated firms with relevant information, government is most likely to have an impact on business decision-making.

4.4.2 Government Support

Government assistance in the form of subsidies is often considered unnecessary. But tax credit is generally welcome. However, interviewees deplore unreasonable delays in the administration of government programs.

> If the government wanted to invest in automation, it could be done in manufacturing connectivity with the greatest impact on the manufacturing sector as a whole.
>
> *Gilles Blais, Bombardier Recreational Products (BRP)*

▶ Tax Credit

In some provinces (Manitoba, Saskatchewan…), the Investment Tax Credit (ITC) for Manufacturing and Processing (M&P) is available to all M&P corporations filing a Corporation Income Tax. It is

designed to encourage plant and equipment investment for use in M&P activities in those provinces. The ITC applies as a percentage of the total capital cost of eligible new and used M&P building, machinery and equipment purchases made during the year, including installation costs.

Approach 3:
Canadian tax legislation should establish a tax credit for the portion of SME investment related to automation equipment.

▶ Mobilization of the Non-Profit Sector

It is important that the government adhere to the needs of manufacturing companies to accompany them whenever necessary in their automation efforts. A model to consider is the management of SMART programs that have seen the Ontario government and FedDev Ontario and FedNor agencies collaborate with Canadian Manufacturers and Exporters (CME).

Approach 4:
The government must systematically mobilize the associations in place to make known its programs, even to manage them.

4.4.3 A Canadian Asset: Integration

The steady decline in prices of robots tends to transform this equipment into "raw materials" such as computers or microelectronics. The added value of robotics now lies in integration, programming, commissioning and maintenance. The International Federation of Robotics (IFR) says that two-thirds of automation costs are already due to integration and peripherals - the average price of a robot is $ 60,000. This ratio is likely to grow over time. Integration in industrial automation is the key element of automation.

However, it is a predominantly Canadian industry, made up of dynamic SMEs, although generally small in size.

▶ Recognition of the integration industry

The industry of integration and manufacturing of robotic and peripheral equipment is one of Canada's industrial assets, but it is too often unknown. We must recognize the existence of a structuring pole in Canada in robotic integration. In addition to the Group of Experts in Automation and Robotics (GEAR), the existence of various manufacturing centers such as the Quebec Industrial Research Center (CRIQ), the Manufacturing Centre of Excellence in Saskatoon, the Manufacturing Centre of Excellence (MCE) in Edmonton… is a major advantage that should be exploited along the lines of the Manufacturing Innovation Institutes of the Manufacturing USA network (see Appendix 3).

Approach 5:
It is recommended that official recognition be given to GEAR; and existing manufacturing centers could be used as hubs. An approach such as a niche of excellence, an industrial cluster or any other appropriate form is suggested to ensure its effectiveness.

▶ Creation of an Investment Support Structure

Any Canadian manufacturing strategy must focus on working with Canadian integrators: this is where the added value of robotics comes in, and that's where the market is. But what do integrators need? Highly skilled labor available through company-university cooperation projects and student internships.

A model of enterprise-university cooperation is represented by PROMPT, which funds scientific research and experimental development (SR & ED) in ICT in Quebec through partnerships that generate a return of 7: 1 (in conjunction with the Natural Sciences and Engineering Research Council of Canada - NSERC). One could imagine a similar model on a Canadian scale for manufacturers who invest in robotic equipment.

Typically, an integrator could partner with his client and solicit scientific support from a university as part of a robotic integration project.

> An ideal research project would be the equipment integrator and the manufacturing customer looking to automate. Each of the two partners would put a little money to develop the research project and the government takes over most of the project. In the end, they will have the ideal expert through the student who has been trained, as this will be the person who designed the system.
>
> *Prof. Lionel Birglen, Polytechnique Montréal*

> We have excellent research results in robotics, now they have to be transformed into products. There, I think there is a leverage.
>
> *Prof. Clément Gosselin, Laval University*

Approach 6:
It is proposed that a structure be established to support applied research in the field of industrial automation equipment manufacturers. It will be responsible for setting up company-university partnerships and facilitating relations between stakeholders.

The proposed structure could be NSERC which has a good field experience with PROMPT or GEAR which has the best industry knowledge.

▶ Made in Canada

It is estimated that 70% of the output of Canadian integrators is exported from Canada. On the other hand, Canadian manufacturers often purchase their own integration services abroad. How to convince manufacturers to buy integration services and peripheral equipment from Canadian suppliers that are world-class?

Approach 7:
Canada could adopt a "Made in Canada" strategy that focuses on the systematic promotion of existing expertise and the development of innovative solutions.

▶ Promotion of standardization among integrators.

There are a number of standards for robotics, including ISO 15745 to improve device interoperability, and define tools for industrial automation systems and integration, and open systems application integration framework.

Other standards exist for robotic safety such as ISO 10218-1 and ISO 10218-2. A Canadian version of these standards exists under the name CAN / CSA-Z434 adopted by the CSA Technical Committee on Industrial Robots and Robot Systems. It is now a Canadian national standard.

The work of IIC and Plattform Industrie 4.0 on the interoperability of the Industrial Internet Reference Architecture (IIRA) and Reference Architecture Model for Industry 4.0 (RAMI 4.0), are also to be followed. The future of the Internet of industrial objects is negotiated within this forum.

Approach 8:
It is recommended that the government promote appropriate standards for robotic integration and Industry 4.0 in order to foster confidence in the manufacturing sector and accelerate industrial automation.

▶ Pilot Projects in the Broader Public Sector.

As a pioneer in the field of automation, Japan considers industrial automation and automation of services as a whole. The expertise acquired in the manufacturing sector is explicitly applied in the tertiary sector. Thus, the Japanese authorities do not hesitate to finance the acquisition of robots in front-line services (firefighters, police and ambulance), maintenance of infrastructure (sewers, aqueducts, bridges, tunnels, port installations) hospitals.

This use of automation in the service sector will help to present the robot as a collaborative partner in the popular imagination and not merely as a substitute for the human being. The Japanese robotics strategy states that automation should be considered as "a collaborating system with human where both parties supplement each other to draw an upward spiral for improvement."[26]

Approach 9:
It is recommended that the federal government undertake a series of pilot projects with the assistance of industrial automation integrators and universities in areas of future service.

> Service robots used in domestic applications are the cousins of industrial robots. With all the problems of demography that we face, we can predict the arrival of service robots in a horizon not too far.
>
> *Pr Clément Gosselin, Université Laval*

The selected projects may include first responder services, engineering works managed by Transports Canada, or a municipality, a healthcare institution run by a provincial government. Such an initiative would enable the integrator industry and the robotics departments of Canadian universities to acquire world-class expertise.

4.4.4 Social Dimension

Whatever the scenario - Graetz-Michaels, who claims that the volume of labor will remain stable or BII + E, which foresees a 42% reduction in the volume of employment - a significant number of people will experience professional difficulties. Massive staff retraining and no less massive layoffs will occur. Therefore, provision should now be made for vocational guidance for young people and vocational training schemes for employees in the process of recycling. In both cases, it will be necessary to prepare people for the automation professions.

> Since electrification, the story of the twentieth century has been the race between education and technology.
>
> *Carl Benedikt Frey and Michael A. Osborne, University of Oxford, 2013*

[26] Idem, cf. p. 17.

The goal is not to curb automation because jobs disappear but to prepare and adapt people to the needs of a largely automated manufacturing sector (and soon services) so that they can benefit from the new environment instead of being hurt.

▶ Automation and Training Watch Observatory

A monitoring laboratory could be set up which systematically follows companies in the process of automation. Whenever a company receives public or private funding, it may be responsible for completing a brief questionnaire on expected impacts on staff and sending it to the observatory.

The observatory would then contact a university, a college or a vocational training center and, depending on the case, would offer, on request, training options adapted to the needs required by the situation.

Approach 10:
Support the creation of a "FutureSkills Lab" to document the impacts of automation and to refer affected employees towards an appropriate vocational training option.

The observatory could be the "FutureSkills Lab" proposed to the federal government by Dominic Barton as part of the work of the Advisory Council on Economic Growth and announced in the 2017 budget (see box below).

According to the chairman of the Federal Minister of Finance's Advisory Council on Economic Growth, the FutureSkills Lab should take the form of an independent body to set up a series of pilot training programs. The future federal agency should use innovative approaches to collect information on labor market needs. More importantly, it would seek to rigorously measure the results.[27]

Investing in Skills Innovation

As recommended by the Advisory Council on Economic Growth and the Forum of Labour Market Ministers, new approaches are needed to address skills gaps and support lifelong learning throughout Canadians' working lives. To that end, Budget 2017 proposes to provide $225 million over four years, starting in 2018–19, and $75 million per year thereafter, to establish a new organization to support skills development and measurement in Canada.

Working in partnership with willing provinces and territories, the private sector, educational institutions and not-for-profit organizations, this organization will:

- Identify the skills sought and required by Canadian employers.
- Explore new and innovative approaches to skills development.
- Share information and analysis to help inform future skills investments and programming.

Budget 2017 - Canada

[27] Campbell Clark, "A FutureSkills Lab could be the Liberals' key to improve job training", The Globe and Mail, February 6, 2017.

Appendix I – Case Studies

The companies that are the subject of a detailed presentation have been selected on the basis of their belonging to the different segments of the manufacturing sector in order to give as complete an overview as possible of the variety of automation processes. OEMs or integrators in robotic solutions were also introduced because of their knowledge of the manufacturing market.

This is in no way a list of the best companies selected based on any comparative standard (technological innovation or marketing, sales, best practices, etc.).

Siemens Canada Engineering and Technology Academy (SCETA), manufacturier
Bombardier Recreational Products (BRP), manufacturier
Cisco, équipementier
Festo, équipementier
Lantic, manufacturier
Medtronic, manufacturier

Siemens Canada Engineering and Technology Academy (SCETA)

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Oakville, ON
L6H 0H6
Tél. (647) 960-0469
SCETA website

Contact	Dr. Tom Murad, director	
Data	*Founded* *Headquarters* *No. of employees* *Main activity*	2014 Oakville ± 60 Training
Mission	Training future employees and managers of Siemens Canada.	
Strategy	Training based on the German dual system.	
Means	Recruit students two years prior to graduation.	
Markets	College and university students.	
Issues and opportunities	University or college studies and work are integrated. This ensures the company recruitment of well-trained students.	

Background

The Siemens Canada Engineering and Technology Academy was originally designed with the support of Employment and Social Development Canada and the Canadian Manufacturers & Exporters (CME), but the bureaucratic burden has deterred Siemens Canada from continuing the experience.

The Academy really began to function in October 2014 and its first cohort of students began training in May 2015. The first students were hired by the company in early 2017. The Academy is currently registering its third cohort of students.

Nature of the system

The Academy is managed by three full-time staff, including a Director who reports to the President and Chief Executive Officer of Siemens Canada. Governance is ensured by a steering committee whose members represent the divisions of Siemens.

Its operation is based on the main principles of the dual system in force in Germany. To this end, a series of agreements have been concluded with universities in Ontario and Alberta: University of Waterloo, McMaster University, Mohawk College, University of Alberta in Edmonton, and Northern Alberta Institute of Technology (NAIT). In 2017, two institutions were added: Ryerson University in Toronto and Algonquin College in Ottawa.

A cohort is composed of 25 to 30 students.

Working Principle

Students who are selected enter the Academy in May and immediately receive a salary. All of school tuition is also paid by the Academy. In exchange, they commit to work for four years at Siemens after their graduation.

Students must still have to attend two years of college or university at the time of their recruitment by the Academy. Students are recruited in May and spend four months at the Academy before

returning to university for eight months. Typically, a student will spend two four-month periods at Siemens. A full-time salary is paid to him for two years.

The time spent at the Academy is divided into two. The student must take courses in engineering, but also in management, law, negotiation, quality control and even communications. It is a mix of technical training, leadership practice and humanities. The student spends this time in class or in a laboratory to familiarize himself with the equipment used by Siemens.

Course manuals, video and audio documents have been developed especially by the Academy for the Siemens Mechatronic Systems Certification Program. Each student receives the same software as a Siemens engineer. This is complemented by a distance learning program where the student has access to the Siemens World Library, which contains 3,000 courses.

The other half of the time is spent in one of the ten global divisions of Siemens under the supervision of a mentor who is a senior engineer or executive. The student is not assigned to a single mentor for the entire four-month period, instead he is spending a few weeks in each of the Siemens divisions with a different mentor each time. These mentors were chosen on a voluntary basis in advance, and they have been trained to do so.

Mentoring is a well-structured system where each week the mentor must report on the work done. For its part, the student also fills out a form where he must say what he likes or dislikes and what he has learned. This feedback system allows the Academy to follow the path of each student on an individual basis and to rectify the course of things, if needed.

When the student finishes his training period, Siemens awards him a certification in mechatronics. It is at this point that the student chooses which division he will work for. The Academy therefore provides training that is valid in the ten global divisions of Siemens - each of these divisions is active in Canada.

Specificity of the Canadian Academy

The Canadian Academy differs from the German Academies as it recruits college or university students under study. In Germany, Siemens recruits students at the high school level and trains them for two years in an Academy which has received an official accreditation from the German education system. Most of these students are then hired at a Siemens factory as technicians. The best of them are sent to the university, but, unlike Canada, they are assigned to a division from the outset.

Ripple Effect

A study committee was established by the Office of the Premier of Ontario to promote the Siemens dual training system in other companies. The president of Siemens Canada is a member of this committee.

Issues

The next step for Siemens is to open an Academy in Quebec on the same model as that operating in Oakville. For linguistic reasons, it will be a fully autonomous Academy. It will be called upon to create links with Quebec universities. This Quebec Academy is part of a project that was announced in January 2017 in Davos after a meeting with the Premier of Quebec: Siemens "intends to invest $ 22 million to set up a platform of expertise in 4.0 technology, and the implementation of an integrated training system in the workplace based on the dual German model."

Bombardier Recreational Products (BRP)

726, St-Joseph,
Valcourt (Quebec)
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Tel. 450 532-2211
http://www.brp.com/en

Contact	Gilles Blais, Director, Global Strategy Vehicle Manufacturing, Systems and Technologies, and Joël Bombardier, Manager, Manufacturing Systems and Technologies	
Data	Founded Headquarters N. of employees Main activity Clients	1941 (supund-off in 2003 as BRP) Valcourt (Quebec) 7,900 Recreational products manufacturer Consumers
Mission	Based on three specific long-term approaches: growth, agility and Lean enterprise, BRP demonstrates its agility and capacity to innovate.	
Strategy	Change from a mass production mode to a custom build-to-order mode.	
Means	Sales through a worldwide network of more than 4,200 dealers and distributors.	
Markets	100 countries. 70% os the market is located in the United States.	
Issues and opportunities	Develop a manufacturing connectivity solution adapted to the needs of BRP.	

Background

Bombardier Recreational Products (BRP) is the heir of the company created in 1942 by Joseph-Armand Bombardier, under the name of "Auto-Neige Bombardier Limitée". Beginning in the 1970s, the company diversified into railway construction and then, in the 1980s, into aeronautical construction. The new giant was hit hard by the commercial aviation crisis that followed the September 11, 2001 attacks in New York and Washington, and by the end of 2003 sold its recreational sector that formed the core of the original business.

The headquarters of the new BPR company is located in Valcourt, where the Laurent Beaudoin Design & Innovation Centre, the Product Development Center and manufacturing plants are located. In 2003, all of BRP's manufacturing was concentrated in Valcourt. Today, the company has plants in Gunskirchen (Austria), Júarez (Mexico)[28], Querétaro (Mexico), Rovaniemi (Finland), Spruce Pine (North Carolina) and Sturtevant (Wisconsin).

Announced in December 2015, the Valcourt 2020 project aims to transform two BRP plants into a state-of-the-art facility equipped with the latest equipment at a cost of $ 118 million. The first elements of Valcourt 2020 are expected to enter service in November 2017.

Products and services

Initially, BRP only manufactured snowmobiles, marine bikes and off-road vehicles. Today, the company has diversified its production to offer a range of recreational vehicles, including Ski-Doo and Lynx snowmobiles, Sea-Doo watercraft, Can-Am off-road vehicles and side-by-side vehicles, Can-Am Spyder roadsters, Evinrude and Rotax marine propulsion systems, as well as Rotax engines for karts, motorcycles and small aircraft.

[28] BRP has two factories in Júarez. It was there that the company's first plant outside Canada was installed in a premise that belonged to RCA. In 2014, it built a second factory in the same city.

FIG. 35 - INTERIOR OF THE VALCOURT FACTORY

Automation

The first robots were installed in the early 1990s when Recreational Products still was a division of Bombardier. There has even been an excess of various technologies composed of autonomous systems. This equipment was poorly integrated and used in the wrong place. As an example, there were many sensors on the assembly line that gave the start-stop signal. Result: The chain was often stopped for reasons of sensor malfunction. The operation had become so complex that there was always something out of control.

In 2004, BRP decided to take a step back and take a break. The decision was made to put the right technology in the right place. Priority was given to the overall architecture of automation and data management. This is all the more important as the company moves from a mass-production mode to a demand-side "build-to-order" mode - currently operating in mixed mode. At present, all processes are under review. The tools available are used to their maximum while waiting for the evolution of the company towards a customized production mode oriented customer.

The big challenge is to manage the flow of data. Connectivity exists at BRP, but it is point-to-point connectivity. The company has embarked on a program of global transformation of the operating model in order to achieve customized production. The number of models has exploded, making production more complex. BRP's research teams have embarked on the definition of a bus topology for manufacturing applications to link all their heterogeneous systems. Joël Bombardier says: "How are we going to exchange data to make good management of digital information? The manufacturing bus is the key to the connectivity of the data stream. However, nobody really does it apart from the British firm ATS Applied Tech Systems. A lot of R&D work remains to be done."

One of the difficulties is that it is practically impossible to deploy Industry 4.0 in the company with a return on investment defined in advance. Industry 4.0's core tools are too broad to be used in the calculation of future depreciation. "If the government wanted to invest in automation, it is in manufacturing connectivity that it could do so with the most benefits for the manufacturing sector as a whole," says Gilles Blais. Connectivity is not limited to the manufacturing bus, but it is also necessary to think in terms of control system architecture (SCADA) in order to process a large number of telemetries in real time and to control all of the technical equipment. In general, you need to have the relevant data to be able to improve processes.

BRP is in a transition period. The company deploys automation equipment. It strives to do so in a planned manner in accordance with the needs of global connectivity. Initially, the company will clean up the IT data systems of the assembly and, in a second step, it will extend it to the actual manufacturing so as to obtain data streams for continuous improvement. At the same time, the

company will also want to get the data back from the receipts. In BRP's vision, these should be included in Product Lifecycle Management (PLM) to enable the right revenue to be sent at the right time to the right equipment.

Technology platform

BRP robotics installations are based on about 50 Fanuc robots at the Valcourt plant (there are as many at the Júarez-1 plant) that are complemented by multiple related equipment such as Allen & Bradley and Mitsubishi programmable logic controllers (PLC), wireless clamping tools, pick-to-light systems, vision systems, a test chamber, etc. The equipment is mainly connected to update the programs. The next step will be the extraction of data to be able to validate from Valcourt a robot course in simulation in Júarez.

BRP acquired its first collaborative robots: two Universal Robots (one implanted and one in laboratory) and a Green Fanuc (in laboratory).

Issues

BRP is switching from a mass production mode to a "build-to-order" mode. To manage the new complexity introduced by this transition, it is essential to automate the operation according to Industry 4.0. The challenge is to deploy multi-point and interactive connectivity.

Cisco Canada

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Contact	Rick Huijbregts, Vice President of Digital Transformation and Innovation	
Data	Founded Headquarters N. of employees Main activity Clients	1984 San José (Californie) 73,700 (1,700 au Canada) Telecommunications manufacturer All types of businesses
Mission	Shape the future of the Internet by creating unprecedented value and opportunity for our customers, employees, investors, and ecosystem partners.	
Strategy	Establish partnerships with experts in different fields of activity.	
Means	2,000 IT integrators to serve the SME.	
Markets	10,000 corporations in Canada.	
Issues and opportunities	Convince the manufacturing sector to plan its automation based on the analysis of the data extracted from the equipment.	

Canadian background

Over the past five years, Cisco has invested heavily in Canada. These include the Cisco Canada Innovation Program, which has injected some $ 150 million into Canadian companies and venture capital funds; the creation of 12 university research chairs; and a $ 4 billion R&D initiative with support from the Government of Ontario. Cisco has also partnered with 15 colleges and universities to conduct research projects. In some respects, the company aims to fill the gap left by the disappearance of Nortel.

FIG. 36 – TORONTO INNOVATION CENTRE

Finally, in January 2016, Cisco opened an Innovation Centre in Toronto to catalyze and showcase digital innovation and development. It is intended to bring together business partners, start-ups, application developers, incubators and universities to work on smart cities, the environment and the manufacturing sector. The Toronto Innovation Centre is part of a network of nine similar centers around the world.

Overall, Cisco invests $ 115 million annually in R&D in Canada, primarily in Ottawa-Kanata. Initially, this research effort was essentially product oriented. In recent years, R&D has redefined itself around processes, often with the help of third parties, hence the crucial role played by the network of innovation centres.

Technology approach

At the core of Cisco's manufacturing offer is a partnership with Rockwell Automation at the Hanover Trade Fair in April 2007. The industrial automation solutions provider then asked Cisco to design a custom Ethernet infrastructure for its customers. Cisco understood that the manufacturing sector was a space that needed to evolve rapidly and captured the opportunity to fly. The aim was to fill the vacuum that existed between the engineers who designed the automation equipment and the information technology experts.

As the Internet of objects, digital disturbance or industry 4.0, pioneered industrial production, Cisco began to take an interest in the manufacturing sector. The company identified two trends. The first trend was to optimize manufacturing processes: how to make machines work better, how to predict when they will break down so that the supply chain can be managed accordingly. The second trend was to incorporate increasing intelligence into products manufactured by manufacturers. In either case, Cisco found itself on familiar ground. The digitization of telecommunications in the 1980s and 1990s had completely renewed this industry and Cisco had been the spearhead of this renewal.

Cisco is working with Rockwell Automation to leverage data that is extracted from manufacturing equipment. As of 2012, the company has developed a series of solutions that fit into the "Connected Factory" concept: wireless, logical and physical security, collaboration, etc. This is a platform-like approach that aims to create a digital infrastructure that can be connected with all machines, with products that come out of those machines and with employees on the floor. This "digital plumbing" has to be introduced everywhere in the form of industrial switches, networking equipment, Internet objects, fire systems, which are suitable for both dusty environments and a research laboratory "clean room" Industrial development.

Cisco does as much business with small business as with large business. Indeed, the small company is often a subcontractor of a highly-automated multinational. It is therefore essential to upgrade the small business so that it can enter the ecosystem of the globalized global enterprise. When one thinks in terms of supply chain, one sees that all the actors of the manufacturing sector are closely intertwined. Industry 4.0 not only means that all the company's equipment and products must become visible from a central dashboard, but also the equipment and products of its suppliers and customers. The imperative of connectivity thus gains place in place the entire manufacturing sector.

In Canada, SMEs are lagging behind in automation. That is why it is necessary to make constant efforts to promote it in order to avoid being marginalized and destined to disappear in favor of foreign competition. This approach is all the more flexible as Cisco can secure financing through its wholly-owned subsidiary Cisco Capital, which offers the means to take over the entire project - including equipment purchased from Cisco partners.

Cooperation with the education sector

Starting in 1998, Cisco Canada launched the "Networking Academy" program, which leverages Cisco's IT and networking expertise to develop and deliver courses in Canadian schools, colleges and universities.

- Students acquire 21st century technical and business skills and obtain industry-recognized certifications that prepare them for careers in IT and entrepreneurship.
- Today, there are 204 active academies across Canada with over 22,400 students enrolled in the last 12 months. Since the program's inception, 142,000 students have enrolled and graduated.

- In 2013, Cisco extended the "Networking Academy" to address youth unemployment and the needs of underserved and high potential students. Through the NPower program, students complete the Networking Academy A + certification and are paired with employers for internships. In its fourth cohort, 87% of NPower students had a full-time job. Cisco is working with NPower to expand this program nationally.[29]

Cisco received the Information Technology Association of Canada's Award for Excellence in Public Sector Innovation for the Connected North program.

- Established in 2013, Connected North helps to provide new educational and health care opportunities to Aboriginal students and educators across Canada.
- The program leverages the latest Cisco collaboration technology to bring unique experiences, experts and opportunities for real-world problem solving into classrooms.

Business strategy

In a typical manufacturing automation project, the information technology (IT) segment supported by Cisco may represent 10% of the investment, compared with 90% for the purchase and integration of robotics equipment with all its peripherals. Cisco's recommendation is to encourage the customer to begin to define their equipment needs with the robot supplier. Cisco intervenes when it comes to connecting these devices and securing them.

Cisco does not sell anything directly to the end user. Conscious of not being an automation expert, Cisco has always taken care to build on a partnership strategy. Rockwell Automation is its core partner in the manufacturing process. But the company has also partnered with IBM, Siemens and Schneider Electric, and more recently with Deloitte and Accenture. In Canada, Cisco works with 2,000 IT integrators to serve small and medium-sized businesses, not to mention traditional carriers: Bell, Rogers and Telus.

The industrial user always passes through an intermediary who will then contact Cisco to obtain one of the standardized solutions of the "Connected Factory" series. Deployment and integration into the SME's equipment is carried out by the intermediary professionals. For large companies with complex needs, a Cisco group called "Advanced Services" has the manufacturing expertise required to design the system architecture. But again, the specialists of "Advanced Services" will act in concert with a third-party integrator.

Issues

Build a platform based on collaboration, mobility, cloud and Internet of Things that will underpin the whole process towards the entire automation of manufacturing companies. Cisco must convince every company, large or small, of the need to incorporate a digital dimension into its business strategy.

[29] Based in New York, NPower is a non-profit organization that trains military veterans and low-income young adults to become IT professionals.

Festo

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Contact	Patrice Charlebois, Industry Segment Manager - Food & Beverage, Biotech/Phama	
Data	Founded Headquarters N. of employees Main activity Clients	1925 (in Canada since 1976) Esslingen 18 700 employees (150 in Canada) Automated solutions manufacturer Manufacturing sector
Mission	Provide automation solutions and transfer knowledge to customers.	
Strategy	Reproduce with machines what nature has developed and perfected over the course of evolution.	
Means	Simplify as much as possible the processes of industrial customers' production.	
Markets	Manufacturing companies.	
Issues and opportunities	Work with customers to increase productivity. Festo puts its expertise, global vision and passion for retail at the service of sustainable growth in a constantly changing world.	

Background

Festo is a German family-owned company founded in 1925 and based in Esslingen am Neckar (near Stuttgart). This company was founded by Albert Fezer and Gottlieb Stoll to develop carpentry tools such as milling, drilling and grinding. In the 1950s, the company recognized the potential of using compressed air for propulsion and control of multiple industrial applications. In 1956, Festo introduced a complete pneumatic tooling program for the first time, thus laying the foundations for modern automation.

Today, Festo develops and markets motion automation systems using both pneumatic (compressed air) and electrical energy. Festo is a major player in robotics and has a presence in 61 countries. Its subsidiary Festo Didactic, which offers teaching materials in the field of automation, holds the world's leading position. Providing technical solutions at the forefront of innovation, but also ensuring that knowledge is transferred to third parties, is part of its mission.

About the company

"The philosophy of the original Festo owners was that humans do not invent anything. When we have an industrial challenge before us, we look at what nature has found to solve it, "explains Patrice Charlebois. Thus, the company reproduces with machines what nature has developed and perfected over the course of evolution. This is the mission of its "Bionic Learning Network" research laboratory. Each year, the company chooses an animal for its extraordinary properties and makes it a robotic replica: bird, fish, dragonfly, chameleon, kangaroo, etc. The latest in the series is a butterfly.

As in nature, the Festo bionic butterflies do not collide with each other when flying in groups. They are also able to bypass obstacles. They succeed because they are part of a network of infrared cameras that document in real time the position of each butterfly in the three dimensions of space. These prototypes are not used as such, but they are used to develop new applications. Thus, the purpose of the butterfly is to develop robots that can avoid unexpected obstacles when they move in a factory. "Biomimicry" allows Festo to develop more efficient and agile robotic systems.

In total, Festo invests more than 7% of its revenues in R & D. It holds more than 2,000 patents registered internationally.

FIG. 37 - FESTO BIONIC BUTTERFLY

Source: Festo.

Improvement of traditional solutions

A typical solution of Festo pneumatic technology is a system of automatic valves in a center of dispatch of packages. The parcel labeled with a bar code arrives on a conveyor and must be pointed at the place where the trucks wait for different destinations: Toronto, Kingston, Ottawa, etc. A vision system reads the address and activates the valve that will direct the package towards the right truck. It is a simple, inexpensive system and easy maintenance.

This new valve system is multi-functional. Previously, it was necessary to manufacture valves 3.2 (3 positions and 2 outlets) or 5.2 and store both types in warehouse. The client had to make choices and learn to live with, even if his needs changed along the way. Now the Festo valves are multi-functional and can be configured 3.2 or 5.2 as required.

To facilitate the work of integrators, Festo has developed a Handling Guide Online (HGO) which is a web-based selection and sizing tool for Cartesian robot solutions. If an integrator needs a three-axis robot to grab biscuits on a conveyor and move them to a plastic tray, it is sufficient to describe the need in a HGO questionnaire: work envelope, weight to move, speed movement, etc. Fifteen minutes later, the engineering work is completed with the robot's specifications, the dimensions of the mechanical axes, the force of the engine, etc. Previously, this engineering work took at least half a day of the integrator's time.

Industrie 4.0 solutions

CAD/CAM systems, digital equipment and computerization of office tasks have made impressive amounts of data available to manufacturing companies. But these data are little used today. At best, the analysis is done by human beings who are quickly overwhelmed and who keep their work in their offices without sharing it with the whole company.

The challenge is to automate the analysis of available data and to extract integrated deductions with action. For example, a tire manufacturing company will, of course, collect data on the start of the period of use of the winter models: for example, winter tires are mandatory in Sweden and Finland, December 1, Quebec as of December 15, and so on. Tire production is adjusted accordingly in factories serving these companies. That's not all: in Quebec's tire manufacturing plants, we see that productivity is falling at the end of September. This is the opening of the hunting season. The production of tires is therefore shifted to other periods or other factories, and so on. All data having a direct or indirect impact on the manufacture of tires are collected, analyzed and translated into actions in the production chain.

Business strategy

Festo Canada is an automation partner for integrators and manufacturers. The company works with the integrator to develop the solution. When the solution is installed at the manufacturer, Festo will work with the latter to ensure maintenance.

Quebec issues

For too long, the Quebec government has neglected manufacturing jobs. Manual labor has been devalued. It is the opposite of Germany where manual labor has always been the object of all the attention of the government. The result is that Quebec has many good engineers, but a chronic shortage of technicians. The situation began to change as a result of representations made by the Grouping of Suppliers in Industrial Automation (RÉAI) and in particular in its February 2013 brief. The result was the so-called “Gazelles” initiative, launched in the framework of the Quebec Industrial Policy 2013-2017.

The Strategic Action Plan 2016-2019, launched in April 2016, marks a turning point in that it promotes the "innovative manufacturer", that is to say companies that give a prominent place to robotization, automation and technology development. According to Patrice Charlebois, "this action plan should be accompanied by a campaign to raise awareness of the need for a dynamic and automated manufacturing sector. This campaign should start at school and include factory visits. In companies, managers should be encouraged to inform employees. "

The Innovative Manufacturing Action Plan is timely to meet the challenge of the Canada-EU Comprehensive Economic and Trade Agreement (CETA) concluded in October 2016. Patrice Charlebois says: "European companies will sell their products in 2018 cheaper than they sell today. In addition, President Trump's American protectionism will encourage European companies to turn to the Canadian market. To face European competition, Quebec companies have no choice: they must accelerate their movement towards automation."

Lantic

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http://www.lanticinc.com/en/

Contact	Bob Copeland, Vice President Operations	
Data	Founded Headquarters N. of employees Main activity Clients	1888 Montreal 800 Sugar Refinery Retailers and manufacturers
Mission	Supplying sugar to Canada at the lowest possible cost.	
Strategy	Energy saving and process automation.	
Means	Cane sugar and beet sugar refinery.	
Markets	Canada	
Issues and opportunities	Succeed in automating the production tool while maintaining an infrastructure dating back to the 19th century. Meeting the regulatory challenge (carbon tax).	

Background

Lantic Sugar was founded in Montreal in 1888 and Rogers Sugar in Vancouver in 1890. The two companies merged in June 2008 to form a single operating entity named Lantic Inc.

Products and services

Lantic includes three sugar refineries in Canada: two sugar cane refineries in Montreal and Vancouver, and a sugar beet refinery in Taber, Alberta. The company also has a dry blending plant (iced tea, lemonade, jam, etc.) located in Toronto.

Sugar cane arrives by ship in the Montreal and Vancouver refineries in the form of brown sugar after having been first extracted in the country of origin. To be sold as refined sugar, the cane needs to undergo a second extraction: filtration, discoloration and crystallization. At the Taber plant, Lantic does both primary extraction of beet which is a heavy industrial activity that requires additional temporary labor, and secondary extraction.

Storage is carried out in the company's silos in Taber (30,000 tonnes), Montreal (9,500 tonnes), Vancouver (6,000 tonnes) and third-party warehouses across Canada. Packaging for the industrial market and bagging for the retail market are entirely carried out by Lantic. Liquid sugar for specialized industries (mainly beverages and chocolate) is sold in bulk.

Automation

As early as 2000, Lantic invested $ 2 million in a high-speed automated bagging line for 2 kg bags; Then in 2014 the company invested an additional $ 4 million for an industrial bagging line for 20 and 40 kg bags. Both projects were carried out in Montreal. A $ 5 million investment was made in Vancouver for a cubic sugar line.

Lantic has abandoned the traditional technique of filtering to animal black composed of debris from calcined bones of animals by ion exchangers purchased from the French firm Novasep (formerly

Applexion). Completed in two phases (2000 and 2005), the project required an investment of $ 6 million.

In 2002, for its Montreal refinery, Lantic purchased four robots for the palletization of retail bags and industrial bags. Vancouver followed in 2009 with robots also palletizing. A bagging line was deployed in Taber, also in 2009, which will be supplemented by palletizers in 2018.

Centrifuges are equipment used to remove the color of sugar. Lantic began automating its 15 centrifuges in Montreal in 2005 and the process is expected to be completed by 2020. Next, it will be centrifuges in western Canada. Each new centrifuge costs about $ 1 million. The new centrifuges are controlled by industrial programmable logic controllers (PLCs), each of which replaces two or even three old machines and allows significant energy savings.

Lantic also intends to introduce its own energy recovery and water treatment system in 2018 (the company uses the St. Lawrence water to cool its equipment). This is a $ 5 million investment for highly automated equipment that will be quickly amortized as the company today pays $ 1.3 million a year for its water. In addition, energy recovery will save on electricity consumption.

The whole is managed by a SCADA type system called Wonderware by Schneider Electric, which is an integrated supervision platform for all refining activities and equipment in real time. It increases operator operational capabilities with user-friendly and contextualized user-machine interfaces, an intelligent alarm management system, flexible reporting and analysis tools, as well as additional functional modules for sub-systems, and integration with the central system of the company. In Western Canada, Lantic uses Emerson's DeltaV platform.

Technological platform

The robots in Montreal were acquired from the German equipment manufacturer Haver & Boecker and the palletising systems were developed by Montreal integrator Premier Tech. One of the palletising robots in Montreal, as well as the Taber bagging line, posed many mechanical problems at the time of commissioning.

The centrifuges were purchased from the Braunschweigische Maschinenbauanstalt AG (BMA) for Montreal and the Putsch group for Taber. The bagging equipment comes from FAWEMA.

Workforce

A position of Institutional Director of Engineering was created in 2016 to carry out the operational standardization of the company's equipment. The engineering department has 10 permanent engineers and five contract engineers (there is also a technical department for maintenance). Until then, equipment, including robots, was purchased from different vendors, increasing maintenance costs.

Lantic has developed a four- and eight-month internship program in engineering with universities - École de technologie supérieure (ETS), Polytechnique Montréal and Université de Sherbrooke in Quebec; Southern Alberta Institute of Technology (SAIT), University of Alberta, University of Saskatchewan, University of Victoria and British Columbia Institute of Technology (BCIT) in Western Canada. These internships have just been formalized and the first cooperative students are due to enter in May 2017.

Refinery employees are unionized and have always shown a great deal of mistrust of automation as they associate with downsizing. However, all the automation projects were carried out without

layoffs. Workforce reductions were carried out exclusively by attrition (a layoff of 59 employees took place in Montreal in 2014 as a result of an administrative reorganization foreign to automation).

Business Strategy

The sugar industry is capital intensive and energy intensive. The equipment is being permanently upgraded to reduce labor and energy costs.

Lantic has a structural surplus production capacity, as the sugar markets are highly protected. The sugar market was specifically excluded from the North American Free Trade Agreement (NAFTA). Conversely, the Canadian market is open, although it enjoys temporary protection against US and European imports. Growth opportunities are essentially limited in Canada and Lantic is already Canada's largest producer.

Lantic exports 40,000 tons of sugar a year on a production capacity in the order of one million tons. The destinations are Mexico, the Caribbean, India and some countries of Africa. However, the Comprehensive Economic and Trade Agreement (CETA) between Canada and the European Union is called upon to open up the European market for products containing sugar on a gradual basis. The products of the dry blending plant in Toronto can therefore be exported - excluding granulated sugar from the Montreal and Vancouver refineries.

The prospect of selling products containing sugar on the European market will force Lantic to adopt a much more personalized marketing policy. So far, Lantic sells sugar as a commodity to industrial and commercial customers exclusively.

Issues

Lantic's infrastructure is extremely old: the Montreal building dates back to 1888, the Vancouver building dates back to 1890, and Taber dates back to 1950. Maintaining the infrastructure takes up much of the annual capital investment, to the detriment of equipment projects. The challenge is to increase the share of equipment without compromising the necessary maintenance of infrastructure.

Lantic must have a growing regulatory demand for health and safety and the environment. In particular, the carbon tax in Quebec, British Columbia and, since January 2017, in Alberta. The Alberta regime is the most rigorous regime in Canada. These regulations put pressure on investment in process automation.

Medtronic

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Contact	David R. Lee, Sr. Principal Engineer	
Data	Founded Headquarters N. of employees Main activity Clients	1949 (1968 in Canada) Minneapolis (Brampton in Canada) 85 000 (725 in Canada) Manufacture of catheters Healthcare
Mission	Contributing to human well-being by applying biomedical engineering to the research, design, manufacture and sale of instruments or devices that alleviate pain, restore health and prolong life.	
Strategy	Focus on the niches of excellence of the company.	
Means	The company holds more than 53,000 patents.	
Markets	More than 50 countries.	
Issues and opportunities	Moving from semi-automation to real automation by 2020.	

Background

Medtronic is the world's largest medical equipment company. Founded in 1949 in Minneapolis by Earl Bakken with his brother-in-law Palmer Hermundslie to repair medical devices, the company developed in 1957 the first battery-powered pacemaker. In January 2015, Medtronic acquired Dublin-based Covidien surgical equipment manufacturer and moved its headquarters to Ireland on this occasion. However, the operational headquarters remains in Minneapolis.

The US giant bought CryoCath in 2008 for $ 400 million. CryoCath is one of the great successes of the Canadian medical device industry. It specializes in developing technologies for patients with diseases such as atrial fibrillation, a common form of arrhythmia. More than 95% of its production is destined for foreign markets.

Since then, the company has become one of Medtronic's fastest-growing divisions.

Products and services

Manufacture and assembly of catheters for the treatment of atrial fibrillation. Medtronic produces 100,000 catheters per year at its Pointe-Claire plant that are sold worldwide, primarily in the United States, Europe and Japan. The only major market where the company is entirely absent is India.

Automation

Catheter manufacturing processes are manual and automation has just begun. The decision to automate is mainly due to a quality requirement. In the medical equipment industry, which is highly regulated, absolute quality is essential. However, in a factory where production depends on the manual intervention of multiple operators, it is difficult to maintain a constant quality. The reduction in cost comes second and, moreover, is partly related to the qualitative stake: the production of defective parts has a cost. Research has therefore been undertaken to install efficient and repetitive equipment.

FIG. 38 - CARDIAC CRYOABLATION CATHETER

Medtronic currently introduces semi-automated equipment in 10% of the company. The entire production chain is semi-automated; some channels still operate in manual mode.

The company internally creates tools that require human intervention at the beginning of the process and at the end, the task itself being performed automatically. As the equipment used by Medtronic is very miniaturized, it is very difficult to stock up on the market.

The assembly itself is done mechanically, but the vision system that performs quality control is automated. When assembling a catheter, one has to use glue. The machine checks where the glue is applied and in what quantity. In the future, the entire control process should be automated by means of a laser system.

Obstacles to automation

Industry is regulated and any change in production must be validated by different organizations. Whenever Medtronic modifies a process, the company must prove that the end product will not be affected. As the company sells in many countries, it must not only obtain approval from Health Canada, but also from the Food and Drug Administration (FDA) in the United States, CE marking in the European Union, the Pharmaceuticals and Medical Devices Agency (PMDA) in Japan, etc. Any major approval requires 180 days, not including in-house preparation time.

Workforce

To carry out the semi-automation of 10% of the production lines, Medtronic has hired staff specialized in process development and tool improvement.

An intensive training effort was made to accompany semi-automation. In general, employees consider positively these semi-automation efforts because no positions have been removed. It is about adopting tools to help them work. They perceive this as support to achieve the necessary quality, it is also useful on an ergonomic level.

Issues

The company will continue to extend semi-automation beyond the current 10% to reach 75% by 2020.

At the same time, the Medtronic development groups in Pointe-Claire and Minneapolis are working together to complete the full automation of the production chain in the medium term. The company intends to start this phase in 2020. It is likely that some form of collaboration with external robotics groups will then be necessary.

Appendix II - Questionnaire

Company description	
Q. 01	**Is your organization a manufacturing company?** **Yes** ☐ **No** ☐ *[If the answer is NO, the rest of the questionnaire does not apply.]*
Q.02	**Last name ……..…..** _____ **Name of organization ……..** _____ **First name ……..……** _____ **City ……..……** _____ **Phone or e-mail ……..…..** _____ **Province ……..…** _____ **If different, where are your world headquarters located:** **City: _____, Prov./State/Country: _____**
Q.03	**What is your main field of activity?** *[Multiple answers are allowed.]* *[For example: Metal working, aerospace or automotive, food processing, pharmaceuticals, pulp and paper, electrical machinery, or electronic components...]* **1 -** ……_____ **2 -** ……_____ **3 -** ……_____

Q.04	**How do you qualify your organization in the supply chain of the manufacturing sector?** **OEM (provider of parts or subsystems) ……..** ☐ **Product designer ……** ☐ **Distributor ……..** ☐ **Other ……..** ☐ **If you answered « Other, » please specify:** _____
Q.05	**How many full-time employees currently work for your organization?** *[Please, indicate approximate numbers of full-time employees]* **In your home province** ……..___ **Elsewhere in Canada** ……..___ **In foreign countries** ……___ **If you answered "In foreign countries," please specify: _____**
Confidentiality. Answers to the following questions will be treated as **confidential**. Information will be used only in an aggregated form in order to perform statistical analyses. Neither CATA nor its partners will use this information; it will not be divulged to any third party.	

Market information	
Q.06	**What percentage of your sales do you ship to…?** **…your home province …… __ %** **… the United States …… __ %** **…elsewhere in Canada …….. __ %** **… other countries …… __ %** **For those who answered "Other countries," please specify what countries:** **_____**
Q.07	**The United States intends to increase its protectionist policies. Do you foresee a negative impact on your sales?** ☐ **YES** ☐ **NO** ☐ **Don't know yet. / Not sure** **Any further comment on this topic? _____**

Q.08	**If you answered "YES," please indicate if you have a corporate strategy to get round the impact of American protectionism?** **Increase sales in your home province**…….. ☐ **Increase sales elsewhere in Canada**…..…… ☐ **Increase sales in foreign countries (Europe, Latin America, Asia…)**…. ☐ **Outsource part of my production in the US (open a local plant)**…….… ☐ **Other measures (please specify.)**…….…..…… ☐ _____

Corporate Strategy	
Q.09	**What are the main objectives of your innovation strategy?** *[More than one answer is possible.]* ☐ **Reduce the cost of your main product** ☐ **Improve the quality of your main product** ☐ **Launch new products** ☐ **Increase the volume of production** ☐ **Other** *[If you answered "Other," please specify:]* _____

Q.10	**Does your organization conduct R&D?** **YES ☐** **NO ☐** **Don't know ☐**
Q.11	**What are the main obstacles facing the manufacturing industry today?** *Very important* *Important* *Fairly important*

	Regulation	☐	☐	☐
	Recruitment of skilled staff	☐	☐	☐
	Financing	☐	☐	☐
	Lack of government support	☐	☐	☐
	No particular obstacle	☐	☐	☐
	Other	☐	☐	☐
	[For those who answered "Other," please specify:] _____			

Automation process	
Q. 12	**What type of advanced technology is currently being used by your organization?** Robot systems ☐ Other automated systems ☐ Neither ☐ **For those who answered** "Other automated systems," please specify (3D Printing, Sensors, Internet of Things, Big Data, etc.): _____ *[If you checked "Robot systems" or "Other automated systems," please go to Q.17]*
Q. 13	*[For those who answered "Neither" in Q-12]* **Does your organization intend to equip itself with…** Robot systems ☐ Other automated systems ☐ Neither ☐ **For those who answered** "Other automated systems," please specify (3D Printing, Sensors, Internet of Things, Big Data, etc.): _____ *[If you checked "Neither", please to Q-15]*

Q. 14	**When do you plan to install this equipment?** **Later in 2017** ☐ **Following year (2018)** ☐ **Within two years (2019)** ☐ *If you plan to purchase different types of equipment, please specify which year for each system:* _____ *[Please go to Q.16.]*
Q. 15	*[For those who checked "Neither" in Q-13]* **Please, explain why you chose not to automate your organization:** *[Choose all that apply.]* **Our production cannot be automated** ☐ **Automation is too costly** ☐ **Lack of information on ROI** ☐ **Lack of qualified labour** ☐ **Other reason** *[Please specify.]* _____
Q.16	**In your opinion, how can the government accelerate the deployment of automation in your organization:** **Government subsidies……** ☐ **Workforce training……** ☐

	R&D government programs…… ☐ **Consulting specialized services on automation……** ☐ **Other measures……..** ☐ **If you answered "Other measures," please specify:** _____ *[For the respondents to Q-13 (those who have no robot or other automated equipment), please go directly to Q-25.]*	

Automation details

Q.17	**What is the main reason which incited you to automate your company?** _____
Q.18	**How many robot systems do you have?** _____ **How many automation systems (non-robots) do you have?** _____
Q.19	**Please, specify which are the main brands of robot systems or other automated systems used in your company:** _____
Q.20	**What is the approximate value of…** **… your robots?** _____ **… your automation systems (non-robots)?** _____
Q.21	**What part of your production is automated?** **100%** ☐ **25% to 49%** ☐ **50% to 99%** ☐ **1% to 24%** ☐
Q.22	**What processes are automated?** *[Choose all that apply.]* Design ☐ Manufacturing ☐ Distribution ☐ Other (please specify.) ☐ _____
Q.23	**Since you introduced advanced technologies in your company, did you measure any positive or negative changes?**

	Very important	*Important*	*Fairly important*
Reduced production cost	☐	☐	☐
Increased production volume	☐	☐	☐
Enhanced product quality	☐	☐	☐
Reduced manpower	☐	☐	☐
Technical problems (failures, errors…)	☐	☐	☐
Other changes	☐	☐	☐

	*If you answered "Other changes," please specify:*_____
Q.24	**Does you company intend to purchase more robot systems or other automated equipment in 2017?** *[Those who are already automated at 100% may skip this question.]* ☐ **YES, in 2017** ☐ **YES, within two years (2019)** ☐ **NO** ☐ **Not sure / Does not know** **If you answered YES, how many robot systems or other automated systems do you intend to purchase? _____**

CATA Special Reward

Thank you for your time. If you wish to receive a copy of the market study on Advanced Manufacturing and/or participate in the special CATA draw and have a chance to win a smartphone worth about $800, please answer our last question.

Q.25	**I want…** ☐ … **to receive a free copy on Advanced Manufacturing in Canada.** ☐ … **to participate in the draw organized by CATA (the winning prize is a smartphone).**

Do not forget to return your questionnaire.

By E-mail jgrens@cata.ca
By fax **(514) 313-5751**

THANK YOU!

Appendix III - National Network of Manufacturing Innovation Institutes

In July 2012, the United States President's Council of Advisors on Science and Technology issued a report entitled "Capturing Domestic Competitive Advantage in Advanced Manufacturing". The report was prepared by the Steering Committee of the Advanced Manufacturing Partnership (AMP). This report describes the current state of the manufacturing sector in the United States, analyzes the role of this sector in job creation, and identifies a series of recommendations to strengthen the US industry.

One of these recommendations calls for the establishment of a national network of Manufacturing Innovation Institutes in order to make the link between scientific discoveries and commercial products or practical applications. Each of these tripartite institutes (enterprise-university-government) has the task of prioritizing a critical industrial area. The federal government invested between $ 70 and $ 120 million per institute and the private sector an equivalent amount.

Today, the network called "Manufacturing USA" has 14 institutes out of the 15 planned. The project is so promising that it inspired China's "Made in China 2025" strategy, which calls for the creation of 40 manufacturing innovation centers along the lines of the American institutes. However, the position of Donald Trump's new administration on the program is not known yet.

- - -

"(…) To enable the United States to successfully translate discoveries into products or applications in manufacturing, we recommend the establishment of a national network of Manufacturing Innovation Institutes (MIIs) to bridge the gap between basic research performed in universities and national laboratories, and our production enterprises, particularly SMEs. These Institutes would serve as anchors for technology development, education, and workforce training as illustrated in Figure 48. In effect, the MIIs would function as embedded nodes within a distributed network of research institutes concurrently anchoring both a national and a regional innovation system.

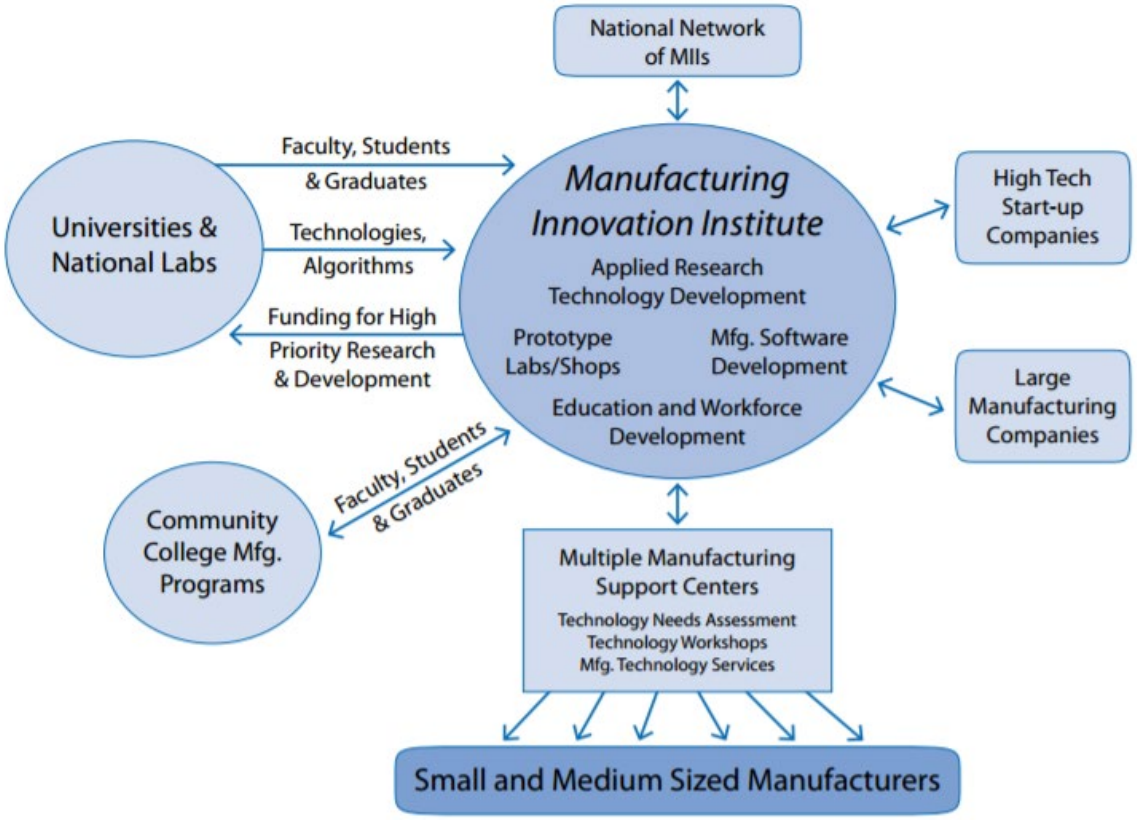
MIIs should support priority areas in cross-cutting manufacturing technology, focusing initially on those recommended above, and subsequently on priority new technologies as they arise. Future areas of support would be expanded to include areas of emerging technologies that have the greatest potential for commercialization into new products, and adoption to create faster, cleaner, and better production processes. These areas are to be identified using the proposed model and roadmap process for prioritizing investment in advanced manufacturing technology. An open, competitive process with peer review should be used to establish the MIIs.

Each Manufacturing Innovation Institute should:

- ✓ Focus on an area of U.S. national economic strength or a promising emerging technology.
- ✓ Be hosted by an industry consortium (two or more members) and a university or national lab. New or existing partnerships can apply for government matching funds to create an MII with the membership of two or more large companies, the participation of related SMEs, and at least one major research university, with active participation by other regional universities and community colleges.
- ✓ Be governed by a Board of Directors composed of representatives from business, academic, and government organizations supporting the MII.
- ✓ Operate independently with contractual flexibility, with the provision that all MIIs will be members of the national network and will follow a similar governance model defined by a national governing board.
- ✓ Be staffed with full-time applied researchers, engineers, and innovation enablers who support the process of technology commercialization, industrial scientists and engineers in residence, part time faculty, post-doctoral researchers, and student interns.

- ✓ Serve as hands-on "training centers" for university and community college manufacturing programs.

FIG. 39 - MANUFACTURING INNOVATION INSTITUTE MODEL



- ✓ Conduct projects that include pre-competitive research and proprietary technology and product research, with a strong intellectual property (IP) protocol that favors manufacturers.
- ✓ Receive support via a mixed funding model from industry, academia, and government, with government (State or Federal) funding guaranteed for a minimum of 5 years with the potential of renewal for a total of 10 years.
- ✓ Receive an industrial 1:1 match to government funding for each MII.
- ✓ Establish distributed manufacturing support centers throughout the region to assist SMEs that want to adopt new technologies.
- ✓ Provide assistance to community colleges wishing to develop and strengthen advanced manufacturing programs.
- ✓ Provide grants to other universities and businesses that are developing complementary and enabling technologies.
- ✓ Provide a shared infrastructure for technology development and serve as a "collaboratory" for research universities and businesses by providing existing and startup businesses with greater access to research, students, internships, workforce development, technology transfer, and commercialization.
- ✓ Provide a variety of business services such as design, digital manufacturing, prototype and test services, and staff training."

« Report to the President on Capturing Domestic Competitive Advantage
in Advanced Manufacturing »,
Executive Office of the President's Council of Advisors
on Science and Technology, July 2012

Advanced manufacturing sector

Initiative on Manufacturing Automation in Canada

Automation in the manufacturing sector is changing the nature of the plant into a high-tech center.

When the first robots arrived in the manufacturing sector in the 1960s, they transformed the automotive industry and gradually the world of big business.

Since the financial crisis of 2008 and, subsequently, the arrival of collaborative robots, this is a different type of phenomenon. The industrialized countries have become aware of the importance of developing their manufacturing sector and of reshoring those of their companies that were outsourced. At the same time, collaborative robotics or cobotics brought automation to SMEs. Everything that is automatable is called to be.

All industrial sectors will have to undergo the same transformations as the old automotive industry - that is to say, undergo the same shocks.

Sector after sector, Canada's entire economy will be affected by the surge of automation, the robots of which are the concrete manifestation. That's why the CATA Alliance can claim that mastering automation is crucial to the future of Canadian manufacturing.

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CRIQ INNOVATION PARTNER

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