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ONLY THE SMART SURVIVE:

How Canada Can Remain Competitive in Manufacturing

October 2016

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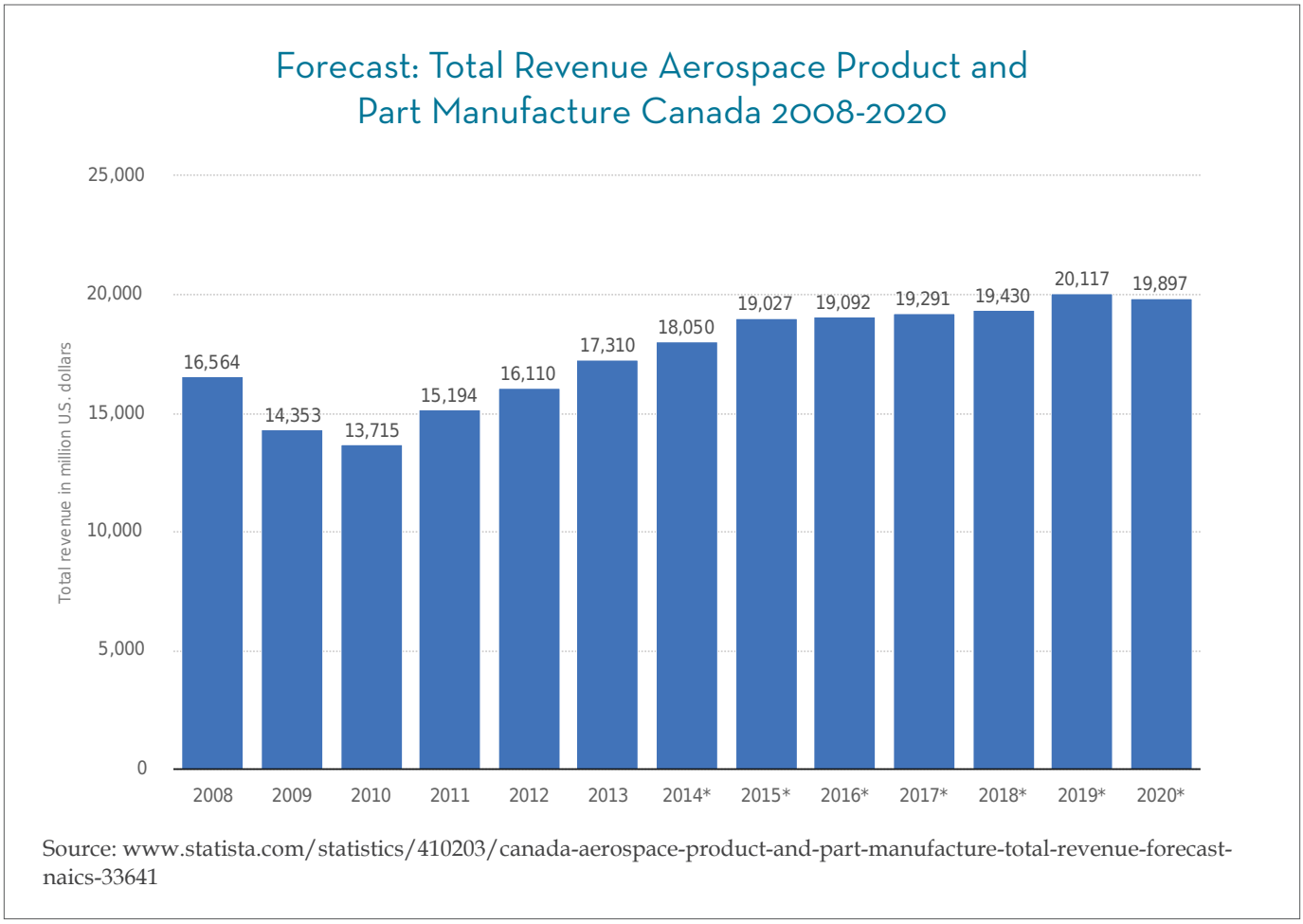
INTRODUCTION: MANUFACTURING MATTERS

Manufacturing is still Canada's wealth creation powerhouse, adding more value and more dollars to the economy than any other sector and is number two in job creation. However, Canada's position as a manufacturing hub is not what it once was. Canada's ability to compete internationally as a top manufacturing destination has deteriorated. The pulp and paper industry for instance, once a thriving industry in Canada, has seen a production decrease of 17% between 2009 and 2014, while production in China has increased by 25% over the same period.[1] With the exception of a few bright spots such as food and transportation equipment, Canada's production numbers have remained either flat or in slight decline since 2010.[2]



Source: www.statista.com/statistics/410203/canada-aerospace-product-and-part-manufacture-total-revenue-forecast-naics-33641

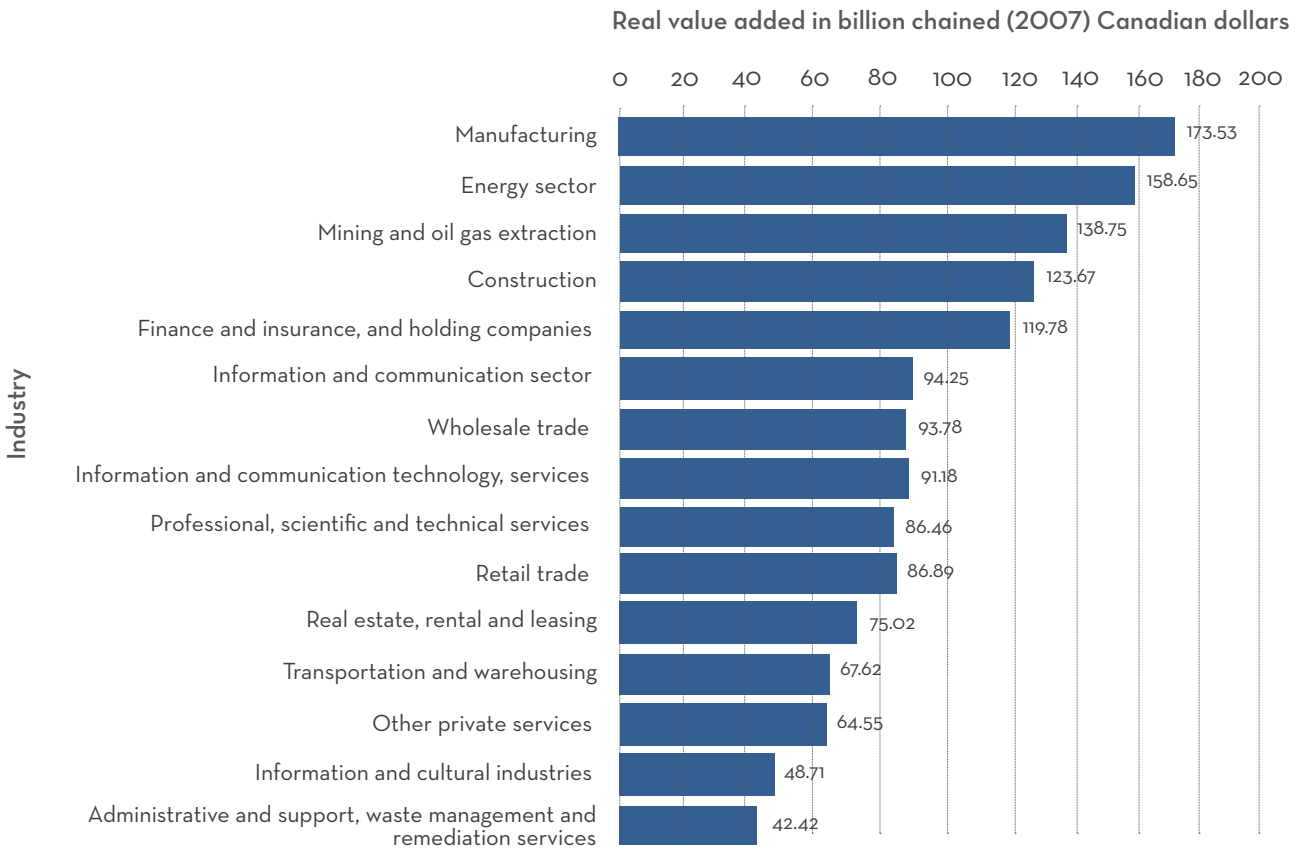
1 VDP – Facts about Paper 2016. http://www.statista.com/statistics/240598/production-of-paper-and-cardboard-in-selected-countries

2 http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/manuf11-eng.htm

New technology is reshaping the global manufacturing landscape and changing the factors affecting where global manufacturers choose to invest. New technologies, new skills and new infrastructure are required to support innovative manufacturing practices and attract global manufacturing mandates.

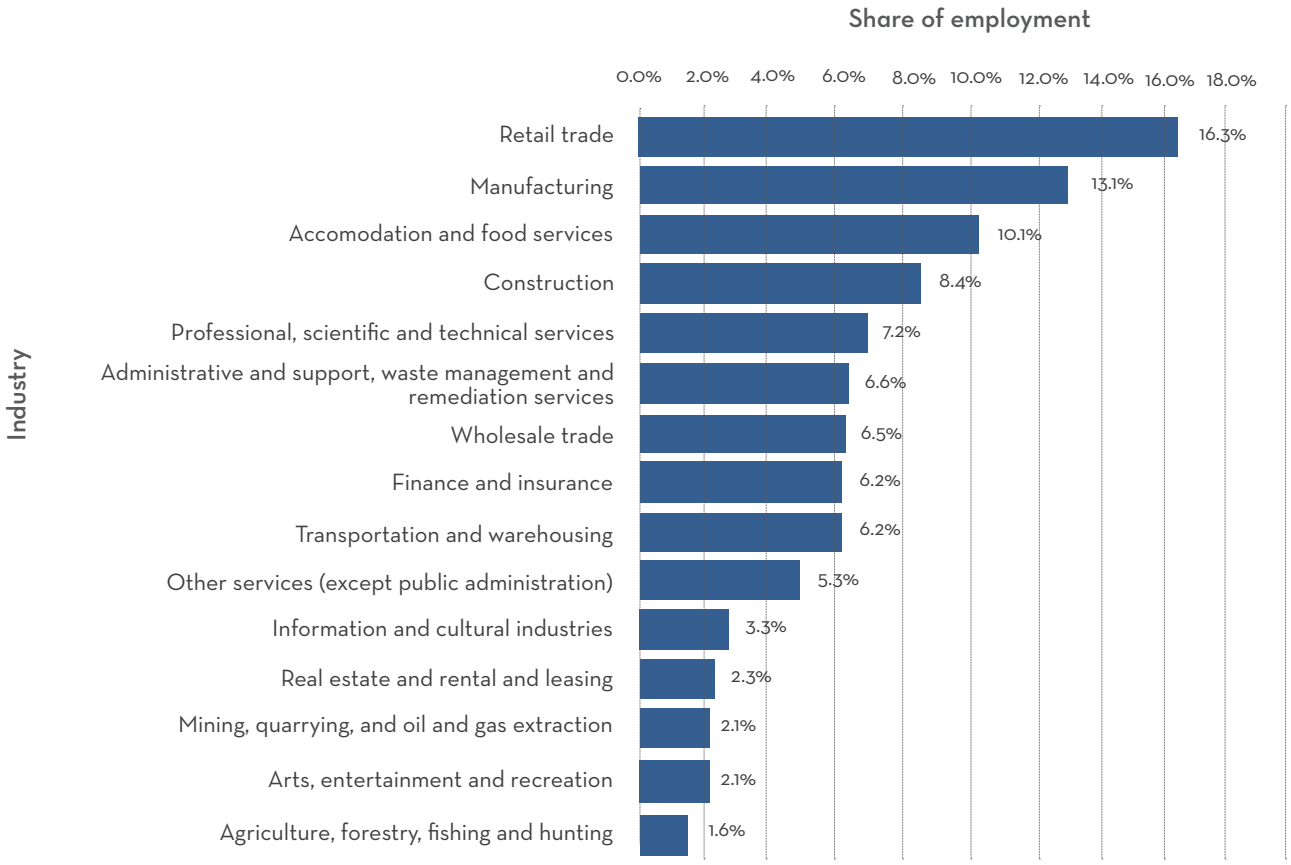
As a whole, Canadian manufacturers have been slow to embrace new technology, mainly due to market risk. The lack of investment at all levels is having a demonstrable impact on competitiveness.

Real Value to GDP by Sector



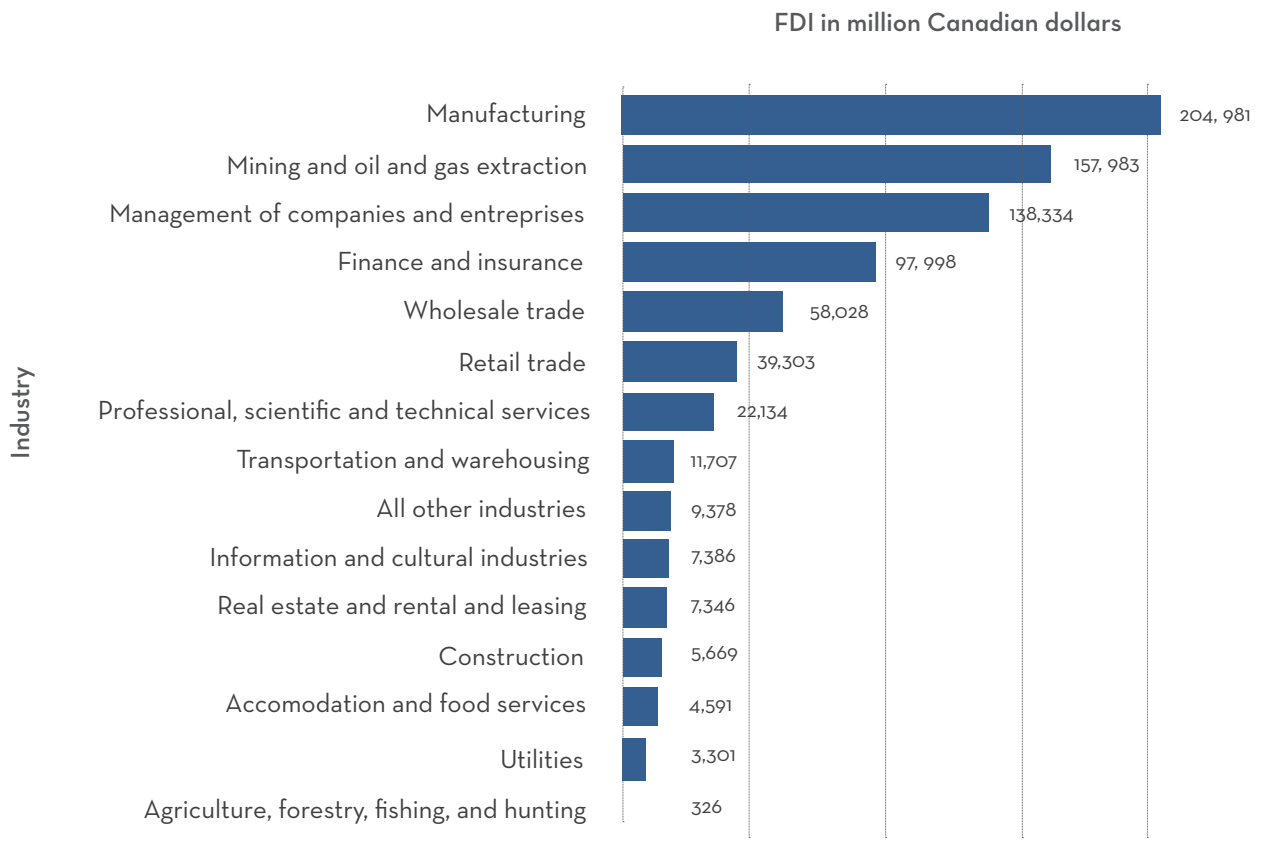
Source: Stats Can, 2014, Canada. Published June 2016. Statscan.gc.ca.

Share of Employment by Sector



Source: Stats Can, 2014, Canada. Published June 2016. Statscan.gc.ca.

Foreign Direct Investment



Source: Stats Can, 2014, Canada. Published June 2016. Statscan.gc.ca.

As a country, we continue to fall behind in innovation and competitiveness. Canada is ranked 15th in the world in competitiveness and 22nd in innovation by the World Economic Forum.

	GCI 2015–2016			
Country/Economy	Rank (out of 140)	Score (1–7)	Rank among 2014–2015 economies*	GCI 2014–2015 rank (out of 144)
Switzerland	1	5.76	1	1
Singapore	2	5.68	2	2
United States	3	5.61	3	3
Germany	4	5.53	4	5
Netherlands	5	5.50	5	8
Japan	6	5.47	6	6
Hong Kong SAR	7	5.46	7	7
Finland	8	5.45	8	4
Sweden	9	5.43	9	10
United Kingdom	10	5.43	10	9
Norway	11	5.41	11	11
Denmark	12	5.33	12	13
Canada	13	5.31	13	15
Qatar	14	5.30	14	16
Taiwan, China	15	5.28	15	14
New Zealand	16	5.25	16	17
United Arab Emirates	17	5.24	17	12
Malaysia	18	5.23	18	20
Belgium	19	5.20	19	18
Luxembourg	20	5.20	20	19
Australia	21	5.15	21	22
France	22	5.13	22	23
Austria	23	5.12	23	21
Ireland	24	5.11	24	25

Source: http://reports.weforum.org/global-competitiveness-report-2015-2016

Despite outperforming most other advanced economies of the world through the worst of the 2008 global economic downturn, the relative strength of the Canadian economy at the time has not translated into improvements in global competitiveness rankings. The balance of trade in goods remains negative since 2008, and Canada's export of goods continues to fluctuate below 2008 levels.

While global production of passenger vehicles has increased by 40% since 2005, Canada's share of that production has shrunk by 0.89%, falling every year for the last three years. Industries like automotive and aerospace have extremely high multipliers, creating 3:1 and 1:1 indirect jobs respectively, and rely on the allocation of global mandates to domestic assembly plants to feed the local value chain. These, along with life sciences, are among the highest contributors to R&D spending in Canada. In 2014, the aerospace industry spent $1.8 billion in R&D.

Without a continued mandate, manufacturing in this country will continue to decline.

In interviews conducted for this report, when asked about upgrading manufacturing technologies, the Canadian manufacturing community revealed a hesitancy to make the investments that could help Canada climb towards the front of the pack. Manufacturers, especially smaller ones, cite a need to prioritize where and how to leverage innovation in ways that will drive efficiencies without consuming vast resources.

It is not easy being a manufacturer in Canada. Global competition has never been tougher, and Canadians have to contend with a fluctuating currency, high wages, skills shortages and soaring

Source: https://www.ic.gc.ca/eic/site/mfg-fab.nsf/eng/00201.html

electricity costs in Ontario. For years, Canada's manufacturing sector has been described as ailing,[3] depressing,[4] in crisis,[5] faltering[6] and on a road to nowhere.[7] The Bank of Canada has described manufacturing as disappointing,[8] mainly because of the decline in employment and still modest gains in investment.

And today in real terms, Canada's real manufacturing output still has not recovered to pre-crisis levels.

3 John Geddes, "Time for the campaign to get serious on economic policy," *Maclean's*, Sept. 8, 2015, www.macleans.ca/politics/ottawa/time-for-the-campaign-to-get-serious-on-economic-policy/

4 Michael Babad, "Why Canada's manufacturing sector is so depressing," *The Globe and Mail*, March 2, 2015, www.theglobeandmail.com/report-on-business/top-business-stories/why-canadas-manufacturing-sector-is-so-depressing/article23242422/

5 Andrew Jackson, "The dismal state of Canadian manufacturing," *The Globe and Mail*, Aug. 7, 2014, www.theglobeandmail.com/report-on-business/rob-commentary/executive-insight/the-dismal-state-of-canadian-manufacturing/article19937927/

6 Leah Schnurr, "Canada manufacturing falters again in August," *Reuters Canada*, Sept. 1, 2015, http://ca.reuters.com/article/businessNews/idCAKCN0R13Y520150901

7 "The road to nowhere," *The Economist*, April 9, 2015, www.economist.com/news/business-and-finance/21648065-canadian-government-no-longer-propping-up-carmakers-dead-not-forgotten

8 Theophilos Argitis, "What's wrong with Canada's manufacturing? The engine Poloz hopes will drive country's recovery is misfiring," *Financial Post*, May 10, 2016, http://business.financialpost.com/news/economy/whats-wrong-with-canadas-manufacturing-the-engine-poloz-hopes-will-drive-countrys-recovery-is-misfiring

Employment is often cited as the biggest disappointment in manufacturing as job numbers have been mostly shrinking for the past decade. Employment peaked at 2.3 million jobs in 2004 and declined until the great recession of 2008-2009 provoked a sharp decline of 280,000 jobs. Employment has held roughly steady ever since.

The percentage of Canada's workforce employed in manufacturing has dropped from almost 20% 40 years ago to 9.5% today.

However, this trend of declining employment is evident in almost all OECD countries. From 1998 to 2008, the United States lost almost 25% (4.1 million) of its manufacturing jobs. From 1990 to 2003, manufacturing employment fell by 29% in the United Kingdom, 24% in Japan, 20% in Belgium and Sweden and 14% in France.[9]

But manufacturing is not in the midst of a generalized decline. Instead, it is going through transformative change all around the world.

Consider that 70 years ago, farming was the most common occupation, employing a third of Canadians. Today, the industry has become so productive and efficient that just 1.8% of our population works in agriculture and is able to feed us while exporting $61 billion of food to other countries. This is all thanks to automation and amazing improvements to fertilizer and genetics.

A similar transformation has been underway in manufacturing for decades. Toronto used to have a "garment district" between Bathurst Street and Spadina Avenue, and Montreal had its "rag trade" on rue Chabanel with tens of thousands of workers in tight rows hunched over sewing machines. Those jobs are mostly gone, and today, instead of a textile industry, we have a fashion industry. With incredible designers like Roots, Lululemon and so many others,[10] the type of work has been transformed. The design, marketing, logistics and management are highly paid and done in Canada while the clothes are mostly assembled by machines or overseas.

9 Statistics Canada, *Canada Year Book, Manufacturing*, 2011, www.statcan.gc.ca/pub/11-402-x/2011000/chap/man-fab/man-fab-eng.htm

10 Chris Danforth, "20 Canadian brands every highsnobiety reader should know," *Highsnobiety*, Nov. 20, 2014, www.highsnobiety.com/2014/11/20/canadian-clothing-brands/

Incredible advances in manufacturing technology, from robotics to 3D printing to artificial intelligence, are making manufacturers orders of magnitude more productive than anything we have seen in history.

It is a time of exciting opportunities, but also highly competitive. If Canadian manufacturers try to compete on costs with countries like China and Mexico, then Canada will lose. But if we invest in new technology and lead in innovation and in R&D, then we can succeed and win in manufacturing. Reversing the trend means rethinking what we value and measuring manufacturing success in a new way.

There are many exciting examples of investments such as General Motors announcing 1,000 highly skilled, new engineering jobs[11] that will focus on self-driving cars. Indeed, the future success of manufacturing depends on our ability to deploy Canadian brains to innovate, create and commercialize new products.

However, research shows that the Canadian business sector invests relatively little in R&D compared to peers abroad even in industries that are highly R&D intensive by international standards.[12]

- Lower R&D intensity in the Canadian manufacturing sector is affecting Canada's performance.
- R&D in Canada is labour intensive and less capital intensive relative to other countries.
- Fewer large firms undertake R&D in Canada than in highly R&D-intensive countries.

Canada needs to craft new ways to foster R&D in Canadian manufacturing because the economic benefits could be enormous. Canada has world class capabilities in engineering, software and artificial intelligence. By refocusing the metrics that we guage our manufacturing success to include a broader spectrum of inputs. Manufacturing is more than production output. The product development, engineering and process engineering are high value inputs to manufacturing . Creating a policy environment that recognizes and rewards these high value inputs will result in improved investment attraction performance. As one executive interviewed for this report characterizes it, "Canada needs to invent products for others to produce rather than produce products that others invent."

The Purpose of this Report

To address the challenges facing Canada's manufacturing sector, this report examines specific drivers behind investment attraction and the changes to global supply chains. It also looks to global best practices to identify specific lessons that can be replicated in Canada.

This document is intended to inform a dialogue between government and industry—a dialogue that should lead to putting in place modern policies and incentives to support Canada regaining its competitive standing on the world stage, particularly in sectors such as automotive, aerospace, clean-tech and biotech.

11 Peter Armstrong, " GM plan to hire up to 1,000 engineers in Canada a major boost for self-driving car's future," *CBC News*, June 10, 2016, www.cbc.ca/news/business/gm-canada-engineers-1.3624257

12 Council of Canadian Academies

SECTION 1: THE ROAD TO RECOVERY

Canada's competitive ranking has fallen over the years. The World Economic Forum's 2014 report, *Future of Manufacturing*, makes reference to the Competitive Industrial Performance Index (CIP) in which Canada is shown to have fallen from a ranking of seventh place in 2000 to 17th place in 2012. The CIP defines competitiveness as the "capacity of countries to increase their presence in international and domestic markets whilst simultaneously developing industrial sectors and activities with higher value added and technological content."

Addressing Canada's lagging competitive standing requires an understanding of Canada's manufacturing sector and its challenges.

Canada as a Choice: A Good Place to Do Business

On a positive note, Canada ranks ninth among the 60 largest economies in the world as a good place to do business, according to a study by Grant Thornton LLP.

The ranking is based on 22 indicators across five growth areas: business operating environment, technology, labour market, market growth and financing environment.

Canada ranks first for its business operating environment, which considers key indicators such as foreign trade and exchange regimes and controls and policies towards private enterprise and competition.

However, Canada ranked 20th in technology as companies need to invest in the latest innovations to stay competitive. Canada needs to work on promoting itself as a choice business destination that supports the growth of foreign companies.

There are approximately 51,000 employer manufacturing businesses in Canada. Only 276 (less than half a per cent) of those businesses employ more than 500 people. Ninety-nine per cent of Canadian businesses are small-medium enterprises with 75% of them being micro-enterprises employing less than 10 people[13]. Yet, according to a report by the Centre for Digital Entrepreneurship and Economic Performance (DEEP), SMEs account for 70% of private sector payrolls.

Complicating matters is a decline in the number of mid-size firms in Canada.[14] While they make up only 1.7% of total firms, they contribute 16% of total jobs in Canada, represent 17% of total exports and pay higher wages than their smaller peers. It is especially troubling that the decline is most prominent in Canada's manufacturing sector.[15] This trend places more pressure on Canada's larger businesses to drive growth.

Commitment to Innovation

Research by DEEP reveals that Canadian companies have identified barriers, such as a lack of financing, that make it difficult to grow their small businesses into large-scale companies with the capacity to compete internationally. According to the OECD, Canadian firms have historically (1970s, 1980s, 1990s) had the second-lowest level of average technology investment as share of GDP. The record improved somewhat in the 2000s when Canada ranked 11th among the 21 OECD countries in total investment in ICT.[16]

According to a 2010 study by the Canadian Manufacturers and Exporters, investments by Canadian manufacturers had fallen by 37% since 2000. As a result, there was a 33% technology gap between Canadian and American firms, which goes a long way towards explaining Canada's comparatively poor performance.

Access to larger markets increases incentives to innovate. Innovation requires fixed costs. The larger the market, the more profitable it is for firms to invest in innovation. Trade liberalization, by expanding the size of the market, encourages firms to export and simultaneously invest

13 Industry Canada, *Key Small Business Statistics*, July 2012

14 BDC, *Canada's mid-sized firms in decline, BDC study shows*, Feb. 13, 2013, www.bdc.ca/en/about/mediaroom/news_releases/pages/mid_sized_decline.aspx

15 BDC, *Study on Canada's Mid-sized Firms,* 2013

16 Centre for Digital Entrepreneurship and Economic Performance (DEEP), *Driving Canadian Growth and Innovation*, May 2013

and innovate, which in turn raises firm-level productivity growth.[17] In 2011, the Business Development Bank conducted a survey that found that 44% of Canadian SMEs are not active internationally and that 26% see no benefits to expanding to that level—despite a well established link between export activity and high growth potential.[18] In 2005, the Canadian Imperial Bank of Commerce discovered through a study that 57% of Canadian small business owners were interested in using their business as a means of generating income while balancing other commitments or lifestyle choices. Striving for high growth and the intense demands that go along with it were not a high priority.

Canadian Chamber of Commerce-led interviews found that Canadian companies recognize they need to invest in new technology to remain competitive, but cite access to capital and lack of access to skills as significant barriers.

Recognizing the Link Between R&D and Productivity

As reported in DEEP's research, there is a demonstrated link between extensive R&D investment and a firm's propensity to qualify as a "high-growth" or "high-impact" organization.

High-growth firms in Canada are no exception: a significant number are characterized by their export orientation and their sizable investments in R&D. Industry Canada finds that, on average, exporters were more R&D-focused and growth-oriented and had been in operation for more years than non-exporters. Furthermore, Canadian high-growth firms spend 20% or more of their investment budget on research. A U.K. study by NESTA (2009) corroborates this by finding that "innovators" in the U.K. experience double the revenue growth of "non-innovators."[19]

As is the case with countries such as Germany (see page 19: Case Study: Germany), collaboration between private sector and research universities is an important method of supporting SMEs with research capacity. Yet in Canada, only one in five SMEs has worked with a post-secondary institution. Of those, 44% said the experience provided access to expertise they did not have along with new ways of seeing things. Thirty-four per cent said it gave them the resources necessary to do R&D.

A review of OECD data comparing sources that contribute to a given country's GERD[20] reveals that while Canada's R&D efforts benefit from foreign investment and government spending, industry is not investing to the same level as countries like Germany, the Unites States and Korea and is, in fact, demonstrating a slight decline where others, such as the U.S. and Korea, are trending positively. The interactive dashboard can be viewed online at: Chamber.ca/resources/oecd-interactive-dashboard.

17 Statistics Canada, *Empirical Evidence from Canada Firm-level Data on the Relationship Between Trade and Productivity Performance*, June 16, 2015, www.statcan.gc.ca/pub/11f0027m/11f0027m2015097-eng.htm

18 BDC, *Investments: BDC Viewpoints Study*, October 2011

19 NESTA, *The Vital Six Per Cent: How High-growth Innovative Businesses Generate Prosperity and Jobs*, 2009

20 GERD: Gross Domestic Expenditure of Research and Development as a percentage of GDP

Figure 1: FDI as Percentage of GERD

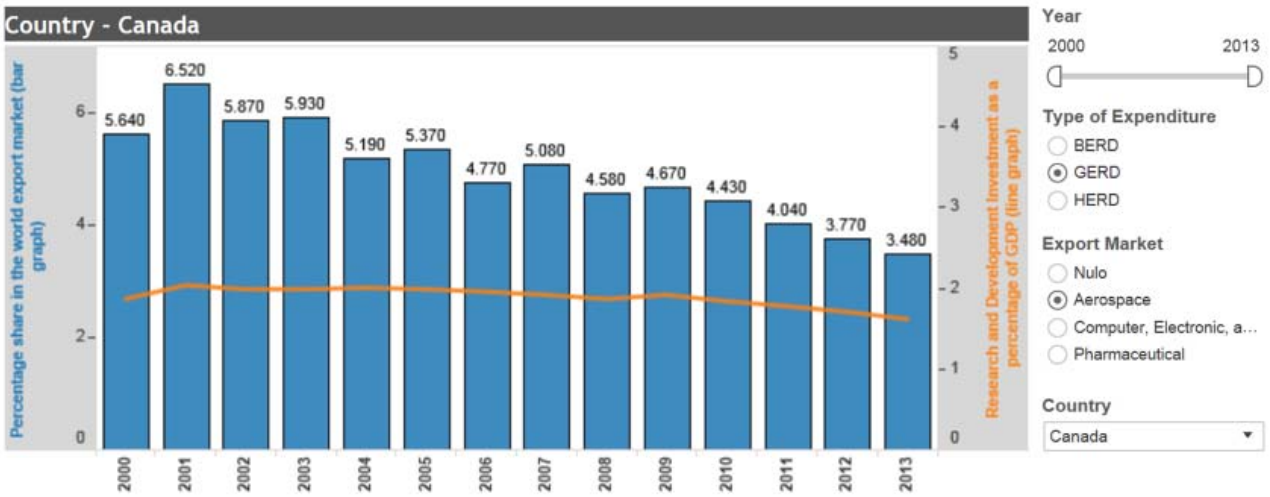
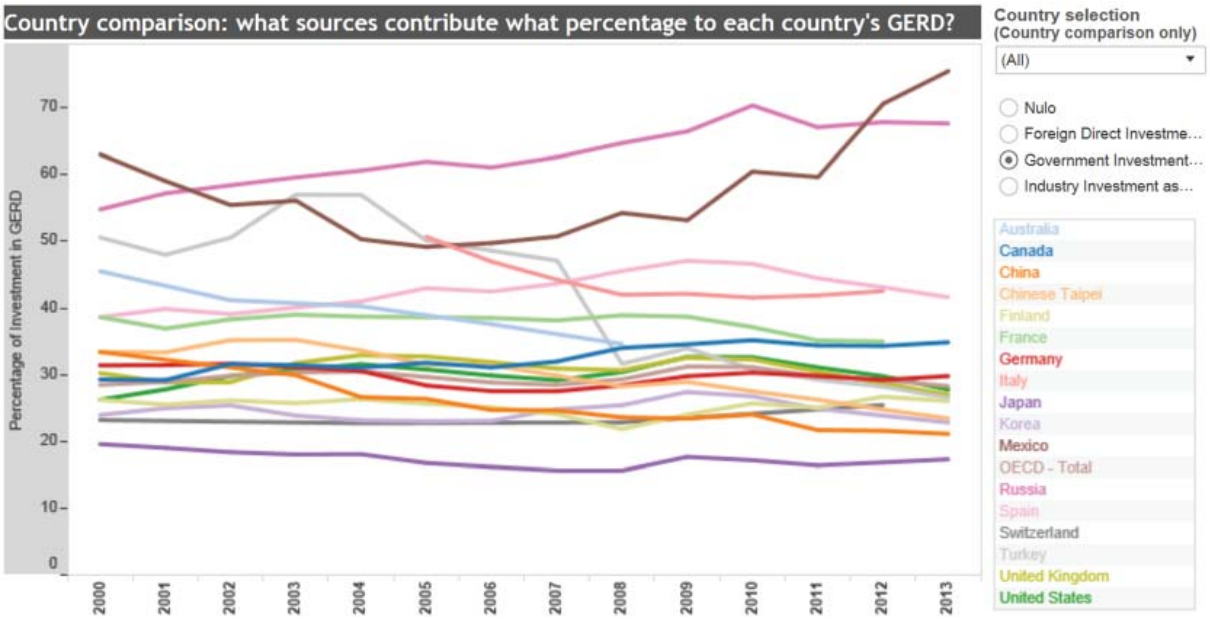


Figure 2: Industry Spending as Percentage of GERD



Source: OECD GERD data, Canadian Chamber of Commerce. Chamber.ca/resources/oecd-interactive-dashboard

The Link Between R&D and Growth

Skills and management competencies are an important driver of SME success. A 2006 study[21] found that exceptional rates of R&D investment and innovation are tightly correlated with above average management competencies. Firms that make investments in managerial assets through training and exposure to research, technology and international markets have increased rates of success.

A study conducted by the London School of Economics and McKinsey concluded that Canadian firms are, on balance, well-run, but lag firms in the United States, Japan, Germany and Sweden, all of which outperform Canada when it comes to producing high-growth firms.[22]

Acess to Capital

Executives interviewed by the Canadian Chamber indicate that they "struggle constantly with accessing capital to finance their innovation in the forms of technical demonstrations and prototypes—without which, innovation simply remains ideas and not reality." [23] These opinions were corroborated by a report from Harvard that shows the "intellectual distance" between innovators and capital providers can be a huge barrier to funding. Further emphasizing this challenge, the DEEP report notes R&D-intensive firms are seen as high-risk and are declined financing twice as often as the average SME.[24]

On the value chain side, participation in the value chain requires investment for research expansion. While Canada's banking sector tends to be relatively competitive, access to capital continues to be identified by Canadian business as a key challenge.

Canada's capacity to compete in international markets depends on its ability to innovate. Access to capital is critical to early-stage technology companies because the funding enables them to survive and grow.

These fast-developing firms represent just 5% of the companies in Canada but they account for 45% of new job creation. The technology they develop allows Canadian companies to export their knowledge and establish international partnerships.

Yet, Canada's venture capital sector remains small and, for many entrepreneurs, difficult to access.

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21 John Baldwin and Guy Gellatly, *Innovation Capabilities: The Knowledge Capital Behind the Survival and Growth of Firms*, Statistics Canada Research Paper, Catalogue No. 11-622-MIE, 2006

22 Nick Bloom, Stephen Dorgan, John Dowdy, Tom Rippin and John Van Reenen, *Management Practices Across Firms and Nations*, London School of Economics and McKinsey & Company Inc., 2005

23 The Canadian Chamber of Commerce, *Manufacturing Innovation: Driving Canada's Biggest Sector through Disruptive Technologies*, December 2014

24 Centre for Digital Entrepreneurship and Economic Performance (DEEP), *Driving Canadian Growth and Innovation*, May 2013

SECTION 2: BEST BETS FOR CANADA'S MANUFACTURING FUTURE

Canada's manufacturing future depends on four key elements:

Harnessing Transformative Technology

As computers, data science and broadband internet converge with manufacturing, new technologies are emerging (3D printing, advanced robotics, and artificial intelligence), and existing technologies, such as computer controlled cutting machines (CNC machines), are finding new relevance and uses within modern supply chains. These changes are leading to new approaches not only to the way products are made but to the skill sets necessary for making them. More importantly, there is a clear opportunity to harness existing Canadian expertise in robotics software and artificial intelligence in product and process development.

Investment in Digital Infrastructure

In addition to access to skills and a supportive policy environment, Canadian firms competing for mandate opportunities should be able to demonstrate access to strong telecommunications and broadband digital infrastructure. While Canada's telecommunications firms have the responsibility of supplying digital infrastructure, recent government decisions sometimes negatively impact the ability of Canadian telecoms to deploy leading and globally competitive technologies.

Improved Market Access

Access to markets is important, especially when a company must set up production in a particular market to sell products or services there. For example, access to the U.S. automotive market has played an important role in the development of the Canadian auto parts sector.

The North American Free Trade Agreement (NAFTA) and a highly competitive transportation and logistics network contribute to Canada's access to U.S. markets. Canada can be an excellent base for companies looking to sell across North America.

As Jeffery Immelt notes, protectionism and anti-globalization are on the rise:

> *You would think that companies like GE that give people good jobs, make good products and contribute to their communities would be valued. That governments would try to nurture growth and address big problems like income inequality and unemployment. That global integration would be seen as a force of good and would continue to grow.*
>
> *You would be wrong. Today, big companies are distrusted; governments and global institutions are failing to address the world's challenges; and globalization is being attacked as never before.*[25]

He goes on to note:

> *Our competitive advantage is digital productivity. When we digitize power plants and hospitals by connecting them to the industrial internet, we improve global productivity. In Pakistan, we are using analytics to improve energy efficiency and expanding capacity. In India, we can use the internet to deliver healthcare to remote regions. In China, engine analytics are improving airline productivity. Every industrial company must also be a digital leader. This is the next wave of competitiveness.*[26]

A Strategic Investment in People

For developed countries such as Canada, advanced skills are essential to the ability to deliver the R&D capacities that sit at the higher value added end of the supply chain curve.

Countries, like Germany, ensure they have access to relevant talent through strong linkages between their private sector, research communities and government. They stream their students from an early age towards programs that best suit their aptitudes and provide early on-the-job training and skills development through work placement programs. Furthermore, incentives are provided to increase collaboration between science and industry that contribute to setting the national framework for a basic and applied research agenda—one that aligns with the needs of industry and the competitiveness of the country. From this model, relevant and skilled labour is developed both in the workforce and through the universities and research centres. In Germany, it is aligned through a focus in helping grow the country's competitiveness on the world stage. Based on Germany's top tier rankings, it is working.

25 Jeffery Immelt, May 2016 address to New York University Stern Business School

26 Ibid

Case Study: Germany

Germany is oft-cited as an example of a global standard that has been able to sustain manufacturing as a relevant source of employment, growth and exports. A 2015 report by the Brookings Institution studying Germany's success in manufacturing noted that the sector "accounts for 20% of German employment and generates 22% of national GDP and 82% of total goods exports."[27]

Three Core Drivers

The success of Germany's manufacturing sector is based largely on three inter-related elements:

1) *A federalist policy effort to support clusters of globally competitive manufacturers, in particular, its small- and mid-sized Mittelstand firms.*
2) *Public-Private collaborations on applied research to support innovation.*
3) *A dual model of vocational education to sustain a highly trained workforce.*

Strong Institutional Research Networks

Germany boasts a highly coordinated technology strategy that employs a broad range of institutional actors such as universities, public research organizations, state and federal governments and industrial research organizations and foundations.

These institutions collaborate across multiple levels of government to support manufacturing through basic scientific research, applied industrial research, innovation incentives and targeted strategies to develop clusters and new technologies.

Basic research in Germany is conducted by various German institutions including:

- *A broad network of universities and applied science universities.*
- *National laboratories such as the Helmholtz Association, Germany's largest research organization. Helmholtz acts as an umbrella organization for different research entities in earth sciences, energy, aeronautics, space and transport, health sciences, advanced materials, IT and particle physics.*
- *Other research associations, including the Leibniz Association and the Max Planck Institute. The latter focuses on fields such as astrophysics, computer systems, genetics, neuroscience, biosciences, chemistry, material sciences, computer science, particle and quantum physics, and microbiology.*

Basic research is important to manufacturing for two reasons:

- *It provides the theoretical foundation for applied research and helps identify new research fields with potential application for industrial use.*
- *It provides a vehicle for the federal government to shape the priorities of its broader industrial technology policy through grants and research bonuses.*[28]

Organizations, like Fraunhoffer and Helmholtz, help others bridge the "valley of death": that stage of production development where the potential return on investment is high but equally high levels of uncertainty prevent firms, particularly SMEs, from investing significantly in R&D.[29]

27 Brookings Institution, *Skills and Innovation Strategies to Strengthen U.S. Manufacturing: Lessons from Germany*, 2015

28 Brookings Institution, *Skills and Innovation Strategies to Strengthen U.S. Manufacturing: Lessons from Germany*, 2015

29 Ibid

Government Support

Federal government support in Germany is centred on support for technologies and regional clusters.

Germany's federalist strategy begins with its national innovation policy, the High-Tech Strategy 2020 (HTS). The HTS provides incentives to increase collaboration between science and industry through which it sets the framework for basic and applied research.

The HTS allocates 15 billion euros to research-related cross-cutting technologies that have broad applicability across multiple manufacturing industries. Funds are awarded on a competitive basis that requires collaboration among public, private and civic institutions.

Recognizing the critical importance of clusters, Germany's federal ministry of Education and Research launched in 2009 the Leading Edge Cluster Competition, a contest that promotes up to 40 million euros to five clusters, selected every 18 months, to develop a key technology that has the potential to impact an entire supply chain.[30]

Germany Prioritizes Skills and a Future Workforce

Human capital is a critical determinant of innovation. Complex, capital-intensive systems increasingly define manufacturing and demand qualified production workers who possess the practical knowledge, creativity and adaptability to implement and improve new processes and technologies.[31]

The German education and training system prepares its manufacturing workforce from a relatively early stage in the education system.

At the end of primary school (age 10-12) parents, students and educators decide on one of three common lower secondary schools.

After completing lower secondary school, three paths are presented to students:

- *A dual system that includes a work apprenticeship for three to four days with the remaining one to two days attending vocational school. Forty-five per cent of German students select this path.*
- *The pursuit of full-time vocational education and training. Fifteen per cent of students elect to follow this path.*
- *The continuation of grammar school en route to university. Thirty per cent of students follow this path, with numbers growing.*

For the 45% of students who choose the dual system, companies sign them into two to three-year apprenticeships, providing an hourly wage just below that of an entry-level worker.

Employers participate within the dual system for a variety of reasons:

- *It allows firms to begin a long-term skills investment into apprentices who become a higher skilled full-time workforce upon completion of their training.*
- *It provides firms with access to qualified labour which in turn provides the firms with a productivity advantage over their competitors.*

30 Ibid

31 Brookings Institution, *Skills and Innovation Strategies to Strengthen U.S. Manufacturing: Lessons from Germany,* 2015

- *Apprenticeships allow firms to evaluate young workers before hiring them full-time. This is particularly important given Germany's powerful labour unions, which make it hard to fire workers once they are hired.*

  The German education and training system significantly benefits innovation in Germany's manufacturing community by:

  1) *Providing workers with essential basic skills that serve as the foundation to obtain advanced and specialized on-the-job skills and experience.*

  2) *Providing a focus on active learning and adaptability, favouring both early-career apprenticeships and lifelong learning.*

  3) *Giving industry access to a training system that quickly and easily responds to industrial and occupational changes. This is due in part to close collaborations between companies, industrial chambers, research institutions and governments.*

There are key practices that should be explored to help Canada:

1) *Promoting better regional collaboration between public, private and civic actors.*

2) *Targeted institutional interventions to address market and coordination failures.*

3) *Incentive-based investments into key research areas to support SME-based R&D as well as private sector and University collaboration.*

While Canada's universities are developing high quality talent, there remain issues with how that talent aligns with the needs of industry. Furthermore, there is a challenge with retaining foreign students in Canada following the completion of their studies.[32]

32 The Canadian Chamber of Commerce, *Talent for an Innovation Economy*, to be released in September 2016

SECTION 3: SEEKING GLOBAL MANDATES

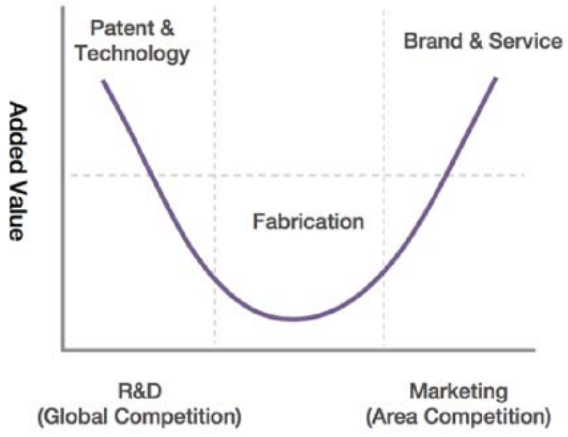
New forms of competition are emerging as different segments of supply chains require different capabilities. A large proportion of manufacturing output has shifted towards the developing world. However, the actual fabrication or production stages of supply chains are becoming relatively standardized and subject to lower economic returns. It is the pre-production (e.g. R&D and design) and post-production (e.g. marketing and logistics) segments where high levels of added value are concentrated.[33]

By accessing higher value manufacturing mandates, Canadian firms not only help their company's fortunes in Canada, they often drive innovation that benefits other enterprises and the broader Canadian economy.[34]

But to attract high value opportunities, manufacturers will need to demonstrate they have access to talent and investment in advanced manufacturing technologies. Otherwise they risk seeing mandates redirected to competitors in other parts of the world.

Attracting global investment contributes to innovation, productivity and competitiveness and is one method by which Canada can close its competitiveness gap. But this investment must be earned. Domestic assembly plants compete with their global counterparts for production mandates.

Generic Smile Curve in a Value Chain



Source: Global Agenda Council on the Future of Manufacturing

From 1990 to 2014, global trade grew five-fold while global Foreign Direct Investment (FDI) grew six-fold across the world. FDI growth is bolstered by the economic contribution of foreign affiliates globally. Illustrating this point, the total assets of foreign affiliates rose from $3.9 trillion in 1990 to $102 trillion in 2014. Currently, approximately 82,000 multi-national enterprises have 810,000 foreign affiliates world-wide and

33 World Economic Forum, *The Future of Manufacturing: Driving Capabilities, Enabling Investments*, 2014

34 Public Policy Forum, *Attracting Global Mandates and Investment in Canada*, 2011

75 million employees abroad. It is also important to note that where companies choose to invest is also changing. In 2014, it was reported for the first time that FDI inflows to developing economies had surpassed those to developed economies. Countries like Germany and Canada have recently fallen from the top five investment destinations, with Canada, in particular, falling to seventh place in 2014.[35]

Global manufacturers use value chain analysis for assessing competitive advantage (R&D, fabrication, logistics) to find the best combination of talent and cost savings in determining product mandates. As reported by the Conference Board of Canada in its 2011 report *Attracting Global Mandates and Investment in Canada*, "when Canadian operations of international companies win global and regional mandates, they attract investment in innovation-oriented activities that benefits the broader Canadian economy."[36]

Benefits of Investment

There are several benefits that come with the attraction of investment, such as capital from the investor to build a new facility, upgrade an existing one or acquire a local company, creating employment opportunities for locals. FDI also brings tech transfer, new management competencies and connectivity to distribution and supply channels.[37]

Investment Drivers

Through interviews for this report with manufacturers in various sectors, we discovered the drivers of global decision makers for awarding mandates (in no particular order) include:

- Jurisdictions that demonstrate a consistent commitment to the rule of law
- Access and proximity to market
- Access to a skilled work force
- Labour productivity
- Infrastructure, particularly energy supply and transportation
- Other cost inputs such as energy (electricity rates), transportation and materials
- Innovation and product quality from local assembly plants
- Regulatory regime
- Incentives to allocate

35 IVEY, *Future of Canadian Manufacturing*, 2014

36 Public Policy Forum, *Attracting Global Mandates and Investment in Canada*, 2011

37 IFC/World Bank, *Investment Generation Toolkit*, www.wbginvestmentclimate.org/toolkits/investment-generation-toolkit/module1-step2-substep1_economic-and-other-benefits-from-fdi.cfm

The Technology Gap

Canadian companies have yet to fully embrace technologies such as the internet of things (IOT) and cloud computing, both of which are instrumental in the future of manufacturing. This was confirmed by recent research conducted by Microsoft Canada in October 2015. Microsoft interviewed 700 C-suite executives regarding cloud computing and the IOT. While 49% of the executives interviewed believe advanced technology helps maintain competitiveness, 85% say they are not fully making use of technology in their business strategies. When asked why, 70% said cost was a factor, 56% identified integration issues and 28% cited security concerns. With regards to cloud computing, 52% of executives are considering cloud based solutions while only 18% are actively implementing cloud computing into their business. The Microsoft survey revealed even less encouraging statistics with regards to the internet of things: 53% of those surveyed were completely unaware of the IOT, 24% were unaware of how it could impact their business and 72% indicated they were confused by it.[38]

Leveraging Technology to Gain Efficiencies

In 2006, DHL and Don-Bur, a manufacturer of vehicle trailers, jointly developed the Teardrop, an aerodynamic trailer delivering fuel and CO_2 savings of up to 12%. Through the project, Don-Bur managed to withstand the local economic recession and became one of the of the most successful trailer companies in the U.K. Don-Bur increased staffing levels by about 20% and local suppliers have benefited from increased production rates.[39]

Using Data for Supply Chains Savings and Efficiencies

A global transportation company developed a proprietary "telematics" system that combines information on the mechanical behaviours of delivery vehicles and behavioural patterns of drivers and helps the company increase its fuel efficiency throughout the process. The vehicles are equipped with multiple sensors to gather information on their speed, direction, braking and performance of specific parts and components of the engine. At the end of each driver's shift, all the information is uploaded to a data centre. Off-the-shelf telematics software helps to gather and compile the data. Using proprietary applications, the company's personnel queries and analyses the data and draws conclusions about vehicle maintenance and logistics processes. Improved driving behaviour helps the company reduce fuel consumption thereby improving its carbon emissions. Maintenance of vehicles reduces waste (parts, oil, etc.) because of reduced idling time and fewer engine restarts.[40]

Disruptive Technologies

Underpinning the ability to achieve greater efficiencies are new technologies that are being used in innovative ways to enhance supply chains. These technologies include 3D printing, sensors, the internet of things and robots. They can provide savings on inputs into the manufacturing process, reduce transportation costs and allow for nimble and flexible manufacturing practices—all qualities being sought by global manufacturers.

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38 Christine Wong, "IoT? 'Never heard of it,' say over half of Canadian businesses," *itBusiness.ca*, Nov. 19, 2015, www.itbusiness.ca/news/iot-never-heard-of-it-say-over-half-of-canadian-businesses/61713 and Mark Cox, "Mixed messages from Microsoft survey on Canadian business use of cloud," *Channelbuzz.ca*, Nov. 19, 2015, www.channelbuzz.ca/2015/11/mixed-messagess-use-of-cloud-15729/

39 World Economic Forum, *Beyond Supply Chains*, January 2015

40 World Economic Forum, *Beyond Supply Chains*, January 2015

Key technologies:

- **Advanced robotics**, which are smaller and safer than previous generations' robots and allow manufacturers to create leaner, more efficient and lower cost productions operations, which may contribute to "re-shoring" production back to Canada.
- **3D printing**, which lends to fast and flexible prototyping and manufacturing.
- **Energy storage**, a solution that could help manufacturers shift production to off-peak times, lowering their energy bills.
- **Internet of things**, which delivered through embedded sensors and actuators in machines allow businesses to manage assets, optimize performance and create new business models.

Emergent Artificial Intelligence[41]

Artificial intelligence (AI) is the science of doing by computer the things that people can do. Self-driving cars and automated drones are examples that are moving towards widespread adoption.

While AI allows a machine to perceive and respond to changes in its surroundings, emergent AI takes things one step further by enabling machines to learn automatically by assimilating large volumes of information. An example is the Never-ending Language Learning (NELL) project from Carnegie Mellon University. NELL reads facts by crawling through hundreds of millions of web pages and attempts to improve its reading and understanding competence in the process so as to perform better in the future.

As is the case with next generation robotics, AI will lead to significant productivity advances contributing to machines performing certain human tasks more efficiently. For example, evidence suggests that self-driving cars will reduce collisions and deaths and injuries from road transport as machines avoid human errors, lapses in concentration and defects in sight, among other problems. From a manufacturing perspective, AI will lead to safer robots that are aware of, and react to, their surroundings, permitting increased human robot interaction. Additionally, artificial intelligence will support faster prototyping of products allowing companies to react to demands of clients more quickly and efficiently.

On their own, emerging advanced technologies are impressive and will generate significant change within the manufacturing process. However, it is the combination of new technologies that will lead to new and disruptive supply chain practices such as additive manufacturing and distributed manufacturing.

As the name suggests, additive manufacturing is opposite to subtractive manufacturing. As opposed to cutting material away from a larger block, 3D printers use a loose material (either liquid or powder) to build, layer by layer, a three-dimensional shape based on a digital template.

3D printers are currently being used to prototype parts for the aerospace and automotive sectors. Other applications include medical, where the ability to 3D print human cells are being tested. It is now even possible to create living tissues.

41 World Economic Forum, *Top 10 Emerging Technologies of 2015*, March 2015

The next steps for manufacturing include the 3D printing of electronic components such as integrated circuit boards. There is even now research being done into 4D printing that promises to bring in a new generation of products that can alter themselves in response to changes in heat and humidity.

Distributed manufacturing turns on its head the way we make and distribute products. While not necessarily a technology itself, distributed manufacturing as a model takes advantage of high speed internet to transfer plans and instructions to3D printers and computerized cutting tools known as CNC routers.

The idea behind distributed manufacturing is to replace as much of the material supply chain as possible with digital information—such as NASA did when it emailed instructions for a spanner to the International Space Station where a 3D printer printed the tool. To manufacture a chair, for example, rather than sourcing wood and fabricating it into the product in a central factory, digital plans for cutting the parts of a chair can be distributed to local manufacturing hubs using CNC routers. Parts can then be assembled by the consumer or by local fabrication workshops.

The distributed manufacturing model is currently making use of the maker movement—individuals who are using their own 3D printers to make products out of local materials. It is expected that distributed manufacturing will enable a more efficient use of resources, with less waste capacity in centralized factories and less capital needed to build first prototypes and products.

It should reduce the overall environmental impact of manufacturing: less material is wasted in the fabrication process, and digital information is shipped over long distances instead of physical products or raw materials, which further reduces the amount of energy required for transportation.

Digital Infrastructure

It is evident the future of manufacturing is digital and will be driven by data. Underpinning advanced manufacturing is the need for strong and efficient digital infrastructure.

As the internet of things continues to drive new manufacturing practices, new devices come online, and the volume of data increases, manufacturers will require access to high bandwidth networks.

Regrettably, Canada currently has one of the world's least ambitious targets for high speed internet. The Government of Canada's *Digital Canada 150 Strategy*, released in 2014, set a target of 98% access to five megabits per second (Mbps) download speed by 2019. This target falls far behind those of Germany, Denmark and Sweden, which have committed to download speeds ranging from 50 Mbps to 100 Mbps.

Regulatory bodies that make decisions that create disincentives to the deployment of next generation network technology have a negative impact that goes well beyond the telecom sector.

SECTION 4: THE FUTURE OF MANUFACTURING REVEALED IN THE AUTO SECTOR?

There is a significant opportunity to position Canada as a leader within the nascent autonomous vehicle industry. This will require not only the effort of industry but also strong and coordinated policy decisions by all levels of government in Canada to ensure the Canadian auto industry can access R&D, clusters of excellence, skills and testing environments.

Self-driving, autonomous cars are no longer the things of imagination and science fiction. It is no longer a question of if but of when.

As an example, GM will release "Supercuise" in 2017 Cadillacs. Volvo and the Swedish government have partnered to run the "Drive Me" initiative in Gothenburg Sweden, which will see up to 100 self-driving cars negotiating public roadways. BMW has been testing autonomous technology on its 2 Series models. Daimler is testing both highly and fully autonomous vehicles in the Unites States and Germany.

Development of autonomous vehicle (AV) technology touches on all aspects of the auto sector and more: OEMs, suppliers, technology providers, academic institutions, municipal governments and regulatory boards.

While we have already seen vehicles with partial automation, fully automated vehicles that require no human intervention are still at least 10 years away and will require significant research and development. Canada's opportunity lies in captializing on the distinction between the traditional perspective of manufacturing output—making widgets—and the high value inputs to the manufacturing process, such as product design, engineering, testing and product development. By creating the incentives that open the door to technological innovation through the application ideas and removing the barriers that hinder optimal efficiency, Canada can become a global leader in areas where it has already demonstrated capacity and sophistication.

The Boston Consulting Group recently developed a research paper on autonomous cars and has estimated the following milestones:

- 2016: GM's supercruise feature to be released on Cadillac models (now 2017)
- 2017: AVs capable of traffic jam autopilot and autonomous valet parking
- 2018: Highway autopilot with lane change
- 2022: Urban autopilot capability
- 2025: Fully autonomous vehicles

Several key factors will impact the speed at which AVs will develop:

- Adequate demand for autonomous vehicles
- Protection from cyber attacks
- Regulations and policies that need to be updated and ready for self-driving vehicles
- Uncertainty over liability
- Overcoming societal resistance
- Development of critical technologies

Nascent Technology

The functionality of AVs relies on a collection of innovative technologies to process the inputs from sensors and on software to interpret inputs and translate them into action. Vehicle manufacturers and suppliers need to invest heavily in hardware such as sensor technology and high speed processors, software and IT, systems integration, and assembly to produce AVs on a commercial scale.

Sensors: According to the Boston Consulting Group, sensors are, at the moment, the most critical technology to be further developed before they can be used commercially. Technologies such as Lidar sensors and GPS must be further enhanced and their costs scaled down before OEMs will adopt them.

Software: Software will be required to interpret sensor data and trigger the actuators that govern vehicle braking, steering and acceleration. Software will need to be intricate to contend with the complexity of the driving environment.

Processors: OEMs and leading suppliers will need to invest heavily in the processing power and software architecture and integration necessary for fully autonomous driving.

Testing: While fair condition testing is ongoing, there remains a need to address severe weather conditions such as a whiteout snowstorm or sudden heavy fog, which would effectively blind the vehicle. What action would the vehicle take in such circumstances?

Connectivity: AVs will boost demand for connectivity and cloud-based services. Telecoms will need to collaborate with OEMs to explore new service models for consumers with AVs.

Who will do the work? There remain open questions regarding who will be responsible for developing integration technology and its enabling software. Will it be OEMs taking the lead or will they rely on suppliers or technology partners?

The Autonomous Vehicle Opportunity

Canada already has a strong automotive sector, and companies such as QNX are positioning to be among world leaders in the field of autonomous vehicles.

Canada has an opportunity to grow its capabilities in the autonomous vehicle space. To make this happen, Canada will need to explore ways to align government policies and incentives with the industry's current and future requirements:

- Support testing of autonomous technologies in Canada (particularly in cities and urban areas)
- Support industry to increase partnerships with universities to conduct AV R&D
- Ensure industry and universities align to produce the required skills and talent
- Draw on existing clusters in Canada to develop key enabling technologies (e.g. marine technology sector in Nova Scotia specializing in sensors)
- Develop an AV-focused technology incubator in Southern Ontario
- Create a think tank to address policy and regulatory issues related to AVs

CONCLUSION

Government decisions and actions impact a variety of other cost factors that influence a firm's business case. This includes corporate tax rates, investment incentives and direct and compliance costs associated with regulation, permits and programs.

As was noted by the Conference Board, "stimulus packages, including *Canada's Economic Action Plan*, and Ontario's *Green Energy and Green Economy Act* (GEA) and *Jobs Skills Strategy*" have played a role in attracting investment into Canada.

Access to grants also plays an important role in shaping investment decisions. Canada has several competitive programs including the Industrial Research Assistance Program (IRAP), the Ontario Auto Investment Strategy (OAIS), the Scientific Research & Experimental Development Credit (SR&ED) as well as a series of advisory programs offered by federal government agencies such as the BDC and EDC.

A review of existing reports on the topic and interviews with manufacturers in Canada reveal a general consensus that while Government of Canada grants and programs are relatively competitive for small business, the programs could result in a disincentive to growth.

For example, to avoid punitive jumps in corporate taxes, Canadian businesses traditionally employ strategies to keep taxable income under $10 million and profits under $500,000. In Ontario, tax rates double for income earned over these thresholds—jumping from 4.5% to 11.5%. The SR&ED tax credit is another example. While sizeable at $3.6 billion, SR&ED "provides benefits on the basis of firm size rather than growth. Thus while SMEs benefit from a 35% credit rate on the first $3 million in R&D expenditures, the rate drops to 20% after this ceiling has been reached."[42]

Incentive Options to Explore

Executives interviewed by the Canadian Chamber also stated that government programs are "not predictable." They are cumbersome, the application processes are time consuming and there is a lack of alignment between levels of government (federal and provincial). This results in long delays (sometimes up to 18 months to receive funds) and frustration on the part of applicants.

If approvals are slow, firms may miss the window of opportunity to get to market on time. For instance, in knowledge-based sectors, where product cycles are typically short, slow government approvals and response times may stop a project from going forward.[43]

Many companies refer positively to the former Investment Partnerships Program that was jointly managed between (then) Industry Canada and Foreign Affairs and International Trade Canada. The purpose of the program was to attract and retain global mandates. The program provided investors with a coordinated single window of support, helping them navigate programs, policies and regulations across all three levels of government. It is advised that a similar model be re-instated to help simplify and speed up the process of investing in Canada.

42 Centre for Digital Entrepreneurship and Economic Performance (DEEP), *Driving Canadian Growth and Innovation*, May 2013

43 Public Policy Forum, *Attracting Global Mandates and Investment in Canada*, 2011

Flow-through Shares

The flow-through shares model was introduced into the Income Tax Act in Canada over 50 years ago to support the development of the Canadian resource sector (mining, oil and gas). The model allows companies to transfer or "renounce" their exploration expenses to individual investors. The logic is that exploration companies will not earn a profit during early stage exploration work and therefore will likely face little to no income tax. Investors into exploration companies instead apply the exploration expenses against their personal incomes. The key is that any transferred expenses must be performed in Canada. The model has helped develop Canada's mining sector into the world's largest.[44]

It can be argued that research and development share many commonalities with the resource sector. Both are about discovery and commercialization, which rely on large amounts of high-risk, venture capital where revenues are uncertain and remote. As with the resource sector, places where risk capital can be accessed will draw innovators, entrepreneurs and investors, which in turn draws talent and intellectual capital. This, in turn, supports a self-reinforcing cluster resulting in higher-quality jobs.[45]

Innovation Box

The innovation box approach is one that is being adopted by several countries around the globe (U.K., Belgium, Luxembourg, France, Spain, Hungary, Ireland, Switzerland and China). The model aims to reduce the normal corporate tax rate on income derived from patents.

The types of profits that qualify for the lower tax rate and how acquired intellectual property is treated differ significantly among countries. Additionally, the "patent box" rate varies considerably among nations. Finally, some countries put caps on the total tax relief companies can receive from patent boxes.

The reference to "box" comes from having to tick a box on the tax form that indicates this type of revenue is being claimed.

The Canadian Chamber of Commerce proposes the implementation of an "innovation box" approach in Canada that would reduce the normal corporate tax rate for income derived from developing and commercially exploiting patented inventions and other intellectual property connected to new or improved products and services and related innovative processes to the benefit of Canada.

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44 Drew Hasselback, "Flow-Through Shares – Canada's Quirky Tax Innovation," *Financial Post*, March 7, 2013 http://business.financialpost.com/legal-post/flow-through-shares-canadas-quirky-tax-innovation

45 Norton Rose Fullbright, *Flow Through Shares for the Innovation Sector*, May 2012

An "innovation box" approach would encourage companies to locate intellectual property activity and the new high value jobs associated with the development, manufacture and exploitation of innovation inside Canada. If properly designed, it would promote and enhance the innovation capacity of sectors that leverage science and technology innovations throughout Canada. Firms in all sectors across Canada will have a greater incentive to adopt, commercialize or otherwise exploit the output of the R&D process at home in Canada.

Sovereign Patent Pools

Canada has long used intellectual property policy as a defensive position in trade negotiations and continues to face pressure from other jurisdictions to increase protections and term lengths for copyright and patents. There is merit in increasing protections – jurisdictions such the US, South Korea, Japan and Germany have among the highest scores on international IP indexes and have corresponding high scores on international innovation indexes. Canada's scores on both indexes are comparatively weak. Increasing IP protections would encourage the flow of foreign investment into innovation intensive companies. It should be noted that just 12 companies in Canada account for over 50% of the innovation investment in this country.

Part of the rationale for resisting the pressure to increase protections is the structure of Canadian business – over 98% are SMEs – and the inability of companies at that scale to acquire and successfully engage patent portfolios. Without these patent portfolios or the financial resources to license them, small firms in Canada lack the freedom to operate and are at greater risk of patent infringement litigation.

A potential solution employed in jurisdictions like Japan and Israel are sovereign patent pools. Japan, South Korea and France have all created such funds as mechanisms to intervene in the patent landscape by acquiring, licensing and even occasionally enforcing patents. The sovereign patent fund model can help secure and commercialize Canada's IP within the boundaries set by existing international trade rules. The model is also flexible and can adapt to focus on strategic sectors and firms. For instance, a Canadian fund could be oriented toward protecting Canada's existing intellectual property resources and helping secure freedom to operate for Canadian innovators.

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RECOMMENDATIONS

1. **Regulatory Harmonization**
   Canada struggles to meet all the criteria global businesses assess business risk on. Cost inputs such as labour, transportation, energy and materials are more difficult to overcome. Regulatory harmonization and simplification of regulatory hurdles that deter investment should be a straight forward way to reduce negative perceptions. The Government of Canada should take a lead role in removing internal barriers to trade (movement of goods and labour, interprovincial transmission intertie, packaging and labeling), undertake to streamline or harmonize environmental regulations so that they are consistent North America-wide and continue with a policy focus on trade liberalization.

2. **New Metrics**
   Manufacturing is a continuum of input and process. The functional element of stamping, molding or assembly tends to be the most labour and energy intensive but ironically the lowest value. By using the high value components of the manufacturing process (product development, technical demonstrations, engineering, process engineering, branding and marketing) as a measure of success and focusing our efforts and incentives on those processes, we are far more likely to attract global R&D investment.

3. **Foreign Direct Investment**
   Canada must enable foreign direct investment through financial incentives that recognize not only the diversity of Canadian business but the symbiotic nature of the relationship between large and small businesses (flow-through shares for small business with little to no revenue, an innovation box for large companies willing to invest in R&D).

4. **Incentives that Address all Sectors**
   Intellectual property and the ability to use IP portfolios to scale companies is the wealth creator of the future. However, not all companies are able to leverage existing government incentive programs and tax credits to advantage and are being left behind by companies in other jurisdictions that have created more flexible alternatives. Canada should consider a "flow through shares" tax credit model to encourage investment in companies that have not yet realized the income necessary to take advantage of existing tax credits. To keep IP in Canada, we should consider an "innovation box" model that rewards domestic IP. Finally, Canada needs to consider a model of promoting the freedom to operate and the potential gains that might be realized through the creation of sovereign patent pools.

5. **Private/Public Parnterships**
   Collaboration, where the federal government plays a facilitating role to create an environment that encourages innovative ideas and allows Canadian communities to be a test market for next generation products, is needed. By creating a climate that is conducive to product development and developing the standards necessary for that product to thrive, Canada can become the global resource for engineering and product/process, knowledge.

6. **Infrastructure Investments**
   The infrastructure necessary to enable manufacturing to flourish and contribute to job growth will grow in importance and sophistication and will be challenging for countries to develop and maintain. Infrastructure investments in emerging nations have been a successful strategy in attracting multinationals to potential locations. Reinvestment in maintaining competitive infrastructure will become critical for developed nations to keep pace. Public funding support for infrastructure development will be a challenge for developed nations given the expected long tail on sovereign debt issues. Effective public-private partnerships will be essential to address this. While infrastructure alone will not lead directly to best-in-class manufacturing, a serious lack of the right infrastructure or steadily decaying infrastructure will negatively impact a nation's manufacturing competitiveness and create serious obstacles for the supply chain networks of global multinationals.

7. **Alignment of Public R&D Spending**
   Canada's innovation focus on primary research has not attracted the business investment in R&D that other jurisdictions have achieved. While the government's focus on primary research through academic institutions over the past few decades has yielded many technology breakthroughs, it has yielded very few marketable products. Commercialization must be the conclusion of a successful innovation venture. The alignment of research objectives and intellectual property mechanisms between academic institutions and business is needed.

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