

THE FUTURE OF CANADIAN MANUFACTURING: SEARCHING FOR COMPETITIVE ADVANTAGE



Paul Boothe¹
Professor and Director
Lawrence National Centre for Policy and Management
Ivey Business School, Western University

In partnership with
Siemens

EXECUTIVE SUMMARY¹

Despite being buffeted by the global recession and growing competition from emerging economies, the manufacturing sector continues to make a critical contribution to the Canadian economy.

Global manufacturing is undergoing massive change driven by rapidly advancing technology, and the growing importance of consumers and producers in emerging markets.

Future trends in manufacturing include the growth of demand in emerging markets, the changing nature of products and related services, and a technology-driven revolution in the processes used to design, produce and market manufactured goods. Canadian manufacturers will need to recognize and stay ahead of these trends to win competitive advantage.

A framework for discussing strategies for competitive advantage is developed using markets, products and technologies as the organizing ideas.

Canadian manufacturing business leaders and policy makers need to develop coordinated strategies to gain competitive advantage in the global marketplace. We conclude with a report on the priorities identified by a select group of senior leaders at a recent roundtable discussion.

¹ I am grateful to Siemens Canada for supporting this project and for sharing their insights into the manufacturing trends they encounter around the globe. The views expressed in the paper are my own and should not be attributed to any other individual or organization. Sandra Octaviani provided excellent research assistance.

INTRODUCTION

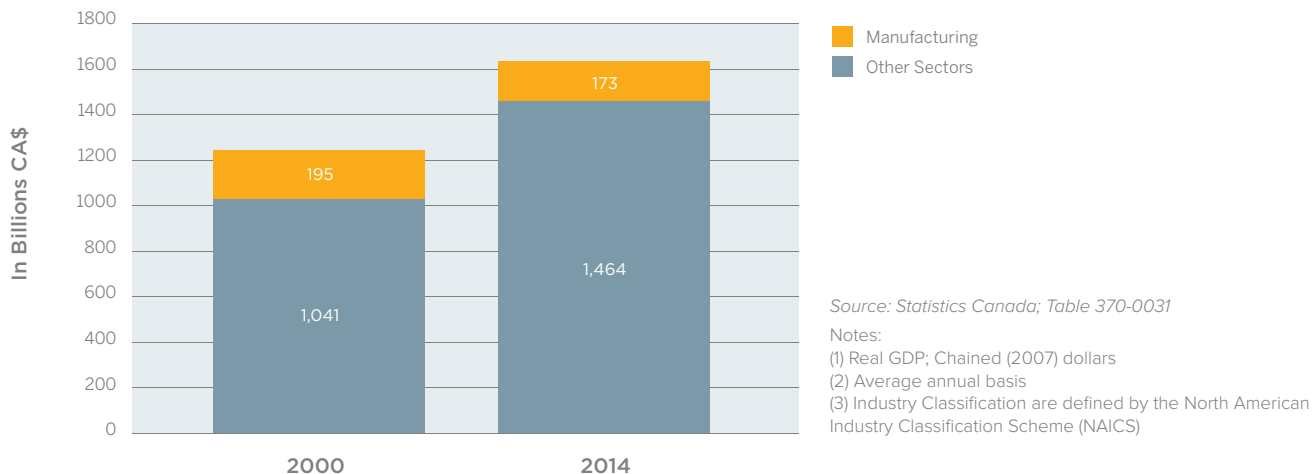
Global manufacturing is undergoing massive change. The volume and range of products and related services are growing rapidly as the number of consumers in emerging economies expands, and innovative production technologies are increasingly applied. Billions of dollars are being expended on products and services that did not even exist ten years ago. Processes that take products from ideas to reality are accelerating and changing radically, enabled by quantum leaps in information technology.

How should manufacturing firms respond to the scope and pace of change to prosper in the increasingly competitive global market place? How should governments develop and execute policies that can facilitate a pro-growth business environment for manufacturers while delivering value to taxpayers? In Canada and around the globe, business leaders and policy makers are wrestling with these questions.

In this paper, we provide some context around Canadian and global manufacturing and the trends that are emerging. Our goal is to stimulate a dialogue around strategies for competitive advantage available to Canadian manufacturers as they confront the challenges that lie ahead. We believe that despite the visible reduction in the Canadian manufacturing sector over the past recent years, Canada possesses strong underlying fundamentals that, when informed by the right strategic focus, can point in the way of a thriving, robust manufacturing industry.

The outline of the paper is as follows; in the next section we lay out some basic facts documenting the changing nature and importance of manufacturing to Canada. Next we look at some emerging global manufacturing trends. We then sketch out a conceptual framework to guide a discussion around strategies for competitive advantage. In the final section, we focus on some of the key priorities business leaders and policy makers have identified as they strive to succeed in the global marketplace.

Figure 1 Manufacturing GDP



THE CHANGING NATURE OF MANUFACTURING

Canada

Manufacturing was hard hit by the deep and prolonged recession that followed the global financial crisis of 2008-09. Manufacturing GDP declined by almost 11 percent over the period from 2000 to 2014, while the rest of the economy grew by 41 percent (Figure 1).

Since 2000, manufacturing employment has declined by over 500,000 workers. Growth in total employment over the period was about 3 million (Figure 2).

Finally, the decline in manufacturing exports has led to an overall decline in exports by Canada. Over the period 2000-2014, overall exports declined by 6.4 percent, while manufacturing exports declined by 26 percent (Figure 3).

Figure 2 Manufacturing Employment

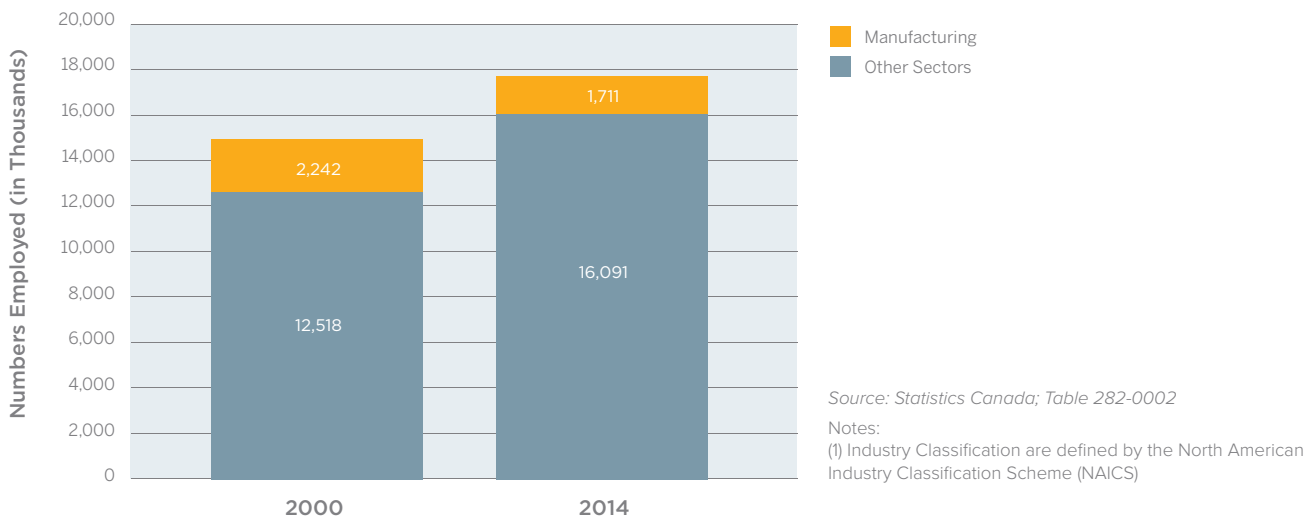
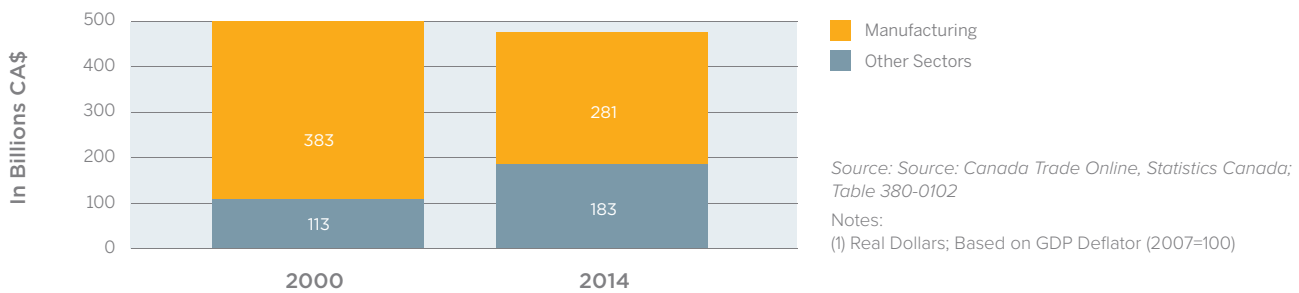


Figure 3 Manufacturing Exports



In sum, the data show that manufacturing has experienced sizable declines over the period 2000-2014 in the areas of output, employment and exports. Meanwhile, other sectors of the economy (especially services and natural resources) grew strongly. These declines were related, in part, to the slow recovery of our biggest customer, the U.S., from the global recession of 2008-09, as well as the massive restructuring of the automotive sector. There was also a gradual loss of production capacity to foreign countries, particularly in labour-intensive industries such as textiles and electronics, in response to rising labour costs in Canada. Key to this is new competition from emerging economies.² In the case of employment, the relatively strong productivity growth of the manufacturing sector and, in particular, durables, has served to reduce the demand for labour per unit of output.³

Despite the declines documented here, manufacturing continues to make a critical contribution to the Canadian economy, particularly to the Canadian trade balance, where it still has a disproportionate role relative to that of other industries. In 2014, it accounted for 61 percent of exports. In addition, in 2014, it represented 10.6 percent of total economic output and directly employed 9.6 percent of the Canadian labour force. Due to its rich linkages with other activities, such as R&D, logistics, engineering, sales and marketing, the manufacturing sector has a substantial multiplier effect on the national economy. Thus, if Canada is to prosper in the future, the decline of manufacturing will have to be reversed and vitality returned to this critical sector.

² Competition from emerging economies is manifest in two fronts – the shifting of Canadian production to emerging economies, as well as competition faced by Canadian manufacturers seeking to access foreign markets where emerging market producers reside (Canadian Manufacturing Coalition, 2012).

³ See Baldwin and Macdonald (2009).

The Global Economy

The global face of manufacturing has been changing as well, with emerging market economies, and in particular China, growing rapidly. In 2000, the top five manufacturing nations were the U.S., Japan, Germany, China and the UK.⁴ By 2013, China had moved up to second place in a virtual tie with the U.S. while the UK had fallen to 7th place, replaced by Korea. Canada, in 10th place in 2000, fell to 11th in 2013 and was replaced by Brazil. In 2000, global manufacturing GDP stood at \$6 trillion (2005 USD).⁵ By 2013, that amount had grown by 57 percent (3.5 percent growth annually) to \$9.5 trillion.

While global output has increased substantially, manufacturing employment has actually declined. Although several emerging economies saw moderate increases in employment (e.g. Brazil, Indonesia, Turkey, Mexico), these increases were swamped by declines in other major economies, notably China and the United States. Thus, like Canada, many developed economies and China have seen declines in employment, especially in durable goods production, in part because growth in productivity has outpaced growth in demand. Further, in recent decades, the rise of automation has gradually transformed much of what constitutes manufacturing employment from manual production line work to knowledge-intensive, higher value-added jobs.⁶

Most of the declines in manufacturing employment in advanced economies over the recent decades have been concentrated in labour-intensive industries, such as textile products and basic metal products. At the same time, industries such as chemicals, aerospace and automotive manufacturing that rely on advanced manufacturing techniques, and are characterized by a high level of R&D intensity and customization for specific markets, have trended upward.

Global trade in manufactured goods has grown substantially since 2000, especially in products tied to the agricultural and natural resource sector. One interesting trend within the growth in global manufacturing trade is the growing size of intermediate inputs (higher foreign value-added content) as a share of global trade in manufactured goods, reflecting the rise of global value chains (GVCs). Overall, durables make up a vast and growing share of global manufacturing exports and imports, the biggest durable product category being Machinery and Transport Equipment.⁷

⁴ Data source: United Nations Statistical Division (UNSD), OECD National Accounts (SNA) Database and Structural Analysis (STAN) Database

⁵ Ibid.

⁶ McKinsey Global Institute (2012).

⁷ WTO Trade Statistics Database. (2013). Time Series on International Trade: Merchandise Trade by Commodity. [Data File]. Retrieved from <http://stat.wto.org/StatisticalProgram/WSDBStatProgramSeries.aspx?Language=E>

Customers

Over the period 2000 to 2012, the mix of customers buying from Canadian manufacturers changed significantly. In 2000, domestic customers made up about 43 percent of total sales with foreigners making up the other 57 percent. By 2012, sales to domestic customers had risen to 50 percent (See Table 1).

Turning to foreign customers in 2000, the largest group of foreign customers was in the U.S., accounting for 50 percent of total sales, and 88 percent of foreign sales. Chinese sales were fifth largest, accounting for less than 1 percent of total sales. By 2012, the U.S. share of Canada's manufacturing sales had declined by roughly 10 percentage points to 40 percent. While China had moved to second place among Canada's foreign customers, it still accounts for less than 2 percent of total sales.

Table 1 **Manufacturing Sales**

Year	Total	Domestic	Export						
			Foreign Total	USA	China	UK	Japan	Mexico	Germany
2000	562.10	241.53	319.27	279.54	2.42	4.95	6.51	1.51	2.67
2012	580.15	289.97	288.64	224.42	9.73	5.32	4.51	3.92	2.80
2013				231.39	10.59	4.73	4.44	4.13	2.77

Source: Statistics Canada/
US Census Bureau

Notes: (1) Values are in
Billions CA\$

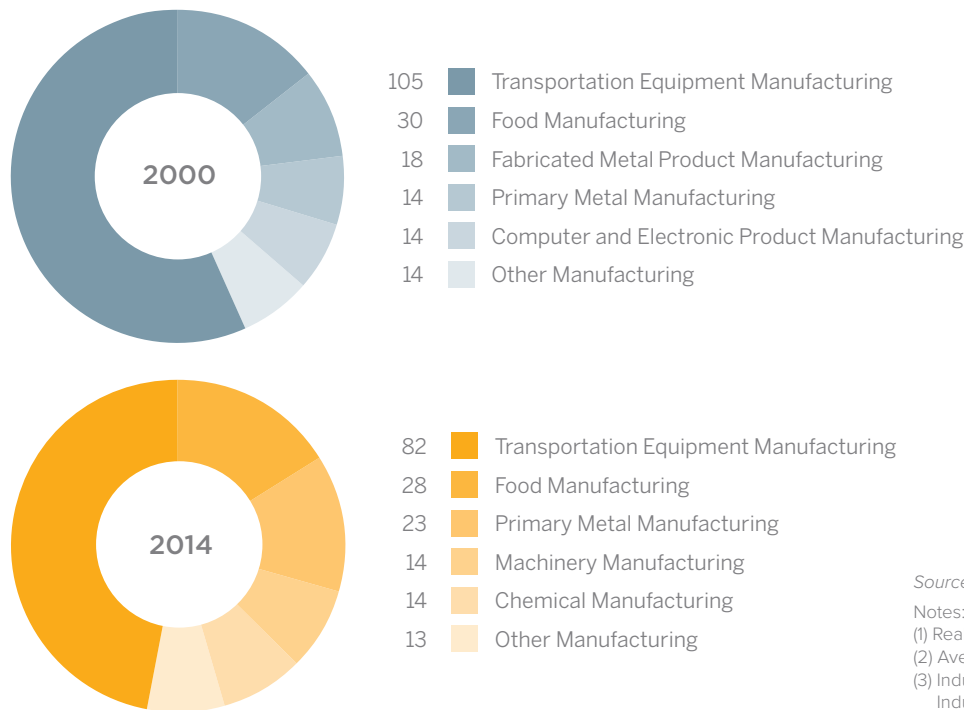
Products

Canadian manufactured products have, with a few exceptions, been focused on the same key sectors since 2000 (see Figure 4). The top five sectors ranked by production include transportation equipment (both autos and aerospace), agri-food (including beverages) and primary metals, chemical goods, machinery and equipment. Since 2000, the computers and electronic equipment industry and fabricated metal product manufacturing have declined in importance due to the relocation of production capacity to lower-cost jurisdictions. These industries have been replaced by chemical and machinery manufacturing industries.

Canada exports a substantial number of intermediate goods, a sign that Canadian firms are well integrated in GVCs. Canadian manufactured goods are more likely to be durables rather than non-durables. Even in industries like textiles that have declined substantially in most developed economies, Canadian firms like Canada Goose have prospered by occupying a niche created by brand and superior quality.⁸

In sum, manufacturing output is growing globally, thanks to rising demand from emerging economies. Yet with few exceptions, manufacturing employment is declining in the face of rapidly increasing productivity. While other developed economies have grown their share of emerging market sales, Canada's share has remained relatively flat.

Figure 4 **Leading Canadian Manufacturing Sectors** (2000 versus 2014)



Source: Statistics Canada Table 379-0031
 Notes:
 (1) Real GDP; Chained (2007) dollars; Billions CA\$
 (2) Average Annual Basis
 (3) Industry Classification defined by the North American Industry Classification Scheme (NAICS)

⁸ Lawrence National Centre for Policy and Management (2014).

FUTURE TRENDS

With fast-paced technological change and rapidly expanding global markets, Canadian manufacturers face a complex planning environment. Complicating matters is that trends are really only clearly apparent with hindsight. What are some of the possible future trends that should be considered? We focus on three areas: markets, products and processes.

Probably the clearest trend from the past decade is the growth of emerging economies⁹ both as consumers of manufactured goods and competitors or collaborators in producing them. While the mature markets of developed economies will remain important, fast growth will come from emerging economies, like China, India, Brazil, Indonesia and Mexico. This points to the need for policy makers to ensure that Canadian manufacturers have access to customers in these markets, and for manufacturers themselves to have sustainable strategies to grow market share in these regions.

Canadian manufacturers must also consider their emerging market counterparts as competitors and potential collaborators who bring their own combination of local knowledge, technologies and cost advantages. How to use collaborators' advantages to grow market share in emerging economies will be a key challenge for Canadian manufacturers in the future.

A second trend comes from the changing nature of products. Many of today's highly successful products did not exist even a decade ago. Products are growing in knowledge content and technological complexity.¹⁰ Furthermore, design and marketing strategy is playing an even more important role in product success. Product cycles have shortened, driving the need for tighter integration of product, production design, and actual production.¹¹

Finally, products are increasingly bundled with services that extend over the product's life, creating new, distinct lines of business for manufacturers.

A third trend focuses on the new processes deployed in the production of manufactured goods. Integrating flexibility is an important factor enabling manufacturers to react quickly to changing market conditions. Advanced manufacturing techniques, powered by industrial software, are being used increasingly to improve product quality, consistency, and performance at lower costs.¹² Nowhere is this more important than in the area of inter-machinery communication where computers no longer simply control robotics, but also integrate various aspects of production processes, even those taking place in different locations around the globe.¹³ A broad array of software tools now make it easier for closer collaboration between producers and supply chain partners through real-time data sharing.

The use of software is also a key contributor to overcoming growing complexity. Software is playing a greater role in the optimization of the entire lifecycle of a product – from product design to production execution and service. Manufacturers are under pressure to shorten time to market and are learning to run product design and production design processes concurrently. The rise in the scope and accessibility of software has given firms powerful new ways to tackle growing process, organizational and production complexities, exploit new efficiencies, and eliminate waste. The use of software has empowered manufacturers of all sizes to focus their scarce resources on innovation and value creation. Indeed, with GVCs firmly established, manufacturers are seeking to optimize product development, production and marketing, and find synergies and savings from planning the system as a whole.

⁹ OECD (2013).

¹⁰ OECD (2013); OECD (2014).

¹¹ Siemens (2014).

¹² UK Technology Strategy Board (2012).

¹³ Economist Intelligence Unit (2014).

A CONCEPTUAL FRAMEWORK

There are many different ways to think about the challenges and opportunities that lie ahead for Canadian manufacturers. It is helpful, therefore, to have a simple conceptual framework to organize our thinking and make linkages between different ideas. One such framework is presented in Figure 5. At the

center of the framework is the goal: a range of mutually reinforcing strategies to gain competitive advantage. At each corner is one of three key elements that must be considered: Parties and Markets, Products and Inputs, and Technologies and Skills. We discuss each of these elements in turn.

Figure 5 **Manufacturing Strategies Conceptual Framework**



Strategies for Competitive Advantage

At the center of the framework stands the overarching issue: How will the elements be combined into a strategy to gain competitive advantage? How do the elements interact with one another? Will competitive advantage be based on innovative products? Will new products find customers in existing and new markets? Will improved quality and reduced cost play an important role? What firm organization and government policies will be needed to support the strategy?

Parties and Markets

This element focuses on the questions: Who and where? Firms start by identifying current and future customers and where they are located. Manufacturing surveys have shown that there is no better catalyst for innovation than demand.¹⁴ Current and potential future competitors, suppliers and potential collaborators should also be identified. Finally, firms should identify the policy makers overseeing legislative and regulatory measures that affect them both positively and negatively, now and in the future.

Products and Inputs

This element comprises answers to the question: What? For example, given the current mix of products and related services, can firms identify what products will be demanded in the future? How will they make the transition from their current to future product mix? Based on their expectations of future products and related services, can firms identify the raw materials and processed inputs they will need? Inputs will need to be sourced and priced. Novel combinations of inputs and innovative products are being driven by strategic collaborations between manufacturing industries and other sectors (e.g. automotive and IT, biotechnology and pharmaceuticals).

Technologies and Skills

This element focuses on the question: How? New technologies and the increased use of software and automation may be an important source of competitive advantage to boost productivity and reduce cost. Software will allow designers to test new product features in a virtual environment, making R&D processes more cost-effective and reducing time to market. Along with new technologies, new skills will be needed. In addition, manufacturing processes, logistics, and service delivery will be streamlined. Finally, design, branding and marketing may also play a significant role in developing competitive advantage.

PRIORITIES FOR BUSINESS LEADERS AND POLICY MAKERS

Manufacturers and policy makers face a bewildering range of issues as they develop strategies for future competitive advantage. Given the trends we have identified in Canadian and global manufacturing, we use our conceptual framework to present the results of a roundtable discussion among senior leaders held to identify their priorities.¹⁵

In March 2015, Siemens Canada assembled a small group of senior executives from Canadian manufacturing firms, policy makers and researchers to discuss the future of Canadian manufacturing. Participants included:

- The author
- Giles Gherson, Deputy Minister of Ontario's Ministry of Economic Development, Employment and Infrastructure and Ministry of Research & Innovation
- Tony Elias, Senior Vice-President of Operations at Valiant Corporation
- Joris Myny, Senior Vice President, Process Industries & Drives Division, Digital Factory Division at Siemens Canada
- Mike Sinnaeve, Global Vice-President of Operational Improvement and Quality at Magna International
- Eric Kiisel, Senior Vice-President of the Energy & Consumer division at ATS Automation Tooling Systems

¹⁴ Canadian Manufacturers and Exporters (2014).

¹⁵ Canadian Business. (2015). Interview: industry bets on the future of Canadian Manufacturing. Retrieved from <http://www.canadianbusiness.com/innovation/the-future-of-manufacturing/>

Future Customers and Markets

Participants were unanimous in their view that future customers, collabourators and competitors would be increasingly located in emerging markets. A common characteristic of Canada's most successful manufacturers is their ability to take advantage of new opportunities by locating and expanding their operations in those markets. Producing close to their fast-growing customer base in emerging markets was judged to be essential for the next generation of Canadian manufacturers to remain competitive.

Participants recognized that the need to succeed in markets outside of Canada and the U.S. poses a number of challenges for firms and policy makers. The next generation of firms needs to develop the expertise and local connections to enter emerging markets, and adapt their business models to accommodate new business cultures, financial, tax and regulatory systems, and trade environments.

In some cases they will be building on existing supply relationships. In other cases, they will be developing a new customer base among emerging economies' burgeoning middle classes.

Leveraging technology to build agility into managing complex supply chains

Manufacturers continually grapple with the logistical challenges that come with integration into global supply chains. In this respect, recent advances in software may help firms gain a competitive advantage by enabling multiple parties to collabourate and share information using a process called "collabourative product data management." The widespread application of sensors and robotics, powered by increasing connectivity and software (also known as the "Internet of Things") will give rise to large amounts of useful data that can be utilized to optimize products and processes.



Role of Policymakers

For policy makers, the challenge will be to open trade access to fast growing emerging markets. Access to new markets will require developing durable relationships with foreign counterparts. In some cases, access will require forgoing [the] protection of domestic industry. In other cases, it will need support for border and transportation infrastructure. A sustained focus on streamlining regulations and processes that impede the rapid transfers of goods, services and people among economies will be an essential item on the policy agenda.

Finally, policy makers will be challenged to build support at home for the kinds of measures that underpin an export-oriented, emerging-economy-focused manufacturing sector. Changing the orientation of business, current and future workers, and ultimately voters will require a commitment from political leaders to effective and sustained public communication.

Future products and inputs

Discussants spent some time outlining the essential characteristics of successful future products for Canadian manufacturing. Tapping into Canada's knowledgeable and innovative talent pool and bright minds will be essential to Canadian manufacturing, as it makes increased use of software for product and production design and simulation. Products will be high in value relative to transportation costs, i.e. relatively inexpensive to ship internationally. Further, products will leverage key Canadian advantages such as partnerships with a thriving innovation network of universities and research institutions.

In the future, products will be increasingly bundled with services such as after-care maintenance and even recycling to add additional value and tie customers to manufacturers over the entire product lifecycle. Finally, Canada can leverage its expertise as a major natural resource producer to supply a host of market-leading products and services based on best-in-class methods in natural resource extraction and processing.

Future technologies and skills

Looking to the future of technology, participants argued that software would be an increasing source of competitive advantage, allowing manufacturers to improve quality, simulate, reduce costs, better manage complex supply chains and customize products to meet changing consumer demands. Recent advances in software have given rise to the integration of product and production design, and production planning, through to final assembly. In the factory of the future, the concurrent design of products and their production, not just within one manufacturing unit but amongst all players in the global value chain - enabled by collaborative Product Data Management Software - will lead to shorter time to market.

Software will stimulate innovation

Software will facilitate the testing of new product ideas with reduced capital, time, and prototyping needs through the possibility of simulated lifecycle planning. With the ability to build and simulate a virtual production facility prior to its physical construction, it will be possible to be faster, reduce cost, and try out more ideas in an affordable way. Virtual production will help firms anticipate and rectify possible technical issues and minimize expensive machine failure and unplanned downtime, and allow the assembly of complex products to be optimized. Such advances, in turn, foreshadow the entry of other disruptive manufacturing technologies such as 3D printing and the new business models that will come with them.

Addressing the mismatch between supply and demand of skills

With advances in manufacturing software being introduced today, and with more on the horizon, skilled workers and innovative capacity will be key success factors for the future of Canada manufacturing. Meeting rapidly evolving skill requirements will be one of the greatest challenges facing manufacturers, with competition from around the globe for technical professionals. Further, young workers training in the skilled trades are in short supply. Participants stressed the need to maintain one of Canada's core advantages: the availability of highly-skilled talent, often at lower cost than in competing jurisdictions.

With respect to availability of skilled people, participants discussed a number of models for creating and retaining talent. Variants included the 'co-op' model – which was viewed as offering the right mix of theory and practice to students. Another was partnerships between firms and educational institutions to offer firm-sponsored 'dual education

programs.' For example, Siemens Canada offers two such programs for engineering and engineering technology students.¹⁶

Where they are already in place, these training programs are mostly working with larger manufacturers. Participants recognized that more work needs to be done to expand and connect such programs with the next generation of manufacturers.

Participants also argued that governments have a key role to play in supporting the collaboration between educational institutions and business. More opportunities are needed for students to receive the professional technical training or skilled trades training that will help them to succeed in manufacturing careers in the future. In particular, governments should leverage their position as the key funder of these institutions to overcome resistance to reform, and engage with smaller firms.



¹⁶ <http://www.siemens.ca/web/portal/EN/SCETA/Pages/Siemens-Canada-Engineering-Technology-Academy.aspx>

“Innovation” incubators to retain and engage local talent

One idea proposed by participants was the development of manufacturing centres of excellence in hub cities like Windsor, London, Kitchener-Waterloo, the Greater Toronto and Hamilton Area and Ottawa. Such centres would give companies a platform to pilot and assess their ideas in ‘smart factories’. The Natural Resources Canada ‘Canmet’ lab in Hamilton and Western University’s Fraunhofer Project Centre in London, that focus on materials innovation, are examples of such centres. If centres like these could also play an ‘incubator’ role, they would provide young innovators with opportunities to explore their ideas and ‘fail quickly’ if the idea were unlikely to lead to commercial success. Such opportunities could be a key attractor to stem the outflow of young technically-savvy innovators who are increasingly leaving for established hubs located in the U.S. in search of such opportunities.

KEY FINDINGS

In this final section, we review some of the key findings from our analysis of current and future trends and the roundtable discussion by senior manufacturing leaders and policy makers.

Canadian manufacturing was especially hard hit by the deep and prolonged recession in the U.S., its largest customer. Yet manufacturing remains a critical contributor to the Canadian economy and must recover its vitality if Canada is to prosper. This requires sustained dialogue between business leaders and policymakers.

The world-wide decline in manufacturing employment is the inevitable result of productivity growing faster than sales, driven by technological changes. For manufacturing employment to grow in Canada, a substantial increase in demand is needed.

Emerging economies will see the fastest growth in demand for manufactured goods and related services. Canadian firms will need strategies to succeed in those markets and in Global Value Chains (GVC) if they are to grow and prosper. Governments have a critical role to play to ensure that Canadian firms have access to these new customers.

To compete successfully in the future, Canadian manufacturers will have to embrace advances in technology and software to reduce time to market and cost and to improve quality and customer choice.

Firms will need to work with educational institutions and governments to ensure the next generation of workers has the skills needed to compete in a global labour market and channel their entrepreneurial energies into bringing innovative product ideas to commercial success.

While many challenges lie ahead, they are matched by opportunities that await Canadian firms that develop winning strategies for competitive advantage. In the changing manufacturing industry, Canada’s contribution will shift from labour to more development in design, production, and simulation thanks to the growing importance of software in manufacturing. Canada has a history of success in manufacturing and an excellent base from which to meet the challenges that come with a changing global manufacturing environment and to restore a thriving manufacturing sector.

ABOUT THE AUTHOR



PAUL BOOTHE
PROFESSOR AND DIRECTOR, LAWRENCE CENTRE

Paul Boothe is Director of the Lawrence National Centre for Policy and Management. His work experience has included university research and teaching, independent consulting to Canadian and international

organizations, and serving as a senior public servant in Canada's provincial and federal governments. At the provincial level, he served as Saskatchewan's Deputy Minister of Finance and Secretary to Treasury Board. At the federal level, his appointments included Associate Deputy Minister of Finance and G7 Deputy, Senior Associate Deputy Minister of Industry and, most recently, Deputy Minister of the Environment.

ABOUT THE LAWRENCE CENTRE

The Lawrence National Centre for Policy and Management aims to bridge the gap between business strategy and government policy by providing a forum for business and government to discuss policy development and implementation.

As a policy and management centre within a world-class business school, the Lawrence Centre is uniquely positioned to explore the areas of public policy that have the greatest impact on business. The Lawrence Centre educates future business leaders in public policy and government leaders in business strategy and conducts leading-edge research on major issues that involve business-government coordination.

The Centre was established in 2001 with a generous gift from Canadian businessman, Jack Lawrence, HBA '56, who was a strong proponent of business playing an active role in Canadian public policy.

REFERENCES

Baldwin, J. & Macdonald, R. 2009.
The Canadian Manufacturing Sector: Adapting to Challenges. Economic Analysis Research Paper Series. Statistics Canada.

Canadian Manufacturing Coalition. 2012.
Manufacturing Our Future.

Canadian Manufacturers and Exporters. 2014.
Manufacturing Issues Survey: New Frontiers.

Conference Board of Canada. 2012.
Walking the Silk Road: Understanding Canada's Changing Trade Partners. Trade, Investment, and International Cooperation.

Economist Intelligence Unit. 2010.
Aiming Higher; How Manufacturers are Adding Value to their Businesses.

Economist Intelligence Unit. 2014.
Networked Manufacturing: The Digital Future
<http://www.economistinsights.com/technology-innovation/analysis/networked-manufacturing>.

Lawrence National Centre for Policy and Management 2014. *Learning from Leading Firms: Diversified Manufacturing*.

McKinsey Global Institute. 2012.
Manufacturing the future: The next era of global growth and innovation.

OECD. 2013.
OECD Science, Technology and Industry Scoreboard 2013. OECD Publishing.
http://dx.doi.org/10.1787/sti_scoreboard-2013-en.

OECD. 2014.
OECD Science, Technology and Industry Outlook 2014. OECD Publishing.
http://dx.doi.org/10.1787/sti_outlook-2014-en.

Siemens. 2014. High Tech for SMEs.
Siemens Industry Journal.

UK Technology Strategy Board. 2012.
A Landscape for The Future of High Value Manufacturing in the UK.

