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MANUFACTURING INNOVATION:

DRIVING CANADA'S BIGGEST SECTOR THROUGH DISRUPTIVE TECHNOLOGIES

December 2014

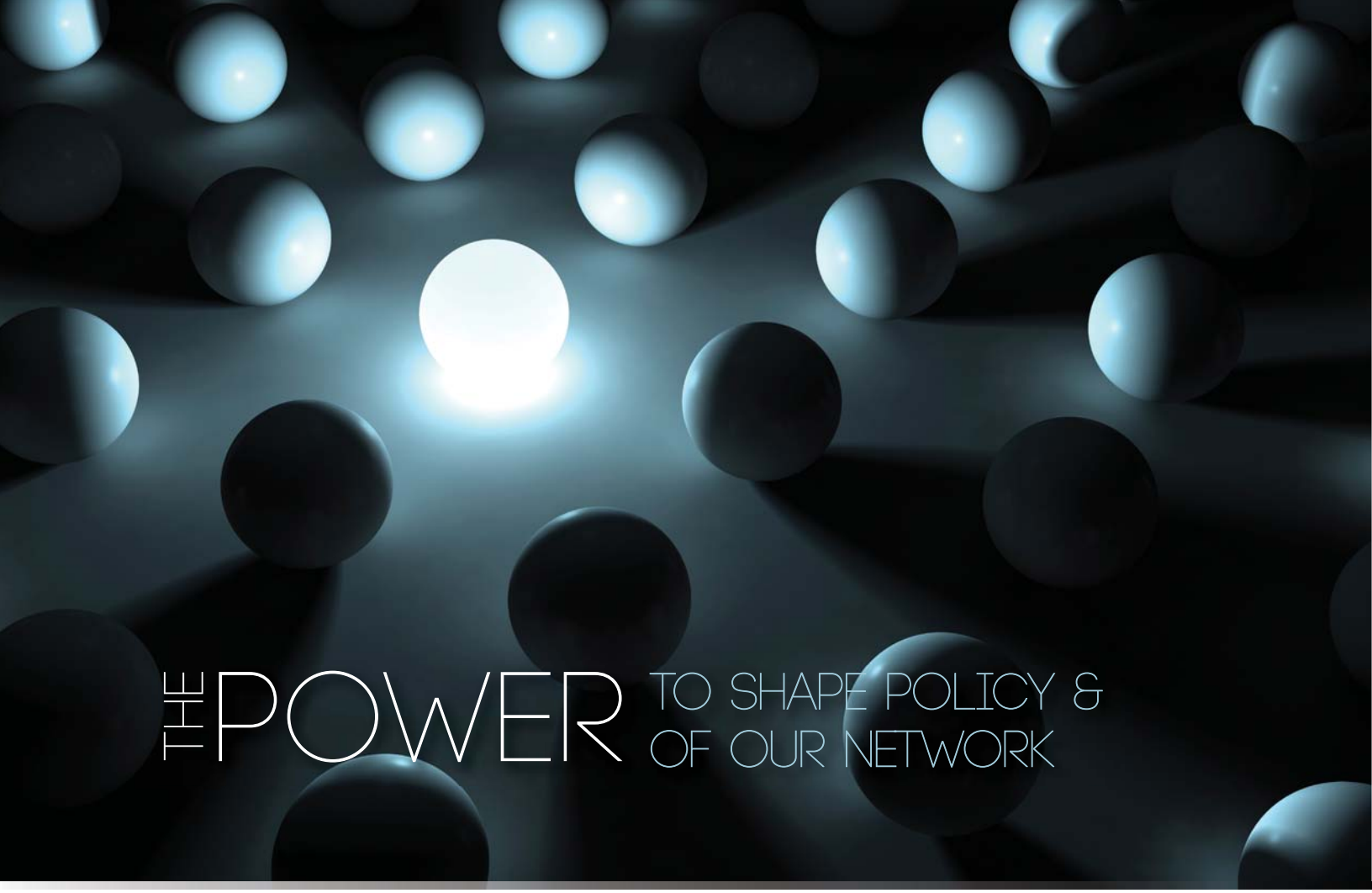

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Manufacturing employs millions of Canadians and generates billions in salaries, sales, exports and taxes. In 2013, close to 80,000 manufacturing businesses generated revenues of more than $590 billion and employed 1.8 million Canadians.[1] In many ways, manufacturing, the largest sector of the Canadian economy, built Canada and it boosts rural and urban economic development from coast to coast to coast.

But something is happening—or not happening—that is dampening the value and impact of innovation in our manufacturing sector. Consider that Canada is ranked 15th in the world in competitiveness and 22nd in innovation by the World Economic Forum.

The Canadian Chamber of Commerce, which has been looking at innovation for years, went to many of its members earlier this year to talk about innovation in manufacturing specifically. We wanted to find out what barriers confront manufacturers when it comes to harnessing technology and innovation in Canada.

We held roundtable meetings across the country from April to September 2014 as well as a series of one-on-one interviews with members over the same period. We asked them all a series of questions (outlined in this paper's appendix) to facilitate open dialogues among business executives, business owners, academics and Canadian Chamber staff.

We met with representatives of over 70 organizations to explore the barriers to manufacturing experienced by Canadian companies.[2] We also drew on other relevant primary and secondary sources to test, validate and provide context to our discussions.

One theme came through very clearly in these meetings: the only way to compete and win in modern manufacturing is through a commitment to innovation.

Our discussions led to three overall recommendations:

1. Manufacturers can leverage best practices in overcoming barriers that currently prevent them from a broader and faster adoption of disruptive technologies that have the power to increase competitiveness and to potentially open new markets.

2. Canada's innovation policy framework must be structured to acknowledge and support business investment in R&D. Government should consider new incentive options, such as adopting an "innovation box" approach to R&D funding that reduces taxes and promotes domestic intellectual property activity.

3. A policy framework that rewards collaboration, recognizes product cycles across various industries, acknowledges that the milestones for innovation incentives cannot be generic across industries and moves beyond a bias for breakthrough technology research is essential to improving Canada's innovation scorecard.

We will build on these recommendations in a subsequent report on the value of government incentives in Canadian manufacturing.

1 KPMG, "Canadian Manufacturing Outlook 2014: Leveraging Opportunities, Embracing Growth", 2014.

2 The Canadian Chamber of Commerce, "Top 10 Barriers to Competitiveness 2014", pp. 22-23.

CANADA'S MANUFACTURING COMPETITIVENESS DRIFT

Disruption is the new normal

New technologies are fundamentally changing how goods are manufactured. This is happening around the world and across sectors. Disruptive technologies alter business processes and consumer behaviour. As noted in the World Economic Forum's (WEF) latest research paper on manufacturing, "the global manufacturing landscape is being transformed by information technologies as well as economic processes linked to the exploitation of the comparative prices of labour, resources and energy across regions."[3]

Google, Apple and Netflix have created whole new industries at the expense of incumbents and imitators. Uber is driving the taxi business, Kijiji is a thriving online marketplace and ebooks are writing new chapters of the physical publishing industry.

Innovation is about adopting these new technologies and finding new ways to compete and thrive. It is about also about risk management—change to thrive. And it is about doing the same things smarter and more efficiently.

Things are no different in manufacturing, a sector that drives and is driven by innovation.

Innovation is a loose concept and one that challenges companies across the supply chain, particularly at the process level. Yet innovations at the process level—even incremental improvements—can create company and supply chain-wide efficiencies that, in turn, lead to greater competitiveness, increased value-add jobs and wealth creation.

Innovation challenges in Canada

But that is not happening in Canada—or at least not enough.

Several recent reports on innovation make for some very sober reading when it comes to innovation—or the lack thereof—in our country.

The latest edition of *The Global Competitiveness Report*, an influential annual publication issued by the WEF, says that Canada has had the soundest banks in the world for the last seven years.[4] That global leadership has not translated into leadership in competitiveness and innovation.

According to the same report, Canada ranks 15th in global competitiveness, down one place from the previous year and down five spots from the WEF's 2009-2010 ranking. That is five places in five years.[5]

Canada is not alone in this downward drift. Sweden fell four places, from sixth to 10th, during the same period, while Germany slipped down one peg, from fourth to fifth. Meanwhile, Japan moved up to sixth spot from ninth, and the United States, Canada's biggest customer and biggest competitor, moved up to third place from fifth.

Our innovation rank, a key component of competitiveness, is troublesome. Canada ranks a distant 22nd in what the WEF calls "the capacity for innovation." This ranking is based on answers to the following question posed by the WEF to executives around the world: In your country, to what extent do companies have the capacity to innovate? Twenty-second place means Canada ranks below Qatar,

3 World Economic Forum, "The Future of Manufacturing: Driving Capabilities, Enabling Investments", November 2014.

4 World Economic Forum, "Global Competitiveness Report – 2014/2015", 2014.

5 *Ibid.*

The Global Competitiveness Index 2014–2015

			SUBINDEX					
	OVERALL INDEX		Basic requirements		Efficiency enhancers		Innovation and sophistication factors	
Country/Economy	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Switzerland	1	5.70	4	6.17	5	5.49	1	5.74
Singapore	2	5.65	1	6.34	2	5.68	11	5.13
United States	3	5.54	33	5.15	1	5.71	5	5.54
Finland	4	5.50	8	5.97	10	5.27	3	5.57
Germany	5	5.49	11	5.91	9	5.28	4	5.56
Japan	6	5.47	25	5.47	7	5.35	2	5.68
Hong Kong SAR	7	5.46	3	6.19	3	5.58	23	4.75
Netherlands	8	5.45	10	5.95	8	5.28	6	5.41
United Kingdom	9	5.41	24	5.49	4	5.51	8	5.21
Sweden	10	5.41	12	5.86	12	5.25	7	5.38
Norway	11	5.35	6	6.05	13	5.24	16	5.08
United Arab Emirates	12	5.33	2	6.20	14	5.24	21	4.83
Denmark	13	5.29	13	5.85	17	5.11	9	5.19
Taiwan, China	14	5.25	14	5.75	16	5.14	13	5.11
Canada	15	5.24	18	5.70	6	5.37	24	4.72
Qatar	16	5.24	5	6.12	20	4.98	15	5.09
New Zealand	17	5.20	9	5.96	11	5.26	25	4.61
Belgium	18	5.18	22	5.53	18	5.07	12	5.11
Luxembourg	19	5.17	7	6.02	22	4.97	18	4.93
Malaysia	20	5.16	23	5.53	24	4.95	17	4.95

The Global Competitiveness Index 2014–2015: Innovation and sophistication factors

			PILLAR			
	INNOVATION AND SOPHISTICATION FACTORS		11. Business sophistication		12. Innovation	
Country/Economy	Rank	Score	Rank	Score	Rank	Score
Albania	114	3.17	104	3.61	120	2.73
Algeria	133	2.91	131	3.22	128	2.60
Angola	144	2.36	144	2.61	142	2.12
Argentina	96	3.37	96	3.69	97	3.04
Armenia	100	3.34	93	3.73	104	2.95
Australia	26	4.55	28	4.70	25	4.41
Austria	14	5.11	7	5.41	18	4.82
Azerbaijan	72	3.59	80	3.86	59	3.33
Bahrain	55	3.83	45	4.35	60	3.32
Bangladesh	122	3.02	118	3.45	129	2.58
Barbados	47	3.92	53	4.28	47	3.56
Belgium	12	5.11	10	5.34	13	4.89
Bhutan	111	3.22	107	3.58	113	2.85
Bolivia	94	3.38	103	3.61	83	3.15
Botswana	110	3.22	116	3.47	102	2.97
Brazil	56	3.82	47	4.32	62	3.31
Bulgaria	106	3.27	105	3.61	105	2.94
Burkina Faso	128	2.95	136	3.00	107	2.89
Burundi	137	2.68	139	2.91	133	2.46
Cambodia	116	3.15	111	3.52	116	2.79
Cameroon	84	3.47	98	3.68	71	3.27
Canada	24	4.72	23	4.90	22	4.54
Cape Verde	109	3.23	114	3.48	101	2.98
Chad	141	2.55	143	2.77	139	2.34
Chile	49	3.88	55	4.23	48	3.54
China	33	4.14	43	4.38	32	3.91

			PILLAR			
	INNOVATION AND SOPHISTICATION FACTORS		11. Business sophistication		12. Innovation	
Country/Economy	Rank	Score	Rank	Score	Rank	Score
Libya	143	2.49	135	3.01	144	1.98
Lithuania	44	3.97	49	4.31	44	3.62
Luxembourg	18	4.93	21	5.00	16	4.85
Macedonia, FYR	76	3.53	89	3.78	68	3.28
Madagascar	105	3.27	117	3.46	94	3.09
Malawi	115	3.17	108	3.54	115	2.80
Malaysia	17	4.95	15	5.24	21	4.67
Mali	97	3.36	102	3.62	92	3.10
Malta	41	4.03	36	4.45	45	3.60
Mauritania	138	2.63	142	2.85	136	2.41
Mauritius	53	3.85	33	4.48	76	3.22
Mexico	59	3.73	58	4.14	61	3.31
Moldova	129	2.94	124	3.35	131	2.53
Mongolia	112	3.20	115	3.47	106	2.94
Montenegro	77	3.53	97	3.69	58	3.37
Morocco	82	3.50	78	3.88	90	3.11
Mozambique	120	3.05	125	3.34	118	2.76
Myanmar	139	2.62	140	2.90	138	2.34
Namibia	91	3.41	94	3.72	91	3.10
Nepal	124	2.98	126	3.34	126	2.62
Netherlands	6	5.41	5	5.57	8	5.25
New Zealand	25	4.61	24	4.80	23	4.42
Nicaragua	125	2.98	129	3.28	123	2.68
Nigeria	103	3.30	87	3.78	114	2.82
Norway	16	5.08	13	5.30	15	4.85
Oman	58	3.76	56	4.23	64	3.29

Source: World Economic Forum, Global Innovation Index 2014-2015.

Malaysia and Ireland. Similarly, Canada ranks 27th in company spending on R&D and 22nd in technological readiness.[6]

Two other influential reports drew similar conclusions. The Conference Board of Canada has given Canada a "D" grade in innovation since 2007, placing our country 13th out of 16 countries studied.[7] A recent report from the Boston Consulting Group reveals that Canada has not had a company on its top 50 list of global innovators since 2010.[8]

Innovation in action

These reports demonstrate what some countries are doing right and, by extension, what Canada is doing wrong in fostering innovation.

In the case of Switzerland, ranked first overall by the WEF in both competitiveness and capacity for innovation, its world-class academic institutions "combined with high spending on R&D and strong cooperation between the academic and business worlds contribute to making it a top innovator." The sophistication of companies that operate at the highest end of the value chain is another notable strength. In the WEF's view, Swiss productivity is further enhanced "by an excellent education system and a business sector that offers excellent on-the-job-training opportunities" and a labour market that balances employee protection with flexibility and the country's business needs.[9]

Germany, which ranks fourth in capacity for innovation and fifth in competitiveness, has highly sophisticated businesses and an innovation ecosystem that is conducive to high levels of R&D innovation. German companies spend heavily on R&D, from process to products, and can rely on an institutional framework, including collaboration with universities and research labs, to support their innovation efforts.

Scale and proximity to market are other factors stimulating innovation in both countries, fostering a learning exchange among businesses and facilitating the development of new goods and services.[10]

Can Canada become Switzerland or Germany from a manufacturing perspective? Not exactly. But as a country, we can extrapolate from these and other examples in collaborating, innovating and skills training.

As we heard in our interviews and at our roundtables, taking better advantage of existing and new technologies can drive company-level, incremental innovation. The efficiencies created will flow through supply chains, increase capabilities and stimulate industry-wide and economy-wide gains in competitiveness.

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6 *Ibid.*

7 Conference Board of Canada, "How Canada Performs", 2014.

8 Wagner, Kim, Andrew Taylor, Hadi Zablit and Eugene Foo, "Innovation in 2014", Boston Consulting Group, 2014.

9 Ibid.

10 WEF, "Global Competitiveness Report", 2014.

Intellectual property and innovation

Without intellectual property (IP), there is no innovation. Or, as the CD Howe Institute's recent report on patents succinctly puts it, "patents reward the innovation and creativity that drive economic growth."[11]

According to the World Intellectual Property Office (WIPO), IP patent filing in Canada and foreign IP filings in Canada are both dropping, meaning that Canada is slipping farther down the list when it comes to IP patent applications. We ranked 19th in the world in such applications filed by residents in 2012 (the latest available statistics), down from 13th in 1998.[12]

CD Howe's report corroborates this finding. Research by its authors shows that, per capita, patent filings in Canada have fallen steadily from 2000, a reflection of how Canada, in CD Howe's view, "appears to be struggling with the commercialization aspect of the innovation process."[13]

These falling IP figures, and the related discussions at our roundtables, point to two problems:

- Canada's IP process needs streamlining.
- Intellectual property is not being commercialized.

According to what we heard at our roundtables, Canada needs better market-based and policy incentives and opportunities to commercialize research. This will spur manufacturers to use both new and existing technologies in innovative ways, thereby driving efficiency while creating jobs, opening markets and creating wealth.

A PwC survey clearly illustrates the connections between innovation and growth—and thus the value of innovation for companies, their supply chains and the economy at large. According to its study, the most innovative companies delivered growth at a rate of 16% above that of the least innovative companies over a three-year period. As well, the innovators are more bullish about their growth prospects.[14]

Our roundtables highlighted how only a small percentage of the 51,000+ manufacturers in Canada will ever experience the commercialization of breakthrough technology. They also highlighted the need for this percentage to increase—more companies have to be more innovative in how they manufacture.

These discussions led to many suggestions about what it will take for the sector to fully recover. For Canada to rise in those influential rankings, the vast majority of manufacturing companies need to do at least three things:

- Adopt a culture of risk taking and innovation. "I can't afford it" is standing in the way of "I can't afford not to."
- Pick the technologies that will provide the most advantage to them and invest sufficiently in ways to capitalize on those investments to remain competitive.
- Be more open to working together as collaboration will feed the innovation ecosystem.

At the same time, Canada needs to attract, foster and retain companies that excel in creating and commercializing breakthrough technology. Those at the bleeding edge of innovation spin off benefits to those further back while, at the same time, making a globalized market take a very close look at those breakthroughs. Value is created and coveted.

According to our conversations with industry, increasing our collective capacity to develop breakthrough technology and fostering a culture of adopting new process technologies are significant parts of a necessary formula to turn Canada's innovation scorecard around.

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11 Brydon, Robbie, Chesterley, Nicholas, Dachis, Benjamin and Jacobs, Aaron, "Measuring Innovation in Canada: The Tale Told by Patent Applications", CD Howe Institute, 2014.

12 WIPO statistical country profiles, www.wipo.int.

13 CD Howe, "Measuring Innovation in Canada", 2014.

14 PwC, "Breakthrough Innovation and Growth", 2013.

THE STATE OF CANADIAN MANUFACTURING AND INNOVATION

Participants in our roundtables spoke clearly about the state of innovation in manufacturing from their perspectives. Comments fell into several broad categories, some of which are below while others are in the "Barriers" section of this report.

In many ways, the observations of our members reflect the innovation imperative that the WEF wrote about in its manufacturing report:

"In the 21st century manufacturing environment, being able to develop creative ideas, addressing new and complex problems and delivering innovative products and services to global markets will be the capabilities most coveted by both countries and companies."[15]

Scaling for innovation

Scaling for innovation continues to be a problem, limiting adoption of technology and creating barriers to new markets. Manufacturers in Canada acknowledge a need to examine their own processes, from product development through to distribution, to improve competitiveness but they see market uncertainty as the key impediment to investing in new technologies. That is not to say innovation "lives" in only certain areas of a company—quite the opposite. But many manufacturers, especially smaller ones, have to prioritize where and how to leverage innovation in ways that will drive efficiencies without consuming vast resources.

Canadian Start-ups with Breakthrough Innovations

D-Wave

Founded in 1999 and based in Vancouver, D-Wave Systems is the first commercial quantum computing company. D-Wave is a recognized leader in the development, fabrication and integration of superconducting quantum computers. Its systems are being used by Lockheed-Martin, Google, NASA and USC, among other world-class organizations and institutions.

Enovex

Enovex is an example of breakthrough technology in advanced materials. A young company based in Atlantic Canada, it is developing a new class of gas production absorbents. These new molecular compounds will unlock a suite of possibilities for future technologies beyond gas separation and production.

15 WEF, The Future of Manufacturing: Opportunities to Drive Economic Growth", 2012.

Being nimble is good business

Being nimble and timely in responding to market changes is critical to competing in a global and rapidly changing sector. This is true of small and big manufacturers alike given that most Canadian manufacturers, regardless of size, compete against large multinational firms, with much of this competition coming from low-cost countries.

That means manufacturers in Canada constantly anticipate the demand and supply in markets where they may have limited influence to affect input costs and drive prices. Staying nimble helps them react quickly and exploit opportunities across the supply chain. It also helps limit losses when they arise.

At the same time, global value chains are expanding faster than ever, and the product cycle is shrinking—as are margins in many cases. This contributes to ever-stronger pressures to increase process efficiencies. As we heard at our roundtables, nimbleness in approach and/or size allows manufacturers to handle these pressures better than those firms that are challenged in reacting to exogenous conditions.

Exporting is essential

Exporting is essential for many manufacturers. Several roundtable participants advised that serving markets abroad is their top priority given Canada's small market and big geography. Whether they export all or some of their products and services, manufacturers are increasingly tapping into external markets to support, if not drive, corporate growth strategies.

Being export-focused has challenges. Chief among them is navigating foreign exchange rates. These fluctuations play havoc on day-to-day operations and have a higher impact on SMEs than on larger firms due to scale.

Export markets are an investment in time, money and energy. Resources must be allocated to building meaningful in-country relationships with trusted advisors who can be a proxy for *in absentia* management in developing sustained market opportunities with other manufacturers in the supply chain and/or end-user customers. Cultivating relationships with local governments is also very important to informing and executing export strategies.

Staying competitive in global markets means constantly refining one's approach to product, product cycle and fulfillment.

Participation in the global supply chain

During interviews with global manufacturers, such as Bombardier, it was apparent that one of the key challenges to overcome in managing a global supply chain is the visibility between the tiers of suppliers. Embedding SME manufacturers within their larger customers improves visibility, communication and collaboration, driving innovation.

This embedded approach comes with some risks, especially if the smaller manufacturers become overly exposed to their big customers. A few consecutive negative quarters or a few bad decisions by these bigger players can sink smaller manufacturers.

But on the whole, our smaller manufacturing members felt it was preferable to be an integral part of trickle-up and tickle-down innovations that stem from being part of global supply chains, as opposed to being isolated from the benefits of that sort of innovation.

Canadian Companies Using Innovative Approaches to Technology to Build a Niche in a Resource Rich Economy

Nanometrics

Nanometrics has taken the incremental innovation approach to using existing technologies in new ways. It provides monitored solutions and equipment for studying man-made and natural seismicity. Ottawa-based, with offices around the world, Nanometrics has more than 30 years of experience servicing global customers. Its real-time and portable systems are used by the world's leading scientific institutions, universities and corporations.

Scintrex

Another example of using existing technology in new ways, Scintrex develops, manufactures and sells state-of-the-art geoscientific sensors and solutions to the oil and gas, mining, government, academic, environmental and archaeological markets. Its wide product line covers such geophysical methods as induced polarization, resistivity, magnetics and gravity.

THE BARRIERS TO INNOVATION

Discussing the state of manufacturing at our roundtables illustrated several barriers to innovation that our members face in manufacturing today. These barriers are not new. Many roundtable participants were resigned in saying they are mostly running to stand still rather than to overcome these barriers.

Challenges in adopting disruptive technologies

"I know some of these technologies work for other companies. But can I afford to invest in them myself?"

Canadian firms are struggling to adopt advanced technologies that can vastly improve productivity. For example, just 6% of firms have adopted a strategy to harness the Internet of Things, allowing them to better monitor their production and distribution processes. In a recent poll, just 22% of C-suite executives indicated they are using data analytics as a tool to better understand their product cycles and the real value of their own innovations.[16]

The slow adoption of disruptive technologies was a key theme at our roundtables. Some members said the investment cost of such technologies, combined with uncertainties about how much they will increase production efficiencies and access to markets, were, in effect, barriers to adoption.

Policy framework

"I deal with enough policy hassles overseas. Why does Canada's policy environment have to be so complicated?"

Understanding the nuances and implications of any given country's tax policy framework can challenge even the most experienced executive. It certainly confounds and frustrates many study participants. A recent PwC survey of more than 1,300 CEOs from around the world found that the rules in areas important to manufacturing, such as R&D tax credits, "are often far from clear cut."[17] Multiply the number of jurisdictions and those tax administration challenges become exponentially more difficult.

SME manufacturers in Canada often struggle to understand and comply with the underpinning details, incentives, steps and variances among the myriad of policy frameworks in which they operate. As a result, the cumulative impacts and costs of government policies can be barriers to innovation, just as thickening borders between countries—a common complaint of manufacturers—is a barrier to exporting.

16 http://www.kpmg.com/Ca/en/topics/C-Suite/currentcsuite/c-suite-presentation-q4-2013-dec-16-tc.pdf

17 PwC, "Delivering Results: Key Findings in the Industrial Manufacturing Industry", 2012, p. 3

But these same policies can also be force multipliers—factors that accelerate growth—for manufacturing companies by way of the incentives they provide. According to the Canadian Manufacturing Coalition, the capital intensity of R&D in manufacturing means that tax credits, such as the Science Research and Experimental Development (SR&ED) program, are considered crucial "to develop new and innovative products and bring them to market more efficiently."[18]

The president of one energy company said that recent pullbacks in SR&ED reduced his investments in innovation. Meanwhile, another senior executive said he would like to see customized incentive programs that foster R&D innovation at the company level.

Cost inputs (labour, energy)

"I can compete on process and products, hands down. But I can't compete on costs alone."

Input costs, such as raw materials, labour and energy, significantly affect virtually every aspect of manufacturing. And in a world of diminishing margins and shorter product cycles, hikes in one of these input costs can change how, when, where and if any given product is produced. Hikes in all of them can have tectonic effects on a country's domestic manufacturing base.

These plates are shifting in Canada, and in various ways. Gone are the days when manufacturers could compete on labour costs. Rising electricity costs are inflating top lines and squeezing bottom lines like never before. In many cases, manufacturers send their labour and energy-intensive production off shore, leaving value-add functions, such as product design, in Canada. However, in the face of some quality control issues abroad, some manufacturers are bringing their production home despite rising energy costs in Canada.[19]

Roundtable participants spoke of their own ways of dealing with input costs. Many executives look to the German manufacturing model, saying that investments in skills and innovation can overcome and help contain rising input costs. What is more, the output of such a model is a series of high-value and highly exportable products.

Access to markets

"Canada is both too small and too big. We look elsewhere for customers and growth."

Canada is a vibrant and small market on a global scale. It is also enormous in terms of sheer mass. These two factors, market size and geographic size, conspire to challenge Canadian-based SME manufacturers, in particular, to grow within their home market. This places a premium on gaining access to foreign markets.

Exporting is therefore increasingly important. But finding, financing and capitalizing on foreign-market opportunities calls for long-term strategies that recognize and overcome challenges posed by long distances and, in many cases, different cultures.

That means manufacturers need robust physical capacities to produce, package, ship and sell products across one and often many borders. This may also mean outsourcing production to foreign markets—taking advantage of close proximity and lower production costs—in addition to leveraging local experts with experience, credibility and capacity to connect manufacturers to opportunities.

18 CMC, "Manufacturing our Future: A Manufacturing Action Plan for Canada – Driving Investment, Creating Jobs, Growing Exports", 2013.

19 KPMG, "Canadian Manufacturing Outlook 2014", p. 2

Access to capital

"Money is the liquidity of manufacturing."

Manufacturing is highly capital intensive. So regardless of the form and amount of capital required—personal savings, angel capital, bank loans, lease financing, debt issuance and/or export finance—there would be no manufacturing without it.

When it comes to financing innovation, some roundtable executives said they struggle constantly with accessing capital to finance their innovation in the forms of technical demonstrations and prototypes. Without those prototypes, innovative ideas simply remain ideas and not realities. At the same time, capital providers have to manage their own risks. They need something more substantial as collateral than dreams and ambition.

As a recent report out of Harvard shows, the "intellectual distance" between innovators and capital providers can be a huge barrier to funding.[20] Bridging the gaps between R&D testing and product selling is done with significant financial strains, not to mention emotional stress. Shrinking that distance is central to expanding the value of innovation in manufacturing.

Access to skills

"We don't just need more people. We need the right people."

Finding and holding on to skilled labour is an ongoing problem for many manufacturers. One manufacturing executive at our roundtable held in Oakville, Ontario taps into university co-op programs to provide his company with a steady stream of educated and motivated talent as well as fresh ideas for innovation. Cultivating that connection, maintaining that flow of good people and ideas, is a key corporate plank of his company's growth strategy. It is also helping students move from education to employment, a major challenge in Canada as highlighted in one of our recent papers.[21]

Challenges in handling increased managerial responsibilities can also impede innovation. Making the transition from chief engineer to chief executive—moving from the lab to the corner office—is a difficult journey for some manufacturing professionals. For some, becoming CEO means taking their eyes off the "innovation ball" as they spend more time running their company. The irony here is that the very sense of innovation that made their company vibrant (and potentially profitable) weakens under the weight of the growth built on that very innovation.

20 Boudreau, Kevin, Eva Guinan, Karim Lakhani and Christoph Riedl, "Looking Across and Looking Beyond the Knowledge Frontier: Intellectual Distance and Resource Allocation in Science", Management Science, forthcoming.

21 The Canadian Chamber of Commerce, "A Battle We Can't Afford to Lose – Getting Young Canadians from Education to Employment", October 2014.

More broadly, manufacturers are trying to increase their own capabilities through skills improvements and other means. In doing so, they are embodying what the WEF captured in its recent manufacturing report. "Future developments in global manufacturing are increasingly relying upon the development of capabilities related to innovation, labour and infrastructures."[22]

The talent challenge is reflected clearly in Canadian Manufacturers & Exporters' (CME) 2014 survey. It found the availability of skilled personnel to be the fourth-highest challenge among 16 challenges facing its members.[23] Tapping into external networks and/or individuals with reliable and relevant in-country expertise in key foreign markets is an additional challenge for SME manufacturers, in particular.

Jurisdictional competition for global capacity limits local supply chain investment

"It's really hard to innovate when head office is a world away and you're competing within your own company."

Competing for internal dollars is a big challenge facing several roundtable participants working at Canadian subsidiaries. They have to compete as much for investments from their foreign-based head office as they do against external competitors. This, in turn, reduces their ability to innovate in Canada, and thus their ability to compete.

One executive said there are many things to consider in making such decisions: the perception by head office of Canada's investment environment being one of them. That perception, in turn, is influenced by factors such as taxation, cost of capital, local labour force, economic forecasts and political risk. The attitudes of federal policymakers also factor into these decisions, putting an onus on maintaining strong relationships with government officials.

Local innovation is the key to attracting those internal dollars. But that is a double-edge sword: it is hard to innovate before you can secure money. This points to the value of ongoing planning and process efficiency in highlighting how ever-more innovation would continue to build on local success. The upshot is that value-add jobs stay in Canada.

A recent paper by Statistics Canada illustrates another side of this jurisdictional challenge. It found that Canadian manufacturing companies that are part of global value chains (GVCs) are more productive than those that are not part of such networks.[24] This argument does not necessarily mean that any given jurisdiction within that GVC is guaranteed funding. Rather, it suggests the exact opposite—each jurisdiction has to fight for internal resources to maximize the efficiency of the entire company.

The impact of these barriers is clearly spelled out in the CME survey of 803 companies from across Canada. It found that more than three-quarters of respondents expect profits to grow in the coming three years and 28% expect that growth to be greater than 10%. The key to hitting those targets, according to CME respondents, is innovation.[25]

22 WEF, "The Future of Manufacturing", 2014.

23 CME, "Management Issues Survey – 2014".

24 Statistics Canada, "Global Value Chains and the Productivity of Canadian Manufacturing Firms", John Baldwin and Beiling Yan, March 2014.

25 CME, "Management Issues Survey – 2014".

THE OPPORTUNITY: HARNESSING INNOVATIVE TECHNOLOGIES

Technology has the capacity to reshape the manufacturing landscape. Consider some examples from the last few decades:

- Computers shrank from being warehouse-sized to palm-sized (and much smaller) while their functions and adoption within almost all manufacturing processes skyrocketed.
- Smartphones with video capacity spread from executive offices to R&D labs, linking more people to more projects in real-time.
- Digital photography wiped out chemical photography almost overnight, highlighting the vulnerability of some companies to under investing in innovation.
- The range of WIFI and Bluetooth in bringing the power of the Internet to employees on the move is ever-expanding.

Individually, these technologies are driving company-level efficiencies that transcend supply chains. Taken together, they are fundamentally changing manufacturing in ways that present significant opportunities and challenges for manufacturers, policymakers and consumers.

Icons of the Canadian Economy: Start-ups that Scaled up by Innovating

BlackBerry

A global leader in mobile communications with offices in North America, Europe, Asia Pacific and Latin America, BlackBerry revolutionized the mobile industry when it was introduced in 1999. Founded in 1984 and based in Waterloo, Ontario, BlackBerry changed the way we work and communicate, using innovative technology that allowed adopters to be more efficient.

Bombardier

Bombardier Inc. is a Montreal-based, multi-national aerospace and transportation company founded by Joseph-Armand Bombardier in 1942 in Valcourt in the Eastern Townships of Quebec. Starting as a maker of snow machines, or snowmobiles, it became a global leader in the manufacturing of regional aircraft, business jets, mass transportation equipment and recreational equipment and a provider of financial services.

Magna

Magna International Inc. is a global automotive supplier headquartered in Aurora, Ontario. Frank Stronach, an innovative entrepreneur, grew Magna into the largest automobile parts manufacturer in North America, by sales of original equipment parts, and one of Canada's largest companies.

The automation of knowledge work

Two important trends are changing the way knowledge work gets done in organizations:

- The emergence of new ways of reaching and engaging workers.
- The automation of knowledge work by means of artificial intelligence and other technologies.

Recent research published by Deloitte University Press shows that online talent marketplaces, such as eLance and oDesk, help employers identify workers with needed skills and engage them in project work. These marketplaces, also known as talent clouds, facilitate communication and negotiation, handle payment and allow employers to rate workers' performance.

Today, talent clouds are commonly used to execute projects in information technology, design, marketing and market research. According to authors Vikram Mahidhar and David Schatsky, the range of skills available through these platforms is expanding to include translators, business analysts and financial modellers.[26]

Some organizations are also adopting a variety of technologies, collectively labelled artificial intelligence (AI), to automate knowledge work. As these technologies improve, increasingly sophisticated tasks can be automated. For example, machine learning can discover patterns and correlations in data; it can be used to guide the development of predictive models and analytics. Siri, the automated assistant on iPhones that appears to understand and respond to spoken requests, is perhaps the most widely known example of this technology.

In Mahidhar and Schatsky's view, AI technologies, such as natural language processing, hypothesis generation and evidence-based learning, may have significant impacts on automating knowledge-intensive tasks ranging from medical diagnosis to responding to call centre inquiries.[27]

These and related advances in artificial intelligence open possibilities for sweeping changes in how knowledge work is organized and performed. Sophisticated analytics tools can be used to augment the talents of highly skilled employees, and as more knowledge worker tasks can be done by machine, some types of jobs could become fully automated.[28]

The Internet of Things

The Internet of Things—embedding sensors and actuators in machines and other physical objects to bring them into the connected world—is spreading rapidly. From measuring the moisture in a field of crops to tracking water flows through utility pipes, the Internet of Things allows businesses and governments to manage assets, optimize performance and create new business models.

According to the McKinsey Global Institute, the Internet of Things also has great potential for improving the health of patients with chronic illnesses and, through remote monitoring, could attack a major cause of rising healthcare costs.[29]

The combined potential of cloud computing, mobile communications, the Internet of Things and quantum computing for big data analytics could provide unparalleled disruption to the manufacturing sector by allowing for unprecedented analysis throughout GVCs.

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26 Mahidhar, Vikram and David Schatsky, "The Future of Knowledge Work", Deloitte University Press, 2013.

27 *Ibid*.

28 McKinsey Global Institute, "Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy", 2013

29 *Ibid*.

KPMG's 2014 *Global Manufacturing Outlook* survey concluded that for manufacturers, the transparency and visibility of supply chains remain major hurdles, along with the ability to effectively measure and understand cost and profitability.[30] Improved analytics will benefit producers and suppliers by linking granular levels of data to operators in real time. As noted in KPMG's report, "speed and frequency can help generate timely insight to help make better business decisions. The reality is that insights around cost and profitability drive today's competitive advantage."[31]

Additionally, cloud computing and mobile communications will enable higher quality interactions between producers, suppliers and customers. Designs and prototypes can be shared with ease and modifications applied with little hassle.

When combined with 3D printing, stakeholders along the entire value chain will be able to access tangible mock-ups at a moment's notice and to design modifications remotely and seamlessly. The gains in time and efficiency will undoubtedly shorten lead times, allowing manufacturers to implement changes and customizations with ease.

Cloud technology

Manufacturers are under constant pressure to increase accuracy, improve production speed, keep up with ever-shorter product lifecycles and capitalize on a vast array of data and information inputs. It can be overwhelming, especially for smaller manufacturers.

Cloud-based strategies help these companies align their resources with the pressures of competition and the expectations of customers. The cloud fosters collaboration like never before.

With cloud technology, any computer application or service can be delivered over a network or the Internet with minimal or no local software or processing power required. In order to do this, IT resources, such as computation and storage, are made available on an as-needed basis. And, when extra capacity is needed, it is seamlessly added without up-front investments in new hardware or programming.[32]

As a paper from Infosys points out, cloud computing is becoming an enabler for innovation in manufacturing. It lowers traditional barriers related to cost, time, location and organizational resources. In short, the cloud provides an unparalleled platform for innovation.[33]

Examples of how cloud computing is innovating manufacturing:

1. The automotive industry uses cloud-delivered telemetrics to track fleet usage through a wide range of data-rich factors. This information helps drivers and fleet managers operate safer and more efficient vehicles. It also helps auto manufacturers deliver firmware updates and check on vehicle safety remotely, in addition to scaling up distribution based on telemetric data.[34]

2. Cloud computing helps manufacturers automate customer service, support and order status inquiries online. Integrating these with order management and pricing platforms expedites production and delivery, saving time and money while gathering a more comprehensive profile of their customers.[35]

3. By leasing software and cloud space, cloud computing standardizes and flattens the cost base of IT investments. This allows manufacturers to outsource many of their IT functions to reliable providers, allowing the time and money that

30 KPMG, "Global Manufacturing Outlook", 2014.

31 *Ibid.*

32 MGI, 2013.

33 Venkataraman, Balaji, and Ashish Mehta, "Enabling Innovation and Growth In Manufacturing – is Cloud Computing the Way Forward?", Infosys, 2013.

34 Infosys, 2013.

35 Colombus, Colin, "10 Ways Cloud Computing is Revolutionizing Manufacturing", Forbes, June 5, 2013.

would otherwise be spent on managing IT to be directed toward R&D and to giving more employees more access to more information. This recipe for cloud-based collaboration leads to greater innovation.

Advanced robotics

Manufacturers have long understood the benefits of robotic automation: increased production speeds, higher rates of throughput and improved consistency and quality. For over two decades, industrial robots have been used to complete various basic manufacturing tasks such as spray painting and welding. But, that is changing rapidly. Recent advancements in artificial intelligence, sensors, vision and hydraulics have greatly expanded the roles played by robots in manufacturing.[36] Today's advanced robots, which are smaller and safer than earlier-generation robots, allow manufacturers to create leaner and more efficient production operations, reduce costs and enhance their competitiveness.[37] Meanwhile, the cost of robots is in decline.

Robots are redefining aspects of the manufacturing industry in several ways. For example:

- Researchers are investigating the commercialization of robots that can read an architect's drawings and build a house using 3D printing technology. Robots are capable of applying successive layers of concrete, constructing walls and domed roofs.[38]

- Larger food processing companies are embracing automation and robotics to improve productivity, lower worker injuries and improve food safety. Robotics with vision-guided capabilities are capable of assessing the most efficient way to process food, pick out ingredients that do not meet quality standards and detect good from rotten produce.[39]

- Google tested its self-driving robotic car on public roads in the early fall of 2014, and Tesla announced plans to produce a car with autopilot.[40] Google Autonomous vehicle navigation may eventually be expanded to buses, agricultural vehicles, forklifts and cargo-handling vehicles, transforming transportation as we know it. Meanwhile, car manufacturers are developing their own driverless cars—in essence, robots helping build robots.

Advanced robotics may encourage manufacturers to "reshore" their overseas production back to Canada and take advantage of the gains in cost, speed and quality that come from this innovative technology.

36 A research paper given to the Canadian Chamber by Bombardier's Jeremy Fish titled "GVCs and Innovation: The intersection of productivity and competition" goes into more detail on the impacts of disruptive technologies in manufacturing.

37 The Canadian Chamber of Commerce, "The March of the Robots", 2013.

38 Katz Ferraro McMurtry P.C., "Robotics: Transforming the Construction Industry", Structure – Winter 2013.

39 Goldman, Corey, "Canadian Food Processors Beginning to Catch on to Benefits of Automation", Financial Post, June 4, 2013.

40 Wadhwa, Vivek, "The Robocars are Coming: It Won't be Long Before We Kick Humans Out of the Driver's Seat", Pittsburg Post-Gazette, October 20, 2014.

But there is a human cost to all of this. For all the production and efficiency upsides of advanced robotics, there are downsides for workers who perform routine, task-intensive jobs. These jobs are susceptible to automation because robots can perform repetitive tasks with a higher degree of precision and accuracy than humans without getting tired, injured or bored. However, people who excel in abstract tasks, such as problem-solving, intuition, persuasion and creativity, have a comparative advantage to robots. The same is true, according to academics David Autor and David Dorn, of people, such as radiology technicians and those in the skilled trades, who combine routine technical tasks with abstract and manual tasks.[41]

Nevertheless, the advance of robots in industry gives rise to skilled jobs and entire industries that design and service robots. This puts a premium on investing in ongoing skills training and in building strong connections between employers and educational institutions.

Energy storage

The volatility of energy costs is a harsh reality for global manufacturers. In Canada, rising energy costs are a major concern of manufacturers. The tremendous potential of energy storage could reduce both volatility and costs.

Energy storage comes in many forms, such as technology batteries and other systems that store energy for later use. Lithium-ion batteries and fuel cells are powering electric and hybrid vehicles, along with billions of portable consumer electronic devices.

According to McKinsey, the capacity of lithium-ion batteries used in electric and hybrid vehicles is expected to double in the next decade, with the cost per unit potentially dropping from $560 KWh to $165 KWh. Over the next decade, advances in energy storage technology could make electric vehicles (hybrids, plug-in hybrids and all-electrics) cost competitive with vehicles based on internal-combustion engines.[42]

Major advances in energy storage, which could double battery capacity in the next 10 to 15 years, will deliver significant gains for manufacturers. For example, better energy storage could help manufacturers shift production to off-peak times, lowering their energy bills.

Reliance on often unpredictable energy grids is a common frustration for global manufacturers and suppliers operating in developed markets. More dependable access to energy, such as through integrated battery/solar systems, would allow for more consistency in offshore manufacturing operations.

Improved energy storage could help prevent power outages in developing economies—power outages that can halt productivity from two to 70 hours on average.[43] This technology could also boost access to energy for rural communities in developing countries, bringing reliable power to places it has never reached.

At the same time, power utilities could save money if they could store more energy rather than purchase it at peak prices. In fact, it is not inconceivable that enhanced energy storage could heavily reduce, if not eliminate, a need for power grids within 20 years or so. That would fundamentally change the energy equation for manufacturing—a clear example of disruptive technology.

41 Autor, David, and Dorn, David, "How Technology Wreaks the Middle Class", New York Times, August 24, 2013.

42 MGI, 2013

43 "World energy outlook 2011", *International Energy Agency, November 2011,* from MGI, 2013.

3D printing

3D printing—the process of building objects by adding one layer onto another instead of using molding or machining that is also known as additive manufacturing—has been evolving since the 1980s. Rapid recent changes in technology have many analysts suggesting that 3D printing is at the tipping point for manufacturing. According to Deloitte, 3D printing will potentially have a greater impact on the world over the next 20 years than all of the innovations from the industrial revolution combined.[44]

Costs for 3D printers have decreased drastically in recent years, making technology accessible to businesses across many industries. Commercial printers are now a fraction of their initial cost, with 3D printers now in widespread use in commercial and some residential settings. Some consumers are even creating new innovations without financial, technological or human capital support from large organizations.

The benefits of 3D printing are clearly evident in early stage manufacturing as the costs of prototyping and product testing can be greatly reduced. Not surprising, the aerospace industry is an early adopter of 3D printing, using it throughout rigorous testing phases.[45]

Printing prototypes is much less expensive in time, energy and resources than machining those same prototypes. Similarly, 3D modelling adds several layers of pre- and post-production diagnostics, and those savings can create efficiencies throughout the manufacturing supply chain. For example, the U.S. Navy uses 3D printing to create new parts in situ thus reducing the need to carry heavy and space-taking inventories of spare parts. This saves time, space, energy and money while increasing operational efficiency.[46] Other industries, such as energy and medicine, have also taken keen notice of 3D printing. Advanced medical companies use this technology to produce customized devices and implants for individual patients.[47]

Additive manufacturing is creating industry disruptions. This, in turn, is causing new businesses to emerge and stagnant and well-established businesses to fail. For instance, 3D printing gives global manufacturers flexibility to localize design and manufacturing, allowing them to be more responsive to local demand and labour fluctuations. 3D printing could therefore affect the entire ecosystem of a firm's operations, from early design to final manufacturing, while also replacing traditional supply-chain models. 3D printing can also reduce wastage by creating objects that are difficult or impossible to produce with traditional techniques. [48]

Though only a fraction of the manufacturing sector (0.02%) currently uses 3D printing, sales of 3D printers are set to double to $4 billion by 2015, and prices for the equipment are declining swiftly.[49] That growing usage is borne out in industry research. The *CAD Trends 2014 Survey* by the Business Advantage Group shows that usage of 3D printing is expected to rise significantly over the next five years. Usage of 3D modelling is already the highest of the 14 factors studied by this research and is also expected to rise.[50]

3D printing can, and increasingly will, disrupt the relationship between production and design. This will alter the entire design-build-deliver model for manufacturers of virtually all sizes in the near-, mid- and long-terms.

In the future, manufacturers will have to be fast, flexible and capable to understand and leverage the implications of 3D printing. Failing to do so will be very costly.

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44 Deloitte, "The Disruptive Manufacturing: The Effects of 3D Printing", 2013.

45 "Print me a Jet Engine", *The Economist,* 22 November 2012

46 Navy Times, "Navy Pushes Ahead with 3-D Printing", July 13, 2014.

47 Irene Petrick and Timothy W. Simpson, "3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition", *Research, Technology and Management: Point of View,* November/December 2013

48 MGI, 2013

49 *Ibid*.

50 The Business Advantage Group, "CAD Trends 2014 – Looking to the Future", 2013.

Advanced materials

Stretchable electronics that measure body temperature, carbon fibre reinforced polymers to make jet engine wings bigger and stronger and alloys for greater conductivity in computers are all examples of advanced materials that are changing the nature of manufacturing.

New materials and new production processes, fuelled by the commercialization of research, are creating new markets for early-adopting manufacturers that have the capacity to make the necessary investments. And the economic spin-off benefits can be significant depending on the materials and processes used. Advances in this area are also reducing environmental impacts along the supply chain.

Nanotechnology advances in rechargeable batteries are a perfect example of innovation in manufacturing. Current lithium-ion batteries have graphite anodes. Instead of using graphite, a team at Singapore's Nanyang Technological University (NTU) used a titanium dioxide gel it developed that dramatically speeds up the chemical reaction that takes place in the battery, making it charge much faster.

To achieve this effect, the team "found a way of forming the titanium dioxide, which is normally spherical in shape, into tiny nanotubes—small rods thousands of times smaller than a human hair. Unlike in typical lithium-ion batteries, additives aren't needed to bind the electrodes to the anode, so reactions take place faster."[51]

This breakthrough could be significantly disruptive in the automotive sector.

"With our nanotechnology, electric cars would be able to increase their range dramatically with just five minutes of charging, which is on par with the time needed to pump petrol for current cars," said Professor Chen Xiaodong who invented this gel. "Equally important, we can now drastically cut down the waste generated by disposed batteries, since our batteries last 10 times longer than the current generation of lithium-ion batteries."[52]

Using existing materials in new and innovative ways is another major trend in manufacturing.

Years ago, "drop-in substitution"—using synthetic materials to replace natural materials—created efficiencies in manufacturing. But that sort of substitution had its limits. These days, a new era of engineering and advancing the functions of existing materials is taking shape that, according to Deloitte, represents a large opportunity for value creation along the supply chain.

As outlined in Deloitte's paper, *Reigniting Growth – Advanced Materials Systems*, existing materials can be engineered using advanced manufacturing and process technologies that perform well enough or better than those dependent on wholly new materials.

Working with existing versus newly invented materials can likely shorten development times, lower development costs and help mitigate risk. And existing materials can be chosen and engineered for their performance, economic characteristics and environmental sustainability.[53]

51 Franco, Michael, "New Batteries Charge 70 Percent in 2 Minutes", CNET, October 13, 2014.

52 *Science Daily*, October 13, 2014.

53 Deloitte, Reigniting Growth – Advanced Materials Systems", 2012.

DECISION MAKING: KEY FACTORS

Like other businesses, manufacturers make a series of ongoing decisions to determine how, when and where to invest capital. But in the case of manufacturing, process improvement and production cycles are often measured in years as opposed to months. That puts the onus on management to take the appropriate steps—using the right inputs to get the best outputs—to make those decisions when there is limited visibility.

Many of the manufacturers we spoke with draw on the following framework—variously applied—to compete today and prepare for tomorrow.

The innovation ecosystem

As a recent report from BCG notes, innovation is a system. It is "a mixture of insight and creativity as well as a disciplined process that consistently promotes progress."

This system has three major components: a strategy comprising of choices on where and how to create growth and value through innovation; a supporting set of processes for research and product development; and an enabling set of systems, tools and capabilities. In BCG's view, this innovation system should be rooted in experimentation and, "like all adaptive systems, it must evolve over time as the external environment and internal needs change."[54]

Questions raised by our members about their innovation systems and about innovation more broadly in Canada include:

- What metrics should we use to determine what innovative technologies to use to increase our overall competitiveness?
- Do we have to change our organizational structure and/or governance to harness more innovation?
- How can we better tap into education and apprenticeship programs to stimulate and help realize innovation through a highly trained and motivated work force?
- Canadian manufacturers cannot compete on labour costs and energy costs. What will it take to encourage more value-add manufacturing in Canada?
- Why is there an overall lack of respect and interest in manufacturing in Canada?
- How can SME manufacturers make greater use of incremental innovation?
- Deployment of new services is a three-legged stool: you need hardware, software and distribution. How can we balance all three when facing a range of internal and external challenges?

54 Andrew Taylor and Kim Wagner, "Rethinking your Innovation System", BCG, October 2014.

Investment decisions

One of the biggest decisions any manufacturer will make in terms of innovation is: What investments should I—and can I—make to stay competitive? In other words, what will it take to finance innovation, recognizing that "keeping the lights on"—which may or may not stem from being innovative—is a reality facing many manufacturers in Canada.

Our roundtables and interviews highlighted several factors manufacturers must consider when making innovation investment decisions, each of which implies making trade-offs. These factors include (but are not necessarily limited to):

- **Bridging time and money gaps***:* R&D is a capital and time-intensive process. This means there are usually long gaps between raising capital for innovation and making money off that innovation. How do you bridge those gaps?
- **Maximizing the supply chain**: Efficient manufacturers benefit from and contribute to their respective supply chains. What investments will maximize that efficiency?
- **Funding to scale**: Manufacturers come in different shapes and sizes and they need to match funding to their scale today and tomorrow. What metrics should they and their capital providers use in costing and allocating capital?
- **Legacy versus new systems**: Manufacturers are regularly faced with decisions on whether to maximize existing systems or build new ones. Of course, some do both.
- **Access to markets**: Canada is a small-market country, meaning most manufacturers look abroad for customers and growth. So they ask themselves: Where in the world are we selling our products now? Will that change over the coming five to 10 years? And if so, how much will it cost to do so?

Regulatory environment, tax structure and incentives

Many of our members feel that governments do not understand how their company's decisions are made nor the context in which they have to make them. As Xerox Canada calls it, the "hydraulics of business decision making" are unfamiliar to the government.

Our members are concerned that governments neither understand nor fully appreciate the drivers of private-sector decision making in highly competitive, global and rapidly changing markets. And they feel these knowledge and experience gaps put added pressure on manufacturers when it comes to seeking incentive tax credits like the SR&ED.

Our members had several comments about Canada's regulatory environment:

- Competition law is a superior tool to foster innovation than regulation.
- Governments need to do a better job of understanding the drivers of manufacturing. They need to know what it is like to compete.
- Figuring out which level of government does what in terms of tax incentives can be confusing and time consuming. Can this not be more clearly laid out?
- Governments have limited resources when it comes to manufacturing and innovation and they have to make trade-offs. Should they direct those resources towards fostering new companies and markets? To growing existing companies? Or do a split of both?

BEST PRACTICES IN MANUFACTURING

Innovating production, hitting payroll and serving clients in a rapidly changing and competitive manufacturing landscape requires strategy, execution and resources.

The following are some best practices discussed during our roundtables and interviews, in addition to practices highlighted in recent research on innovation in manufacturing.

Collaborate to compete

Innovation is shifting to networks rather than hierarchies. It is also increasingly collaborative. Some pharmaceutical companies are patent pooling on fundamental research, an approach that can maximize their combined resources in bringing new products to market. Tesla is opening its patents to competitors to create an infrastructure for electric cars that Tesla cannot create by itself. These companies are collaborating to compete.

Make innovation an input, not a by-product

Embed a culture of innovation throughout the organization, especially in strategic planning and execution. Reward the innovative impulse among employees. Understand that taking big-idea leaps into the brave new world of innovation can bring vast improvements in competitiveness, but that these big steps may not be right for every manufacturer.

Differentiate between innovation and invention

Innovation can make existing resources more effective and efficient. Doing a stem-to-stern review of processes to find those efficiencies can be less risky and more effective than investing in un-tested technologies. This approach does not require reinventing the wheel. But those who do reinvent the wheel lead by example through the risks they take and this can benefit others.

Look to Switzerland and Germany

Canadian manufacturing as a whole should develop more and tighter connections with training and apprenticeship resources. As well, a laser focus on developing virtual prototypes versus manufactured prototypes will reduce costs, enhance risk-taking and drive efficiencies.

Be built for speed

Bringing new products to market quickly avoids giving competitors early looks or the opportunity to influence trial results (by, for example, cutting the price of an existing product in trial markets). In the past, time-consuming trials and test launches too often kill new products before they have a chance to find their market, but today, it is possible to launch new products quickly by using social media and other inexpensive tools.[55]

Learn to fail fast and cheap

Innovation is as iterative as it is important. Failure is all part of innovation. Indeed, many of our members say you need to experience some failures in order to become more innovative. The key is to learn from failure, to contain the costs of failure and to limit the time it takes to know if a new process or innovative improvement is going to fail. In other words, fail quickly and cheaply whenever possible. This can be profitable in the end.[56]

Find balance in policy framework

During our roundtables, several participants reinforced the urgent need to make changes that the Canadian Chamber is advocating by way of policy resolutions and that the Canadian Manufacturing Coalition has previously proposed in its plan, *Manufacturing our Future*. Canada needs a balanced policy framework that:

- Supports investment in innovation
- Encourages market differentiation
- Reduces the regulatory burden
- Strengthens the labour market
- Reviews inter-governmental transfer payments
- Offers different tax treatment for Canadian companies versus multinationals
- Provides funding support for technical demonstrations[57]

PwC's innovation survey highlights some of these best practices at work. According to this study's findings, top innovators:

- Treat innovation just like any other business or management process that can be disciplined and successfully scaled. Only a fifth of the most innovative manage innovation informally, compared with a third of the least innovative companies.
- Target a higher proportion of breakthrough and radical innovations, particularly around products, services, technology and business models. In some areas, the proportion is around twice that of the less innovative companies.
- Plan a wider range of innovation operating models. For example, the top 20% of innovators in the study are twice as likely to consider corporate venturing as a means to drive growth.[58]

55 BCG, 2014.

56 Ibid.

57 CMC, "Manufacturing our Future", 2013

58 PwC, 2013.

RECOMMENDATIONS FOR ADVOCACY

The recommendations stemming from our roundtable meetings affirm and reinforce some of the themes found in the vast literature that exists on the accelerators and the obstacles facing manufacturers when it comes to innovation.

Reform the tax structure

Canada still lags many countries in terms of total spending and in commercializing new technologies. More needs to be done, particularly when governments around the world are looking at adopting tax incentive regimes to encourage companies to exploit and commercialize intellectual property in their jurisdictions.

Coming out of our roundtables, the Canadian Chamber of Commerce recommends adopting an "innovation box" regime 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, services and related innovative processes to the benefit of Canada.

Such an "innovation box" regime would encourage companies to locate intellectual property activity and the new high-value jobs associated with the development of innovation in Canada. It would promote and enhance the innovation capacity of sectors that leverage science and technology innovations. Firms in all sectors would have a greater incentive to adopt, commercialize or otherwise exploit the output of the R&D process here in Canada.

We advocated for this change in our pre-budget submission, and our manufacturing roundtables affirmed that such a change would help Canada's largest sector.

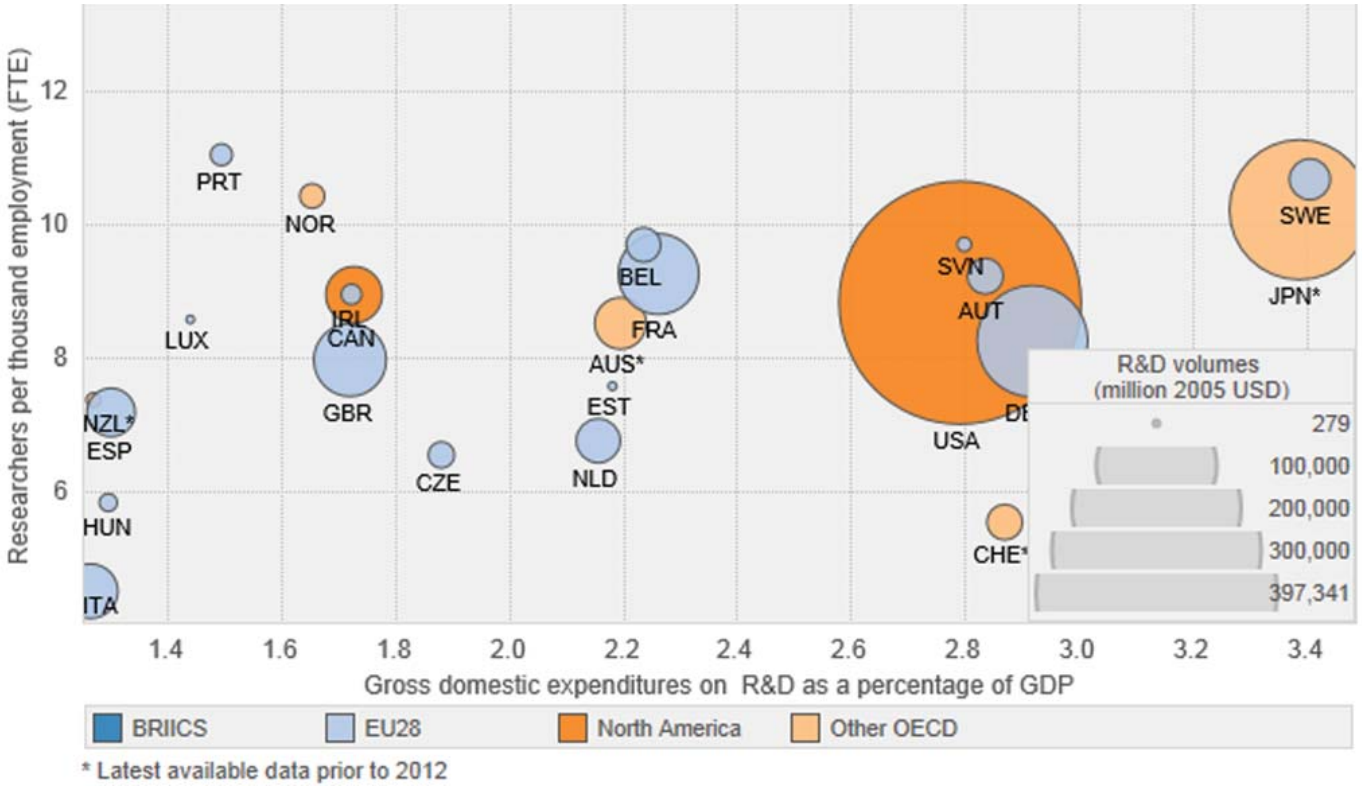
The Leader in Innovative Manufacturing Process

ArcellorMittal Dofasco

Founded in 1912, ArcelorMittal Dofasco is Canada's leading steel producer and a hallmark of advanced manufacturing in North America. With more than 5,000 employees in Hamilton, Ontario, it is the city's largest private sector employer, shipping 4.5 million net tonnes of high quality steel every year.

In the last decade, ArcelllorMittal Dofasco undertook a major facility upgrade to improve energy efficiency. As it notes: energy accounts for 20 to 25% of the cost of a finished steel coil and is the second-largest input cost after raw materials. "Raw material costs can't be compressed. Energy has a degree of efficiency and flexibility that you're always working on. You can control energy costs." A $14.5 million upgrade has resulted in an annual energy savings of $6.8 million.

Human and financial resources devoted to R&D, 2012



Source: RDS is based on the data reported to OECD and Eurostat in the framework of the joint OECD/Eurostat international data collection on resources devoted to R&D. http://www.oecd.org/science/inno/researchanddevelopmentstatisticsrds.htm

Enhance incentives

Some firms in services and manufacturing create value through a wide range of complementary technological and non-technological changes and innovations. Yet R&D remains vitally important for manufacturers to stay competitive now and into the future.

Unfortunately, Canada continues to be outspent by its OECD rivals when R&D is viewed as a percentage of GDP.

There is a disconnect between government funding programs for R&D and the framework necessary for business to engage in R&D in the first place. Canadian manufacturers—small and big, local and global—must do more to inform government and help it recognize that industry needs cooperation and incentives to make long-term R&D investments in process innovations that may not pay off for 10+ years.

As it is, there are costly gaps in the time horizons between the lifespan of government incentives and the R&D investments made by manufacturers. One way to close the gaps and harness more innovation is to make the capital cost allowance horizon more flexible.

Also, incentives for large scale, innovation investments from global companies (i.e., the manufacturing hubs) are not sufficient to overcome the disadvantages of an industrial base that is primarily headquartered outside Canada. This leaves the local supply chain (i.e., the manufacturing spokes)—which is the bulk of manufacturing in Canada—with a market disadvantage. This has to change.

Our support of policy changes for incentives aligns with CME's call on governments and businesses to improve innovation performance by implementing policies to support businesses' in-house R&D and improve the linkages to government and post-secondary R&D efforts.[59]

The Canadian Chamber will look much further into incentives for manufacturers in 2015, thereby building off these roundtables in advocating specific policies that will enhance the state of manufacturing in Canada for years to come.

59 CME, "Management Issues Survey – 2014".

APPENDIX: ROUNDTABLE PRIMER

All roundtable participants were given the following notes to review in advance of attending their respective meeting. A similar template was used for the one-on-one interviews.

What are we looking at?

By using manufacturing as a broad-based example, the Canadian Chamber of Commerce will be examining Canada's poor productivity and competitiveness scores. We will be conducting this examination through the lens of the promising potential of disruptive technologies, such as (not an exhaustive list):

- Automation of knowledge work
- Advanced materials
- Robotics
- 3D printing
- Harnessing big data
- Cloud technology
- Energy storage
- Monitoring/tracking through the adoption of ICT (the Internet of Things)

What is our goal?

Our goal is to improve Canada's innovation ecosystem. To do this, we need to find practical applications for the recommendations contained within current literature that blames industry's failure to leverage technology to generate high knowledge value products and processes for Canada's decline on the World Economic Forum's competitive index. Examples of barriers to competiveness for manufacturing in Canada are:

1. Competition from foreign markets
2. Lack of qualified workers
3. Capital constraints
4. Underinvestment in R&D spending by the government of Canada relative to other jurisdictions
5. Ineffective, inaccessible and outdated intellectual property rights (IPRs) regime
6. Productivity lags in human capital
7. Accelerating technology cycle

We will be looking to innovative companies to help generate practical solutions to leverage disruptive technologies and develop a forward-thinking public policy framework. The project will consist of a series of roundtable meetings with industry, government and academia.

What are the expected outcomes?

Proposed policy alternatives include immigration strategies, tax incentives, improved IPR protection, procurement strategies and more open foreign direct investment. We will conduct a critical examination of these policy alternatives and validate them through a series of roundtables, populated by corporate Canada's manufacturing thought leaders. The results of this process will be compiled into a summary of recommendations for both business and government.

Key concepts and questions for roundtable participants:

1. Definition of innovation: distinction between innovation and invention. Are inadequate IP protections in Canada a barrier to innovation and can an innovative company function without an IP strategy?

2. Abundance of opportunities: technological levers and disruptive technologies. What is here? What is business using? What is next and are the human resources with the necessary skill sets available to take advantage of technological shift?

3. Organizational DNA: vertical integration of innovation and the marriage between engineering and design. What are innovative companies doing to instill a culture of curiosity and drive that forces them to continually reinvent themselves and thrive?

4. Sustainability of relying on cost inputs and high volume/low margin product as a competitive advantage: transformative thinking where a service becomes the product. How can we take advantage of the knowledge economy? Are there best practices?

5. Jurisdictional competition: balancing the limitations imposed by trade agreements with the need to incent a culture of innovation through tax/tariff treatment, procurement policies, direct incentives and government programs. What role should government play? Is there value to government involvement in incubators and accelerators?

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