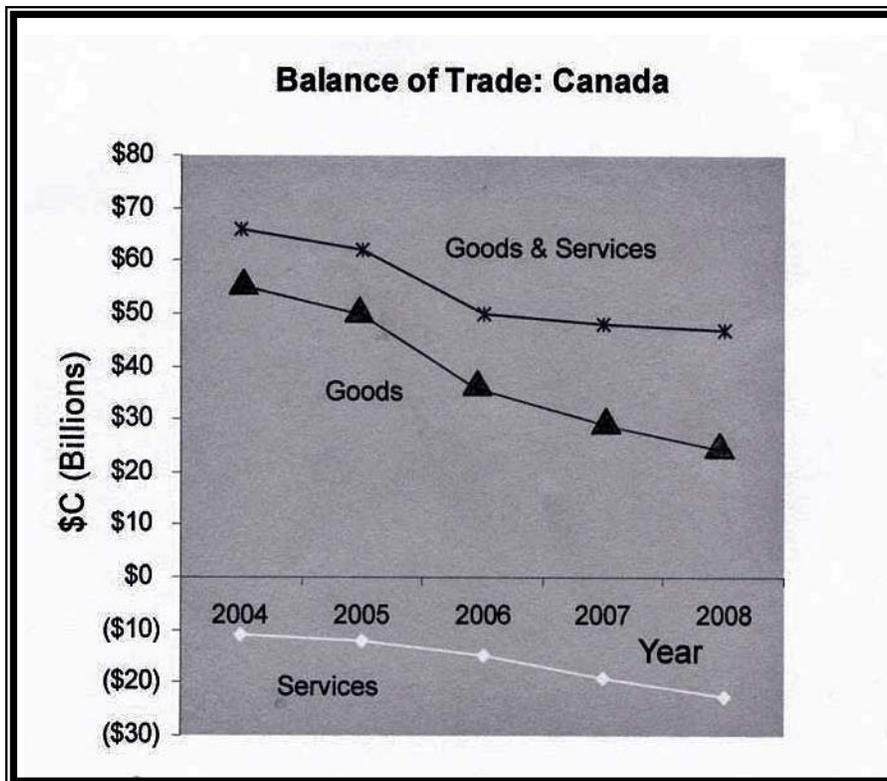


Public Misconceptions about Manufacturing and their Implications for Government



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Canada's balance of trade in both goods and services has been decreasing in recent years. Based on data from Statistics Canada.

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Executive Summary

The Canadian public believes that manufacturing is becoming less important to our economy. This belief, promoted by economists, business writers, and other opinion leaders, is having a profound effect on our society, influencing young people's career choices, our perspectives on sustainable development, interest among entrepreneurs, and public support for government programs to strengthen our manufacturing sector.

This paper analyses several widely held misconceptions about manufacturing, discusses how they hinder government efforts to support the sector, and suggests some possible remedies. The misconceptions analyzed are as follows:

1. The digital economy is replacing the industrial economy, just as the industrial revolution replaced the agricultural age.
2. Manufacturing and service jobs are different.
3. We will do the high value-added service work while others do manufacturing.
4. Health care and education can replace manufacturing as economic drivers.
5. Green technology jobs can make up for losses in manufacturing.
6. We can maintain a high standard of living without manufacturing industries.

The two transitions: agriculture-to-industry and industry-to-information age, share many similarities but neither of them has involved replacing earlier activities. Our ability to produce food has steadily increased and remains essential to our prosperity. Our ability to manufacture goods is no less essential. Unfortunately, the analogy between the current and earlier transitions is starting to break down. This divergence, resulting from the shift of industrial production to low-wage countries, will be increasingly problematic.

The public often hears that jobs in the service sector are growing while those in manufacturing are declining. They fail to understand that many high value-added service jobs (e.g., R&D, engineering, information systems) have close links to manufacturing. When production moves offshore, there is less reason for companies to locate these service jobs here. As low-wage countries implement industrial strategies to move up the value-chain, they are building the human resources and infrastructure needed to accommodate these high value-added functions. In North America, by contrast, there is declining interest among young people in careers based on science, engineering, and technology.

Although services are growing as a percentage of the total GDP, goods have been much more tradable. Our reliance on selling each other services while importing manufactured goods is causing economic weakness in both Canada and the United States. Canada's balance of trade situation is superior to that of the US; due mainly to exports of energy and raw materials. A more sustainable strategy would involve adding more value to our resources prior to exporting.

Green technology and healthcare provide substantial growth opportunities; however, they are not, by themselves, viable substitutes for manufacturing. Services in these and other fields are becoming increasingly tradable and will be subject to the same global competitive pressures as manufacturing. To ensure that these industries are sustainable, we need to fix the problems that are causing the erosion of our manufacturing sector.

Limited public interest in manufacturing, including within the business community, makes building and sustaining Canada’s manufacturing sector more difficult.

For example:

- Because the public underestimates manufacturing’s importance, it is less willing to support government policies and programs aimed at strengthening the sector.
- There is little interest among young people in acquiring the education needed to pursue manufacturing-related careers.
- People with the interest and talent to become entrepreneurs are less likely to consider manufacturing as a venue for business opportunities.
- Manufacturing ventures have greater difficulty attracting financing.
- Companies, even when fully compliant with environmental regulations and following best practices, have greater difficulty dealing with a public that is informed only on the potential downsides of manufacturing.

The government has many programs designed to strengthen manufacturing but more could be done to educate the public about the importance of the sector. Improving public perceptions would create better leverage for existing programs.

To address the public’s poor understanding of manufacturing, several things can be done, including a public outreach initiative to dispel misconceptions and demonstrate manufacturing’s importance. It would be designed to reach key population segments and would inform people about knowledge-intensive manufacturing occupations and the linkages between manufacturing, innovation, and high value-added services. Encouragement and support for collaborative efforts between industry and educators would help young people and their teachers to better understand manufacturing’s importance to our society.

Public concern about environmental issues is justifiably high. The public, however, lacks a balanced view of the environmental costs and benefits associated with manufacturing. Furthermore, it is mostly unaware of industry’s contribution to environmental solutions. A key element of the strategy would be to inform the public on these issues, providing them with a better knowledge base to understand government environmental policies.

Finally, the public’s negative view of manufacturing has been reinforced by the crisis in our automotive industry and the associated need for massive government financial aid. The outreach initiative would address this issue, informing the public that the current support being provided to industry is an emergency measure and that it comes with requirements that domestic automobile manufacturers become more competitive.

Introduction

We often hear that manufacturing is becoming less important as we transition to a service-based (or knowledge-based) economy. This viewpoint comes from many sources, including business commentators, writers, and economists, and is now widely accepted by the public, though not in government. This paper analyses the misconceptions behind the public's perspective on manufacturing, discusses how they hinder government efforts to support the manufacturing sector, and suggests some possible remedies.

Misconception 1: The digital economy is replacing the industrial economy, just as the industrial revolution replaced the agricultural age.

This idea has been quoted so often by economists, business writers, and digital economy pundits, that it has become a truism. Except that, as articulated by Berkley economists Stephen S. Cohen and John Zysman in 1987, it isn't true.¹ Below, we review and update their arguments.

Although the industrial revolution began in Britain, in the late 18th century, the transition from an agrarian to an industrial economy occurred later in North America, and was still underway in the early 20th century. During this transition, people went from farming to factory work and industrial production grew rapidly, soon exceeding agriculture by any economic measure: e.g., sales, fraction of GDP. Often left unmentioned is that as people left farming to take jobs in factories, agricultural production continued to increase, ultimately to levels that greatly exceed those at the beginning of the “shift away from agriculture.” This was due to the continual introduction of new farming methods and technology, much of it the product of the industrial age. Along the way, many industrial age jobs (e.g., farm equipment, food processing, R&D) were created that are closely associated with agriculture.

The shift from a manufacturing to an information-based economy has followed a similar trend. Manufacturing has been decreasing in terms of employment and share of GDP for many years; however, total sales and value-added have steadily increased. The increased output per worker has resulted from more efficient methods and new technology, much of which is a product of the information age. There have also been many service sector jobs created, in design, engineering, business services, etc. that are manufacturing-related.

These two transitions, agriculture-to-industry and industry-to-information age, share many similarities but neither of them has involved replacing earlier activities. Our ability to produce food has steadily increased and remains essential to our prosperity. As explained later, our ability to produce manufactured goods is no less essential. **Unfortunately, the analogy between the current and earlier transitions is starting to break down.** This divergence, resulting from the shift of industrial production to low-wage countries, is becoming increasingly problematic.

¹ Manufacturing Matters: The Myth of the Post-Industrial Economy, Stephen S. Cohen and John Zysman, Basic Books 1987, ISBN 10-0465043844

Many companies with head offices in western countries are increasingly relying on production from low-wage countries instead of investing in new technology and methods to increase the cost-effectiveness of manufacturing at home. Our vision of the factory of the future used to be a highly automated facility, filled with robots and instrumentation, and controlled by highly skilled personnel. That vision is rapidly being replaced by one involving a factory in a low-wage country and big box store in our neighbourhood. To be sure, there are many North American manufacturing facilities that embody the earlier vision, and numerous people still trying to propel that vision forward. Over the last ten years, however, an increasingly large number of companies have been moving production overseas.

Moving production out of North America has significant economic and security implications. The United States has a large and growing trade deficit, a major component of which is manufactured goods. There is also concern in government that loss of leadership in cutting edge manufacturing and related technologies could jeopardize national security. In Canada, our trade surplus has been buoyed by sales of resource-intensive commodities; otherwise, we would have had a trade deficit for several years. It seems absurd to claim to have a knowledge-based economy when relying on other countries to produce most of our electronics, computers, and other sophisticated goods and paying for them by selling coal, oil, and raw materials²

Today, demand for agricultural products is much greater than it was at the time of the industrial revolution. If we had met that demand in the same way as we are meeting our growing demand for manufactured products — by shifting production to other countries — we would no doubt have had increasing food-related balance of trade and security concerns over the last few decades.

Misconception 2: Manufacturing and service jobs are different.

Comparisons based on Standard Industrial Classification (SIC) categories are sometimes used to support the conclusion that the shift to a “post-industrial economy” is inevitable, even desirable. As the following examples illustrate, **such comparisons are based on a faulty understanding of how work is organized.** Consider an assembly line worker, employed by a large automobile manufacturer. She puts cars together. Her counterpart in the service department of an auto dealership does this and more: takes them apart, does repairs, and re-assembles them. The design of a new airplane might originate from engineers working for an aerospace manufacturing firm. Or it may be produced by engineers working at an engineering design firm. Lawyers and accountants can be found doing the same tasks in manufacturing and professional services firms. In chemical plants, company employees and contract workers (employed by service firms) often perform the same tasks. Finally, an updated computer algorithm can be provided in a ROM chip (manufactured good) or as a software download (service). These examples demonstrate that classifying work as either manufacturing or services is artificial.

² This paper acknowledges the contribution of knowledge-based occupations to resource processing but questions why we limit ourselves to a relatively low level of value-added.

We should be more interested in whether the work involves a high skill level, produces high value-added output, embodies innovation, and contributes to exports.

If the distinction between manufacturing and service jobs is artificial, why should the public be concerned with preserving a strong manufacturing sector in North America? The following two arguments explain why:

Balance of Trade and National Interest

Our high standard of living, health & safety, and national security all depend on us being able to acquire, use, and ultimately dispose of a large amount and variety of manufactured products in a cost-effective and environmentally sustainable manner. If we lose our ability to produce these goods, we will have to depend entirely on supplying services to goods-provider countries. **For tradable services, the same competitive factors that are causing the migration of manufacturing to low-wage countries are gradually coming into play.** The situation is not sustainable.

Opportunity to Prosper by Innovating

According to Professor Stephen Cohen, *"Most innovation does not come from some disembodied laboratory. In order to innovate in what you make, you have to be pretty good at making it — and we are losing that ability."* This view was recently endorsed by two leaders of major knowledge industry associations.³

Manufactured products and processes are becoming increasingly knowledge-intensive and are generating significant numbers of high value-added jobs in fields such as design, development, information systems, and production management. Contrary to public perceptions, these high paying jobs will be located mostly in the countries where manufacturing operations occur. It's true that these services can be produced here and delivered to global markets though the Internet. But why should they be? There are real advantages to locating R&D, engineering, and other manufacturing-related professional services close to production operations. It makes it easier, for example, for engineers to see production problems firsthand and build close relationships with production people. The next section discusses how low wage countries are reducing our lead in innovation. If this continues, there will be fewer reasons why these service jobs would remain here.

Misconception 3: We will do the high value-added service work.

During the early stages of deindustrialization, it looked like a convenient division of labour was occurring: North America and Western Europe would focus on higher-value industries while the low-wage countries took over assembly line, build-to-print mass production. Companies formulated global strategies, where business functions (engineering, design, manufacturing, distribution, etc.) would be done in whichever part of the world provided the best solution. The notion of core competencies was created,

³ Russell Lefebvre, IEEE President, IEEE Communications, Dec. 2008; also quotes William Wulf, recent past president of the US National Academy of Engineering

whereby companies would keep in-house only those activities that they were really good at or were essential to their business strategy. The rest would be contracted out.

For many people, the geographic division of labour described above has been appealing. Our companies would be populated by MBAs and other well-educated professionals doing high value-added work at computer terminals in office buildings while, in the developing world, people would run the assembly lines, producing low cost goods for us to buy. Unfortunately for us, the people in these countries have other ideas. Their governments are successfully implementing industrial strategies, aimed at moving up the value chain. **Not only are increasingly sophisticated products being produced in countries such as China, India, South Korea, and Singapore, more of the design and engineering work is being done there as well.** While still maintaining a large labour cost advantage, these countries are graduating and employing ever greater numbers of scientists, engineers, and technologists. In North America, on the other hand, there is less interest in science, engineering, and other manufacturing-related occupations.

Our strength in innovation has often been cited as a reason why we will be able to keep a large share of creative and knowledge-intensive jobs. There is ample evidence to support this view, for example, the IMD 2008 World Competitiveness Yearbook⁴ ranked the US and Canada fourth and fifth respectively, out of twenty-five large countries. Many new industries emerged here, including electronics, computers, and modern biotechnology. There is, however, mounting evidence to suggest that our lead in innovation and technology is narrowing. A recent study⁵ ranks the United States and Canada in eighth and fourteenth place respectively in innovation. Among large countries, the US was second, after South Korea, and Canada was eighth. China and India were ranked lower but that will likely change as these countries grow their science and technology assets at a much faster rate than Western Nations. Another recent study⁶ compared the US, EU countries, and China, based on a number of indicators, including: gross expenditures on R&D, numbers of researchers, patents, and high technology exports. The study concluded that *“the trends are very unfavourable for the US and the EU. They show that it is just a matter of time ... until China will be a scientific superpower comparable to the US and EU, and perhaps lead the world by a reasonable selection of indicators.”*

As more of our companies outsource R&D and other technical functions to low-wage countries, either through contracting out or direct investment, it's apparent that our advantages in creativity and innovation are being eroded. This issue, however, receives little public attention.

Misconception 4: Health care and education can replace manufacturing as economic drivers.

A local Detroit TV station recently did a series on the potential of healthcare to create jobs and revitalize the Michigan economy. Healthcare seems to have it all: growing fast,

⁴ IMD World Competitiveness Yearbook, 2008

⁵ The Innovation Imperative in Manufacturing, Boston Consulting Group, J.P. Andrew et al, March 2009

⁶ The Race for World Leadership of Science & Technology, R.D. Shelton & P. Foland, NSF ENG-0739505

technology-intensive, and vitally important. Best of all, while the local auto plant may be shutting down due to foreign competition, people don't expect that it could happen to their local hospital. They are likely right on the short-term but longer-term, domestic healthcare will face global competition.

A recent Deloitte study⁷ demonstrates that **medical care is becoming a globally traded service, subject to the same competitive forces as other tradable goods and services.** The study compiled data on “in-bound and out-bound medical tourism”, i.e., foreign nationals seeking medical care in the US, and US citizens going abroad for medical care. The table below, using the Deloitte data, shows that while the US currently has a trade surplus in healthcare, it will have a growing deficit within ten years.

Current and Projected Balance of Trade on Medical Care⁷

Year	Outbound Medical Tourism (US spending abroad)	Inbound Medical Tourism (Foreign spending in US)	Contribution To Trade Balance
2008	\$2.1 billion	\$5 billion	\$2.4 billion (surplus)
2017	\$49.5 billion	\$8 billion	\$41.5 billion (deficit)

Healthcare has been growing at a much faster rate than the overall economy, making it an attractive career destination. At the same time, however, its costs have been rising faster than wealth is being generated in the rest of the economy. Consequently, a higher percentage of our wealth has to go to pay for it. The means by which this happens – a combination of consumer and taxpayer outlays – differs somewhat among Canada, the United States, and Western Europe; however, the basic problem remains the same: Healthcare costs cannot grow indefinitely at a rate faster than the overall economy. Eventually, cost containment pressures will lead to increasing foreign competition.

The public realizes that there is a funding problem with health care, but public discourse is usually about who should pay, or which system is most efficient. People fail to connect wealth generation in general with the viability of the healthcare system. In earlier times, this was obvious to people living in a small town that had to support its own doctor. In today's complex economy, it's less easily seen.

Misconception 5: Green technology jobs can make up for losses in manufacturing.

Politicians on both sides of the Canada-US border have been talking about the potential of green technology and “green collar” jobs to revitalize our economy. The media is, by and large, equally enthusiastic and public expectations are running high. While environmental technologies and businesses are becoming increasingly important to the economy and have a promising future, there are three factors, discussed below, which limit their potential as a substitute for losses in other sectors.

⁷ Medical Tourism: Consumers in Search of Value, Deloitte Centre for Healthcare Solutions, 2008

First, most environmental products and services are tradable and will ultimately be subject to the same global competitive forces that have resulted in the migration of one industry after another to low-wage countries. **If we want to build a green technology industry that is economically sustainable, we will need to fix the problems that have caused the loss of manufacturing capacity in other sectors.** The public is currently focusing on environmental opportunities as an alternative to fixing these problems. They need to understand that this will not work in the long term.

Second, to the extent that environmental spending is driven by government policy, it will have negative indirect effects on the rest of the economy. For example, it's likely that a cap-and-trade system on greenhouse gas (GHG) emissions will be implemented in North America in the future. This will effectively remove a subsidy (damaging the environment without financial penalty) that is currently available to energy producers and other companies. If industries in low-wage countries can continue to utilize this subsidy, they will have a new advantage over North American industry. Our companies will have to include this new factor in decisions about where to locate new facilities. To date, only Western nations have taken concrete steps to implement GHG cap-and-trade systems. The low-wage countries, which have been gaining an increasing share of global manufacturing, have so far only made vague promises about following suit. The same argument can be made with respect to other types of environmental, health, and safety regulations. Also, if governments use subsidies and other levers to force widespread adoption of environmental technologies before they are ready, the resultant cost increases will cause spending on other types of products and services to decrease.

Third, much of our exported environmental services are funded by the governments of Canada and other Western nations. While there are sound foreign policy reasons for providing this funding, the resultant export sales are partly paid for by our taxes, not foreign buyers. Their true contribution to our balance of payments is substantially less than would be inferred by the value of exports alone.

There will, of course, be ample opportunity for environmental products and services to make real contributions to our economy and it's possible that clean technology will lead the next economic growth cycle, much as automobiles, electronics, and information technology did in earlier cycles. However, the public needs to understand that: a) the environmental industry will be affected by the same factors that led to our loss of leadership in other industries; and b) jobs created by government legislation or spending must be paid for with funds that would otherwise be used elsewhere.

Misconception 6: We can maintain a high standard of living without manufacturing industries.

Such a scenario would have us paying for manufactured goods entirely by provision of services to other countries. To assess the likelihood of this scenario, it's useful to examine trends in international trade. Since Canada's economy is closely linked to the United States, our analysis looks at data (shown on Page 7) for both countries.

Trends in Canadian and US Trade Flows

Canadian Trade Statistics⁸ (\$C Billions)						
Year	2004	2005	2006	2007	2008	% Δ 04 - 08
Goods						
Exports	\$429	\$450	\$454	\$463	\$490	14.2%
Imports	\$363	\$387	\$404	\$415	\$443	21.9%
Surplus (Deficit)	\$65.8	\$62.3	\$49.5	\$48.0	\$47.2	-28.3%
Services						
Exports	\$65.4	\$67.1	\$67.2	\$67.3	\$68.0	4.0%
Imports	\$76.4	\$79.3	\$82.0	\$86.5	\$90.5	18.5%
Surplus (Deficit)	(\$11.0)	(\$12.1)	(\$14.8)	(\$19.2)	(\$22.5)	104.2%
Goods & Services						
Exports	\$494	\$517	\$521	\$530	\$558	12.9%
Imports	\$439	\$467	\$486	\$501	\$533	21.3%
Surplus (Deficit)	\$54.8	\$50.2	\$34.7	\$28.9	\$24.7	-55.0%
% Services/Total						
Exports	13.2%	13.0%	12.9%	12.7%	12.2%	
Imports	17.4%	17.0%	16.9%	17.2%	17.0%	

US Trade Statistics⁹ (\$US Billions)						
Year	2004	2005	2006	2007	2008	% Δ 04 - 08
Goods						
Exports	\$808	\$895	\$1,023	\$1,148	\$1,291	59.9%
Imports	\$1,477	\$1,682	\$1,861	\$1,968	\$2,112	43.0%
Surplus (Deficit)	(\$670)	(\$787)	(\$838)	(\$819)	(\$821)	22.6%
Services						
Exports	\$353	\$389	\$434	\$497	\$544	54.2%
Imports	\$292	\$314	\$349	\$389	\$405	38.6%
Surplus (Deficit)	\$61.1	\$75.6	\$85.0	\$108	\$140	128.7%
Goods & Services						
Exports	\$1,161	\$1,284	\$1,457	\$1,646	\$1,836	58.2%
Imports	\$1,770	\$1,995	\$2,210	\$2,357	\$2,517	42.3%
Surplus (Deficit)	(\$608)	(\$712)	(\$753)	(\$711)	(\$681)	11.9%
% Services/Total						
Exports	30.4%	30.3%	29.8%	30.2%	29.7%	
Imports	16.5%	15.7%	15.8%	16.5%	16.1%	

⁸ Statistics Canada, Canada's balance of international payments, CANSIM tables 376-0001 and 376-0002

⁹ US International Trade in Goods and Services, United States Department of Commerce, March 13, 2009

The current global economic crisis started in the US and, while its causes are complex, the unsustainability of US economic growth, based on consumption rather than production, is widely acknowledged as a key factor. In the five-year period ending in 2008, the US trade deficit, already massive, increased by 12%. This happened in spite of significantly improved export performance in goods and services. In this time period, the goods trade deficit increased by 23%, while the services trade surplus more than doubled. The growth rate differential between service exports (54%), and imports (38%) was impressive, but so was the one for goods: 60% for exports vs. 43% for imports. The reason why the overall trade deficit continued to grow, in spite of these improvements, was due to the relative contributions of goods and services. From 2004 to 2008, the US increased its goods trade deficit by \$US151 billion (\$821B - \$670B) while its services trade surplus increased by \$US79B (\$140B - \$61B), i.e., just over half as much.

While smaller in absolute terms than the goods trade deficit, the US surplus in services grew faster, increasing from 9% of the goods deficit (\$61B/\$670B) to 17% (\$140B/\$821B). It's reasonable to ask, if this trend were to continue, would the US eventually be able to balance its demand for goods imports with service exports? There are three factors working against this happening:

1. Many of the highest value-added service exports are intimately associated with manufacturing (e.g., patents, R&D, consulting, etc.). A continued decline in its manufacturing sector will make it more difficult for the US to lead in this area.
2. Low-wage countries are rapidly acquiring the know-how to provide these manufacturing-related services, both domestically and for export.
3. Many other tradable services, not specifically related to manufacturing, e.g., accounting, insurance, education, software, are increasingly being located in low-wage countries and delivered globally.

Canada has maintained an overall trade surplus; however, it declined from \$C54.8 billion in 2004 to \$C24.7 billion in 2008 – a drop of 55%. Over this time period, we had a net deficit in services, which more than doubled: from \$C11 billion to \$C22.5 billion. Our goods trade surplus declined by 28%, from \$C65.8 to \$C47.2 billion. Our goods exports increased by 14%, whereas our services exports only increased by 4%. Meanwhile, our imports of goods and services increased by 22% and 18% respectively. According to Statistics Canada data (not provided here), most of the increase in our goods exports was from energy and resource-intensive materials, such as metals, fertilizers, and commodity chemicals. Exports of higher-value added goods showed smaller increases or, as in the case of automobiles, a net decrease.

The contribution of services to exports varied little in either country over the 2004 – 2008 time period: In the US, it went from 30.4% to 29.7%. In Canada, it went from 13% in 2004 to 12% in 2008.

The high standard of living enjoyed by North American consumers is increasingly dependent on low cost goods made elsewhere. The US pays for most of these purchases by maintaining a capital account surplus. Unfortunately this net positive flow of investment funds into the US is mostly to buy government bonds, rather than to support industry growth. As the US government goes further into debt, its ability to use these funds to support either economic growth or healthcare will be severely curtailed. In Canada, we have so far been able to balance our purchases of foreign goods within our current account, by depending heavily on exports of resource-intensive commodities. The long-term viability of this strategy is highly questionable; however, the Canadian public tends to view our reliance on non-renewable resources solely as an environmental issue, without considering its economic aspects.

How Public Misconceptions Create Difficulties for Government

By and large, governments at all levels understand the importance of manufacturing. In Canada, we have many programs to support industry, by fostering innovation and entrepreneurship, and by helping companies become more competitive and gain access to investment and markets. The health of the manufacturing sector and its contribution to prosperity, however, is a much stronger preoccupation within government than among the public at large. **Limited public interest in manufacturing, including within the business community, makes building and sustaining Canada's manufacturing sector more difficult.** For example:

- Because the public underestimates manufacturing's importance, it is less willing to support government policies and programs aimed at strengthening the sector.
- There is little interest, among young people, in acquiring the education needed to pursue manufacturing-related careers.
- People with the interest and talent to become entrepreneurs are less likely to consider manufacturing as a venue for business opportunities.
- Entrepreneurs who are pursuing manufacturing opportunities have greater difficulties attracting financing.
- Companies, even when fully compliant with environmental, health, and safety regulations and employing best practices, have greater difficulties dealing with a public that is informed only on the potential downsides of manufacturing.

The public's negative view toward manufacturing has been reinforced by the crisis in our automotive industry, and the associated need for massive government financial aid. They are not happy with taxpayer funds going to support what they perceive as an uncompetitive industry, lacking in innovation, and paying inflated wages.

What Can be Done

1. Develop a public outreach strategy to dispel misconceptions and demonstrate the importance of manufacturing. It should be designed to reach key segments of the population: teachers, students, business people, and the media.
2. The strategy would address the fact that manufacturing-related occupations often have an unfairly low status within our culture. For example, the education required to become a fully qualified machinist requires mastering mathematics and computer programming skills that would be daunting to a great many university graduates. Yet, as “blue collar workers”, machinists receive little recognition for these abilities.
3. Work with industry to provide more opportunities for high school students and their teachers to learn about manufacturing through plant visits, student projects, mentoring, etc. There have already been several notable initiatives of this type, for example, those undertaken by the aerospace associations in Quebec and Manitoba.
4. High school students who excel in science and math usually only take a minimum of “Shop” courses. This practice minimizes the opportunities for these students to apply their analytical abilities to practical applications. It would be useful to examine the feasibility of substituting some of the laboratory sessions in high school science courses with learning projects that utilize shop facilities and processes.
5. Create opportunities for high school students to explore how computers can be used to design products, and simulate and control manufacturing processes. This could be accomplished using low cost systems, located in high schools.
6. Review current student entrepreneurship programs to examine how manufacturing-based ideas and activities could receive more emphasis.
7. Currently, the public looks to ecologists and “environmentalists” for information on the environment. The roles of chemistry, physics, and engineering in identifying and solving environmental problems are poorly understood. Industry’s role, in particular, is mostly unrecognized. The outreach initiative could provide the public, educators, and the media, with a more balanced view of the environmental costs and benefits of manufacturing. This will lead to a better informed public and increased interest among young people in fields related to sustainable manufacturing.
8. Communicate to the public that the current support being provided to the automotive industry is an emergency measure; that the industry is much more than assembly line workers doing repetitive tasks for inflated wages; and that government support is being provided with requirements that the large automobile companies become more innovative and competitive.