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Challenges of Rapid Technological Change: Catching Up with The Jetsons

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CHALLENGES OF RAPID TECHNOLOGICAL CHANGE: CATCHING UP WITH "THE JETSONS"

Andrei Sulzenko[*]

INTRODUCTION

The Canadian economy is currently in the midst of a period of unparalleled economic change. Globalization, the information revolution, and the shift towards knowledge-based activities are creating new challenges for the overall Canadian economy and for firms and individuals. These trends have been accompanied by an increase in the role and importance of technological change. In the new economic order, success is highly dependent on our ability, collectively and individually, to adapt to an environment of rapid technological change.

This Article explores the nature and implications of this transformation in the economic environment. It looks at indicators of the growing importance of innovation. It identifies challenges and opportunities that have emerged as a result of the heightened importance of ideas and inventiveness. The Article also looks at evidence that sheds light on how well Canadians are adapting to the new knowledge and an innovation-based economic order. There are shortcomings in Canada's performance to date, but steps are being taken to help lay a foundation for the development of a more innovative and competitive economy. Indeed, it is paramount we become more innovative, since countries whose innovative capacity is developing fastest will be in the best position to take advantage of technological change. In Canada's case, rising standards for innovation are set by our closest neighbour, and world's foremost technological leader – the United States. It is no longer a question of "Keeping up with the Joneses," but "Catching up with 'the Jetsons.'"

I. THE INCREASED IMPORTANCE OF TECHNOLOGICAL CHANGE

Technological change in itself is not new. Canada's economic history is very much a story of entrepreneurial efforts directed towards the exploitation of new products and processes. The innovative process that Austrian econo-

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mist Joseph Schumpeter labeled "creative destruction" has been at the root of the major changes that have occurred over time in the structure of the Canadian economy. It underlies the decline in the importance of agriculture and resources depicted in Figure 1, the strong growth in manufacturing in the decades prior to World War II, and the shift that has occurred towards service sector activities over the last half of this century. Most recently, technological developments have led to a dramatic growth in the high-tech goods and service sectors of the Canadian economy (Figure 2).

Figure 1

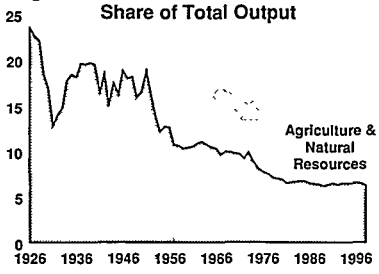
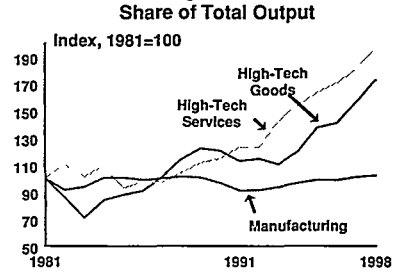


Figure 2



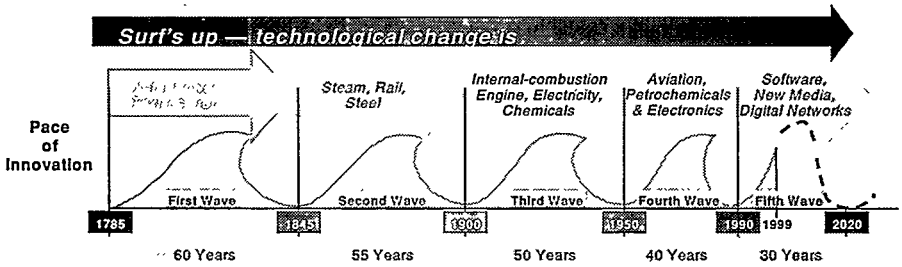
Source: Industry Canada compilations based on Statistics Canada data

What is new is the extremely rapid pace of technological change. Over time, major cycles of innovation have become successively shorter. In the late 18th and early 19th century, the first major wave of innovation, based on the harnessing of water power for the production of textiles and iron, spanned about sixty years. The third innovative cycle, involving the development of the internal combustion engine, the replacement of mechanical with electrical power, and the creation of a chemical industry, ran from about 1900 to 1950. Currently we are in the midst of the fifth major wave of industrial innovation, focusing on digital information and communication technologies. The present cycle, which began just prior to the 1990s, is projected to run its course by around 2020, a span of thirty years or about half that of the first innovation wave (Figure 3).

At the same time, technological change has become a major factor in virtually all sectors of the economy. All industries are under strong competitive pressure to come up with new ways of satisfying consumer wants and to devise new and more efficient ways to produce their goods and services. Even Canada's resource sector has embraced the need for technological change. The increased emphasis on innovation is reflected in the strong

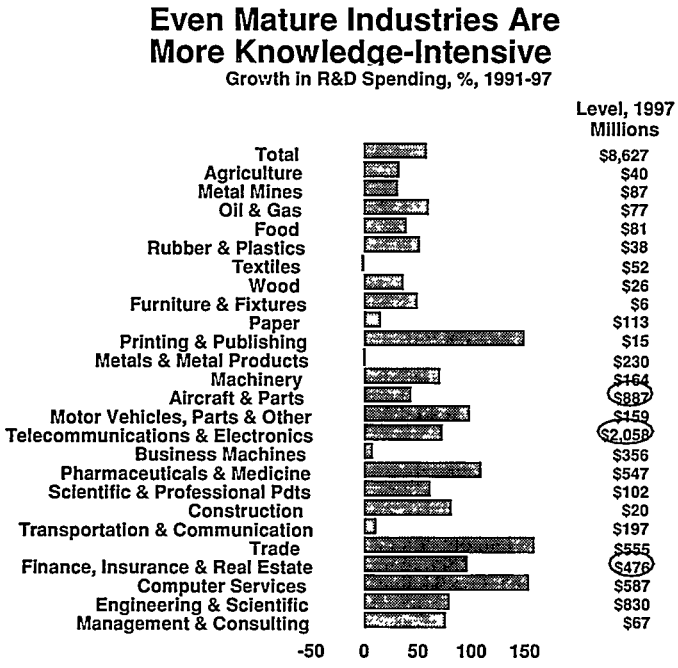
growth of R&D spending over the 1990s (Figure 4).[1] While there are significant differences between sectors in R&D spending, almost all industries have substantially increased the share of resources committed to R&D over the recent period.

Figure 3



Source: The Economist, February 20, 1999.

Figure 4



Source: Statistics Canada, Industrial R&D, 1997 Intentions

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[1] *See* INDUSTRY CANADA, INVESTING IN INNOVATION (1998) [hereinafter INVESTING IN INNOVATION].

The more rapid pace and increased pervasiveness of technological change is the result of a number of factors. With the increased educational attainment of the population and the development of large academic and research communities, knowledge development has become an important pursuit in its own right. The search for new knowledge has resulted in important discoveries that have led to the creation of a variety of new products and technologies. Second, the dramatic improvements that have occurred in information and communications technology (ICT) have impacted on almost every aspect of the economy and has stimulated a vast number of related technological improvements. ICTs have been termed "enabling" or "general purpose technologies" because their impact on the economy and other prevailing technologies is so significant.

Third, and perhaps most important, globalization has increased the importance of innovation. Firms have a greater incentive to innovate because successful products can be marketed on a world-wide basis. Globalization has thus allowed firms to exploit more fully the economies associated with R&D activities. In addition, global competition has increased the pressure on firms to innovate. In an environment of intense international competition, firms face a high risk of failure if they do not improve their product offerings and take steps to ensure that they are at least as productive as foreign firms competing in their domestic and major export markets. Canadian firms are essentially involved in a race in which one of the most critical factors is the speed of innovation.

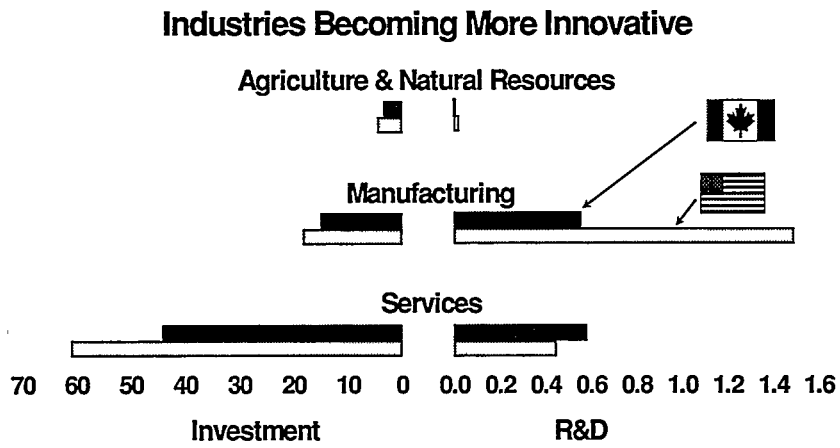
Since much of Canada's trade is with the United States, it is U.S. firms that set the relevant competitive standard for most Canadian industries. Canadian producers must, therefore, race alongside the world's technology leader and foremost knowledge-based economy. It is a formidable challenge and one that gives rise to a number of questions. What underlies the success of the United States as a knowledge-based economy? How does the performance of Canadian firms compare with that of U.S. firms in activities affecting technological change? And what needs to be done to increase the pace of innovation in Canada and improve the competitive prospects of Canadian firms?

II. DIMENSIONS OF TECHNOLOGICAL CHANGE

Canadian industries have been improving their innovative capacity, but they continue to lag behind the United States on many important indicators of knowledge-based development. This is certainly the case with respect to R&D. Despite the substantial increase in their R&D investments, Canadian manufacturing firms still devote a much smaller share of their output to R&D

than U.S. firms. It is only in the much less-intensive service sector that the share of output devoted to R&D investment is higher in Canada than in the U.S. (Figure 5).

Figure 5



R&D : R&D spending as % of GDP, 1997. Investment: Ratio Net Investment Stock to GDP, 1996.
Source: Industry Canada compilations based on OECD data

Figure 5 provides a snapshot comparison of major sectors of the Canadian and U.S. economies in terms of investment and R&D spending. Technological change depends on both processes; while R&D leads to the creation of new technologies, investment is the main vehicle through which these technologies become incorporated into the productive process. The investment data pertain to capital intensity as indicated by the ratio of net investment stock to GDP in 1996. It can be seen that in all major sectors, but especially in the service sector, the U.S. economy is significantly more capital-intensive than the Canadian economy.[2]

Canadian firms are also relatively slow in adopting advanced technologies. A 1993 survey found that Canadian manufacturing firms have trailed behind U.S. firms in the use of technologies such as computer-aided design and engineering systems, numerically controlled machines, robots, automated material handling systems, and automatic inspection systems. While large Canadian establishments have not performed poorly – indeed they appear to have outperformed U.S. firms in the adoption of multiple technologies – there is a significant disparity of small and medium-sized enterprises between the two countries (Figure 6). Overall, the survey found that Cana-

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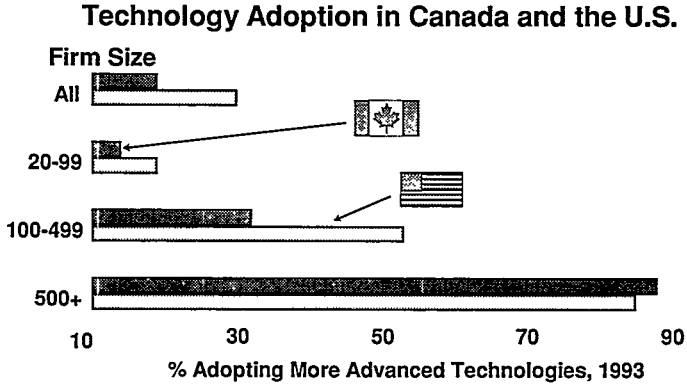
[2] *See id.*

dian companies are about half as likely to adopt multiple advanced technologies as their U.S. counterparts.

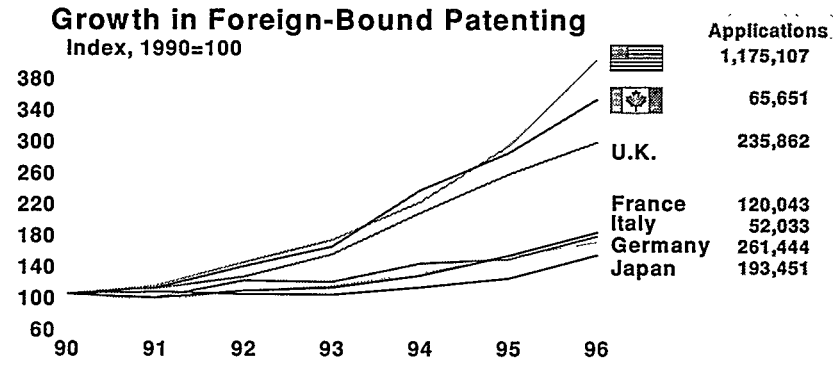
Figure 6



NOTE: It should be indicated that chart refers to adoption of 5 or more advanced technologies
Source: Statistics Canada

Another indicator of the growing importance of innovation is the significant increase in patenting activity among industrial countries. While R&D pertains to the input side of the innovative process, patents focus on outputs. They are an imprecise measure of R&D outputs, because not all useful innovations can meet the basic patent tests of novelty, utility, and ingenuity, and, even where an invention is patentable, it is not necessarily in a firm's interest to seek patent protection. It is significant, nonetheless, that patenting activity by most industrial nations is growing faster than ever. Figure 7 shows the strong growth over the 1990s in patent applications filed by inventors outside their country of residence.

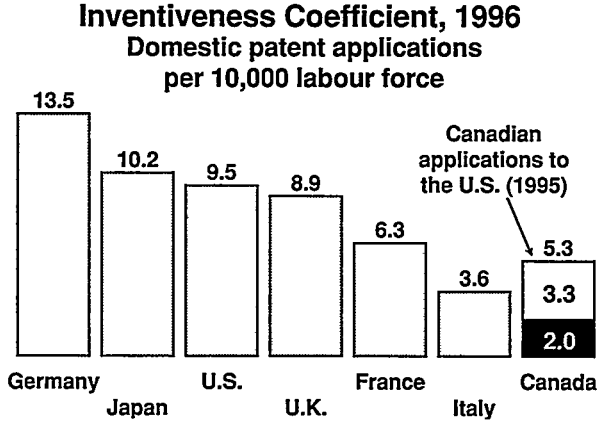
Figure 7



Source: Industry Canada compilations

From Figure 7, it can be seen that foreign-bound patenting by Canadians has grown very rapidly.[3] In this area of activity, Canada's growth ranks second to the United States among G-7 countries. Domestic patent applications by Canadians have also increased at a rapid pace, well above that of most other industrial countries. However, relative to the size of its labour force, Canada's absolute level of patent activity is still low in comparison to that of other industrial countries. Figure 8 shows that even after Canadian patent applications in the United States are included, Canada ranks low in terms of its patent propensity or "inventiveness coefficient."[4]

Figure 8



Note: Japan data adjusted to be comparable to the other countries. Canada's coefficient of 5.3 is an overestimate of inventiveness, since patent applications may be filed on the same inventions in both countries.
Source: Industry Canada compilations based on OECD data

One of the central factors underlying the increasing importance of research and innovation has been the growth in high-technology activities. Sectors such as computers, telecommunications equipment, pharmaceutical products, medical equipment, and biotechnology account for a high share of the innovative activity within industrial economies. In 1997, for example, the telecommunications and electronics sector accounted for almost a quarter of all Canadian R&D (see Figure 4). It is significant, therefore, that high-technology activities are much more important within the United States than

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[3] *See* INDUSTRY CANADA, RECENT JUMPS IN PATENTING ACTIVITES: COMPARATIVE INNOVATIVE PERFORMANCE OF MAJOR INDUSTRIAL COUNTRIES, PATTERNS AND EXPLANATIONS 3-9 (1998).

[4] *See* INDUSTRY CANADA, INVESTING IN INNOVATION, *supra* note 1.

within the Canadian economy, and that they have been expanding at a faster rate in the United States than in Canada. Based on OECD definitions and calculations, high-tech industries accounted for under thirteen percent of manufacturing in Canada in 1994, as compared to over twenty-four percent in the United States (Figure 9).[5] Since 1970, the high-tech share of manufacturing has grown by one-third in the United States and by under a quarter in Canada. Figure 10 shows how, over the 1981-98 period, U.S. growth has outstripped Canadian growth in three important high-knowledge industries – drugs and medicine, computer services, and communications equipment.

Figure 9

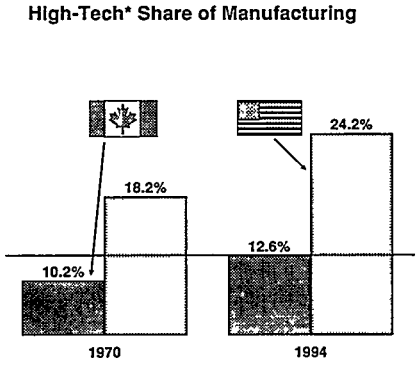
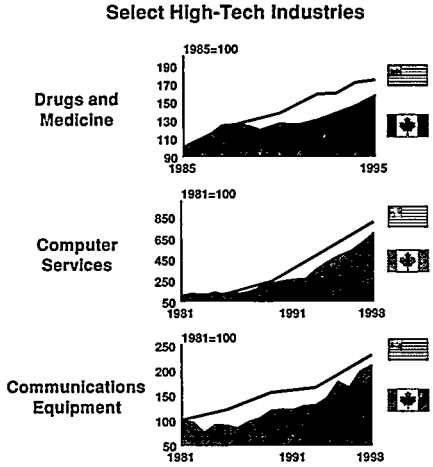


Figure 10



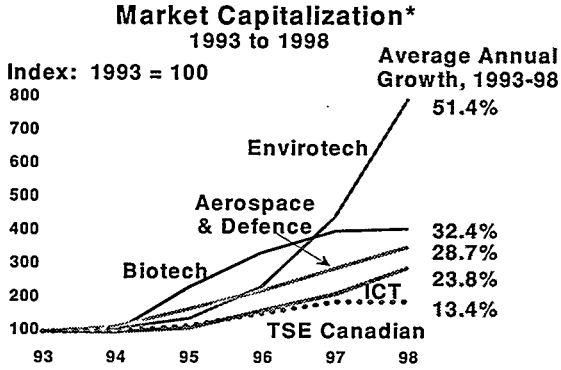
* Industries classified as high-tech according to their R&D intensity, defined as the ratio of business-enterprise R&D to production.
Source: OECD

Included within the high-tech sector of the economy are many new and emerging industries. Over recent years, we have seen a proliferation of new firms in industries such as biopharmaceuticals, bio-agriculture, bio-aquaculture, bioforestry, information and communications hardware and software, environmental technologies, telehealth, and aerospace. These emerging industries are growing on average at about 2.5 times the rate of total GDP. While many of the firms consist of relatively small, privately owned enterprises, there has also been a strong growth in high-tech shares traded on the Toronto Stock Exchange (TSE). Measured in terms of market capitalization, the growth rate of publicly traded firms in industries such as envirotech, aerospace, biotech, and ICTs has greatly outpaced the TSE aver-

[5] *See* INDUSTRY CANADA, INVESTING IN INNOVATION, *supra* note 1, at 10.

age (Figure 11). In the envirotech sector, the growth rate between 1993 and 1998 was almost four times the TSE average. Despite the impressive growth of our emerging industries, however, the Canadian picture once again pales by comparison to the surging growth rates of new high-tech industries in the United States.

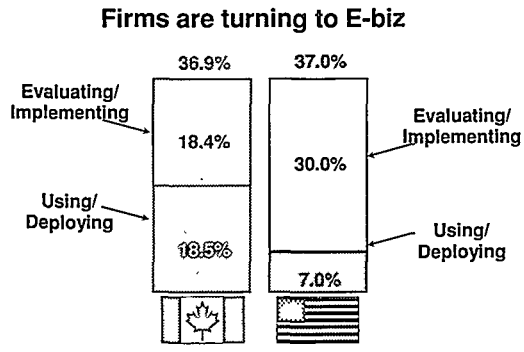
Figure 11



* Based on sectoral portfolios composed of 10-15 Canadian firms.
Source: Industry Canada compilations based on data from the Toronto Stock Exchange.

Another significant feature of the new global environment is the growth in electronic commerce. Households and businesses in particular are increasingly going on-line to purchase needed goods and services. Electronic commerce or "e-biz," which is itself a product of the information revolution, is stimulating the development of new information technology and content, and is leading to the introduction of a range of new goods and services tailored to the needs of an information society. Electronic commerce is still in its infancy, but many observers expect that, in coming years, this will be an area of explosive growth. In terms of this particular attribute of knowledge-based development, Canada's performance compares well with its neighbour. For some time, Canadians have been at the forefront in the use of electronic banking. Canadian firms also appear to be responsive to the opportunities created by electronic business, with a recent survey indicating that the proportion of firms deploying or implementing e-commerce is about the same in Canada as in the United States (Figure 12).

Figure 12



Source: International Data Corporation (Canada), Ltd. 1999

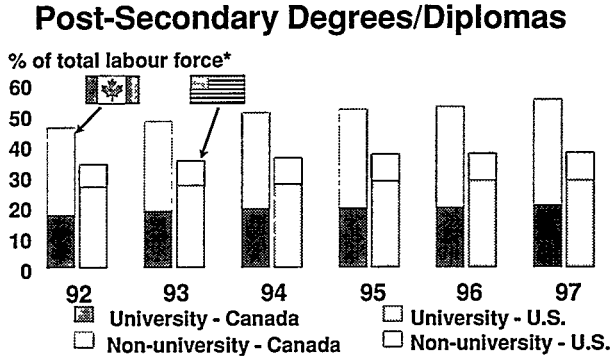
The increased emphasis on innovation and the growing importance of knowledge-based activities are placing new demands on industrial economies. One of the areas in which certain stress points have emerged is human resources. Structural changes in the Canadian economy have increased the demand for workers with advanced education and well-developed skills and has further reduced employment opportunities for unskilled workers with little education. Some rapidly growing industries are encountering shortages of engineers, information systems analysts, college-trained technologists, and other professionals with specific experience and skill sets.

In general, Canada ranks well in terms of educational attainment. The proportion of the Canada's labour force with post-secondary education was significantly higher than the rate for the United States (Figure 13) and substantially above the average for all OECD countries. The United States has a higher proportion of university-schooled workers, however, and better developed systems of employer-provided training. The amount of formal training available at the workplace is low in Canada compared to most other industrial countries.

Along with a highly educated workforce, a prerequisite for a successful knowledge-based economy is a strong economic infrastructure, including particularly a well-developed information infrastructure. As we enter into the 21st century, an information infrastructure, including not only communications hardware, but also the applications required to manipulate and transmit information and the supporting institutional framework, is becoming as important to Canada's development as the transportation infrastructure was at the beginning of the 20th century. Significant progress has been made in building Canada's information infrastructure. Almost all households in Canada have traditional wired telephone and basic broadcast services, and close to three-quarters of households receive cable television. Meanwhile, penetra-

tion rates for newer technologies, such as cellular phones and the Internet, are rising rapidly. In 1997, sixteen percent of Canadian households were connected to the Internet, more than double the percentage of households that were on-line in 1992.

Figure 13



* Labour force 25 to 64 years of age
Source: Statistics Canada; U.S. Bureau of Labor Statistics

While Canada is making progress in building its infrastructure, it has some ground to make up if it is to keep pace with the United States and other countries such as Finland and Sweden which are leading the way in the use of ICTs. As Figure 14 indicates, Canada trails behind the United States in the development of some aspects of ICT infrastructure.[6] As well, computer and Internet use is somewhat higher in the United States than in Canada. In 1997, for example, 18.6% of U.S. households were on-line, as compared to the sixteen percent in Canada.

A highly developed information infrastructure must ensure that all groups in society are adequately connected. Steps are being taken to address this issue in Canada through the establishment of areas of "public cyberspace" within schools, libraries, and public buildings. Virtually all schools and libraries in Canada now have connections to the Internet (Figure 15).[7] Meanwhile, through the federal government's Community Access Program, public sites are being established which enable citizens in an increasing number of rural and remote communities to access the Internet.

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[6] *See* INDUSTRY CANADA, REPORT CARD ON THE STATE OF CONNECTEDNESS IN CANADA 5, 24 (1999).

[7] *See id.* at 10, 11.

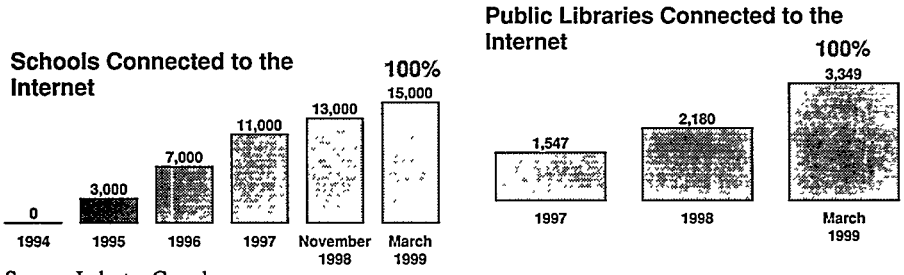
Figure 14

Indicators of ICT Infrastructure

Telephone Penetration, %, 1997	98.6	93.8
Cable Penetration, %, 1997	73.7	67.3
Cell Phone Subscribers per 100, 1997	13.8	20.7
Secure Web Servers for E-Commerce per 100,000 Inhabitants, 1998	3.4	6.1

Source: Statistics Canada, Canadian Economic Observer February 1999 and World Telecommunication Development Report 1998.

Figure 15



Source: Industry Canada

III. CHALLENGES

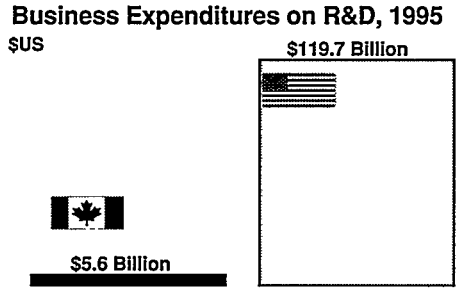
Given the well-entrenched nature of globalization and the other forces underlying the transformation of the world economy, rapid technological change is likely to remain a central feature of the economic environment. To be competitive, firms must adapt to an economic system which highly rewards the creation and application of ideas. To establish a foundation for solid long-term growth, countries must create conditions that foster rapid technological change. How can this be achieved? More specifically, what are

the key challenges Canada must address to better position itself in this new environment?

A. Strengthening Canada's Innovative Capacity

A major part of the task of strengthening Canada's innovative capacity clearly must involve the strengthening of those aspects of Canada's economic and social infrastructure with a significant influence on the country's innovative capacity. We identified a number of the critical gaps in the previous section. To become a more innovate economy, Canada must invest more in R&D. Domestic firms obtain new technology by importing intermediate and capital goods incorporating the latest technical advances. They also derive significant spillover benefits from the technology foreign investors transfer to their affiliates in Canada. However, in an highly competitive global economy where there is a premium on innovation, these mechanisms cannot fully compensate for inadequate R&D. Canada is seriously disadvantaged by this country's low business expenditures on R&D – which compares poorly with the U.S. expenditures not only in absolute terms, but also measured as a percentage of GDP (Figure 16).[8]

Figure 16



Business Expenditure on R&D, % of GDP

	1981	1985	1990	1995
Canada	0.6	0.8	0.8	0.9
U.S.	1.7	2.1	2.0	1.7

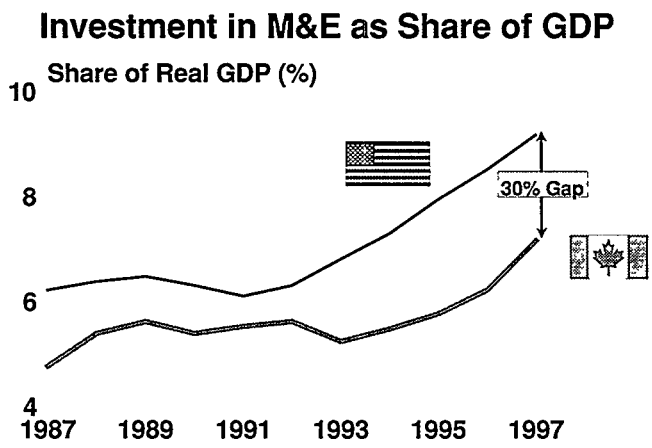
* 1991 data
Source: OECD

Canada also needs higher rates of capital investment. Over the last decade, Canadian investment in machinery and equipment as a share of GDP has remained consistently below rates in the United States. The current gap is

[8] *See* INDUSTRY CANADA, "KEEPING UP WITH THE JONESES: HOW IS CANADA PERFORMING RELATIVE TO THE UNITED STATES," The Micro-Economic Monitor M-2 (June 1997).

about thirty percent (Figure 17).[9] This suggests that Canada has been lagging behind the United States in the introduction of new capital equipment embodying the latest technological developments. It suggests that the United States has been moving more aggressively to restructure and revitalize its plants to improve efficiency or to respond to opportunities for the marketing of new types of goods and services.

Figure 17



Source: Industry Canada Compilation based on Statistics Canada data

Particularly troubling is the recent trend in Canada's inward direct investment. As indicated by its share of GDP, foreign direct investment is much more important to the Canadian economy than to the economy of other industrial countries. Inward investment has been an important mechanism through which Canada has acquired new knowledge, skills, and technology from other countries. While stocks of inward investment are continuing to increase, Canada is losing ground as an investment location. Over the past decade there has been a sharp downtrend in this country's share of global as well as North American inward direct investment. Figure 18 illustrates the ten percentage point drop in Canada's North American share over the last decade, including the accelerated decline since 1990.[10] In the investment area, therefore, one of the issues with which we must grapple is how to restore Canada's position as one of the world's leading host economies.

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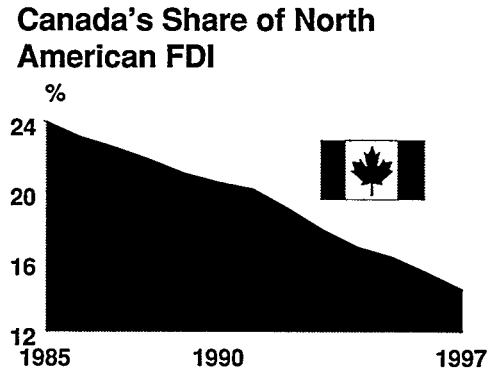
[9] *See* INDUSTRY CANADA, IMPROVING PRODUCTIVITY: THE KEY TO HIGHER LIVING STANDARDS 6 (1999).

[10] *See* INDUSTRY CANADA, TRADE AND INVESTMENT MONITOR: CANADIAN PERFORMANCE MEASURES 94 (1998).

Figure 18



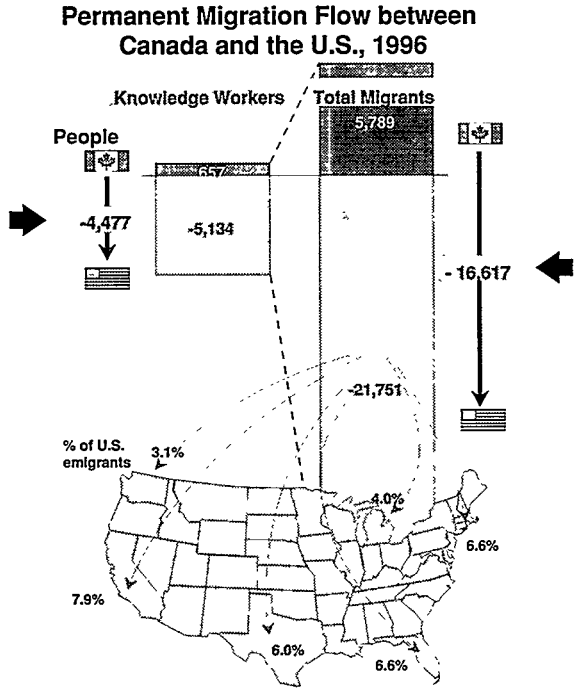
Source: Industry Canada compilations based on Statistics Canada data

To strengthen Canada's innovative capacity, there is need, as well, to focus on some serious issues in the human resource area. Well-educated and highly skilled workers are needed to generate new ideas, to translate ideas into useful technologies, and to manage activities so that investment opportunities are identified and realized. We have done an impressive job raising the overall educational standards of the Canadian labour force. Engineering and science education, however, have not received as much emphasis in Canada as in other industrial countries.

In addition, we must do more to make Canada an appealing home for highly skilled professional workers. Professionals and managers comprise a rising share of the permanent emigrants from Canada to the United States. U.S. data suggest that, between 1965 and 1996, these two categories grew from 14.5% to 21.1% of Canada's permanent emigrants. In 1996, there was a net outflow of 16,617 permanent emigrants from Canada to the United States and over 5000, or over a quarter of Canada's net emigrants, consisted of knowledge workers (Figure 19).[11] While emigrants account for a small proportion of Canada's professional workforce, we cannot afford the continuing outflow of what might be our "best and brightest," attracted by brighter economic opportunities in the United States.

[11] *See* INDUSTRY CANADA, PERSPECTIVES ON THE "BRAIN DRAIN" 5 (1998).

Figure 19



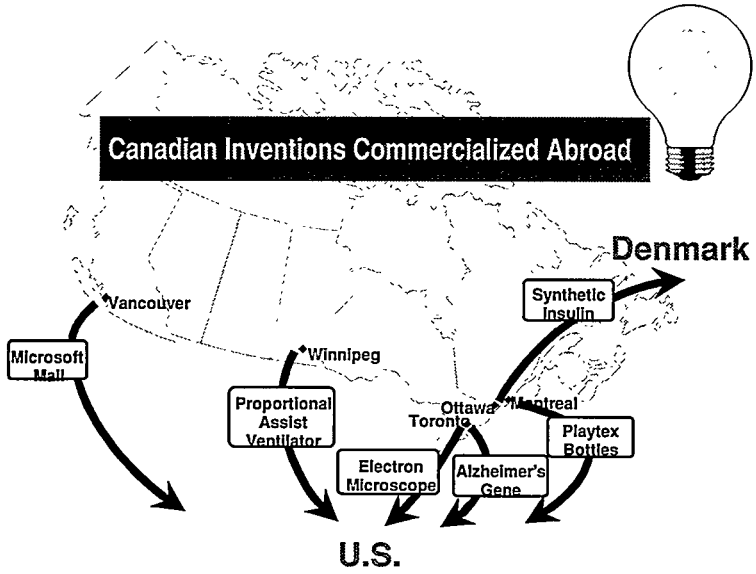
Source: Statistics Canada; U.S. Immigration and Naturalization Service

B. Improving Canada's Ability to Commercialize Ideas

Given the limited resources Canada has to devote to the development of new ideas, it is vitally important that we realize the commercial opportunities from the research that does occur in this country. Some progress has been made in this area. In response to current financial pressures, a number of Canadian universities have established centres to actively market discoveries with potentially commercial application. In addition, a significant venture capital industry has emerged in Canada and this has improved access to financing for new high-risk developments in emerging industries. It remains the case, however, that a significant proportion of Canadian inventions are commercialized abroad (see Figure 20).[12]

[12] *See* INDUSTRY CANADA, INVESTING IN INNOVATION, *supra* note 1.

Figure 20



Collaboration among academic, public, and private sector researchers can facilitate the research process and improve the prospects that research findings will lead to the development of useful products and processes.

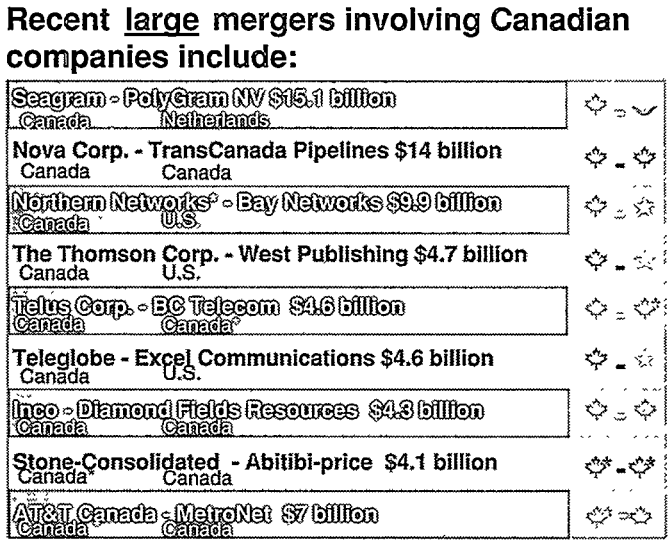
For smaller countries like Canada, it is particularly important that there are internationally agreed upon standards that reflect a proper balancing of the benefits and costs of regulating particular goods and services. We have had unfortunate experiences with countries adopting narrowly defined regulations that favour particular domestic technologies, thereby limiting competition and discouraging innovation.

C. Facilitating Structural Change

Technological advances are leading to the emergence of new businesses and new ways of doing business. In some areas (notably, information technology, telecommunications services, and broadcasting) the boundaries between industries are becoming blurred. One consequence has been an increase in industrial and corporate restructuring. Globally, there has been a surge in merger activity in recent years as multinational enterprises reposition themselves to increase their market power or to take advantage of available economies of scale and scope (Figure 21). Canada has been a significant participant in this process; in 1998, merger and acquisitions with a value of fifteen billion dollars (U.S.) took place in Canada, while Canadian firms

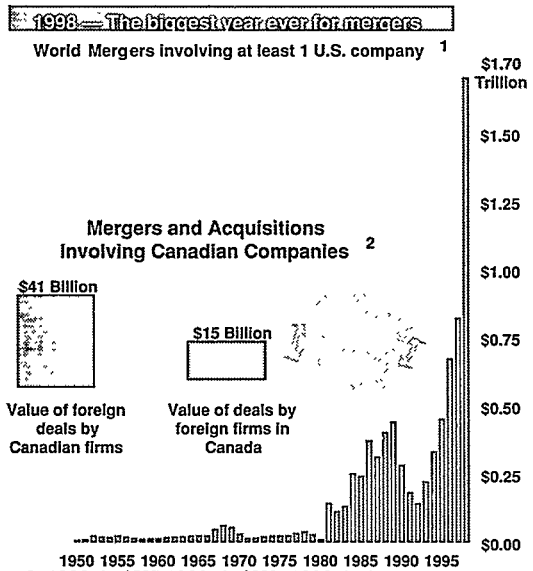
were involved in foreign deals with an estimated value of forty-one billion dollars (Figure 22).

Figure 21



* Canada is country of residence of HQs, but control is U.S.
** Northern Telecom's new name
Source: Crosbie & Co. Inc. cited in Macleans, January 25,1999; National Post

Figure 22



1 As of Dec. 9, 1998, in $US 1990; 2 $US, 1998 deals
Source: KPMG (Canada), 1999; Fortune, January 11, 1999

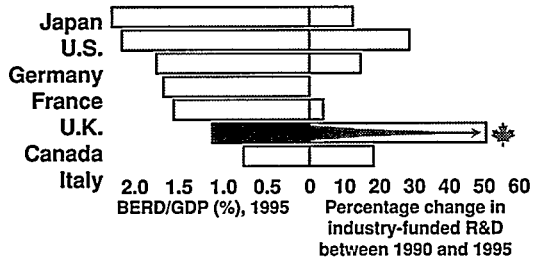
While there is a need to be sensitive to the potential dangers from high levels of market concentration, in general, corporate restructuring should be facilitated and encouraged. They are part of the process through which nations will realize the benefits of innovation, which may involve new organizational and managerial practices as well as new products and production processes.

IV. How Are We Responding to the Challenges and Preparing for the Future?

A major part of the responsibility for making Canada a more innovative economy must necessarily fall to the business sector. Corporations must realize that their success in the new global knowledge-based environment depends on their ability to foster innovation and to implement the organizational and human resource practices needed to realize the opportunities created by new technologies. There are some indications that this message is starting to get through. As can be seen in Figure 23, industry-funded R&D rose by about fifty percent between 1990 and 1995, reducing the gap between R&D investment (as a proportion of GDP) in Canada and in other major industrial countries.

Figure 23

Industry Research and Development



* Business Expenditure on Research and Development
Source: OECD

Contributing to this change has been the marked increase in the outward orientation of Canadian firms over the 1990s. Both trade and outward foreign direct investment have increased substantially in relation to GDP in the recent period. As a result, Canadian firms can now undertake research projects that would be uneconomic if they were confined to serving the domestic market. At the same time, firms are facing strong pressures to come up with

innovations that will provide them with a competitive edge in export markets.

For its part, the federal government is making a major commitment to promoting a more innovative culture throughout Canadian society. During most of the 1990s, government spending on R&D declined in Canada, as in other industrial countries. The situation has now changed and this year's budget outlines how the federal government will be investing about one and a half billion dollars in new money to increase Canada's R&D capacity.

The federal government is primarily promoting its vision through an innovative strategy centred around four key objectives:

1) Expanding Canada's knowledge infrastructure;

2) Accelerating the commercialization and adoption of innovative processes and products;

3) Upgrading the quality of Canada's human resources; and,

4) Establishing a business environment that supports innovation and investment.

In each of these areas, a number of specific actions are being pursued.

The importance of actions to expand Canada's knowledge infrastructure is underscored by the fact that, at present, more than two-thirds of Canada's technological inputs come from foreign sources. The federal government promotes collaboration among researchers through its Networks of Centres of Excellence program launched in 1989. It also promotes the generation of knowledge through the activities of Canada's major funding Councils[13] and the Canadian Foundation of Innovation. While continuing to support these programs, the government will be devoting increased attention to fostering innovation in a number of specific areas, including biotechnology and clean production technologies. Efforts are also being directed to help industry develop a Technology Roadmaps program that will lead to increased information exchange about market and technological opportunities and facilitate the creation of project consortia.

The Organization for Economic Cooperation and Development (OECD) has found that the relatively slow take-up of new discoveries by Canadian firms is one of the main deficiencies of Canada's innovation system. The

[13] Canada's major funding councils include the Social Sciences and Humanities Research Council of Canada (SSHRC), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the National Research Council of Canada (NRC).

government is responding to this issue through a number of initiatives, including Technology Partnerships Canada (TPC), a program which supports high-risk, near-market development and demonstration projects across Canada. TPC, in which the government shares risks and rewards with private investors, is expected to leverage up to about two billion dollars in project spending over the next three fiscal years. Special assistance is being provided to SMEs engaged in near-market technology development through the joint efforts of TPC and the National Research Council's Industrial Research Assistance Program. In addition, in an attempt to speed-up the pace of technology adoption, the government will be devoting specific attention in coming years to the identification and development of promising communications technologies and applications.

In the human resources area, it has been recognized that it is important for all parties, including industry, government, and educational institutions to work together to ensure that Canadian workers have the capabilities that are critical to a dynamic, knowledge-based economy. The federal government will continue to collaborate with industry groups to develop human resource strategies that respond to training needs and address particular skill shortage problems. Support is being provided for the development of innovative technologies that could help Canadians adjust to an environment requiring a lifelong commitment to learning. As well, to facilitate education and training, the federal government recently introduced a major post-secondary scholarship program (the Millennium Scholarship) and increased tax incentives for continuing study.

The final component of the innovative strategy requires that we reflect on the overall policy framework that has been created as a consequence of the government's macroeconomic policies and its actions in such areas as competition, trade and investment, the environment, intellectual property, and consumer health and safety. From a macroeconomic perspective, considerable progress has been made in recent years. The elimination of the federal deficit, recent reductions in the federal debt-to-GDP ratio, and progress in reducing slack along with the extent of unemployment in the economy have considerably improved the climate for investment in Canada. Reforms in other areas have also helped make the environment more conducive to risk-taking and innovation. Significant recent developments include trade liberalization, reforms that have streamlined the federal regulatory process, the introduction of increased competition in telecommunications markets, and the elimination of Canada's compulsory licensing system for pharmaceuticals. It is also significant that Canadian firms benefit from R&D tax incentives that are among the most generous in the world.

V. CONCLUSIONS

Rapid technological change has become a central feature of modern industrial economies. In the current highly competitive global environment, firms must innovate simply to stand still. To move ahead, a firm must outperform its competitors in generating new ideas and effectively translate those ideas into useful products and processes. That is a major challenge. It is a particularly formidable challenge for Canadian firms that must race alongside producers from the world's most innovative and leading knowledge-based economy.

There is considerable scope to improve Canada's performance. We can become more innovative by committing greater resources to R&D, increasing rates of capital investment, building an advanced information infrastructure, and investing more in the development of this country's human capital. By making the needed investments, the Canadian economy will be more favourably positioned to generate and commercialize ideas, to acquire and adapt new technologies, and to shift resources towards promising new areas of economic activity.

Some significant progress has been made in recent years. In the face of increasing international competition, Canadian firms have significantly increased their commitment to R&D. The federal government has devoted greater effort to establishing a policy framework that is conducive to innovation and business investment. We must build on these efforts to establish the foundations for a prosperous economy that will generate attractive employment opportunities and support continuing improvements in the living standards of Canadians as they enter the 21st century.