A Profile
of
the Canadian Manufacturing High-Technology Industries

Can D. Le
Marketplace Innovation Directorate
Innovation Policy Branch
Industry Canada

June 2001

A Profile
of
the Canadian Manufacturing High-Technology Industries

Acknowledgement

The author wishes to thank Marie Tobin, Jeanne Inch, Hollis Whitehead of the Innovation Policy Branch, and Gilles Claveau of the Information and Communications Technologies Branch, Industry Canada, for their helpful comments on the various drafts of this report. Felismina Henriques de Oliveira, Jane Barrett, Looc My Lau, and Vanessa Chang provided research assistance at different stages of this project. The author, however, is responsible for any omission or error that remains.

The views expressed in this report are those of the author. They should not be construed as the official position of Industry Canada.

TABLE OF CONTENTS

Executive Summary

For the purposes of this study, the manufacturing high-technology industries in Canada consist of the following components: aircraft and parts; communications - electronics; office, store, and business machines; and pharmaceuticals. This classification is based on the Organization for Economic Cooperation and Development (OECD) sectoral definition of high-technology manufacturing industries.

The following objectives guided the study:

(i) to analyze the overall economic performance of manufacturing high-technology industries in Canada based on some key indicators such as: gross domestic product (GDP), research and development, trade, employment, and wages;

(ii) to contrast the performance of these industries to that of the whole Canadian manufacturing sector;

(iii) to examine, in depth, their trade and employment aspects;

(iv) to compare their performance to that of the same industries in the other Group of Seven (G7) industrialized countries, including Japan, France, Germany, Italy, the U.K, and the U.S., as well as those in smaller OECD countries such as Australia, Denmark, Finland, Norway, and Sweden; and

(v) to analyze the performance of each of these industries in Canada: aircraft and parts; communications - electronics; office, store, and business machines; and pharmaceuticals.

This study shows that Canadian manufacturing high-technology industries as a group were very dynamic and fast growing compared to the whole manufacturing sector in Canada.

With regard to trade, these industries accounted for an ever increasing proportion of both Canadian merchandise exports and imports. Among the four industries studied, communications - electronics emerged as the most predominant industry, in terms of both export and imports.

Among Canada's trading partners in manufacturing high-technology industries, the U.S. remained the most significant, accounting for 81% of Canada's exports and 51% of its imports in 1999. In 1988 Canada had a $4 billion trade deficit with the U.S. By 1999, this had changed to a $741 million surplus. On the other hand, Asia Pacific countries as a group became an increasingly important trading partner of Canada, mostly in the communications - electronics, and office, store, and business machines industries.

Canada's trade deficit with Asia Pacific grew substantially, from $1 billion to $7 billion, during the same decade.

Canadian high-technology industries were responsible for 8.6% of total employment in the manufacturing sector - or 183,000 employees - in 1988. By 1998, this proportion had increased to about 10%, or 211,000 employees. Among the four high-technology industries, communications - electronics led the group in employment (37%), followed by aircraft and parts (29%), pharmaceuticals (19%), and office, store, and business machines (15%). However, in terms of employment growth over the 10-year period (1988-1998) the pharmaceuticals industry grew the fastest, followed by communications - electronics, and aircraft and parts. Employment in the office, store, and business machines industry dropped over the same period.

While the manufacturing high-technology industries were the focus of this study, employment in the computer services industry was also examined since it is closely associated with employment in the manufacturing high-technology industries. In 1988, employment in the computer services industry was equal to about one-third the level of total employment in the manufacturing high-technology industries. By 1998, following a substantial growth in computer services in Canada, the employment levels in the two groups became almost equal.

Toronto, Montreal, and Ottawa-Hull played by far the most important role in generating employment in the manufacturing high-technology and computer services industries in Canada. The average annual growth rates of employment in the combined computer services industry and manufacturing high-technology industries were found to be highest in Edmonton and Calgary, followed by Ottawa-Hull, Vancouver, Winnipeg, Montreal, Kitchener-Waterloo, and Toronto.

On the international scene, the performance of Canadian manufacturing high-technology industries compared very favourably with performance in other OECD countries. When looking at growth in value added, percentage of manufacturing employment, and share of OECD research and development (R&D) and exports, the performance of Canadian manufacturing high-technology industries surpassed that of the other G7 countries, but trailed behind some smaller countries, including Finland and Sweden, and Australia and Denmark to a lesser extent.

An analysis of individual manufacturing high-technology industries over the 10-year period resulted in the following observations. The percentage changes in employment were based on the period running from 1988 to 1998, those in trade to 1999, and those in share in total OECD manufacturing high-technology exports to 1996.

Aircraft and Parts

- Employment increased by 20%, with most employment concentrated in Montreal, Toronto, and Winnipeg.

- Exports grew by 255%, imports by 95%, with the U.S. as Canada's most significant trading partner, followed by the European Union (E.U.).

- Internationally, Canada's share of OECD R&D expenditures in the aircraft and parts

industry grew faster than those of the countries used in the comparisons, except for Japan and Sweden. Canada's share of OECD exports also grew faster than those of the other countries except for Japan, France, and Denmark.

Communications - Electronics

- Employment increased by 23%, with most employment concentrated in Montreal, Ottawa-Hull, and Toronto.

- Communications - electronics exports grew by 393%, imports rose by 332%. The U.S. remained Canada's most important trading partner, followed by Asia Pacific.

- Internationally, Canada's share of OECD R&D grew by 41%, faster than all G7 countries except for Italy; growth was faster than Denmark but slower than Australia, Finland, Norway, and Sweden. Canada's share of OECD exports grew faster than the other G7 countries except for the U.K.; growth was faster than Denmark and Norway but slower than Australia, Finland, and Sweden.

Office, Store, and Business (OSB) Machines

- Employment dropped by 27%, with most employment concentrated in Toronto, Ottawa-Hull, and Montreal.

- Exports grew by 132%, imports by 102%. The U.S. remained by far Canada's most significant trading partner.

- Internationally, Canada's share of OECD R&D grew by 14%, faster than France, Italy, the U.K., the U.S., Denmark, Finland, and Norway, but slower than Japan, Germany, Australia, and Sweden. Canada's share of OECD exports grew by 8%, faster than France, Italy, Japan, Germany, the U.S., Norway, and Sweden, but slower than the U.K., Australia, Denmark, and Finland.

Pharmaceuticals

- Employment increased by 60% - highest among the four manufacturing high-technology industries - with most employment concentrated in Toronto and Montreal. Employment in Toronto increased substantially while Montreal experienced a steady decline.

- Exports increased by 626%, imports by 454% – also highest among the manufacturing high-technology industries. The U.S. remained Canada's most significant trading partner, followed by the E.U.

- Internationally, Canada's share of OECD R&D grew faster than any other country both in

the G7 group and in the group of smaller countries. Canada's share of OECD exports also grew faster than any other country in both groups.

PROFILE OF THE CANADIAN MANUFACTURING HIGH-TECHNOLOGY INDUSTRIES

1.0 BACKGROUND

Among all industrial groups in Canada, the manufacturing high-technology industries received the most attention in the last fifteen years, due to its fast growth rate and its pervasive impact on the whole economy. The purpose of this study is to shed some light on these industries.

1.1 Objectives

Using the definition of manufacturing high-technology manufacturing adopted by the OECD, this study aimed at meeting the following objectives:

(i) analyzing the overall economic performance of these industries in Canada based on some key indicators such as: gross domestic product (GDP), R&D, trade, employment, and wages;

(ii) contrasting the performance of these industries to that of the whole Canadian manufacturing sector;

(iii) examining in depth their trade and employment aspects;

(iv) comparing their performance to that of the same industries in the other G7 countries including Japan, France, Germany, Italy, the U.K, and the U.S., as well as those in smaller OECD countries such as Australia, Denmark, Finland, Norway, and Sweden; and

(v) analyzing the performance of each of the high-technology manufacturing industries in Canada: aircraft and parts; communications - electronics; office, store, and business machines; and pharmaceuticals.

1.2 Definition

There are many definitions of high-technology products and industries, such as those used by the U.S. (for example by the Department of Commerce and the National Science Foundation) and the OECD. In order to undertake international comparisons, this study used the definition based on industry used by the OECD. Based on this definition and on the concordance of the OECD International Industrial Classification with Statistics Canada's 1980 Standard Industrial Classification, manufacturing high-technology industries in this study consist of the following industries: aircraft and parts; communications - electronics; office, store, and business (OSB) machines; and pharmaceuticals (see Appendix A for details).

1.3 Data Sources

All of the Canadian data used in this study were based on the 1980 Standard Industrial Classification (SIC) of Statistics Canada. Trade data were obtained through the Trade Information and Enquiry Retrieval System (TIERS), employment data were from the Labour Force Survey (LFS), and other data were from CANSIM (Canadian Socio-Economic Information Management System) and various publications by this agency. At the time of writing of this report, trade data were available up to 1999. Since employment data by Census Metropolitan Area and by 1980 SIC from the LFS were available only up to 1998, for the related variables such as GDP, R&D, and wage, only data up to the same year were used.

It should be noted that the employment data used in this study came from special tabulations provided by Statistics Canada based on the LFS. These data may be different from those originating from other sources. LFS data were used since they were available for Census Metropolitan Areas (CMAs), a geographical unit used for employment comparisons.

Most of the international data on value-added, employment, shares of OECD research and expenditures (R&D), and share of OECD exports were obtained from the published Structural Analysis (STAN) Database of the OECD. Other yet-to-be published data were provided by the OECD's Science and Technology Secretariat. Data on value-added, employment, and exports were available up to 1996 while those on R&D were available up to 1994 only.

1.4 Period of Analysis

The period chosen for the trade part of this study runs from 1988 to1999, covering the transition of the Canadian economy to the environment governed by the Canada/U.S. Free Trade Agreement (FTA) and then the North American Free Trade Agreement (NAFTA). For the other parts, the analysis period is from 1988 to 1998, due to the reason mentioned in the previous paragraph. With regard to international comparisons, some data were available only until 1996, others until 1994. Therefore, care must be taken when interpreting the findings of this study accordingly.

2.0 ECONOMIC SIGNIFICANCE

The economic significance of the four manufacturing high-technology industries within the Canadian economy was assessed in terms of some key variables, including: GDP, R&D, trade, employment, and wage. Given their importance, the trade and employment impacts of these industries were evaluated in depth.

2.1 Overall Economic Significance

Although still relatively small in size compared to the other groups of the Canadian manufacturing sector, manufacturing high-technology industries as a group had become increasingly important over the 10-year period, from 1988 to1998.

Figure 1 shows a general increase in economic significance of these industries within the manufacturing sector in terms of GDP (1992 prices) and employment. Between 1988 and 1998, the percentage of high-technology with respect to GDP (1992 prices) increased from 8.6% to 11.2%, and employment from 8.6% to 9.8%.

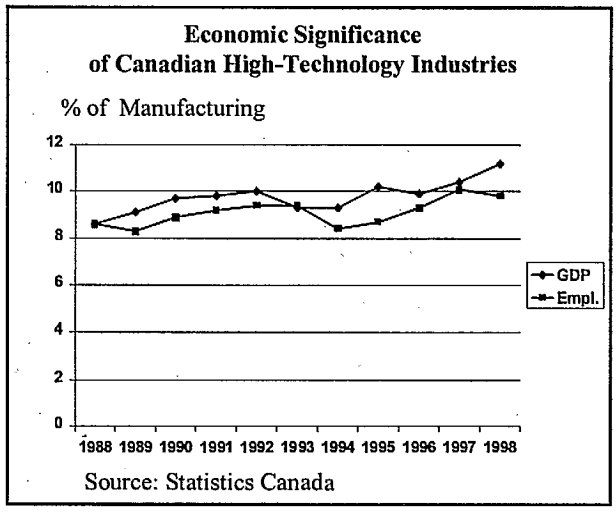

Figure 1

Figure 2 shows that during the period 1988-1998 the average annual growth rates in GDP (1992 prices) and employment of the manufacturing high-technology industries are much higher than those of the Canadian economy as a whole or the manufacturing sector.

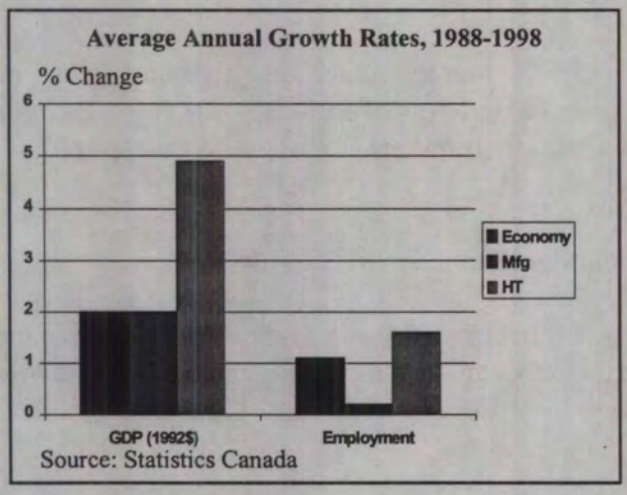

Figure 2

2.2 Research and Development

Since research and development (R&D) is the criterion used to define industries in terms of their technology intensiveness, the high-technology industries by definition are the most R&D - intensive. They account for a major proportion of R&D expenditures in the manufacturing sector. In 1988, high-tech industries accounted for close to 60% of the manufacturing sector's total R&D expenditures; by 1998, this share had increased to more than 75% (Figure 3).

In 1998, the communications - electronics industry accounted for 55.7% of R&D expenditures in the four manufacturing high-technology industries, followed by aircraft and parts (23.9%), pharmaceuticals (11.6%), and office, store, and business machines (8.7%). These R&D expenditures represent a significant increase from 7.0% in 1988 for pharmaceuticals, a slight increase from 22.1% for aircraft, a very minor increase from 55.4% for communications - electronics, and a significant reduction from 15.5% for office, store, and business machines.

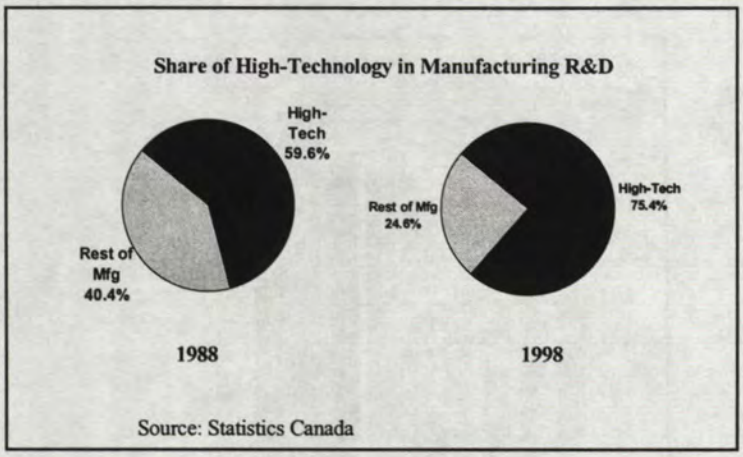

Figure 3

2.3 Wages

With regard to wages, workers in high-technology industries in general earned more than the average worker in the manufacturing sector. The salary premium enjoyed by these workers varied from approximately 8% in communications - electronics, 16% in pharmaceuticals, 20% in office, store, and business machines, and 24% in aircraft and parts as shown below and in Figure 4.

Industry	1998 Average Weekly Earnings
Aircraft and Parts	$965
Office, Business, and Store Machines	$919
Pharmaceuticals	$943
Communications - Electronics	$880
Total Manufacturing	$756

Sources: Statistics Canada, Annual Estimates of Employment, Earnings, and Hours

From 1988 to 1998, the average weekly salary premium of workers rose from 3% to 22% in the office, business, and store machines industry; from 13% to 25% in the pharmaceuticals industry; from 12% to 16% in the communications - electronics industry; and from 26% to 28% in the

aircraft and parts industry.

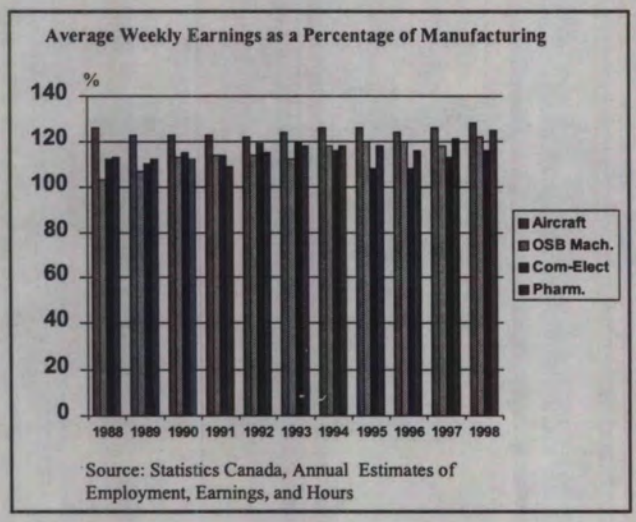

Figure 4

3.0 TRADE

Canadian trade by manufacturing high-technology industries grew substantially over the period from 1988 to1999. Exports volume grew from $9 billion to close to $35 billion, while imports grew from $17 billion to $54 billion. The overall trade deficit grew from $8.2 billion to $18.7 billion (Figure 5).

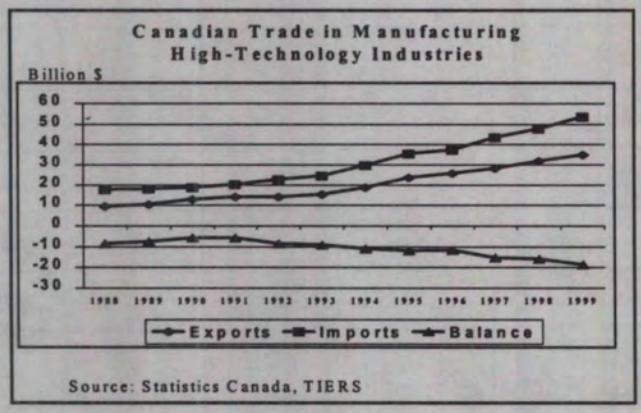

Figure 5

In terms of share in total trade, the share of high-technology exports grew from 6.5% to 9.8% over the period, while the share of imports increased from 13.5% to 16.7% (Figure 6).

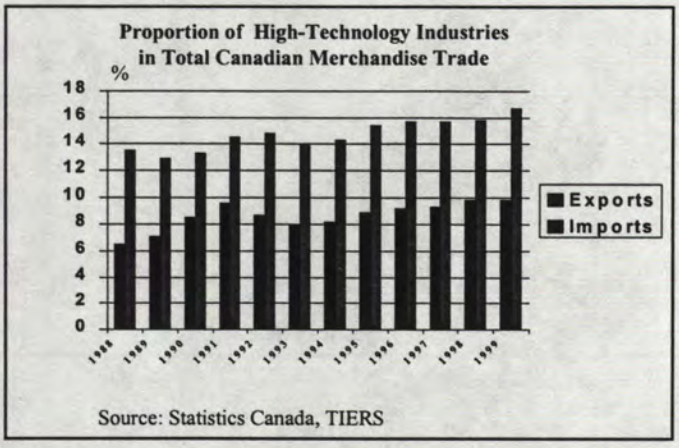

Figure 6

3.1 Distribution of Trade by Individual Manufacturing High-Technology Industries

The composition of Canadian high-technology manufacturing trade changed significantly over the period 1988-1999 with an increasing share by the communications - electronics and pharmaceuticals industries, and a decreasing share by the aircraft and parts industry, and especially the office, store, and business (OSB) machines industry (Figures 7-8).

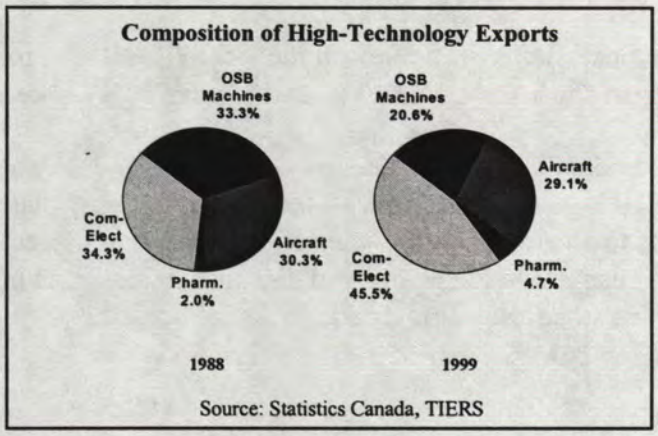

Figure 7

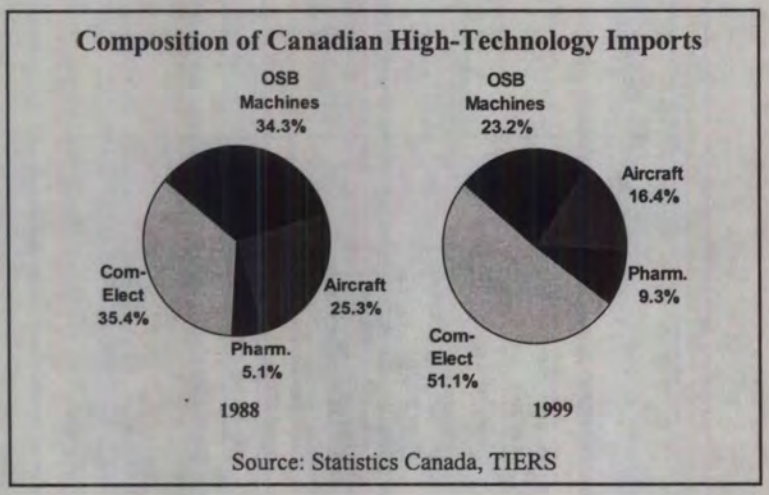

Figure 8

- The communications - electronics industry emerged as the most prominent industry in terms of high-technology manufacturing trade: in 1999, it accounted for almost 46% of Canadian manufacturing high-technology exports and 51% of its imports - well above its 1988 figures of 34% and 35% respectively.

- The office, store, and business machines industry diminished in importance, with its exports share dropping from 33% to 21%, and its imports share from 34% to 23%.

- The aircraft and parts industry's share of exports remained basically unchanged at about 30%, while its share of imports dropped from 25% to 16%.

- The pharmaceuticals industry, while still modest in its relative importance, more than doubled its export share from 2% to 5%, and increased its imports share from 5% to 9%.

In terms of balance of trade, the communications - electronics industry accounted for almost two-thirds of the trade deficit in manufacturing high-technology (mainly due to electronic parts and components), followed to a lesser extent by the office, store and business machines industry and the pharmaceuticals industry. On the other hand, the aircraft and parts industry has consistently generated a trade surplus since 1989 (Figure 9).

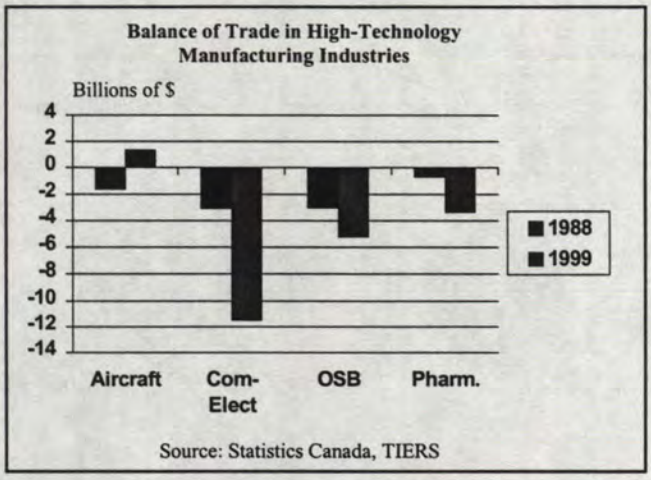

Figure 9

The trends in individual high-technology industries show that both exports and imports in the communications-electronics industry started to grow substantially in 1993-1994 while trade in the other industries grew at much lesser rates.

3.2 Distribution of Trade By Major Countries/Regions

Canadian trade in manufacturing high-technology industries was analyzed in terms of its distribution among the following five countries and regions:

- the United States;
- Asia Pacific (South Korea, Taiwan, Hong Kong, Singapore, China, Thailand, India, Malaysia, and Australia);
- the European Union (E.U.);
- Japan; and,
- the rest of the world.

Traditionally, the U.S. had been the main trading partner of Canada in the manufacturing high-technology industries. Recently, this role had changed somewhat. From 1988 to 1999, the U.S. share of Canadian manufacturing high-technology exports increased from 71% to 81%; however its share of Canadian imports fell from 60% to 51% over the same period.

While the increase in the U.S. share of Canadian exports corresponded to a decrease in the European Union's share, the reduction in Canadian imports from the U.S. was matched by an increase in Canadian imports from Asia Pacific. The U.S. accounted for close to one half of Canada's trade deficit in this area in 1988. By 1999, Asia Pacific accounted for more than 40% of Canada's trade deficit (Figures 10-12).

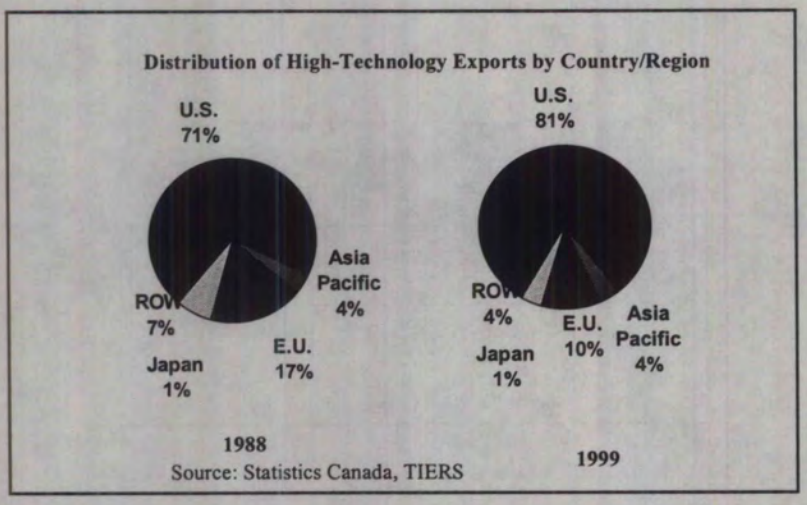

Figure 10

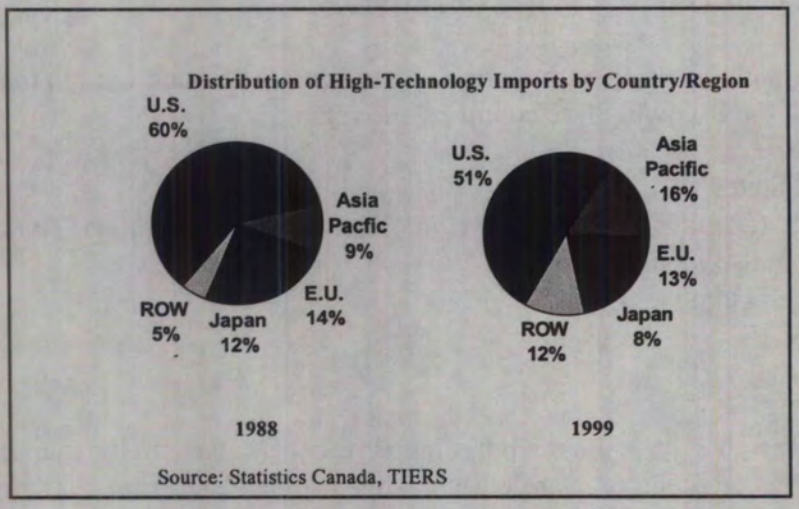

Figure 11

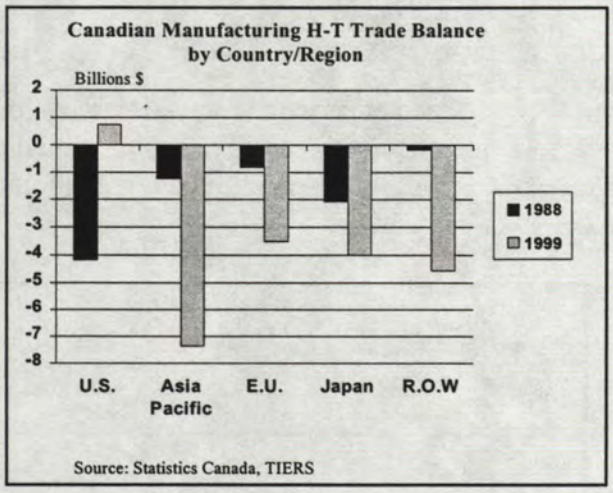

Figure 12

It can be seen from Figure 12 that while Canadian balance of trade in manufacturing high-technology with the U.S. improved significantly over the 1988-1999 period, it worsened with regard to all the other regions of the world.

The trends of Canadian trade with four major regions of the world are presented in Figures 13-16. The following observations can be made:

United States

The U.S. continued to be, by far, Canada's most important trading partner in the high-technology area. Canada's trade balance with the U.S. improved steadily from a $4 billion deficit in 1988 to a $741 million surplus in 1999 (Figure 13).

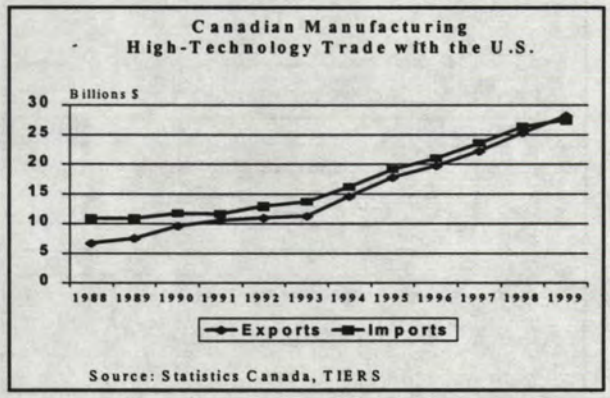

Figure 13

Asia Pacific

By 1999, Asia Pacific had become Canada's second most important source of imports, largely due to the presence of off-shore manufacturing plants of multinational enterprises (MNEs). Canada's exports to this region were still much smaller than its imports, leading to an increasingly larger trade deficit (Figure 14).

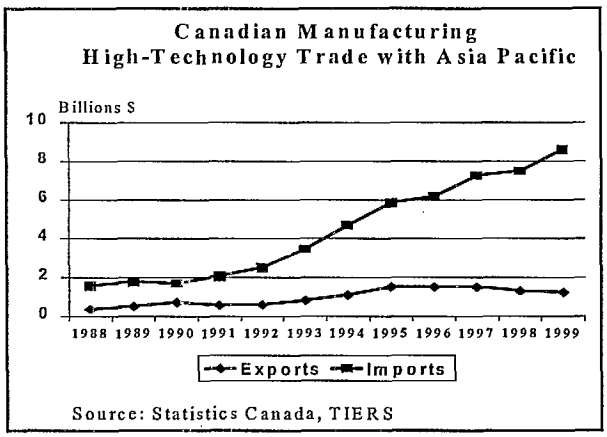

Figure 14

European Union (E.U.)

Canada's imports from the European Union kept pace with its exports until 1996, after which there was a surge in imports; exports rose only steadily, leading to an increasingly large trade deficit (Figure 15). Canada's trade deficit with the European Union increased from $831 million in 1988 to $3.5 billion in 1999.

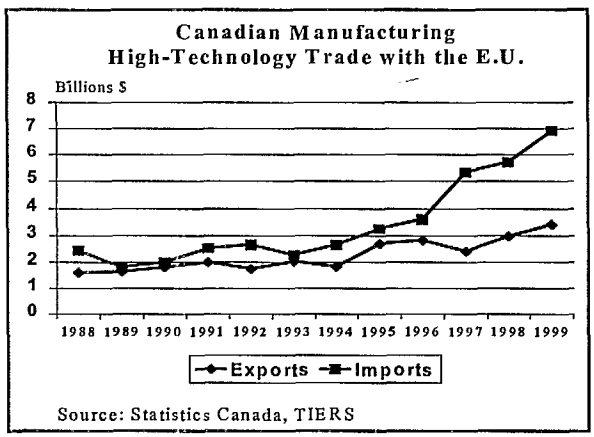

Figure 15

Japan

Canada's exports to Japan were still modest over the period, while imports from Japan increased steadily, leading to an ever-rising trade deficit (Figure 16).

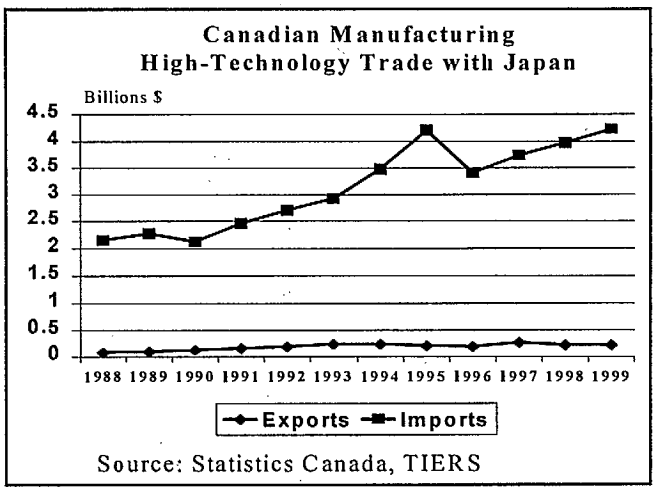

Figure 16

Rest of the World

In 1988, the rest of the world accounted for 8% of Canadian exports in manufacturing high-technology industries and 5% of its imports. By 1999, these proportions had changed to 5% and 12%, resulting in an increase in Canada's trade deficit with the rest of the world from $144 million to close to $5 billion.

3.3 Distribution of Trade By Individual Manufacturing High-Technology Industries

The following section provides a breakdown of the distribution of exports and imports in 1999 by the four manufacturing high-technology industries and by regions/countries:

i. Aircraft and Parts

Exports

Canadian trade in aircraft and parts is the only area where this country enjoyed a growing trade surplus, which stood at about $1.4 billion in 1999. The U.S. accounted for about three-quarters of Canadian exports, rising from $2 billion in 1988 to about $8 billion in 1999. In the period of analysis, the share of Canada's exports to Asia Pacific, Japan, and the rest of the world remained

unchanged, while the European Union's share dropped from 19% to 15%. The breakdown of Canadian exports in this area in 1999 is as follows:

Country/Region	Canadian Exports - 1999	% of Canadian Exports
U.S.	$7,874 million	78%
Asia Pacific	$242 million	2%
E.U.	$1,496 million	15%
Japan	$46 million	less than 1%
Rest of the world	$477 million	5%
Total Exports	$10,135 million	100%

Source: Statistics Canada, TIERS

Imports

Canadian imports of the products of the aircraft and parts industry mainly came from the U.S. (55%) and the European Union (35%), with the rest divided between Japan and the rest of the world. Asia Pacific played an insignificant role in this area. The volume of Canadian imports from the U.S. increased by more than 60%, from $3 billion in 1988 to $4.9 billion in 1999, while that of the European Union more than doubled during the same period, from $1.4 billion to over $3 billion. Following is the breakdown of Canada's 1999 imports of aircraft and parts:

Country/Region	Canadian Imports - 1999	% of Total Canadian Imports
U.S.	$4,853 million	55%
Asia Pacific	$37 million	less than 1%
E.U.	$3,089 million	35%
Japan	$298 million	3%
Rest of the world	$486 million	6%
Total Imports	$8,763 million	100%

Source: Statistics Canada, TIERS

ii. Communications - Electronics

Exports

Canadian exports of the products of the communications - electronics industry increased more than fourfold between 1988 and 1999. At more than $13 billion, the U.S. accounted for 83% of these exports in 1999, followed by Asia Pacific (5%), the European Union (7%), Japan at less than 1%, and the rest of the world at about 4%. The volume of Canadian exports to the U.S. expanded close to fivefold, from $2.3 billion to almost $13 billion. The distribution of Canadian exports in this area in 1999 is given below.

Country/Region	Canadian Exports - 1999	% of Canadian Exports
U.S.	$13,081 million	83%
Asia Pacific	$796 million	5%
E.U.	$1,171 million	7%
Japan	$95 million	Less than 1%
Rest of the world	$703 million	4%
Total Exports	$15,846 million	100%

Source: Statistics Canada, TIERS

Imports

Canadian imports of the products of the communications - electronics industry increased from $6.3 billion in 1988 to $27.3 billion in 1999. The volume of imports from the U.S. more than quadrupled during the same period, from $3.3 billion to $14 billion.

The proportion of imports from Japan decreased markedly from 22% to 8%, while the proportions from Asia Pacific and the rest of the world increased appreciably, from 15% to 20% in the case of Asia Pacific and from 5% to 15% from the rest of the world. The share of the European Union increased slightly from 5% to 7%.

The distribution of Canadian communications - electronics imports in 1999 was as follows:

Country/Region	Canadian Imports - 1999	% of 1998 Imports
U.S.	$13,515 million	49%
Asia Pacific	$5,483 million	20%
E.U.	$1,790 million	7%
Japan	$2,317 million	8%
Rest of the world	$4,230 million	15%
Total Imports	$27,335 million	100%

Source: Statistics Canada, TIERS

iii. Office, Store, and Business Machines Industry

Exports

Most Canadian exports of office, store, and business machines (essentially computers and peripherals) were manufactured/assembled by Canadian subsidiaries of U.S. firms which sent back their products to the U.S. This is the reason why the U.S. share of Canadian exports in this area had always been predominant. From 1988 to 1999, the U.S. share rose from 73% to 87%. The shares of other countries/regions dropped over the same period: Asia Pacific from 3% to 2%; the E.U. from 20% to 7%; Japan from 0.7% to 0.6%; and the rest of the world unchanged at 4%. The distribution of these Canadian exports in 1999 is given below.

Country/Region	Canadian Exports - 1999	% of Total Canadian Exports
U.S.	$6,225 million	87%
Asia Pacific	$156 million	2%
E.U.	$497 million	7%
Japan	$38 million	less than 1%
Rest of the world	$260 million	4%
Total High-Tech Exports	$7,176 million	100%

Source: Statistics Canada, TIERS

Imports

Canadian imports of office, store, and business industry were more evenly distributed, from a geographical point of view, than exports. The role of the U.S. as the most prominent source of imports diminished over the years: in 1988, the U.S. accounted for over two-thirds of Canadian imports in this area; by 1999, this proportion had dropped to 50%. The reduction in the proportion of the U.S. imports to Canada was matched by a corresponding rise in the proportion of imports from Asia Pacific which more than doubled over the same period, from 10% to 24%. The proportion of imports from Japan remained unchanged at 12%, while that of the European Union dropped from 6% to 4%. The proportion of the rest of the world rose from 4% to 10%. The break-down of Canada's imports of office, store, and business machines is given below.

Country/Region	Canadian Imports - 1999	% of Canadian Imports
U.S.	$6,265 million	50%
Asia Pacific	$2,973 million	24%
E.U.	$450 million	4%
Japan	$1,536 million	12%
Rest of the world	$1,188 million	10%
Total Imports	$12,412 million	100%

Source: Statistics Canada, TIERS

iv. Pharmaceuticals

Exports

The volume of Canadian exports to the U.S. in pharmaceuticals rose about twenty-fold between 1988 and 1999, from $93 million or 41% of Canadian total to $1.1 billion or 66%. On the other hand, those of Asia Pacific, the European Union, Japan, and the rest of the world all declined during the same period. The distribution of Canadian pharmaceuticals exports in 1999 was as follows:

Country/Region	Canadian Exports - 1999	% of Canadian Exports
U.S.	$1,081 million	66%
Asia Pacific	$47 million	3%
E.U.	$233 million	14%
Japan	$38 million	2%
Rest of the world	$248 million	15%
Total Exports	$1,647 million	100%

Source: Statistics Canada, TIERS

Imports

The share of Canadian imports of pharmaceuticals from the U.S. rose significantly, from 43% in 1988 to 58% in 1999, while the shares of Asia Pacific and Japan remained virtually unchanged. The share of imports from the European Union dropped from 35% to 32%. Following is the distribution of Canadian pharmaceuticals imports in 1999.

Country/Region	Canada's Imports - 1999	% of Canada's Imports
U.S.	$2,886 million	58%
Asia Pacific	$118 million	2%
E.U.	$1,584 million	32%
Japan	$66 million	1%
Rest of the world	$347 million	7%
Total Imports	$5,001 million	100%

Source: Statistics Canada, TIERS

4.0 EMPLOYMENT

4.1 Distribution by Individual Manufacturing High-Technology Industries

In the following section, the employment distribution and growth rates in the manufacturing high-technology industries across Canada and in selected cities and regions were examined, and a comparison made of these growth rates with total manufacturing and industrial employment.

The relative level of employment in high-technology industries in the manufacturing sector increased steadily from 8.6% in 1988 to 9.8% in 1998 (Figure 17).

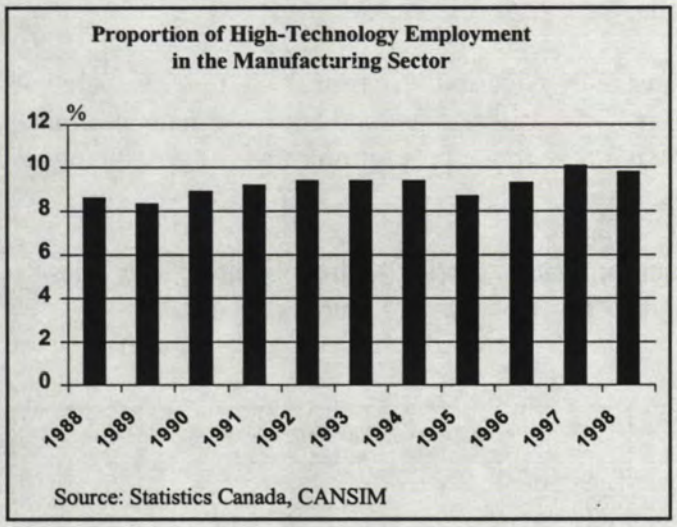

Figure 17

The total number of workers in this group rose by 15% from 183,000 to 211,000 between the same years. The distribution of workers among the industries in the group in 1998 is as follows:

Manufacturing High-Technology Industry	Distribution of workers in 1998	Percentage of total (%)
Communications - Electronics	78,300	37.1%
Aircraft and Parts	60,300	28.6%
Pharmaceuticals	40,600	19.2%
Office, Store, and Business Machines (OSB)	31,900	15.1%
Total	211,100	100%

Source: Statistics Canada, Labour Force Survey

The most notable changes in this distribution, from 1988 to 1998 were the significant drop in the proportion of the workers in the office, store, and business machines industry (from 24% in 1988 to 15% in 1998) and the increase in the proportion of workers in the pharmaceuticals industry, from 14% to over 19%.

The trends of employment in manufacturing high-technology industries in Canada and its distributions in 1988 and 1998 are shown in Figures 18 and 19.

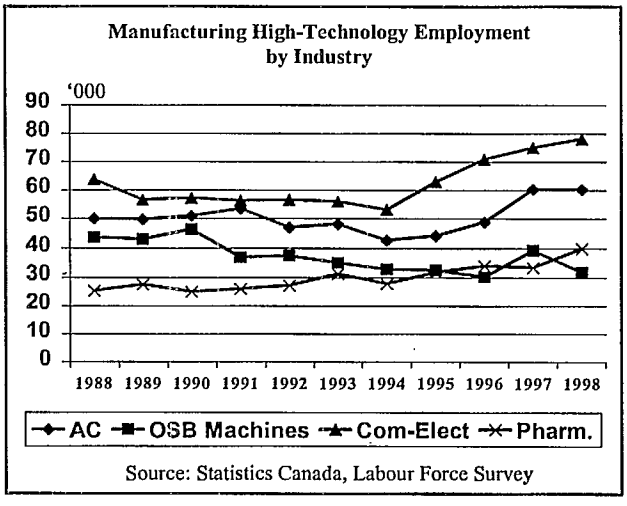

Figure 18

In the period 1988 to 1998, there was a substantial increase in employment in the pharmaceuticals industry (60.5%), and a moderate increase in the communications - electronics industry (22.5%) and the aircraft and parts industry (20.3%). The office, business, and store machines industry, on the contrary, experienced a significant reduction in employment (26.7%).

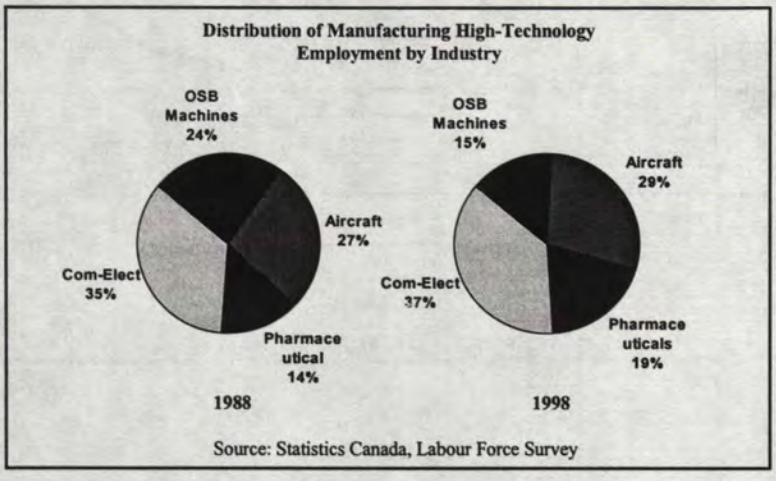

Figure 19

Although the computer services industry was not included among manufacturing high-technology industries, it is closely related to these industries because of its use of high-technology. In 1988, employment in the computer services industry was about one-third of total employment of high-technology manufacturing industries. Due to the substantial growth in computer services employment, by 1998 the two levels of employment were almost equal (Figure 20) . Therefore, when the level of employment in the computer services industry was added to that of the manufacturing high-technology, the combined employment amounted to 249,200 in 1988 and 421,900 in 1998, an increase of close to 70%. In terms of proportion of total Canadian industrial employment, this represented an increase from 1.9% to 2.9% over the same period.

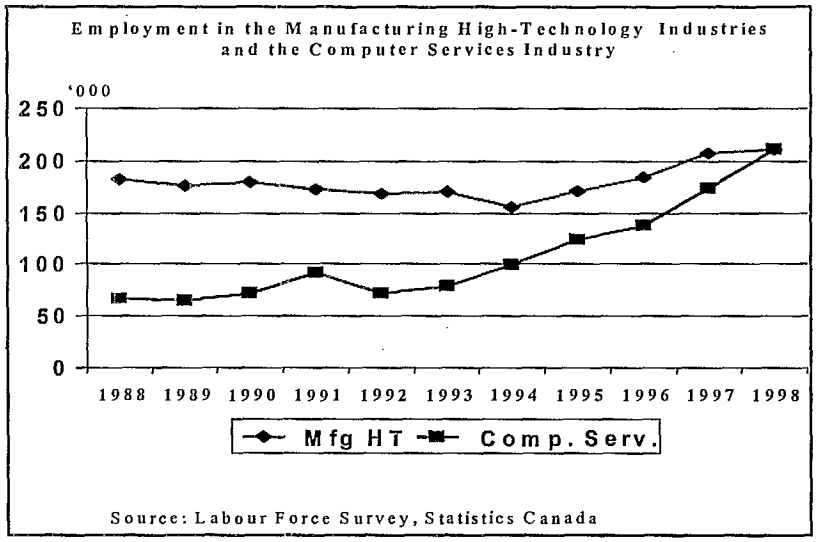

Figure 20

4.2 Distribution by Census Metropolitan Areas

Over half of employment in the manufacturing high-technology industries was concentrated in large metropolitan areas of Canada, with the remainder spread throughout other locations, mostly in Ontario and Quebec.

The Toronto, Montreal, and Ottawa-Hull areas accounted for about two-thirds of total Canadian manufacturing high-technology employment in the large metropolitan areas of Canada in 1998. The remainder of jobs in these industries were in Vancouver, Calgary, Winnipeg, Kitchener-Waterloo, and Edmonton. The distribution among these eight major Canadian cities in 1998 (Figures 21-22) was as follows:

Census Metropolitan Area	Manufacturing High-Technology Employment 1998	Percentage of Canadian Total
Toronto	61,800	29.3%
Montreal	57,200	27.1%
Ottawa-Hull	18,500	8.8 %
Vancouver	10,400	4.9%
Calgary	7,100	3.4%
Winnipeg	5,900	2.6%
Kitchener-Waterloo	4,200	2.0%
Edmonton	1,200	0.6%

Source: Statistics Canada, Labour Force Survey

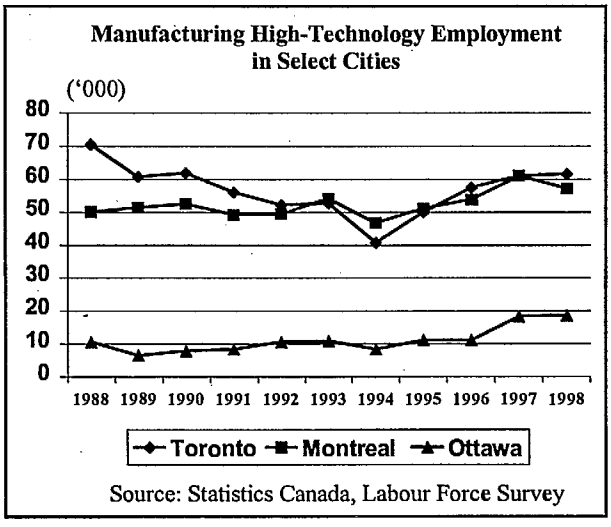

Figure 21

Figure 22

When employment in the computer services industry was added to that in the manufacturing high-technology industries, the combined employment in the above cities more than doubled, while the relative ranking among these cities remained more or less the same as shown in the following table and in Figures 23 and 24:

Census Metropolitan Area	Manufacturing High-Technology and Computer Services Employment 1998	Percentage of Canadian total
Toronto	119,800	28.4%
Montreal	92,800	22.0%
Ottawa-Hull	44,000	10.4%
Vancouver	27,300	6.5%
Calgary	19,300	4.7%
Winnipeg	10,300	2.4%
Edmonton	10,100	2.4%
Kitchener-Waterloo	7,600	1.8%

Source: Statistics Canada, Labour Force Survey

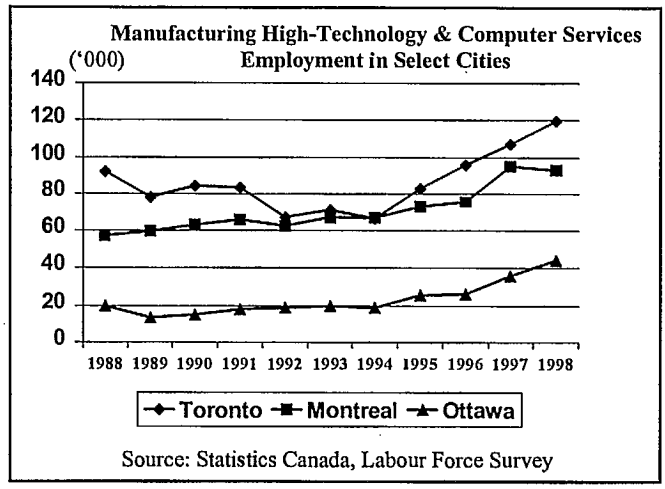

Figure 23

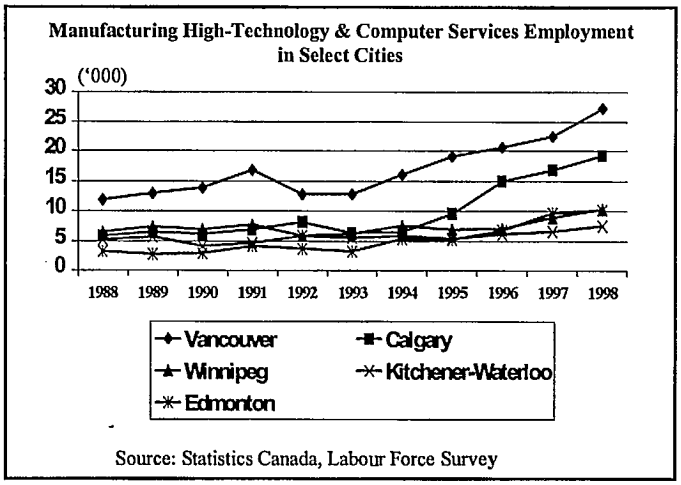

Figure 24

Figures 25-26 show the average annual growth rates of employment (1989-1998) in manufacturing high-technology industries and in the combined group of manufacturing high-technology and computer services industries in major metropolitan census areas. Due to the fast-growing computer services industry, the growth rates of the combined industries in Calgary, Edmonton, Vancouver, and Ottawa experienced growth rates in employment of the combined group which far exceeded the national average.

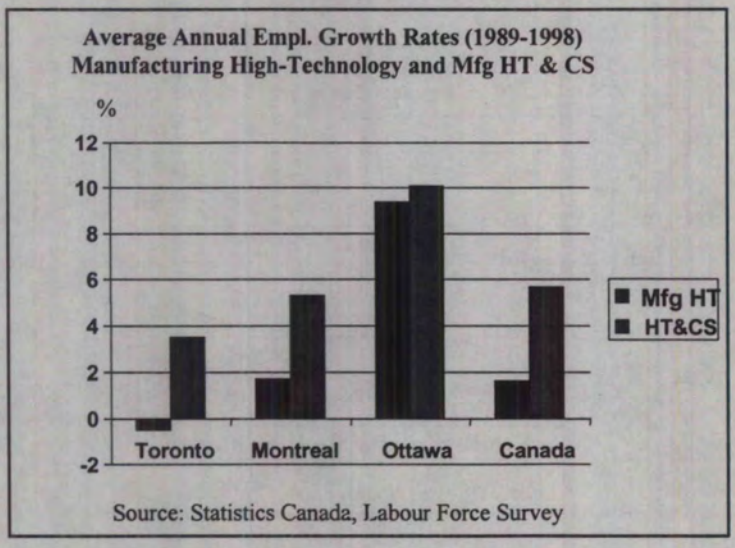

Figure 25

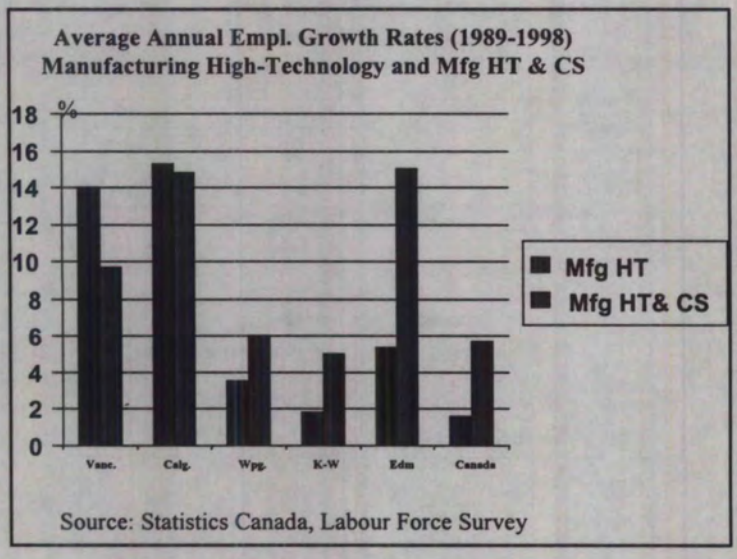

Figure 26

4.3 Analysis of Manufacturing High-Technology Employment in Selected Census Metropolitan Areas

This section provides an analysis of the employment situation of high-technology manufacturing industries in the Toronto, Montreal, Ottawa-Hull, Vancouver, Calgary, Winnipeg, Edmonton, and Kitchener-Waterloo areas. Employment in manufacturing high-technology industries was first analyzed in terms of its proportion of total employment in the Canadian manufacturing sector. Subsequently, it was analyzed in terms of the combined manufacturing high-technology and computer services industries as a proportion of total Canadian industrial employment. Following are the data - for selected census metropolitan areas in Canada - on employment (in thousands) in manufacturing high-technology industries (Mfg HT), manufacturing sector (Mfg), computer services industry (C. Ser.), the combined manufacturing high-technology and computer services industries (MHTCS), and total industrial employment in Canada (I. Empl.).

		MfgHT	Mfg	%	C. Ser.	MHTCS	I. Empl.	%
Toronto	1988	70.5	426.5	16.5	21.3	91.8	2,110	4.4
	1998	61.8	441.6	14.0	57.9	119.7	2,330	5.1
Montreal	1988	50.1	324.1	15.5	7.0	57.1	1,536	3.7
	1998	57.2	309.1	18.5	35.6	92.8	1,637	5.7
Ottawa-Hull	1988	10.5	30.2	34.8	9.5	20.0	495	4.0
	1998	18.5	35.6	52.0	25.5	44.0	545	8.1
Vancouver	1988	3.4	83.5	4.1	8.4	11.8	760	1.6
	1998	10.4	93.0	11.2	16.9	27.3	960	2.8
Calgary	1988	2.7	31.5	8.6	3.1	5.8	380	1.5
	1998	7.1	46.0	15.4	12.2	19.3	495	3.9
Winnipeg	1988	5.1	46.9	10.9	1.3	6.4	329	0.8
	1998	5.9	49.4	11.9	4.4	10.3	363	2.1
Edmonton	1988	1.7	37.5	4.5	1.6	3.3	409	2.8
	1998	1.2	43.7	2.7	8.9	10.1	482	3.6
Kit. - Wat.	1988	4.0	57.0	7.0	1.2	5.2	189	2.8
	1998	4.2	56.2	7.5	3.4	7.6	212	3.6
Canada	1988	182.8	2,120	8.6	66.4	249.2	12,819	1.9
	1998	211.1	2,147	9.8	210.8	421.9	14,326	2.9

Source: Statistics Canada, Labour Force Survey

i. Toronto

The number of manufacturing high-technology workers in the Toronto area dropped from 70,500 to 61,800 from 1988 to 1998, representing 16.5% and 14%, respectively, of the total manufacturing employment in the area. This drop was caused by the reduction in employment in the aircraft and parts industry; the office, store, and business machines industry; and the communications - electronics industry. These reductions were offset by a doubling of employment in the pharmaceuticals industry, from 9,300 to 19,900. In fact, by 1998, the pharmaceutical industry was the most important high-technology industry in the area.

The overall reduction in employment in manufacturing high-technology industries in Toronto was more than compensated for by the increase in employment in the computer services industry; the combined employment of these industries rose from 91,800 in 1988 to 119,700 in 1998, accounting for 4.4% and 5.1% respectively of overall total industrial employment in the area.

ii. Montreal

In Montreal, the communications - electronics industry showed the strongest expansion of its employment from 10,400 workers in 1988 to 17,600 in 1998 - an increase of more than 69%. Employment in the aircraft and parts industry also expanded, although at a more steady pace, from 22,500 to 28,200 - an increase of 25%.

Both the pharmaceuticals industry and the office, store, and business machines industry experienced a slight decline in employment - from 10,000 to 8,900, and from 7,200 to 2,300 respectively. The combined effect of these changes led to a slight increase in high-technology manufacturing employment in Montreal from 50,100 to 57,200, or from 15.5% to 18.5% of the total manufacturing employment in the city.

Similar to the case of Toronto, the computer services industry in the Montreal area also experienced strong growth in the same period - a fivefold increase, from 7,000 to 35,600. During the period of analysis, the combined employment of this industry and the manufacturing high-technology industries rose by 62.5%, from 57,100 to 92,800, representing an increase in total industrial employment in this area from 3.7% to 5.7%.

iii. Ottawa-Hull

Compared to Toronto and Montreal, the manufacturing sector in the Ottawa-Hull area had a higher concentration of high-technology industries; in terms of employment, these industries accounted for 52% of total manufacturing employment, compared to 14% in Toronto and 18.5% in Montreal in 1998.

The two main manufacturing high-technology industries in the Ottawa-Hull area - office, store,

and business machines, and communications - electronics - together accounted for 18,500 workers in 1998. These industries and the computer service industry together accounted for 44,000 workers, or 8.1% of total industrial employment in the area in 1998, more than doubling the 4.0% in 1988. With this 8.1% ratio, Ottawa-Hull is also by far the most high-technology intensive region of Canada.

iv. Vancouver

Although employment in manufacturing high-tech industries in Vancouver in the period of analysis was still small compared to the high-technology industries in Toronto, Montreal, and Ottawa-Hull, it grew by more than 200%, from 3,400 employees in 1988 to 10,400 employees in 1998, thereby increasing its proportion in total manufacturing employment in the area from 4.1% to 11.2%. Together with the computer services industry, manufacturing high-tech industries accounted for 27,300 employees in 1998 or 2.8% of total industrial employment in the area - a significant increase from 1.6% in 1988.

v. Calgary

The manufacturing high-technology industries in Calgary developed from a relatively small base in 1988 when these industries accounted for 2,700 employees. This number increased almost threefold to 7,100 in 1998, representing 15.4% of the area's total manufacturing employment. While the growth of Calgary's manufacturing high-technology industries was rather impressive, its computer services industry grew even faster, from 3,100 to 12,200 employees, over the same decade. Taken together, with a total of 19,300 employees in 1998, these industries accounted for 3.9% of Calgary's total industrial employment, over two and a half times the ratio of 1.5% in 1988.

vi. Winnipeg

The main manufacturing high-technology industry in Winnipeg was the aircraft and parts industry which employed 3,000 workers in 1988, and 3,700 in 1998. Although the other manufacturing high-technology industries were also present in the area, together they accounted for only 2,200 workers in 1998. The proportion of high-technology workers in the whole manufacturing sector in the area remained between 11% and 12% during the decade 1988-1998. However, due to the significant growth of the computer services industry - from 1,300 workers in 1988 to 4,400 in 1998 - the combined work force of these industries raised their share of total Winnipeg's industrial employment from 1.9% to 2.8% in the same time period.

vii. Edmonton

In Edmonton, the number of manufacturing high-technology workers actually dropped from 1,700 in 1988 to 1,200 in 1998, or from 4.5% to 2.7% of its manufacturing sector. However, the

computer services industry in the area expanded more than fivefold, from 1,600 employees to 8,900 employees during the same period. As a result, the share of the combined work force of these industries in the area's total industrial employment increased from 0.8% to 2.1%.

viii. Kitchener-Waterloo

The number of workers in the manufacturing high-technology industries in the Kitchener-Waterloo area remained rather stable at around 4,000-4,200 or 7%-7.5% of the manufacturing sector in the area during the period 1988-1998. Due to the emergence of a fast-growing computer services industry - which employed about 3,400 employee in 1998 - the share of the combined manufacturing high-technology and computer service industries in Kitchener-Waterloo in total industrial employment in the area rose modestly, from 2.8% in 1988 to 3.6% in 1998.

5.0 INTERNATIONAL COMPARISONS

The performance of the Canadian manufacturing high-technology industries can be best assessed by comparing them to that of other countries. For the purposes of this report, Canada was compared to two groups within the OECD: the other G7 countries, and a group of smaller countries (Australia, Sweden, Norway, Finland, and Denmark). The variables used for these comparisons are the shares of high technology value-added and employment within the manufacturing sector, and the shares of R&D and exports of Canada's manufacturing high-technology industries in the OECD.

Most of the discussions here were based on the incremental changes of these variables between 1988 and 1998. The absolute levels of some variables, such as the shares of R&D expenditures or the shares of exports in high-technology manufacturing industries, vary substantially from one country to another, depending on the relative sizes of their economies. However, the incremental changes in these variables over several years reflect, in a more effective way, the evolution of manufacturing high-technology industries in Canada.

5.1 **Value-Added** (Figures 27-30)

The proportion of high-technology industries within the manufacturing sector of a country is one of the indicators of its technology intensiveness. On this account, at 10.5% in 1996, Canada was behind major industrialized countries in the world, such as the U.S., the U.K., Japan, and France, but ahead of Italy and Germany, the latter due to its absorption of the much less technology-intensive East Germany in 1989.

Among the group of smaller countries, Canada was well ahead of all of the pack, except for Sweden, where high-technology industries accounted for 10.4% of its whole manufacturing sector in 1998, slightly lower than Canada's proportion of 10.5%.

From 1988 to 1996, the percentage of high-technology value-added in the Canadian manufacturing sector increased from 7.9% to 10.5%, proportionally more than any other country in the above comparisons, except for Finland, which saw its high-technology value-added percentage increase from 5.3% to 9.5%.

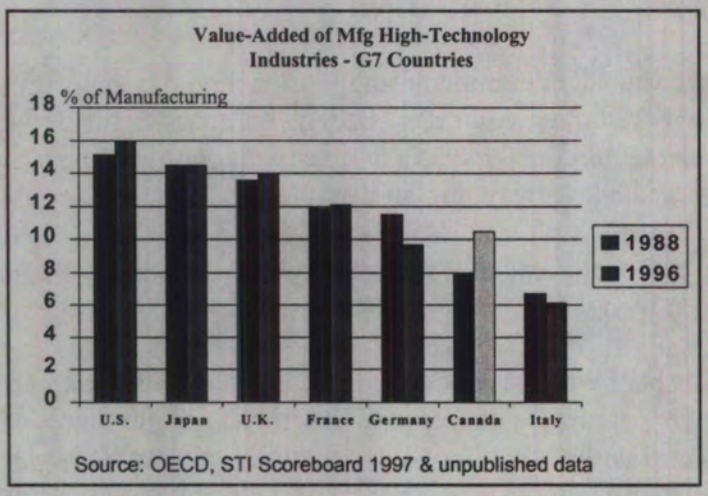

Figure 27

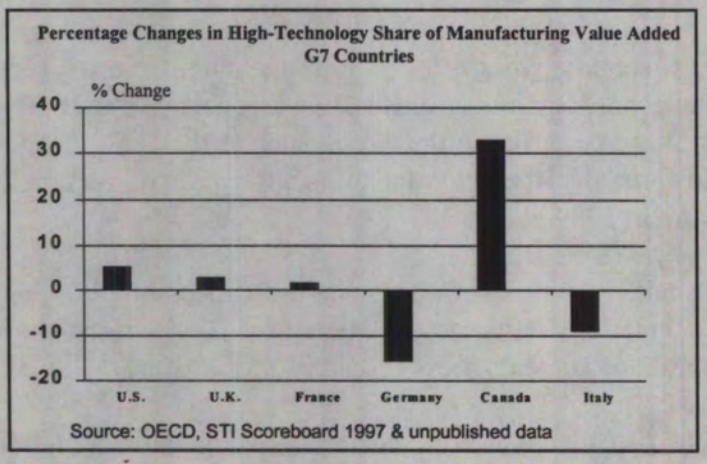

Figure 28

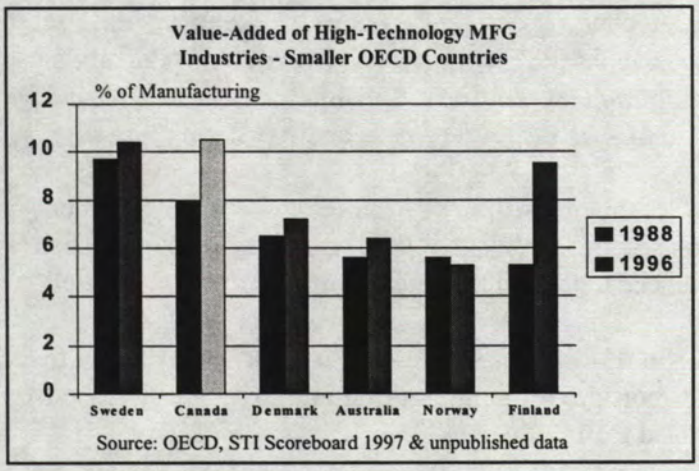

Figure 29

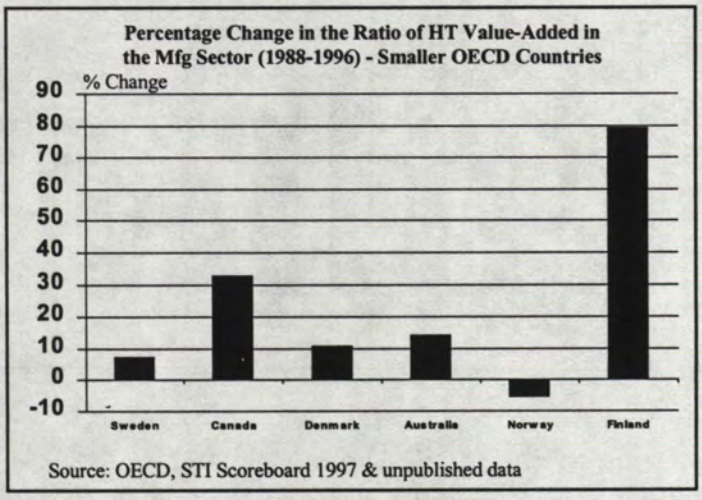

Figure 30

5.2 **Employment** (Figures 31-34)

The proportion of high-technology employment in the manufacturing sector is another indicator of the technology intensiveness of a country. At 8% in 1996, Canada's proportion was lower than that of the other G7 countries, except for Italy which was at 5%. Canada was behind Sweden and Finland, but well ahead of Australia, Denmark, and Norway.

Between 1988 and 1996, the proportion of high-technology employment in the manufacturing sector in Canada increased from 7.4% to 8.0%, while other G7 countries (such as the U.S., Japan, and Germany) experienced a drop in this indicator over the same period.

Canada's performance in this area was relatively less impressive than that of Finland, which saw its high-technology proportion of manufacturing employment increase from 4.7% to 8.3%, and Sweden, which increased from 8.5% to 9.8%.

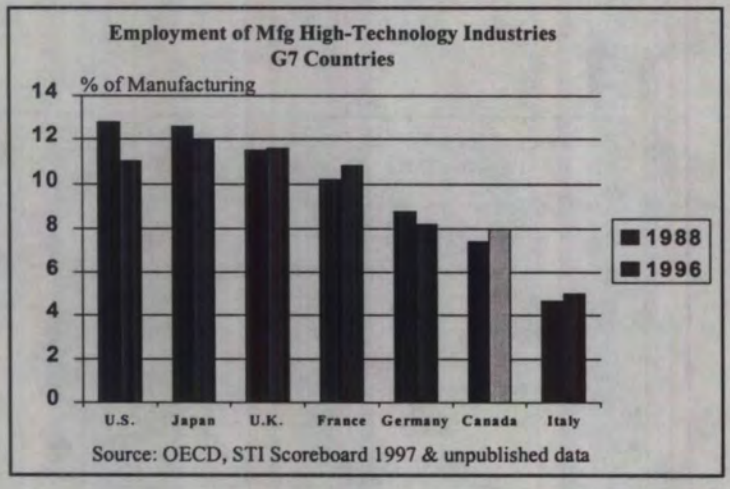

Figure 31

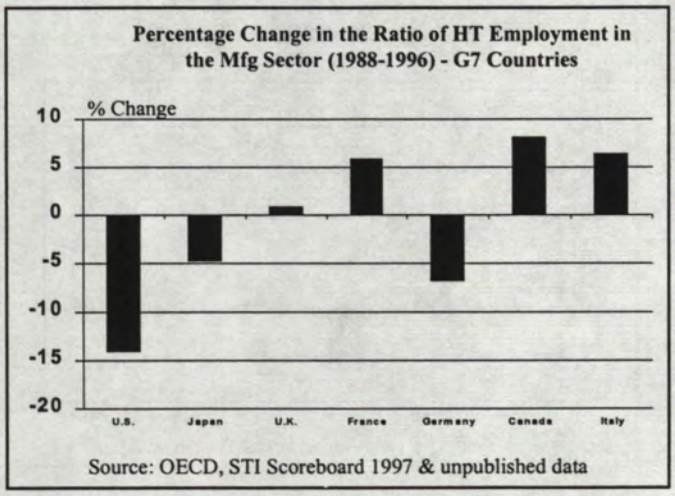

Figure 32

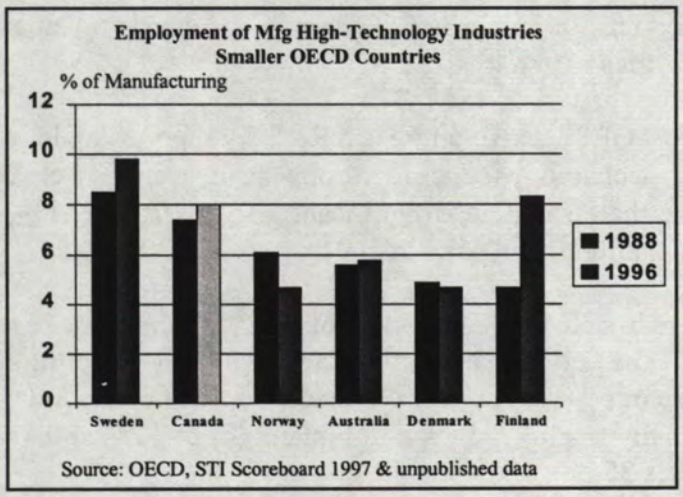

Figure 33

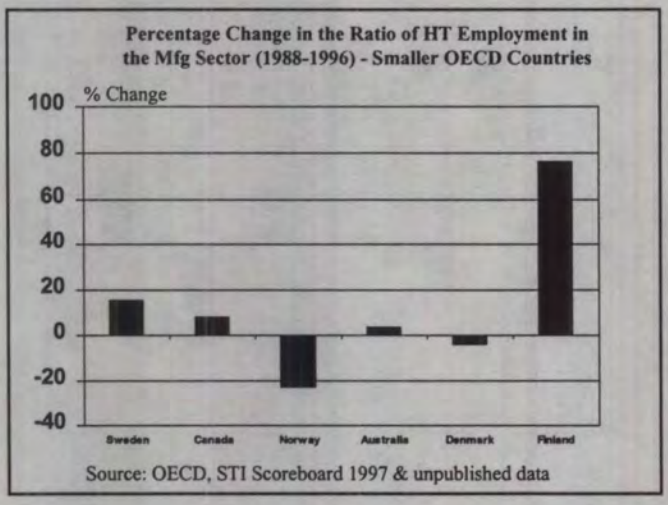

Figure 34

5.3 Share of OECD Research and Development Expenditures (Figures 35-38)

Given the relatively large size of the U.S. economy compared to those of other OECD countries, the U.S. accounted for a major proportion of research and development expenditures in all high-technology industries within the OECD.

While the U.S. share of OECD expenditures on R&D by high-technology industries as a group, and in individual high-technology industries, dropped substantially between 1988 and 1994 (Figure 35), they nevertheless remained significant, varying from 37.1% in communications - electronics to 67.1% in aircraft and parts in 1994.

The R&D shares of high-technology industries of other G7 countries - except for the U.S. - all increased during the same period, with that of Canada growing proportionally the most (Figure 35). Within the group of smaller countries, Canada's growth in this indicator (from 1.7% to 2.5%) was proportionally smaller than that of Finland (from 0.2% to 0.4%) and Sweden (from 1.0% to 1.7%) (Figures 35-36).

In terms of individual high-technology industries, Canada accounted for a higher share of OECD R&D than some G7 countries (based on the 1994 figures). For example:

- Canada's share was higher than that of the U.K. in the office, store and business machines industry (1.6% vs. 1.2%), in the communications - electronics industry (3.8% vs. 3.3%); and higher than that of Japan in the aircraft and parts industry (2.3% vs. 1.5%).

Within the group of smaller countries, Canada accounted for a higher R&D share than any other

country - in both the high-technology industries group and in the individual high-technology industries. The only exception was Sweden, which accounted for 2.3% of OECD's share in the pharmaceuticals industry, compared to Canada's share of 1.5%.

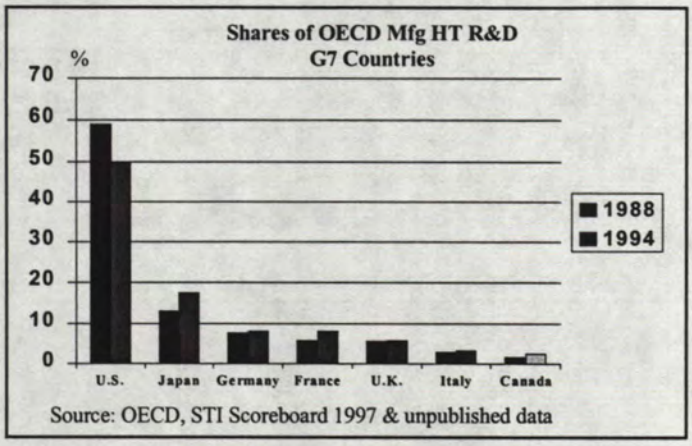

Figure 35

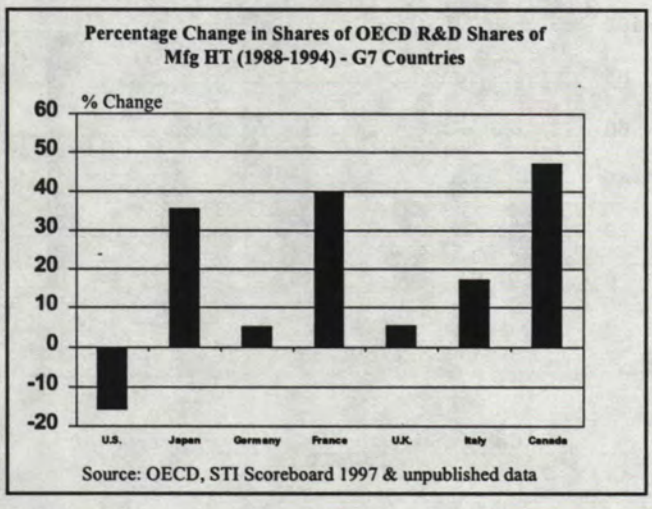

Figure 36

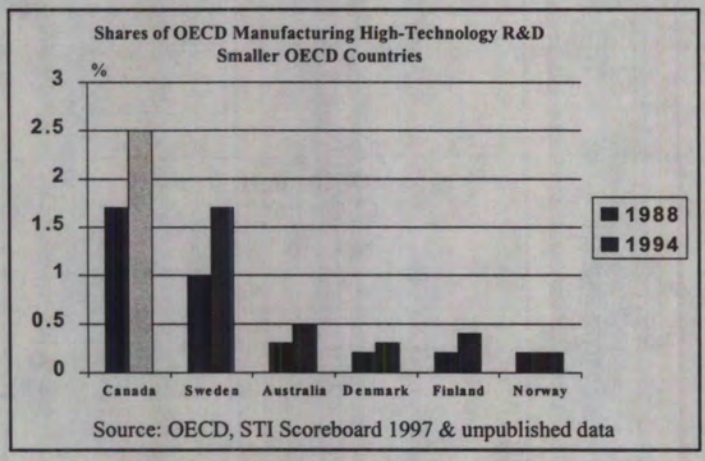

Figure 37

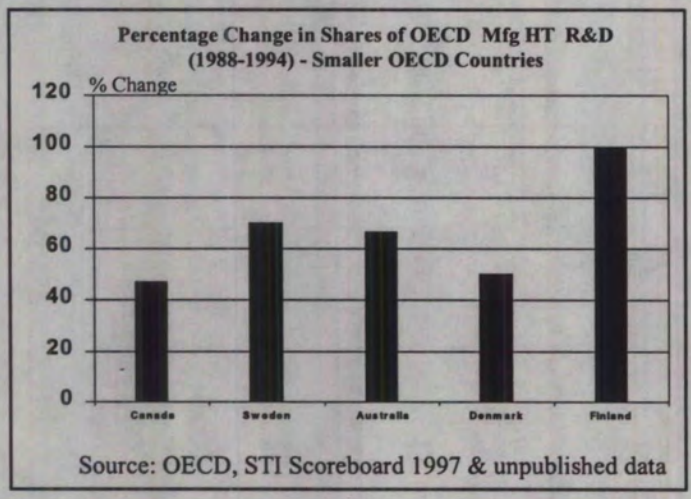

Figure 38

5.4 **Share of OECD Exports** (Figures 39-42)

The R&D intensity of an industry is often used as an indicator of its innovativeness. However, it does not convey any indication of the efficiency of the innovation process of this industry. Furthermore, this measure does not reflect non-technological innovation. However, a more appropriate indicator of the efficiency of the innovation process of an industry that is subject to international competition - such as high-technology industries - can be approximated by its export market share.

Viewed from the above perspective, Canadian manufacturing high-technology industries performed rather well in terms of innovation. Its share of the total OECD manufacturing high-technology exports market increased from 2.5% in 1988 to 3.1% in 1996, while those of the U.S., Japan, Germany, and Italy all decreased. The share of France increased from 7.0% to 8.4% while that of the U.K. increased slightly from 10.3% to 10.9%. The increase in the Canadian share is, furthermore, proportionally more significant than that of France (Figures 39-40).

With regard to the group of smaller countries, Canada's share of high-technology exports within the OECD surpassed Australia, Denmark, and Finland but trailed behind Sweden, which rose from 2.0% to 2.8%. Norway's share dropped slightly (Figures 41-42).

Canada's performance was even more remarkable when viewed by individual high-technology industries. In fact, Canada's share of OECD exports increased across the board between 1988 and 1998, while those of other countries increased in some industries and dropped in others. For example, the U.S. experienced an increase in its export share in communications - electronics, but a reduction in exports in the pharmaceuticals, office, store, and business machines, and aircraft and parts industries. Within the group of smaller countries, Australia and Finland were the only countries which experienced an across-the-board increase in their market shares.

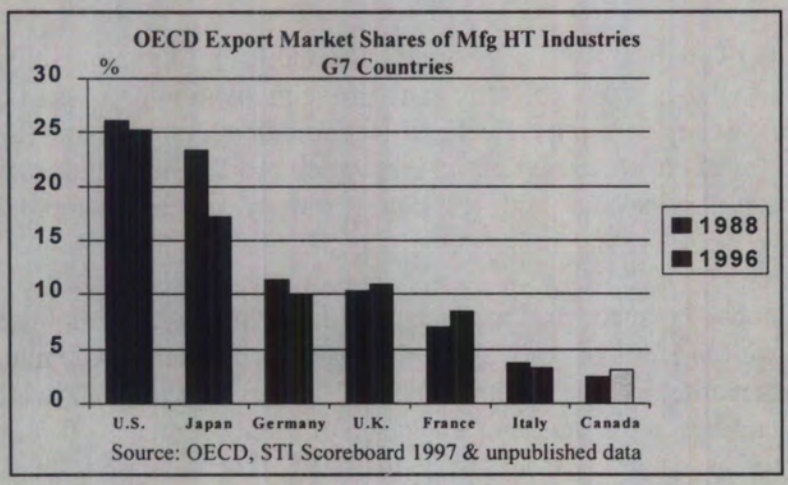

Figure 39

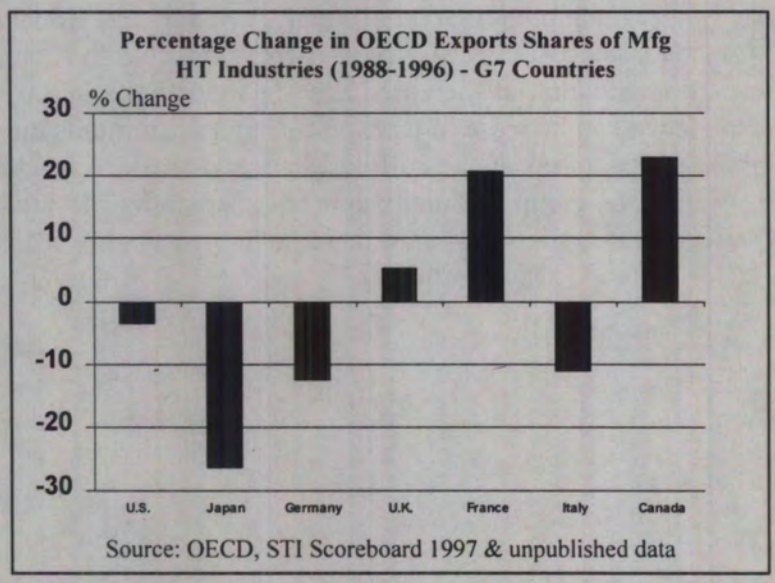

Figure 40

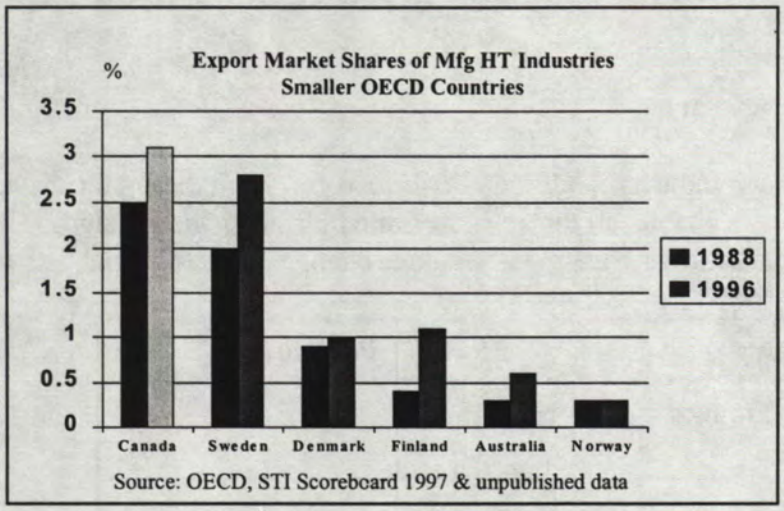

Figure 41

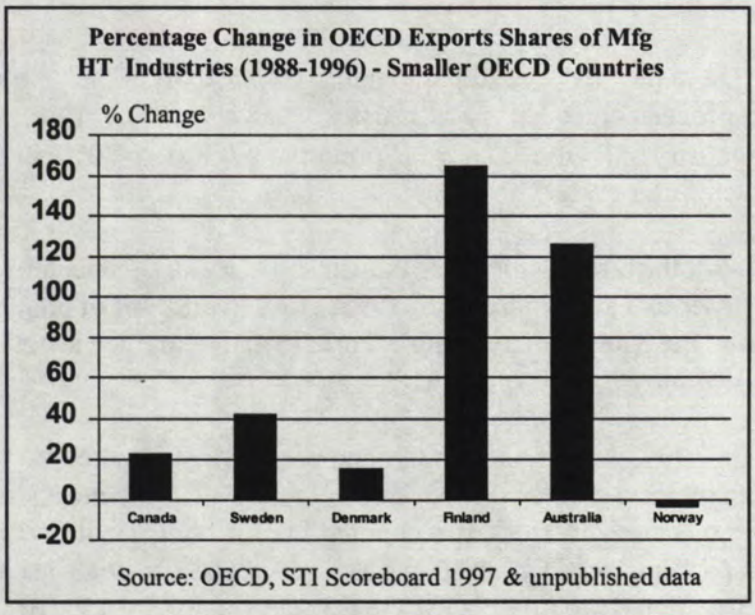

Figure 42

6.0 ANALYSIS OF INDIVIDUAL MANUFACTURING HIGH-TECHNOLOGY INDUSTRIES

6.1 Aircraft and Parts

The aircraft and parts industry in Canada performed very well during the decade 1988-1998. As shown in the following table, all the key economic indicators show a significant improvement during this period. Following are the percentage changes of these variables:

Variable	Period	Percentage Change
Gross Domestic Product (1992 prices)	1988-1998	33%
R&D	1988-1998	166%
Employment	1988-1998	20%
Wage Rate	1988-1998	40%

Source: Statistics Canada

The relative wage rate in the aircraft and parts industry compared to the whole manufacturing sector in Canada improved somewhat, from 126% in 1988 to 128% in 1996. However, employees in this industry still enjoyed a wage premium of close to 30% compared to the average wage in the manufacturing sector.

Most of employment in the aircraft and parts industry in Canada is concentrated in Montreal and Toronto, and, to a lesser extent, Winnipeg. In 1998, close to one half of employment in the industry (47%) was in the Montreal area, while Toronto and Winnipeg accounted for 26% and 7% of total industry employment, respectively.

Over the period 1988-1999, trade in the aircraft and parts industry increased substantially: exports grew by 255% while imports grew by 95%. The U.S. was by far the most significant trading partner of Canada in this area. In 1999, it accounted for 78% of Canadian exports and 55% of Canadian imports. The European Union (E.U.) as a group was Canada's second most important trading partner in aircraft and parts. In 1999, the E.U. accounted for 15% of Canadian exports and 35% of its imports.

The robustness of the Canadian aircraft and parts industry was underscored by a substantial increase in its share of R&D in the OECD, from 1.3% in 1988 to 2.3% in 1996. This represented a proportionate increase of 77%. Canada trailed behind Japan (88%) but was well ahead of the

increases registered by other G7 countries such as France (48%), Germany (67%), Italy (45%), the U.K. (54%), and the U.S, which experienced a decrease (15%).

Among the smaller countries, only Sweden registered a higher increase in the share of R&D in the aircraft and parts industry in the OECD, from 0.4% to 0.8% during the same period, or a proportionate change of 100% in this share.

In 1988, Canada accounted for 3.9% of total OECD exports in aircraft and parts. In 1996, this share increased to 5.1%, or a proportionate increase of 30% over 7 years. While this proportionate increase in Canada's exports share was lower than those registered by Japan (90%) and France (48%), it was far better than the proportionate decrease in the OECD exports shares experienced by Germany (4%), Italy (24%), the U.K. (24%), and the U.S. (6%).

Among the smaller OECD countries used for these comparisons, only Denmark experienced a drop (33%) in its share of OECD exports. Australia, Finland, Norway, and Sweden all experienced a higher increase in their exports share than that of Canada.

6.2 Communications - Electronics

The communications - electronics industry in Canada performed quite well during the decade 1988-1998. As shown in the following table, there was a substantial increase in key economic indicators in this industry. Following are the percentage changes of these variables:

Variable	Period	Percentage Change
Gross Domestic Product (1992 prices)	1988-1998	54%
R&D	1988-1998	147%
Employment	1988-1998	23%
Wage Rate	1988-1998	44%

Source: Statistics Canada

While the average weekly wage in the communications - electronics industry increased by 44% from 1988 to 1998, the wage premium enjoyed by workers in this industry improved significantly, from 12% to 16%.

Most of employment in the communications - electronics industry in Canada was concentrated in Toronto, Ottawa-Hull, and Montreal. In 1998, 18% of employment in the industry was in the Toronto area, 22% in Montreal, and 17% in Ottawa-Hull. Over the 1988-1998 period, employment in this industry in Toronto steadily dropped by 38%, while in Montreal it increased by 69%, and in Ottawa-Hull it increased by 105%.

Over the decade 1988-1999, trade in the communications - electronics industry increased substantially: exports grew by 393% while imports grew by 332%. The U.S. was by far the most significant trade partner of Canada in this area. In 1999, it accounted for 83% of Canadian exports and 49% of Canadian imports. Next to the U.S, Asia Pacific and the E.U. accounted for 5% and 7%, respectively, of Canadian exports. However, on the imports side, Asia Pacific replaced Japan as the second most important source of imports of the communications - electronics industry into Canada: Asia Pacific's share increased from 15% to 20%, while Japan's share dropped from 22% to 8% over the same period.

While the communications - electronics group was responsible for two-thirds of Canada's trade deficit in manufacturing high-technology industries, this deficit was mainly due to the deficit in electronic parts and components ($11.8 billion in 1999). The telecommunication equipment component of this group generated an increasingly significant trade surplus ($3.6 billion in 1999).

Canada's share of OECD R&D in the communications - electronics industry increased from 2.7% in 1988 to 3.8% in 1994 - a proportionate change of 41%. This change was second only to that of Italy - at 44% - and surpassed those of Japan (14%) and France (20%). On the contrary, the other G7 countries experienced a drop in this share: Germany (16%), the U.K. (28%), and the U.S. (13%).

Among the smaller OECD countries, Denmark's share of OECD R&D remained unchanged, while those of the other countries all increased substantially: Australia by 60%, Finland 100%, Norway 100%, and Sweden 53%.

In 1988, Canada accounted for 2.2% of total OECD exports in the communications - electronics industry. In 1996, this share had increased slightly to 3.1% - or proportionately by 41%. This compares very favourably with the increases experienced by the other G7 countries including France (25%), Italy (7%), the U.K. (47%), and the U.S. (28%). In contrast, there was a drop in the shares of Japan (36%) and Germany (16%).

Among the smaller OECD countries, Denmark's share dropped by 13% and Norway's share remained unchanged at 0.3% of total OECD exports, while those of the other countries all increased, including Australia (45%), Finland (170%), and Sweden (70%).

6.3 Office, Store, and Business Machines

The office, store, and business machines (OSB) industry in Canada had an uneven performance during the decade 1988-1998. As shown in the following table, there was an increase in value of shipments, gross domestic product (1992 prices), and R&D expenditures. However, there was a decrease in employment. Following are the percentage changes of these variables:

Variable	Period	Percentage Change
Gross Domestic Product (1992 prices)	1988-1998	419%
R&D	1988-1998	38%
Employment	1988-1998	- 27%
Wage Rate	1988-1998	63%

Source: Statistics Canada

The relative wage rate in the OSB machines industry compared to that of the whole manufacturing sector in Canada improved significantly, from 103% in 1988 to 122% in 1998. This improvement gave employees in this industry a wage premium of 22% compared to the average wage in the manufacturing sector in 1998.

Most of the employment in the OSB machines industry in Canada is concentrated in Toronto, Ottawa-Hull, and Montreal. In 1998, 41% of employment in the industry was in the Toronto area, while Ottawa-Hull and Montreal accounted for 12% and 7% of total industry employment respectively.

Over the period 1988-1999, trade in the OSB machines industry increased substantially: exports grew by 132% while imports grew by 102%. The U.S. was by far the most significant trade partner of Canada. In 1999, it accounted for 87% of Canadian exports and 50% of Canadian imports. The E.U. - with 7% of Canadian exports - was the second most import destination of Canadian exports in office, store, and business machines. On the imports side, after the U.S., Asia Pacific and Japan continued to be the most significant origins of imports. However, the relative positions of Asia Pacific and Japan in Canadian imports has reversed: while Japan's share remained unchanged at 12% during the decade of analysis, Asia's share more than doubled, from 10% to 24%. This trend underlined the steady shift of production facilities for computer equipment by U.S. producers to Asia Pacific.

Canada, Japan, and Germany were the only G7 countries which saw an increase in their shares of

OECD R&D in the OSB machines industry. France, Italy, the U.K., and the U.S. all experienced a drop in their shares. Canada's share increased from 1.4% to 1.6%, or an increase of 14% over the 1988-1994 period, compared to an increase of 41% and 67% in the shares of Japan and Germany respectively. The drop in the shares of France, Italy, the U.K., and the U.S., were respectively, 6%, 14%, 73%, and 10%.

Among the smaller OECD countries, the share of Norway dropped by 67% and that of Finland and Denmark remained unchanged, while the shares of Australia and Sweden increased more than that of Canada, by 50% and 20%, respectively.

In 1988, Canada accounted for 2.5% of total OECD exports in office, store, and business machines. By 1996, this share had increased slightly to 2.7% - or proportionately by 8%. While the shares of France and the U.K. increased by 4% and 10% respectively, those of Japan, Germany, Italy, and the U.S. dropped by 17%, 19%, 29%, and 10%, respectively.

Among the smaller OECD countries, the shares of Norway and Sweden dropped by 40% and 60%, respectively, while those of the other countries all increased: Australia by 123%, Denmark by 78%, and Finland by 117%.

6.4 Pharmaceuticals

Among the four manufacturing high-technology industries in Canada, the pharmaceuticals industry experienced the most significant growth during the decade 1988-1998. As shown in the following table, there was a quite significant increase in all the key economic indicators in this industry. Following are the percentage changes of these variables:

Variable	Period	Percentage Change
Gross Domestic Product (1992 prices)	1988-1998	31%
R&D	1988-1998	339%
Employment	1988-1998	60%
Wage Rate	1988-1998	54%

Source: Statistics Canada

The relative wage rate in the pharmaceuticals industry, compared to the whole manufacturing sector in Canada, rose appreciably. This led to an increase in the wage premium enjoyed by workers in the pharmaceuticals industry -- compared to the average worker in the manufacturing sector - from 13% in 1988 to 25% in 1998.

Most of employment in the pharmaceuticals industry in Canada was concentrated in Toronto and Montreal. In 1998, 49% of employment in the industry was in the Toronto area and 22% was in Montreal. However, while employment in this industry in Toronto steadily increased by 114%, that in Montreal dropped by 11% during the same period.

Over the period 1988-1999, trade in the pharmaceuticals industry increased substantially: exports grew by 626% while imports grew by 454%. The U.S., by far the most significant trade partner of Canada in this area, accounted for 66% of Canadian exports and 58% of its imports in 1999. Next to the U.S, the E.U. accounted for 14% of Canada's exports and 32% of its imports. Canada's trade with Asia Pacific and Japan were still insignificant.

Among all the countries in the comparison, Canada's share of OECD R&D in the pharmaceuticals industry registered the largest increase, from 0.9% in 1988 to 1.5% in 1994 - or by a proportionate change of 52%. This was far ahead of the changes registered by the U.K. (8%) and the U.S. (11%), and was in sharp contrast to the drop in the shares of other countries such as Japan (by 3%), France (7%), Germany (33%).

Among the smaller OECD countries, the shares of Denmark and Sweden increased by 25% and 21%, respectively, while those of Australia, Finland, and Sweden remained unchanged over the decade.

In 1988, Canada accounted for 0.6% of total OECD exports in the pharmaceuticals industry. By 1996, this share had increased to 0.9% - a proportionate increase of 50%. This was far ahead of the increases in the shares of Italy (30%) and the U.K. (8%), and was in sharp contrast to the drop in the shares of France (by 2%), Germany (14%), and the U.S. (30%).

Among the smaller OECD countries, the shares of Finland and Norway remained unchanged at 0.3% and 0.2% of total OECD exports, respectively, while those of the other countries all increased, including Australia (by 47%), Denmark (4%), and Sweden (31%).

7.0 CONCLUSION

This study has shown that during the period of analysis - 1988 to1998 - the Canadian manufacturing high-technology industries were very dynamic and fast-growing compared to the whole manufacturing sector in Canada. All the economic indicators used to measure the performance of these industries - gross domestic product in 1992 prices, research and development expenditures, employment, and wage rate - showed substantial growth.

With regard to trade, these industries accounted for an ever-increasing proportion of both Canadian merchandise exports and imports. Among the four industries studied, communications - electronics emerged as the key trading industry, followed by pharmaceuticals, aircraft and parts, and office, store, and business machines.

Among Canada's trading partners in manufacturing high-technology industries, the U.S. remained the most significant partner, accounting for 81% of Canada's exports and 51% of its imports in 1999. In 1988, Canada had a $4 billion trade deficit with the U.S. However, by 1999, this had changed to a $741 trade surplus. On the other hand, Asia Pacific countries, as a group, became a more and more important trading partner of Canada in this area, mostly in the communications and office, store, and business machines areas. Canada's trade deficit with this region grew substantially, from $1 billion to $7 billion, during the same decade.

Canadian manufacturing high-technology industries accounted for 8.6% of total manufacturing employment in the country - or 183,000 employees - in 1988. By 1998, this proportion had increased to close to 10% of the sector total, or 211,000 employees. Among the four high-technology industries, communications - electronics led the group in employment with 78,000 employees in 1998, followed by aircraft and parts (63,000), pharmaceuticals (41,000), and office, store, and business machines (32,000). However, employment in the pharmaceuticals industry grew the fastest (60%) from 1988 to 1998, followed by communications (23%), and aircraft and parts (20%). On the contrary, employment in the office, store, and business machines industry dropped by over 27% over the same period.

While the manufacturing high-technology industries were the focus of this study, employment in the computer service industry was also considered, since this industry is closely linked with the manufacturing high-technology industries. In 1988, employment in the computer services industry was equal to about one-third the level of employment in the manufacturing high-technology industries as a group. Due to a substantial growth in computer services, the employment levels in the two groups became equal by 1998.

Toronto, Montreal, and Ottawa-Hull are by far the most important employment centres in manufacturing high-technology and computer service industries in Canada. In the period 1988-1998, the average annual growth rates of employment in the combined industries were highest in

Edmonton and Calgary, followed by Ottawa-Hull, Vancouver, Winnipeg, Montreal, Kitchener-Waterloo, and Toronto.

On the international scene, the performance of Canadian manufacturing high-technology industries compared very favourably with that of the industries in other OECD countries. Regarding the growth in value added, percentage of manufacturing employment, and shares of OECD R&D and exports, on the whole, the performance of Canadian high-technology manufacturing industries surpassed that of the other G7 countries but trailed behind some smaller countries, including Finland and Sweden, and, to a lesser extent, Australia and Denmark

8.0 OPTIONS FOR FUTURE ANALYSIS

With a clear picture of the profile of the manufacturing high-technology industries in Canada, a number of policy questions can be raised. Following are some examples:

- Human Resources

  Given that there has been very strong growth in employment in the pharmaceuticals and in communications - electronics industries, and, to a lesser extent, in the aircraft and parts industry, what policy should be developed to ensure that the demand for labour in these industries will be met in the future?

- Regional Development

  Since Western Canada had shown growth potential in manufacturing high-technology industries, and in the computer services industry, what policies are required to help ensure further development of this potential ?

- Development of Specific Industries

  The study showed that the pharmaceuticals industry was growing fastest in Toronto; the aircraft and parts industry and the communications - electronics industry in Montreal; and the communications electronics industry and the office, store, and business machines industry in the Ottawa-Hull area. What specific policies are required to promote further growth of these industries ? Should the other regions of Canada be assisted in developing these industries, especially a "foot-loose" industry such as the computer services industry?

- Industrial Clusters

  In view of the recent employment trends in the manufacturing high-technology industries and the computer services industry, what conclusions can be drawn from the growth potential of specific metropolitan areas in Canada ?

- R&D

  The results of the international comparisons showed that within the OECD, Canadian manufacturing high-technology industries became relatively more and more R&D-intensive. To what extent this can be attributed to government policies, and what can be done to further develop this capacity ?

- Canada vs. U.S. Comparison

  A recent Statistics Canada study shows that multifactor productivity in the U.S. electrical and electronic products industry - one of the manufacturing high-technology industries - grew faster than that of its Canadian counterpart (Statistics Canada, 1999). It would be interesting to examine the factors responsible for this productivity gap, and also to look into the situation in the other manufacturing high-technology industries.

- Trade

  With the emergence of Asia Pacific countries as an increasingly important trading partner for Canada in manufacturing high-technology, are there barriers to trade, especially the non-tariff ones, that must be overcome to further expand Canada's trade with these countries ?

- Computer Services

  Another area that may merit further analysis is Canada's trade in computer services. Although this study has identified the computer services industry as having achieved substantial employment growth, it did not investigate the potential of this industry in the trade area. A detailed analysis of this issue may reveal the regions where Canada has the potential to increase its trade in computer services, and whether there is any way to further promote Canada's trade in this industry.

Appendix A

DEFINITIONS OF MANUFACTURING HIGH-TECHNOLOGY INDUSTRIES

High-Technology Industries, High-Technology Firms, or High-Technology Products?

A great deal of work has been devoted to the issue of measuring high-technology trade (Ministry of State for Science and Technology, 1985; House of Commons, 1992; McGurkin *et al*, 1992; Doyletech, 1995; Davis, 1995, 1996; Le, 1998). However, a profile of Canadian manufacturing high-technology industries, and how they have performed in the last several years has not been dealt with at length. Recent works have attempted to shed some light on this issue; they include reports prepared by the Bank of Nova Scotia (1997) and the Government of British Columbia (1997). While succeeding in focussing public attention on this important segment of Canadian industry, these works were based on non-standard definitions of high-technology industries; thus, their results are not comparable. There are several definitions of "high-tech".

The term *high-tech* was originally used in the 1970s to denote "a style of interior decor which favoured high-quality industrial furniture and fittings, such as metal factory shelves and tubular steel shelving, to imitate the hard metallic surfaces and textures of the industrial and technological environment". This term was also used to describe "a style of modern architecture, which regards architectural design as a branch of industrial technology" (Brewer, 1992).

Later on, it took on a new meaning in denoting "any technology requiring the most sophisticated scientific and engineering techniques, as microelectronics, data processing, genetic engineering, or telecommunications" (Random House, 1987). The term *high-technology* currently used in the media reflects this last meaning.

The U.S. Department of Commerce formalized the use of this term with the establishment of its definition of high-technology industries called the DOC-2 List. This was later revised to become the DOC-3 List, which was subsequently supplemented in 1990 by a definition based on products (as opposed to industries) called the Advanced Technology Products (ATP) List.

The U.S. Department of Commerce uses the DOC-3 List in many of its economic analyses, but regularly publishes its high-technology trade data based on the ATP classification (Davis, 1996; McGuckin *et al*, 1992).

Since 1980, the OECD has been using a system in which industries are classified into high-technology, medium-high technology, medium-technology, medium-low technology, and low technology, based on their R&D intensity - a proxy for their technology intensity (the sectoral approach). In 1997, the OECD proposed to add another classification based on the R&D intensity of products (the product approach).

A full discussion of these classifications can be found in another Industry Canada report (*op. cit.*, Le, 1998).

The use of R&D intensity as a criterion for determining the *technology content* of an industry or a product is open to debate: Is this a suitable criterion? Is it related to technology use or technology production? The OECD had experimented with various criteria to identify the technology content of an industry but, except for R&D intensity, other criteria were eventually dropped due to the lack of data for their quantification (OECD, 1997). Recently, the use of R&D intensity as an indicator of technology content of an industry has been subject to criticism because: (i) it is only a partial measure; (ii) it treats advanced capabilities as being unidimensional; and (iii) it ignores the fact that industries are not homogenous; hence, an indicator -- the R&D intensity -- which is based on the characteristics of larger firms does not accurately account for the role of small firms in introducing new technologies (Baldwin, 1998). The point made here is that the level of technology within an industry may vary from firm to firm. Therefore, it is argued that there may be *high-technology, medium-technology, and low-technology firms*, rather than *high-technology, medium-technology, and low-technology industries*.

While it is true that firms in any one industry may not have the same level of technology, this is only a short-term phenomenon, because in a free-market competition, those that are technologically backward will eventually be eliminated. Furthermore, the term "high-technology" has widely been used to denote certain specific industries employing sophisticated computer-based technology, including computer hardware, telecommunications, aircraft, and pharmaceuticals. All that the U.S. Department of Commerce, and later on the OECD, did was to try to quantify this definition by tying it to the R&D intensity of industries. In other words, the commonly used definition has become so entrenched that little is gained by debating about its appropriateness.

Components of Manufacturing High-Technology Industries

For the purposes of this study, the OECD sectoral definition is used. Therefore, the following industries - under both the OECD classification (Revision 2) and Statistics Canada's 1980 Standard Industrial Classification - are considered as high-technology:

OECD Definition		*Statistics Canada*	
Industries	ISIC (Rev. 2)	SIC (1980)	
Aerospace	3845	Aircraft and Parts	
		Aircraft and parts	3211
Electronics-communications	3832	Communications - Electronics	
		Record player, radio, and television receivers	3341
		Telecommunication equipment	3351
		Electronic parts and components	3352
		Other communication and electronic equipment	3359
Computers, office machinery	3825	Office, Store, and Business (OSB) Machines	
		Office & computing machinery Electrical computing and peripheral equip.	3361
		Electronic office, store, and business machines	3362
		Other office, store, and business machines	3369
Pharmaceuticals	3522	Pharmaceuticals	
		Drugs & medicines	3741

High-Technology and Knowledge-Based Industries

After the term *high-technology*, perhaps the most common term which is lately used to categorize industries is "knowledge-based". In an attempt to conduct a quantitative assessment of high-knowledge versus low-knowledge industries, Lee and Has (1995) classified 55 Canadian industries into the high, medium, and low-knowledge sectors on the basis of R&D, education, and occupational data. All the high-technology industries considered in the present study fall into the *high-knowledge* group. Other manufacturing *high-knowledge* industries include: scientific and professional equipment, electrical power, other chemical products, machinery, refined petroleum and coal products. This high-knowledge group also includes several service industries such as computer and related services, engineering and scientific services, management consulting services, educational services, health and social services, pipeline transportation, and other business services. Lee and Has' study is useful to the extent that it provides an alternative view of industries, based on criteria other than R&D intensity. Therefore, this study is supplementary - and not contradictory - to their effort, in that it provides a focus on those industries within the high-knowledge intensive group which are commonly known as "high-technology".

Appendix B

List of Asia Pacific Countries/Economies

For the purpose of this report, the following countries/economies are included in the list of Asia Pacific countries:

1. Australia
2. China
3. Hong Kong
4. India
5. Indonesia
6. Malaysia
7. Singapore
8. South Korea
9. Taiwan
10. Thailand

List of Member Countries of the European Union (1999)

1. Austria
2. Belgium
3. Denmark
4. Finland
5. France
6. Germany
7. Greece
8. Ireland
9. Italy
10. Luxembourg
11. Netherlands
12. Portugal
13. Spain
14. Sweden
15. United Kingdom

BIBLIOGRAPHY

Baldwin, John, "Are there High-Tech Industries or Only High-Tech Firms ? Evidence from New Technology-Based Firms," Statistics Canada Research Paper, 1998

Brewer's Dictionary of the 20th-Century Phase and Fable, Houghton Mifflin Company - Boston, 1992

British Columbia Information, Science and Technology Agency (1997), *The British Columbia High Technology Sector, 1988-1995*

Davis, Lester A., "The U.S. Experience with High-Technology Trade Statistics," paper presented at the CATA/Industry Canada Workshop on High-Technology Trade Statistics, Ottawa, October 19, 1995

Davis, Lester A. "U.S. Jobs Supported by Goods and Services Exports, 1983-1994 – Including Special Focus on Exports by High-Technology Industries," Economics and Statistics Administration, U.S. Department of Commerce, November 1996

Doyletech, "Canada's Trade Performance in Advanced Technology Products," report prepared for Industry Canada, September 1995

House of Commons, *Minutes of Proceedings and Evidence of the Standing Committee on Industry, science and Technology, Regional and Northern Development*, Issue No. 22, Thursday May 21, and June 2, 1992

Le, Can D., "Canadian Trade in High-Technology Industries and products: An Analysis of Measurement Methodologies," research paper, Innovation Policy Branch, Industry Canada, May 1998

Lee, Frank and Handan Has, "A Quantitative Assessment of High-Knowledge Industries Versus Low-Knowledge Industries," *The Implications of Knowledge-Based Growth for Micro-Economic Policies*, Peter Howitt ed., Industry Canada Research Series, University of Calgary Press, 1996, p.p. 39-81

McGurkin, Robert, Thomas Abbott, Paul Herrick, and Leroy Norfolk, "Measuring Advanced Technology Products Trade; A New Approach," *Journal of Official Statistics*, Vol. 8, No. 2, 1992, p.p. 223-233

Ministry of State for Science and Technology, Government of Canada, *Canadian Trade in High-Technology: An Analysis of Issues and Prospects*, Ottawa, August 1985

OECD, *Revision of the High-Technology Sector and Product Classification*, Cat. No. DSTI/IND/STP/SWP/NESTI (97)1, June 1997

Random House Dictionary of the English Language, Second Edition, 1987

Slasor, Janet and Tim Whitehead, "Focus on Canada's Major Urban Centres", *Provincial Pulse*, Scotiabank Report, August 25, 1997

Statistics Canada, *The Daily*, Tuesday March 23, 1999