Author - Industry Canada

Publication Date - 1997-06-30

Sector Competitiveness Framework

Telecommunications Equipment Industry

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Foreword

The new Canadian marketplace is expanding from national to global horizons and its economic base is shifting increasingly from resources to knowledge. These trends are causing Canadian industries to readjust their business approaches, and government must respond with new tools to help them adapt and innovate. Industry Canada is moving forward with strategic information products and services in support of this industry reorientation. The goal is to aid the private sector in what it is best qualified to do - create jobs and growth.

Sector Competitiveness Frameworks are a series of studies published by Industry Canada to provide more focussed, timely and relevant expertise about business and industries. They identify sectors or subsectors having potential for increased exports and other opportunities leading to jobs and growth. During 1996 and 1997, they will cover 29 of Canada's key manufacturing and service sectors.

While they deal with "nuts and bolts" issues affecting individual sectors, the Sector Competitiveness Frameworks also provide comprehensive analyses of policy issues cutting across all sectors. These issues include investment and financing, trade and export strategies, technological innovation and adaption, human resources, the environment and sustainable development. A thorough understanding of how to capitalize on these issues is essential for a dynamic, job-creating economy.

Both government and the private sector must develop and perfect the ability to address competitive challenges and respond to opportunities. The Sector Competitiveness Frameworks illustrate how government and industry can commit to mutually beneficial goals and actions.

The Sector Competitiveness Frameworks are being published sequentially in two parts. An initial Overview and Prospects document profiles each sector in turn, examining trends and prospects. The follow-up Framework for Action draws upon consultations and input arising from industry-government collaboration, and identifies immediate to medium-term steps that both can take to improve sectoral competitiveness.

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Telecommunications Equipment Industry SCF

Highlights

Distinguishing Characteristics

The telecommunications equipment industry comprises manufacturers of equipment used for the transmission, switching and distribution of voice, data and video information. The industry's principal customers are telecommunications common carriers, but business and residential purchasers of terminal equipment and private networks have also become an important market segment.

In 1995 the Canadian telecom equipment industry had shipments valued at $9 billion, representing 2.3% of the manufacturing total. More than half all shipments are exported, with the majority of these destined for the U.S. market. The 44,000 workers employed by the industry accounted for more than 2.5% of all manufacturing employment. The industry is concentrated in Ontario. While there is a high degree of Canadian ownership in telecommunications equipment manufacturing, a significant component of the industry consists of subsidiaries of foreign-based multinationals.

There is significant diversity within the industry. The largest Canadian firm, Northern Telecom (Nortel), is a large vertically integrated firm with worldwide revenues of $17.5 billion and Canadian-based operations that are almost ten times the size of the country's second biggest producer. There are about 30 medium-sized Canadian firms with revenues between $100 million and $1 billion, and about 300 smaller companies which serve as specialist component suppliers or software developers.

The Canadian telecommunications equipment industry is the most R&D -intensive industrial sector in Canada. R&D expenditures exceed 15% of the value of shipments, as compared to under 2% for manufacturing as a whole. R&D employment represents a substantial share of total industry employment. While large firms account for most R&D investment, smaller firms commit the greatest share of revenues to R&D.

Telecommunication equipment manufacturing belongs to the family of industries that comprise the information and communications technologies (ICT) sector and that together accounted for 6.9% of total GDP in 1995. Developments in telecommunications equipment have contributed to the dramatic improvements in information technology that are transforming many aspects of life and facilitating the introduction of new, more efficient systems of business organization and operation.

Major Trends

Real shipments of telecommunications equipment increased at an annual average rate of 6.6% between 1981 and 1995, with the most rapid growth occurring over the first half of this period. Since 1981, the industry has lost market share within Canada - the decline being particularlymarked over the 1990s. Exports have also grown strongly, however, and there was a significant $634.3 million trade surplus in Canada's telecommunications trade in 1995. The recent growth in imports and exports partly reflect the impact of the Free Trade Agreement,

which has added momentum to the process of Canada-U.S. market integration.

R&D investment far exceeds capital spending by Canadian telecom manufacturers and real R&D investment has increased significantly over time. This has been accompanied by a growth in the proportion of workers involved in R&D, and an increase in the industry's requirement for highly trained professional workers.

Between 1981 and 1994, labour productivity in telecommunications equipment increased at an average annual rate of 7.2%, which is significantly above the rate for all of manufacturing. The industry ranks high in terms of its rate of adoption of advanced manufacturing technologies. Productivity growth also reflects the impact of the consolidations and major restructurings which have occurred within the industry in recent years. One of the most important developments has been the consolidation of Nortel's Canadian operations from 20 manufacturing plants to 4 four world-scale facilities.

Strong R&D spending and increasing productivity have helped the Canadian industry contend with the major structural changes that are underway worldwide. The overcapacity that has built up in the world market is putting pressure on profit margins in many product areas. Rapid technological change is eroding the boundaries between telecom manufacturing, consumer electronics and computer hardware and software production. The industry is seeing a growth in demand for products that can facilitate service delivery on the Information Highway, but it is also facing uncertainties about the outcome of competition between alternative telecom technologies.

The global market for telecommunications is expected to grow significantly over coming years. In addition, increasing market liberalization is improving market access in a number of formerly restricted markets. The strongest areas of market growth are expected to continue to be in the areas of wireless and data communications equipment. The overall demand for telecommunications is growing most rapidly in Latin America and Asia, and the latter region is expected to become the largest market for telecommunications equipment by the turn of the century.

Policy Links

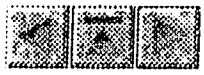
Canadian firms are well placed to participate in the expected growth in worldwide demand for telecom equipment. To achieve success, however, producers must build on the technological capabilities that have been a major source of their competitive strength. They must also strive to improve their competitiveness in the more dynamic regional and telecommunications equipment product markets.

Government can support the industry's efforts to address these challenges. In a number of areas,government policies have significantly assisted telecom equipment manufacturers. Through the Scientific Research and Experimental Development tax credit, the government has supported the industry's investment in the development of new technology. The federal government has also supported research and development by providing assistance for university research and establishing Networks of Centres of Excellence in telecom technology; and by maintaining the Communication Research Centre (CRC) as a source of information and expertise on information technology.

The potential benefits of alliances and other co-operative arrangements among telecom manufacturing firms have been given recognition through initiatives of the CRC and CANARIE. In addition, the federal government has promoted the establishment of pre-competitive alliances through the Strategic Technologies Program, now sunsetted.

Government trade and telecommunications policies have supported the trend towards a more competitive market environment. The Canada-U.S. Free Trade Agreement improved the access of Canadian firms to the large U.S. market, while the more recent North American Free Trade Agreement has reduced barriers impeding Canadian sales to the rapidly expanding Mexican telecommunication equipment market. The government has also helped Canadian firms to win sales in some emerging economies through the provision of competitive export financing.

A recent review initiated by Human Resources Development Canada highlights the need for greater attention to human resource planning and management. Strategies are needed to ensure the future supply of qualified people and to help workers cope with the impacts of re-structuring in the industry. Here, as in other areas, government can play an important facilitative role, but Canadian firms, individually and in concert, must implement the measures that will contribute to success in this highly competitive industry.



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Telecommunications Equipment Industry SCF

Key Points

The telecommunications equipment industry comprises manufacturers of equipment used for the transmission, switching and distribution of voice, data and video information. The data collected by Statistics Canada under Standard Industrial Classification (SIC) codes 3351 (Telecommunications Equipment Industry) and 3359 (Other Communications and Electronics Equipment Industry) cover the producers being examined in this SCF, but the correspondence is not perfect. SIC 3359 contains the important wireless equipment subsector, but it also contains firms that are the outside telecommunications equipment industry proper (i.e. producers of broadcast equipment, signalling devices, flight simulators and radar and navigational equipment). At the same time, establishments such as the Nortel Technology Laboratories in Ottawa, whose primary activity is R&D, are excluded from the data collected under these two SICs.

Global Context

In 1995, the world market for telecommunications equipment was estimated at U.S.$ 168 billion, up 10% from 1994 and almost 70% from 1990. [. World industry data has been derived from a number of independent sources, the principal being Decision Resources Inc. "The World Market for Telecommunications Equipment, 1995", and "The New Era Begins: The State of the World Telecommunications Industry ", December 1996, both by Kenneth S. Hoyt.] North America has historically been the largest market, followed by Europe and Asia. Europe is expected to overtake North America over the next year, and Asia is projected to become the largest telecom equipment market by the turn of the century. This will result in three nearly equal-sized markets, all with strong indigenous suppliers and technology.

The principal purchasers of telecommunications equipment are the carriers (mainly telephone companies) offering communications services to businesses and residences. Carriers world-wide provide annual services exceeding U.S.$ 600 billion and estimated to be growing at about 8% per year. A secondary but growing market exists for end-user equipment. Extensive deregulation, permitting telecommunications' users to own their own equipment, has led to the development of a strong market comprising residential and business customers.

Worldwide, the fastest growing segments of the industry are wireless communications and data communications equipment. The strength of the former reflects the popularity of cellular and mobile communications, while the growth in data communications reflects the impact of globalization in increasing corporations' need for information transfer. Wireless communications, while representing only 20% of telecom equipment revenues in 1993, accounted for about half of world market growth between 1993 and 1995.

Seven companies with annual revenues in excess of $U.S. 10 billion account for 60% of global sales. Three of these major telecom equipment producers are based in North America (Northern Telecom, AT&T), three in

Europe (Alcatel, Siemens, Ericsson), and one in Asia (NEC). The top 25 firms, of which 8 are based in the U.S. and 6 in Japan, account for 85% of global revenues.

North American Context

The Canadian and U.S. telecommunications equipment markets have become increasingly integrated. Recent agreements eliminating most barriers in telecommunications trade between the two countries have added momentum to a process that has been underway for many years, and has involved the establishment of common equipment standards and the gradual reduction of regulatory restrictions in telecommunications. The U.S. market accounts for just over 60 percent of Canada's trade in telecommunications equipment.

Market integration is also reflected in patterns of foreign direct investment. The leading Canadian-based telecom equipment supplier, Nortel, invested in the U.S. initially to take advantage of the opportunities provided by market liberalization. It is now the second-largestequipment supplier in that country. Similarly, the more recent liberalization of the Canadian telecommunications sector has attracted significant direct investment by U.S.-based equipment suppliers.

Mexico has become a significant market for Canadian telecommunication equipment products. Between 1988 and 1993, Canadian exports to Mexico increased from under $Cdn. 3.5 million to over $60 million. The North American Free Trade Agreement has further improved the prospects for Canadian sales. Moreover, this agreement is being implemented as Mexico plans a major expansion of its telecommunications network, which is to include an increase in telecommunications access from the current 8.7 lines per 100 inhabitants to 20 mainlines per 100 inhabitants by the year 200 .

Snapshot of the Canadian Telecommunications Equipment Industry

The origins of Canada's telecom equipment industry can be traced back to 1874, the year the telephone was invented and Alexander Graham Bell contracted with a Brantford tinsmith to manufacture telephones. From that modest beginning, a major knowledge-intensive industry has evolved that has become an important source of employment and significant contributor to the living standards of Canadians.

For the first 100 years of its existence, the industry operated in a stable environment, characterized by heavy government regulation of telecommunications services, significant trade barriers, and relatively slowly changing technology. The gradual unwinding of telecom regulation that began in Canada in the mid-'70s and the reduction in international trade barriers through the 1980s transformed the environment within which telecom equipment firms operate. In the recent period, the industry is being confronted with a continuation of the worldwide process of market liberalization, along with dramatic technological changes that are eroding the boundaries between the industries that participate in various facets of the information technology sector.

The entire information and communications technologies sector accounts for 6.9% of GDP and an estimated 3% of total employment (based on 1995 data). As can be seen from Figure 1, communications equipment accounts for about 40% of Canada's gross production of information technology (IT) hardware. The latter, in turn, comprises approximately 37% of the output of Canada's information technology sector. IT hardware is slightly smaller than the IT software and computer service component of the sector and somewhat larger than the component consisting of the services of telecommunications carriers.

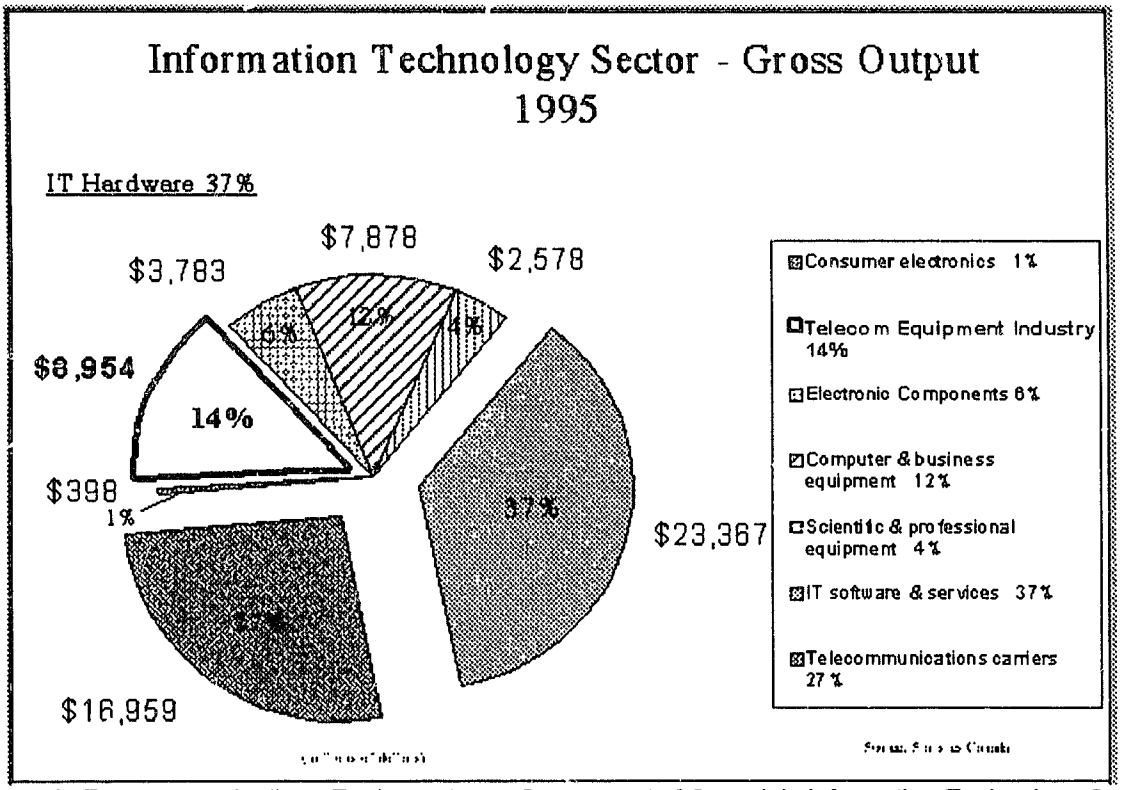

Figure 1: *Telecommunications Equipment as a Component of Canada's Information Technology Sector*

In 1995, the $9 billion shipments of the Canadian telecom equipment industry represented 2.3% of total manufacturing shipments. The 259 establishments engaged in producing telecom equipment employ around 42,000 workers, or about 2.5% of all manufacturing workers. Just over half of total shipments of telecom equipment are exported, and in 1995 this accounted for 1.7% of total Canadian exports.

To understand the contribution of the telecommunications equipment industry, it is also necessary to take account of its important role as a source of innovation. As is elaborated on below, telecommunications equipment accounts for a significant share of all manufacturing R&D. Technological developments in telecommunications equipment have played a role in the broader information revolution that is transforming many aspects of life and facilitating the introduction of new and more efficient systems of business organization and operation.

The two major categories of telecom production are wireline and wireless equipment (Figure 2). Wireline equipment, which accounts for almost 84% of Canadian production, can be subdivided into public network equipment and customer premises equipment. The former is aimed primarily at the common carrier market and includes switching, transmission (excluding broadcasting) and test equipment. Customer premises equipment consists of a broad range of products marketed tobusiness and residential customers. It includes telephone sets (including cordless), telephone answering machines, data communications equipment (modems, multiplexors, fax equipment, routers, hubs, packet equipment and ATM equipment), private branch exchanges (PBXs) and key telephone systems (KTSs).

Wireless equipment consists of mobile and satellite communications systems. Mobile communications, which includes cellular telephone and mobile paging equipment, is a small but rapidly growing market segment.

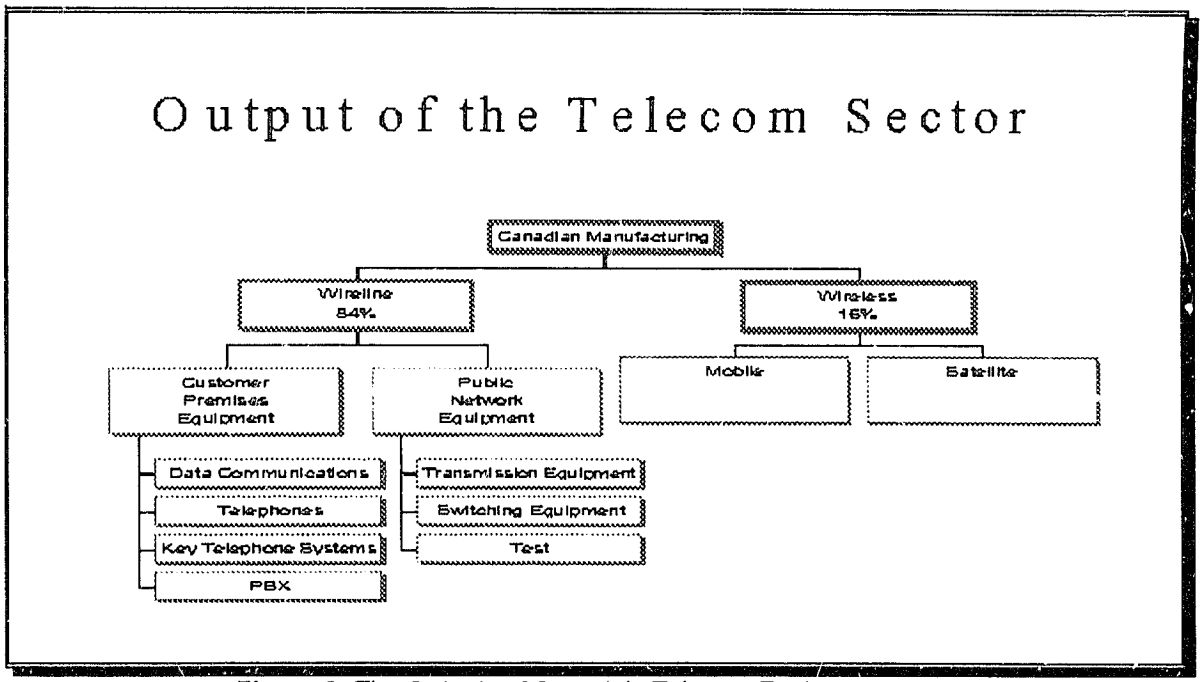

Figure 2: *The Outputs of Canada's Telecom Equipment Sector*

Industry Structure

There is considerable diversity within the Canadian telecom equipment industry. The largest Canadian firm, Nortel is a large vertically integrated firm with worldwide revenues of over $17.5 billion (1996) and worldwide employment of 68,000. Nortel manufactures a wide range of products, but its core business is in public switching products. Although just under a third its workforce is located in Canada, in size, Nortel's Canadian-based operations are still almost ten times those of Canada's second biggest producer, Newbridge Networks. Newbridge employs 2500 workers in Canada and 3400 workers worldwide. Among the world's top 50 telecom equipment manufacturers, Nortel ranks seventh in size and Newbridge thirty-fifth.

There are about 30 medium-sized Canadian firms with annual revenues of between $100 million and $1 billion. This group includes Mitel, Gandalf, SR Telecom and a number of subsidiaries of multinational enterprises. As distinct from the large vertically integrated producers, these firmshave more specialized product lines that derive from the development of new technologies or new applications. In addition, there are close to 300 small companies which serve as specialist component suppliers or software developers. It is estimated that the top 30 companies account for over 90% of total industry revenue. While about half the members of the industry are smaller companies with revenues between $1 million and $10 million, these firms account for only about 5% of industry revenues.

There is a high degree of Canadian ownership in the industry. The larger telecom equipment firms are domestically-controlled and most small, specialized firms are Canadian-owned. An important segment of the Canadian-based industry, however, consists of subsidiaries of foreign multinationals. Major world producers such as Motorola (2nd in the world in terms of global revenues), Ericsson (4th), Siemens (5th), Harris (33rd) and Tellabs (37th) have a presence in Canada, although more often the emphasis of their Canadian affiliates is on research and development rather than manufacturing.

Over 90 percent of the industry's activities are located in Ontario and Quebec. There is a small but growing pocket of expertise in telecom equipment production in British Columbia (MDA and Glenayre, for example) and Alberta (Nortel, Harris and JRC Canada). Telecom production also occurs in Nova Scotia, Manitoba, and Saskatchewan. The latter group of facilities had been operated by Northern Telecom, which until recently had operations in all provinces, but they now operate under new ownership.

Many telecom equipment manufacturers belong to the Canadian Advanced Technology Association (CATA) and the Information Technology Association of Canada (ITAC). These associations represent telecom equipment producers and firms in other industries that share an interest in the development of advanced

technology. CATA's mission is to stimulate business growth through R&D and strategic partnerships over the full range of technology sectors, including telecommunications equipment ITAC, as a national association for the information technology sector, focuses on government policy and various other factors affecting the growth and profitability of firms producing computer and telecommunications hardware, software and services.

Technology and Human Resources

Due to the significance of advanced technology in telecommunications and because Canadian firms must be innovative to succeed in highly competitive global markets, the Canadian industry invests heavily in R&D. Indeed, the Canadian telecommunications equipment industry is the most R&D-intensive industrial sector in Canada. R&D expenditures in telecommunications equipment exceed 19 percent of the value of shipments, as compared to under 2 percent for manufacturing as a whole. One of the fruits of Canada's heavy commitment to research has been the development of advanced digital switching systems which place Canadian firms in the forefront of this important market segment. While large firms, and especially Nortel (which invested $US 1.6 billion worldwide on R&D in 1996) account for most R&D spending, a recent analysis indicatesthat smaller firms (i.e. with sales under $10 million) commit the largest share of revenues to R&D [. Statistics Canada "Industrial Research and Development - 1995 Intentions " Cat. No. 88-202] . This reflects the dependence of these firms on new technologies that will allow them to achieve success in niche markets.

Due in part to the importance of R&D activities, the telecom equipment industry has a high proportion of knowledge-intensive workers and relatively high-paying jobs. In a recent human resources study, total industry employment was estimated at 41,700 in 1995. [. Human Resources Study of the Canadian Telecommunications Industry , prepared by KPMG Management Consulting in association with Pacific Leadership Inc., Tech management and Abt Associates for the Steering Committee of the Human Resources Study of the Canadian Telecommunications Industry, Spring 1996.] An occupational analysis of the telecom equipment and component industries **(SIC 335)** indicates that R&D activities account for an unusually high proportion of employment. [. This is based on data collected for the Canadian Occupational Projection System (COPS) produced by Human Resources Development Canada.] R&D employment was estimated to comprise almost 30 percent of total employment in 1991. Moreover, it was found that the importance of R&D employment had increased substantially over the 1980s, and that this was accompanied by a trend towards the greater use of professionals. In 1991, some 70 percent of R&D workers were classified as professionals. In 1994, average annual salaries in the telecom equipment industry were $45,000, well above the $32,900 average for all of manufacturing.

Policy Framework

The nature and growth of the domestic market for telecommunications equipment has been heavily influenced by telecommunications policies and regulations. Government trade and science policies have also had a significant impact on the growth of the industry.

Historically, in Canada as in all other countries, telecommunications equipment firms supplied their products to heavily regulated telecommunications carriers with whom they generally had close commercial ties. Over the past two decades, government policies and decisions of the Canadian Radio-television and Telecommunications Commission (CRTC) have gradually expanded the scope for competition in the provision of telecommunications products. Competition has been introduced into markets for telephones, terminal equipment, cellular phone systems, long distance telephone service and advanced telecommunications services. These developments have facilitated the growth in telecommunications services and also fuelled a growing domestic demand for telecommunications equipment. Along with the expanding market for traditional products, telecom suppliers have seen the emergence of a demand for new equipment which would allow the introduction of innovative new service offerings. But while market opportunities have expanded, equipment firms can no longer be assured of the loyalty of their long-term customers. They have had to adapt to a new environment where carriers are under strong pressure to obtain high quality supplies at favourable prices and where non-telecommunications firms and individual households are important consumers of telecom equipment.

Trade policies have further increased the role of competition in telecommunication equipment markets. During the 1970s and 1980s, high import tariffs provided Canadian producers with significant protection against foreign competition. The Canada-U.S. Free Trade Agreement (FTA), which began to be implemented in 1989, involved a major liberalization of Canadian policies. Any remaining tariffs on telecommunications products in which there

is significant tradebetween Canada and the U.S. are to be eliminated under the FTA by January 1, 1998. Subsequently in 1994, implementation of the North American Free Trade Agreement (NAFTA) initiated a process of trade liberalization between Canada and Mexico. Mexican import tariffs on telecommunications equipment, which had been between 10 and 20 percent, have largely been eliminated and remaining tariffs are scheduled for removal by the beginning of 1998.

Modest progress in reducing tariffs at the multilateral level was achieved at the Uruguay Round Discussions of the World Trade Organization (WTO). On March 26, 1997, Canada and 38 other governments representing over 92 per cent of the US$500 billion-a-year global trade in information technology products concluded the Information Technology Agreement (ITA). The ITA provides for staged elimination by the year 2000, of most-favoured-nation tariffs on a broad range of information technology products, with the first stage of tariff cuts to begin on July 1, 1997. ITA participating countries include the US, Japan, EU, Hong Kong, Singapore, Switzerland, Australia, New Zealand, Korea, Chinese Taipei, Malaysia, India and Indonesia.

Non-tariff barriers, and especially government procurement policies which favour local firms over foreign suppliers, have been troubling impediments to trade in telecommunications equipment. Telecommunications entities are excluded from the GATT procurement code which sets out principles that are aimed at addressing this issue in a general context. The impact of government procurement, however, has become much less significant with the trend towards privatization of publicly-owned telecommunications carriers.

Government science policies have helped the industry build the technological capacity it needs to survive in highly competitive global markets. Canada's Scientific Research and Experimental Development tax credit has been of particular importance to telecom equipment producers because of their substantial R&D requirements. This incentive, which is generous by international standards, has arguably been a factor in Nortel's decision to locate its core R&D in Canada and the decision of foreign multinationals to maintain significant R&D activities in this country.

The industry has also benefitted from other aspects of the federal Science and Technology strategy, including the support of research in colleges and universities and the establishment of Networks of Centres of Excellence in key areas of telecom technology. Industry Canada's Communication Research Centre, which primarily focuses on the development of advanced wireless telecommunications services, has helped put together private consortia and served as a general source of information and expertise for the information technology sector.

Performance

Growth and Profitability

Over 1981 to 1995 real shipments of telecom equipment grew at an impressive annual average rate of 5%. Growth was especially strong over the first half of this period. Through the late1970s and much of the '80s the industry benefitted from a combination of factors, including the growing use of data communications, the introduction of digital technology into the network, and the emergence of new business and residential markets for telecom equipment. In addition, the opportunities resulting from the move towards deregulation in the U.S. provided a boon to some Canadian firms over the late 1970s and early '80s.

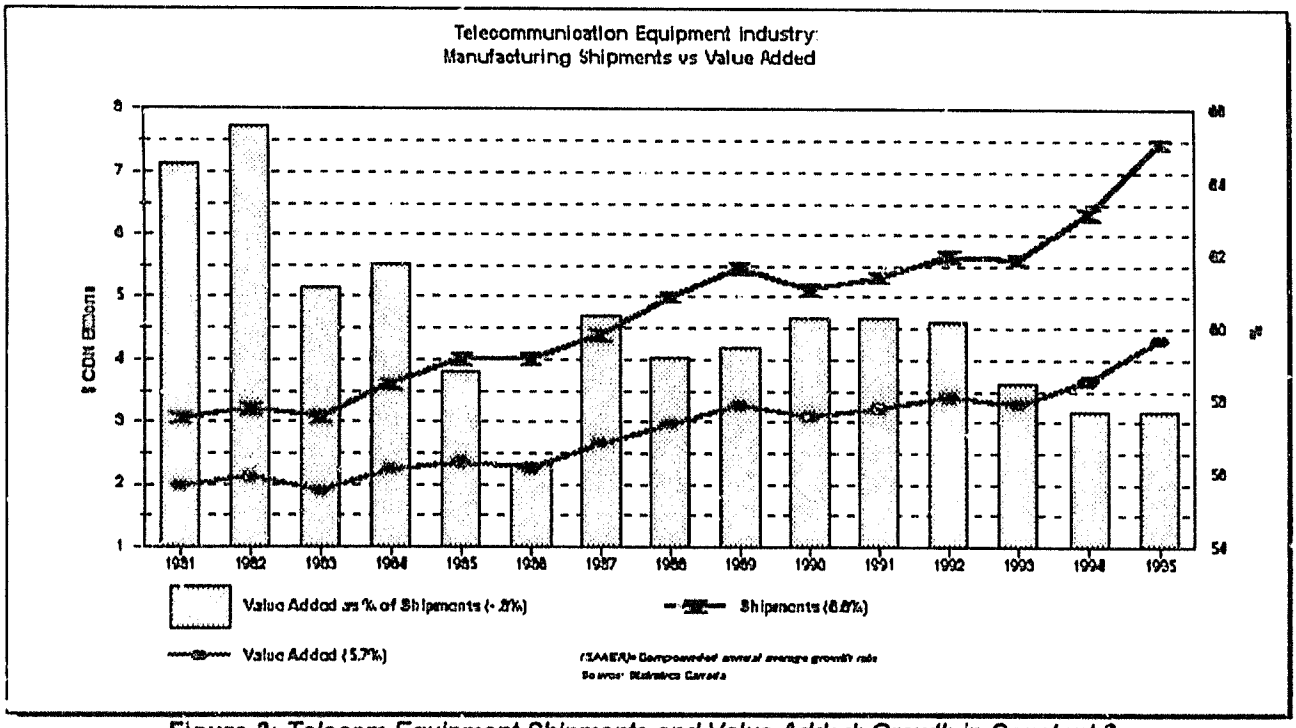

Figure 3: *Telecom Equipment Shipments and Value Added: Growth in Constant $s*

Growth of the telecommunication equipment industry slowed over the 1988 to 1995 period, although it continued to remain above the growth rate of manufacturing as a whole. Like most other Canadian industries, telecom equipment producers were affected by the recession of the early '90s. Shipment patterns also reflect changes in the domestic market where growth weakened over the latter '80s and early '90s due to the maturity of some important product markets (most notably, the markets for public network equipment) and more intense import competition. Exports, as well, grew strongly over this period driven by the improved access of Canadian producers to the U.S. market. But while Canadian firms were able to offset the growth in imports through foreign sales, they were unable to achieve a degree of foreign market penetration that would allow them to enjoy the type of output growth they experienced prior to 1983.

The growth in industry production as measured by value added has lagged slightly behind the growth in shipments. While roughly 60% of telecom equipment shipments represent value added, well above the 40% average for all of manufacturing, this ratio has declined over time. As the production of the industry has evolved, going initially from electro-mechanical to electronic analog and more recently to electronic digital products, firms have seen advantages in contractingout more of the manufacturing process to specialists.

The growth in industry production has not translated into increased employment within the industry. According to the human resources study referenced above, employment in the industry increased from 49,000 in 1981 to 56,000 in 1986, and then fell to 44,000 in 1991, a decline of over 20 percent. A further, albeit more modest, decline reduced employment to under 42,000 by 1995. The loss of jobs are the result of the restructuring that has occurred in the industry. Increased contracting-out, which has led to job opportunities in other industries, has been part of this process. There has also been a number of major rationalizations; with Nortel closing several of its plants and concentrating production at four world-scale manufacturing sites in Calgary, Belleville, Brockville and St Laurent; Motorola and Ericsson closing their Canadian manufacturing operations; and BC Tel and Tie Communications exiting from the equipment manufacturing business. The rapid expansion of other companies, such as Newbridge and Mitel, has not been able to offset the employment losses from these restructurings.

The industry has experienced sharp fluctuations in financial performance. This can be seen in Figure 4, which compares the median return on net operating assets for telecom equipment producers with the return of medium and large firms in manufacturing as a whole. The sharp decline in financial returns over 1988 to 1991 reflects the overall weakness in economic activity as well as the impact of highly competitive telecom markets. The poor financial performance of telecom equipment producers over the latter '80s and early '90s can also be seen from the data in published annual reports relating to the global operations (as distinct from just the

Canadian operations, which is what is shown in Figure 4) of Canadian-based firms. These data indicate that, over 1988 to 1992, the average return on assets for the largest ten telecom equipment producers was somewhat below the return on largely risk-free Canada Savings bonds. Figure 4 also shows the success achieved by a number of Canadian niche producers of telec om equipment over the 1992 to 1994 period. Over this period, very strong financial results were achieved by firms such as Newbridge, SR Telecom and Elcon.

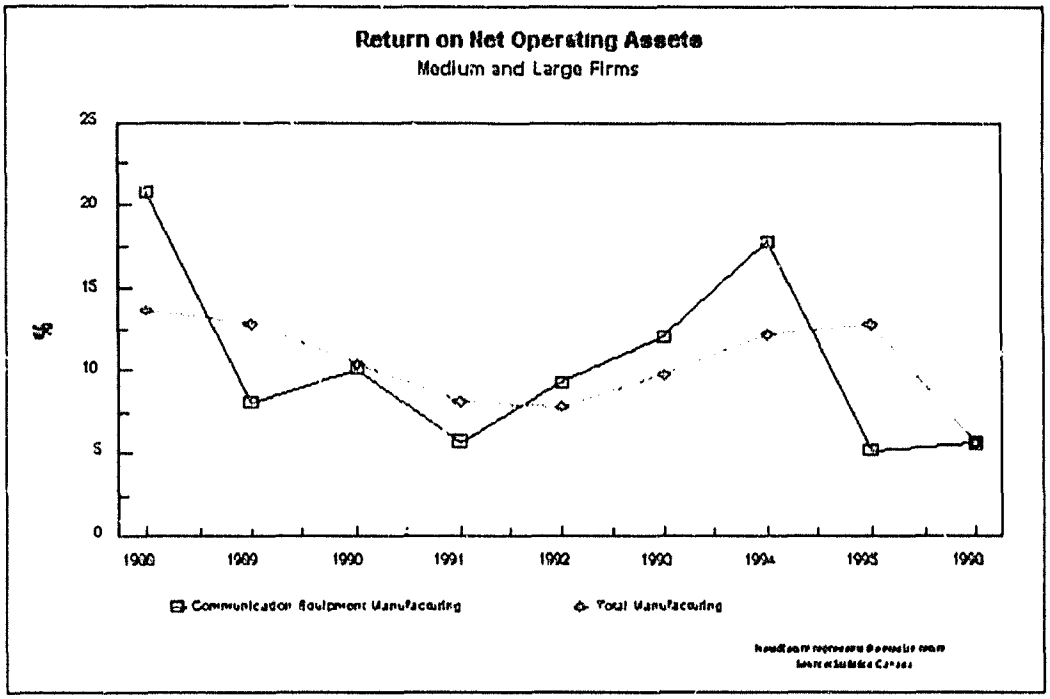

Figure 4: *Return on Net Operating Assets*

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Telecommunications Equipment Industry SCF

Trade

In 1995 Canada had a surplus of $634.3 million in its telecommunications equipment trade with the rest of the world. This is in contrast to the country's significant and increasing deficit in all information technology hardware.

Figure 5 shows that Canadian firms have lost a substantial share of the domestic market to import competition since the early '80s. This is a partly a logical consequence of the globalization of telecommunication equipment markets. While Canadian imports of telecommunications equipment have grown strongly, so have Canadian exports. Telecommunication exports were relatively flat between 1983 and 1989, but since then they have grown particularly rapidly, substantially outpacing the growth in imports (Figure 6).

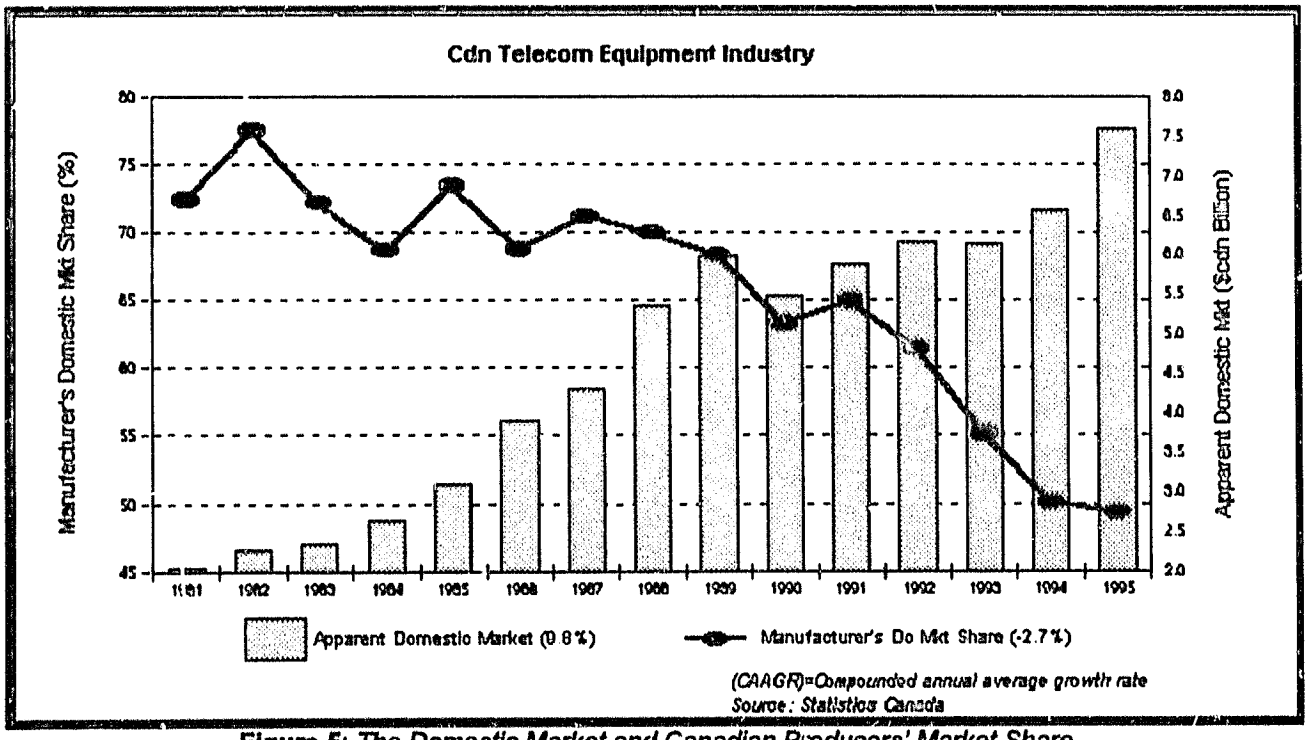

Figure 5: *The Domestic Market and Canadian Producers' Market Share*

Recent trends partly reflect the impact of the FTA which has improved Canadian producers' access to the U.S market. Some 60% of Canadian exports of telecom equipment flow to the U.S. Aside from the impact of the FTA and NAFTA, the size and proximity of the market, the lack of regulatory barriers, and standards that are common with what exists in Canada, makes the U.S. a logical focus for the export initiatives of Canadian firms.

In recent years, however, Canadian producers have also experienced significant success marketing their products in the rapidly growing markets of the Asia-Pacific.

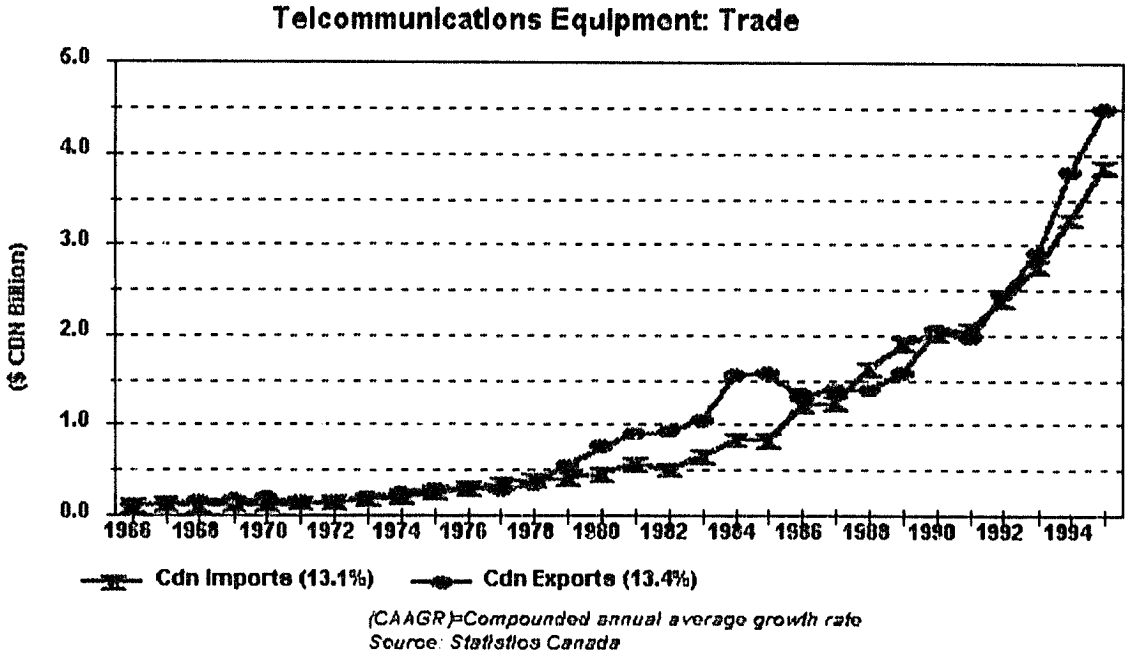

Figure 6: *Telecommunications Equipment Trade*

In the wireline segment of the industry, Canada has tended to record significant trade surpluses. These have more than offset the trade deficits incurred in wireless products in recent years. Within the wireline category, Canada has been particularly successful as a producer of public network equipment. This is due, in no small part, to the advanced technical capabilities of Nortel in this area.

Investment

Over the period 1978 to 1987, the telecom equipment industry experienced extraordinarily strong growth in investment spending. New investment spending has weakened substantially since then. In the early 1990s, investment as a share of shipments (an indicator of the size of the sector) had declined to nearly half the 7 percent ratio achieved on average over the 1980s.

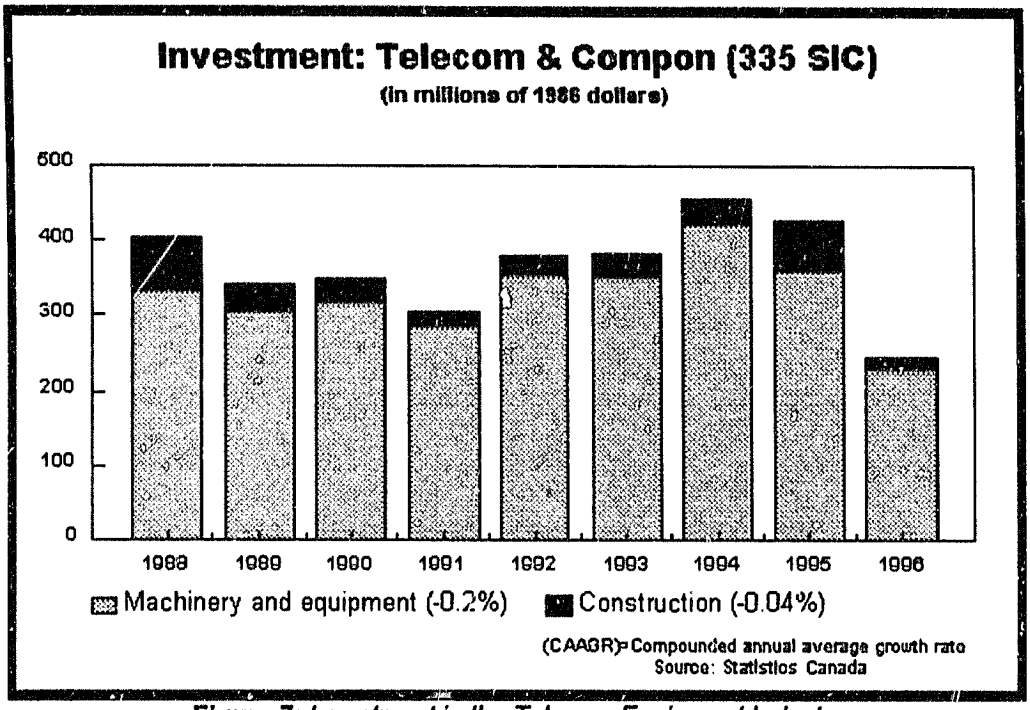

Figure 7: *Investment in the Telecom Equipment Industry*

The decline in investment spending corresponds with evidence suggesting that the Canadian industry, like the worldwide industry, had built up significant overcapacity by the end of the 1980s. The restructurings that have occurred in recent years - the most notable example of which is the consolidation of Nortel's operation from 20 manufacturing facilities spread over all provinces to four plants - have been aimed partly at shedding excess production capacity. Lower investment requirements are also a result of the increasing digitalization of telecom products and the accompanying increase in the importance of purchased, as opposed to own-manufactured, inputs. The integrated circuits which are needed in digitalized products are mainly produced outside the country.

Technology

Intramural investment in R&D exceeded $1.7 billion in 1995. R&D spending is high by comparison to other Canadian industries and has continued to grow at a rapid rate. Since 1963, real R&D spending by the industry has grown at an impressive 8.7% rate, well ahead of the real growth in manufacturing shipments (Figure 8). R&D spending growth slowed over 1988 to 1994, but, even over this period, it outpaced the growth of the industry (as measured by either shipments or value added).

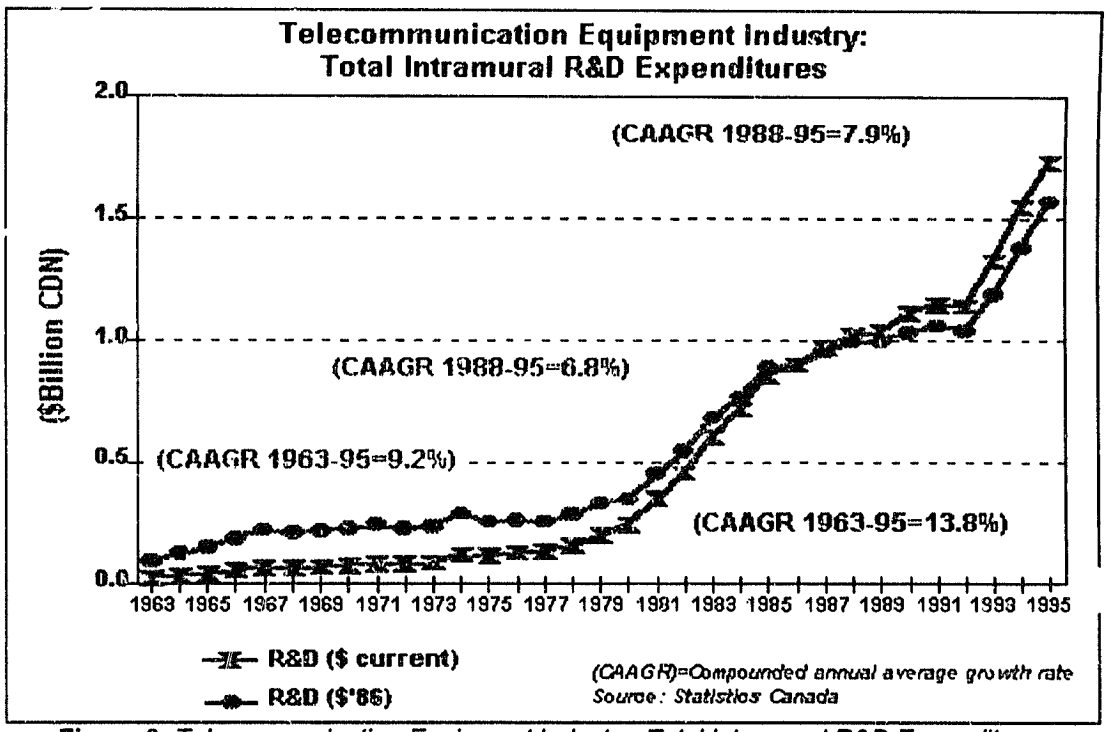

Figure 8: *Telecommunication Equipment Industry: Total Intramural R&D Expenditures*

Nortel, with over 8000 R&D employees in Canada, is this country's largest investor in industrial research and development. Two other firms, Ericsson and Newbridge, rank among the top 15 R&D investors, while a number of other telecom equipment suppliers (Mitel, Motorola, Canadian Marconi, Eicon Technology, Harris, SR Telecom, and Memotec) are among the top 100 Canadian R&D companies. As noted previously, however, if performance is measured relative to revenues, it is the smaller telecom equipment firms that tend to be most research intensive.

An industry's level of technological achievement depends not only on its commitment to new product development, but also the rate at which it adopts advanced production technologies. According to Statistics Canada's 1992 Survey of Innovation, the electrical and electronics industry group, to which telecom equipment producers belong, is one of the most rapid adopters of advanced technology. [. John Baldwin and David Sabourin, Technology Adoption in Canadian Manufacturing , Statistics Canada Cat. #: 88-512, Feb. 1995.] A recent analysis indicates that the largest telecom equipment producers -including Nortel, Mitel, Newbridge and SR Telecom - are at a world class level in terms of their use of manufacturing technology. [. NGL Consulting ltd., "A Proposal Towards a Strategic Plan for the Canadian Telecommunications Equipment Industry," October 1990.] It suggests, however, that the smaller companies in the sector are lagging in the application of the most advanced production technologies. This is consiste nt with the results of the Statistics Canada survey, which found that, across all industries, adoption rates for advanced technology are lower in smaller manufacturing establishments.

Productivity and Labour Costs

Labour productivity in telecom equipment manufacturing is high by comparison to productivity in total manufacturing. Moreover, as can be seen in Figure 9, this gap has been widening over time. Over 1981 to 1995, the average rate of productivity growth in telecommunications equipmentproduction has exceeded the productivity growth in manufacturing overall.

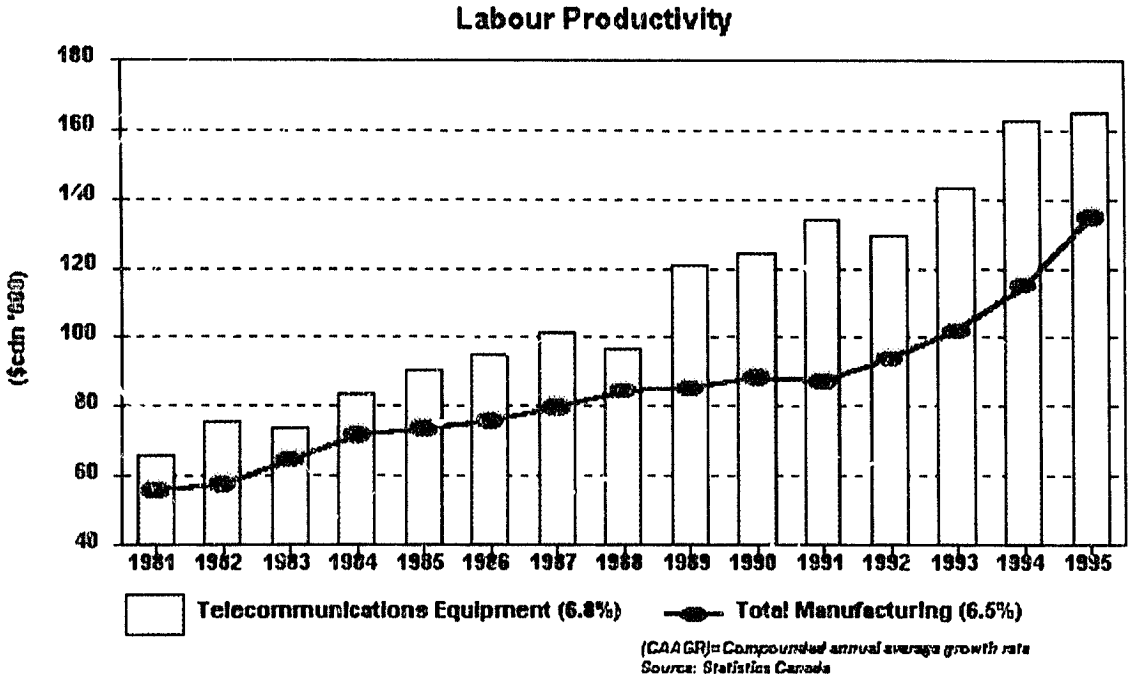

Figure 9: *Labour Productivity*

Production workers in telecommunications equipment are well paid by comparison to other manufacturing workers. In 1994, the average telecommunication production worker received about 15% more in hourly wages than the average manufacturing employee. This gap is less, however, than the labour productivity gap between telecom equipment and other manufacturing industries. Moreover, average hourly wages in telecommunications equipment production grew at 5.3% per annum over 1981 to 1994, significantly less than the growth in labour productivity. Hence, unit labour costs in telecommunications equipment production have been trending downwards.

The industry has experienced particularly strong improvements in labour productivity since 1988. The industry's success in boosting productivity and reducing labour costs per unit of output are partly attributable the major restructurings of recent years. The efficiency gains from Nortel's major consolidation has, in itself, made a major contribution to the industry's favourable performance.

In the wireline segment of the industry, Canada has tended to record significant trade surpluses. These have more than offset the trade deficits incurred in wireless products in recent years. Within the wireline category, Canada has been particularly successful as a producer of public network equipment. This is due, in no small part, to the advanced technical capabilities of Nortel in this area.

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Publication Date - 1997-06-30

Telecommunications Equipment Industry SCF

Changing Conditions and Industry Response

General

Major developments in a number of areas are transforming the economic environment and creating new challenges and new opportunities for the Canadian telecommunication equipment industry. One major factor is the pronounced trend towards liberalization in markets for telecommunication products. The process of deregulation and privatization that is underway in the telecommunications sectors of more developed economies is expanding the potential market available to Canadian equipment producers. With the unwinding of regulatory controls, the long-term contracting and preferred supplier arrangements between phone companies and equipment producers that impeded competition in telecom markets are also breaking down. A World Trade Organization agreement reached earlier this year and scheduled to come into force in January 1998 will open up the $500 billion world market in telecommunications services to increased international competition. The Information Technology Agreement, which will lead to the elimination of tariffs and increased international competition in telecommunication equipment, comes into force on July 1, 1997. An ITA review is planned for the fall of 1997 with a view to further extending the agreement.

A second important development is the commitment of a number of less developed economies to the development of modern telecommunications infrastructures. Countries, such as China, Thailand, Indonesia and Chile, that have experienced rapid economic growth in recent years, have poor telecommunications access. In 1994, for example, China had only 2.3 mainlines per 100 inhabitants, as compared to 57.5 lines in Canada. The recognition by these countries that modern facilities are needed to achieve continued rapid rates of growth is creating important new market opportunities for telecommunications equipment producers.

A third major factor is the technological "revolution" in computerization and communications that is feeding the demand for new telecom products but also eroding traditional distinctions between industries involved in different information technology activities. With the expansion of the Internet and the establishment of facilities for a planned broadband Information Highway, there is a demand for equipment that will facilitate the introduction of a range of new IT services. At the same time, competition is intensifying, with firms in telecommunications equipment, consumer electronics and computer hardware and software vying for a share of these emerging markets. Telecommunication equipment producers are also beginning to expand their range activities and major international firms now have strengths in consumer electronics and computers along with telecom manufacturing.

A fourth development is the increasing popularity of wireless communications. The growing demand for untethered systems is a major structural change with important implications for thefortunes of various telecom exporting countries.

Technology

The competitiveness of Canadian telecommunications firms will continue to depend on their ability to develop new technology and new applications for existing technology. The investment in R&D by Canadian firms compares favourably with that of firms in other developed economies. An attempt to assess Canada's technological competitiveness using patent data found that Canadian telecom equipment firms have performed well; their share of patent counts were greater than one would expect based on Canada's share of world exports and the quality of Canadian patents, as measured by patent citations, were above average. [.DRI/McGraw-Hill CHI Research, "Technology Benchmarking of the Canadian Telecommunications Industry ", May 1994.]

Additional light can be shed on this topic by looking at Canadian firms' involvement in the design and production of leading edge technologies. The key emerging technologies in telecommunications include:

- The Asynchronous Transfer Mode (ATM) switch, which can digitally switch encoded voice data and video signals and is considered to be a promising technology for interconnecting Wide Area networks (WANs), Local Area Networks (LANs) and the public network;
- Photonic Switching, which could be part of a new generation of telecommunications switches designed to facilitate the widespread transmission of high bandwidth signals;
- Digital Subscriber Line Technologies, such as Asymmetrical Digital Subscriber Line (ADSL) technology, which apply sophisticated modulation techniques and allow high bandwidth signals to be carried over existing copper wires;
- Satellite Technologies, which have limited available bandwidth and hold potential primarily for supporting infrastructure development in less developed countries and for specialty applications elsewhere; and,
- Personal Communications Systems (PCS), which operate according to specified national standards and permit wireless access to the public network for users within about 100 metres of a transmitter.

A recent study found that, with a few exception - the most notable being, the space segment of satellite communications - Canadian firms are in a good position to participate in the production of these technologies. [. KPMG Management Consulting et al., op. cit.] Currently, firms are marketing ATM switches in small volume to early adopters, while awaiting an indication that market demand would justify the commercial production of photonic switching and ADSL technology. A growing, but highly competitive market exists for PCS, along with cellular, systems.

The development of advanced technology depends, along with R&D, on access to an adequatemicroelectronics and software support infrastructure. A few large Canadian producers have their own microelectronic capabilities, although they are still dependent on outside procurement for memory chips and most other microelectronics devices. While most companies are almost totally dependent on outside sources for both microelectronics and software requirements, these technologies are readily available and Canadian firms are not disadvantaged relative to foreign competitors in these areas. However, firms require good technical management personnel and the capacity to address problems in the design, procurement or application of microelectronic components and software. With their limited financial and technical resources, small companies are more vulnerable to problems that frequently occur in the design of new software. A number of Canadian telecommunications equipment companies have encountered costly softwar e problems over the past several years.

Trade

Canadian firms are reasonably well positioned to take advantage of liberalization in telecommunication equipment markets, including new opportunities which may arise from current multilateral efforts to phase-out tariffs on telecommunications equipment. The experience they have gained in responding to deregulation and liberalization in North America will help them compete against European and Japanese firms which have only recently begun to adjust to competition in their domestic markets. This advantage should not be overstated, however, since major firms in both countries have substantial experience competing internationally.

Moreover, liberalization can also be expected to lead to increased competition in the domestic market where Canadian firms have been steadily losing market share. An important recent development, supplementing the competitive impact of Canadian tariff reductions, was the conclusion of the 45-year preferred supplier agreement between Bell Canada and Northern Telecom. Since 1994 when this agreement came to an end,

other telecom equipment companies have had an improved opportunity to compete for the business of Canada's largest purchaser of telephone equipment.

Canadian telecommunications equipment companies are also reasonably positioned to respond to market opportunities in less developed economies. While about 60% of Canadian telecom equipment exports go the U.S., Canadian firms have established a significant foothold in the rapidly growing markets of the Asia-Pacific and Latin America. Indeed the Asia-Pacific has become more important than Europe as a destination for Canadian telecom equipment exports (See Figure 10). This is in large part due to the growth in Canadian sales to China. Between 1988 and 1993, Canadian exports of wireline equipment to China increased from $6 million to $226.5 million. The latter figure amounted to over 10% of all Canadian wireline exports in 1993. Wireless sales have also increased and by 1993 China accounted for over 7% of all Canadian wireless exports. Significant, albeit less dramatic, increases have been recorded in export sales to Mexico and Brazil, along with a number other Latin American countries.

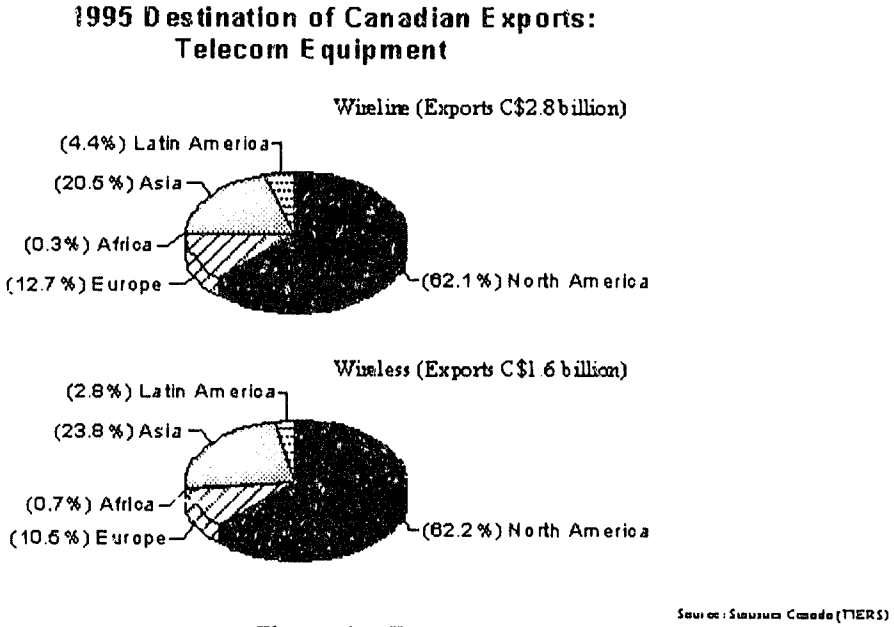

Figure 10: *Export Destinations*

Investment and Financing

While increased competition and excess production capacity are putting pressures on profitability in many companies, firms recognize the importance of maintaining high rates of investment in R&D. The increased pace of technological change is adding to the financial difficulties of firms by leading to shorter development lead times and product life cycles; firms, therefore, generally have less time to recover their investments in the development of new products.

These developments are increasing the pressures for rationalization and consolidation within the industry, and for the establishment of various formal and informal arrangements through which firms can co-operate and share the costs and risks of new product development. The federal government has played, and can continue to play, a supportive role in this area. As noted above, Industry Canada's Communication Research Centre has facilitated the formation of consortia. In addition, through the Strategic Technologies program, the federal government has promoted the establishment of a number of pre-competitive R&D alliances in the information technology sector.

Human Resources

As a result of recent structural changes, the pattern of employment within the telecom manufacturing industry has been changing. In particular:

- employment in fabricating and assembly has declined, reflecting the impact of restructuring and

consolidation within the industry;
- many equipment repair jobs have disappeared because telecom equipment has become more reliable;
- managerial employment has fallen due to restructuring and also a flattening of organizational structures within firms; and
- electrical and electronic engineering jobs, along with computer specialist positions, have grown as a result of the increased investment in R&D and the need for personnel to manage the design and production of increasingly sophisticated IT products.

These trends are expected to continue over the medium-term. [. KPMG Management Consulting et al., op. cit.] The profile of the manufacturing workforce is expected to change as emerging technologies increase the demand for high and low-skilled jobs, and reduce requirements in the middle. Sales and marketing jobs may also increase as firms compete to win customer acceptance of new products.

Based on interviews with telecommunication equipment firms, a recent human resource study suggests shortages of highly skilled workers could arise in some areas of growing demand. [. KPMG Management Consulting et al., op. cit.] Interviewees expressed concern about the availability of "business planning personnel who understand the combination of technology , marketing and corporate finance issues needed for successful planning in a rapidly changing business and technology environment". [. ibid, p.75.] The prospect of shortages was also seen for technical personnel in key specialties, such as system design, test design, high level software design, and analog and radio frequency design.

Sustainable Development

Canadian telecommunications equipment producers have been sensitive to public concerns about the environmental impact of manufacturing and they have responded by introducing advanced technologies that significantly reduce the waste and pollution from their own activities.

In telecom equipment production, the major environmental concerns have related to the use of toxic materials (especially ozone-depleting chemicals and lead) and the management and disposal of wastes. In 1992, Nortel became the first major telecommunications equipment producer to eliminate the use of ozone-depleting chlorofluorocarbon solvents (CFC-113) from its manufacturing and research operations. Nortel has reaped important benefits from its investment in the elimination of ozone-depleting chemicals and has shared its expertise in this area with other firms, including producers in countries such as China, Vietnam and Brazil.

Progress has also been achieved eliminating lead, a toxic substance with the potential to cause severe harm to both the environment and humans. Through the use of lead solder, the electronics industry accounts, globally, for the use of some 20,000 tons of lead per year. Approximately 80percent of this ends up in landfill sites where it leaches into the surrounding soil and water. Nortel has recently come up with a new alloy which contains 99.3 percent tin and 0.7 percent copper. Results of early tests suggest that the new alloy provides an interconnection that is comparable to that of the standard solder containing 37 percent lead. In addition to its important long-term environmental benefits, the new technology offers firms the promise of significant savings in process monitoring and waste management costs.

Internationally, there is considerable interest in promoting the use of manufacturing technologies and processes that are consistent with the broader goal of sustainable development. There is increasing pressure with European countries to control the disposal of electronic waste containing lead. In North America, a recognition of the importance of eliminating the use of ozone-depleting solvents led, in 1989, to the creation of the International Cooperative for Ozone Layer Protection (ICOLP). This agency, which was formed by Nortel, AT&T and the United States Environmental Protection Agency, pools the knowledge and expertise of private companies, governments and research institutions and tries to ensure that the latest information on environmentally-friendly technology is made available to smaller companies.

In addition to reducing the environmental impacts of their own manufacturing activities, telecommunication equipment firms have played a role in the larger shift that is underway towards an information society. Through new product and service developments, the industry is facilitating the trend towards home-based businesses, teleconferencing, at-home shopping, telecommuting, telemedicine and interactive distance-learning. Over the long-term, these developments could help societies realize important savings in the use of valuable resources.

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Author - Industry Canada

Publication Date - 1997-06-30

Telecommunications Equipment Industry SCF

Growth Prospects for the Industry

Demand Outlook

Over coming years, global demand for telecommunications equipment is expected to keep pace with the growth experienced over the recent past. While North America and Europe will continue to constitute the largest markets over the next few years, Asia and Latin America are expected to be the source of the most rapidly growing demand for telecom equipment. Requirements should increase considerably in those Asian economies, such as China and South Korea, that have made the upgrading of their telecommunications infrastructures a major policy objective.

In the domestic market, demand is projected to follow recent trends. Growth is therefore likely to be slower than in the late 1970s and early '80s when demand was furled by the introduction of digital technology and the liberalization of customer premises equipment markets. It is also likely to lag the historical growth rate of about 6 percent per year, resulting from Canadian population growth and the increase in telephone penetration rates. Sales of wireless telecommunications equipment are increasing strongly. As well, equipment demand within Canada is being driven bythe increasing requirement for high bandwidth services. In the coming year, telephone companies across Canada will be experimenting with the introduction of ADSL and fiber-coax networks.

Internationally, demand is growing most strongly in the areas of mobile and data communications equipment, although traditional voice communication products still account for the greatest share of global sales. Cellular phones, a main component of mobile communications, has enjoyed the most rapid sales growth in recent years. North America and Europe were the early adopters of cellular technology, but mobile systems hold considerable potential in developing economies. The number of cellular phones in China has grown dramatically in recent years and Asia, in general, is expected to become a major cellular market in the near future.

Worldwide sales of data communication equipment are small by comparison to cellular sales, but, in terms of market growth, the gap between the two sectors is much smaller. Data communication encompasses a range of products, and while some (i.e. modems, multiplexers, and packet equipment) have experienced a slackening in growth, others (i.e routers, hubs and ATM equipment) continue to enjoy strongly increasing sales.

In the area of switching equipment, which has traditionally been the core business for major telecom firms, producers have been responding to the demand for digital switches. OECD countries that have not already modernized their systems are rapidly converting analog networks to digital. As this need gets filled, producers are focusing more on the major opportunities in large Asian countries such as China, India and Indonesia. In future years, the large-scale introduction of emerging high bandwidth switching technologies (i.e. photonic switching) could temporarily boost the global demand for switching equipment.

The market for transmission equipment is being fuelled by the need to convert technology so it can support the transition from copper to optical fibre networks. While Europe is currently the largest market for transmission equipment, there is a large potential market in less developed economies. Developing countries which lack wired infrastructure could benefit from the adoption of wireless local loop transmission technology.

The international market for telecommunications equipment is being shaped not only by these demand forces, but also by the policy and regulatory changes discussed previously. Privatization and the erosion of "national champion" buying policies have opened up many formerly closed equipment markets to competition.

Current Industry Strengths

The basis of Canadian competitiveness has been the innovative capacity of Canadian telecom manufacturing firms. This has two different dimensions. It consists, on the one hand, of the technological capacity of Nortel, Canada's entry among the large producers that dominate the business worldwide. It is the result, as well, of the capabilities of smaller Canadian firms that have succeeded by identifying and effectively filling market niches and by serving as suppliers to themajor telecom equipment producers.

Preferential policies, often linked to public regulation and ownership of telecom carriers, fostered the growth of the major global wireline producers. But preferred market positions are a feature of the past. Nortel has had to face this reality earlier than its European and Japanese competitors. As a result of its recent restructuring, Nortel has a streamlined and efficient operation that leaves it well positioned to compete in international markets.

Smaller Canadian firms have succeeded as a result of their ability to produce high quality products that satisfy particular consumer needs. The high commitment to R&D discussed previously has been an important factor. A number of these producers have effectively seized on the opportunities arising from the convergence of telecom equipment production with computing and consumer electronics. Successful Canadian niche firms have also taken advantage of the FTA and their favourable access to the world's largest and most unrestricted telecommunication market.

The price competitiveness of Canadian telecom exports has improved as a result of the substantial drop in the Canadian exchange rate over 1992 to 1994 (and in Canadian relative to U.S. unit labour costs, measured in a common currency). This has benefitted both Nortel and smaller Canadian telecom producers. It has been observed that price competitiveness is becoming increasingly important in international markets, with buyers increasingly emphasizing value-for-money, rather than technical performance *per se*. [. KPMG Management Consulting et al., op. cit.]

Current and Future Competitiveness Challenges

Significant challenges face the industry as a result, first, of the state of the world market for telecom products and, second, of certain factors affecting the performance of Canadian producers.

There is considerable over-capacity in the world-wide supply of telecom products. This is creating pressures for further rationalization among the major global suppliers. In the immediate future, however, producers are likely to see the effects of this over-capacity reflected in weak prices and low profit margins in many product lines. While it is difficult to sustain high investment in R&D in this environment, most producers recognize that they must continue to invest heavily in product development to compete effectively.

The global picture is also complicated by the rapid and uncertain course of technological change in the information technology sector. It is difficult to predict precisely how current trends towards convergence, digitalization, and high bandwidth communications will impact on the demand for telecommunications products. There are various possibilities, for example, for improving switching technology. The future depends on which of various competing technologies wins acceptance and how quickly it is adopted.

For the Canadian producers, a primary challenge is to implement strategies that will reduce the costs and risks of participation in this research intensive and highly competitive industry. Co-operative arrangements such as strategic alliances, joint ventures and joint developmentagreements have gained increased popularity among global competitors. Such arrangements also have considerable appeal as a way of allowing smaller Canadian firms to share complementary resources and reduce exposure to the risks of new product development.

Another challenge for the Canadian industry is to preserve the knowledge base that underlies its strength in the design and development of new, leading-edge technologies. Despite the overall decline in employment within the Canadian telecommunications industry, some employers are experiencing shortages of technically qualified employees. Problems have been reported, for example, recruiting qualified radio frequency engineers and software engineers. There is increasing recognition that the Canadian industry must be pro-active in ensuring that they have the skilled, adaptive workforce that is needed to compete effectively in global markets. This suggests that employers must increase their investment in retraining. It also challenges the industry to work with post-secondary educational institutions to ensure that courses are designed with a view to telecom equipment manufacturers' future skill requirements.

Future Opportunities

Significant opportunities exist for the industry to build on its success in designing and producing high value-added products, combining advanced hardware and software technology. While the U.S. is likely to remain Canada's main export market, the most dynamic markets for telecommunication products are in newly industrializing economies in Asia and Latin America.

China is one of the most rapidly growing markets for telecommunications equipment, and it is close to surpassing the U.S. in terms of purchases of telecom equipment. Canadian firms have had some success in the Chinese markets, but they face tough competition from major European, Japanese and U.S.-based telecom equipment manufacturers who have established strong market bases in particular product lines. Nortel recently established a joint-venture manufacturing and R&D facility in China and acquired a microelectronics producer as part of its efforts to strengthen its position in this market.

The growth of the Canadian firms will also depend on their ability to participate in the rapidly growing markets for mobile and data communications equipment. The Canadian industry has not exhibited the same competitive strength in these markets as in network switching equipment, although Canadian firms have a significant technological capacity in many of the rapidly growing product areas. To succeed in these markets, firms must supplement their strength in product development with effective marketing strategies that respond to customers' demand for "value-for-money". Export sales depend increasingly on producers' ability to put together "packages" that involve an attractive combination of price and quality and often include additional incentives such as concessionary financing.

The Bottom Line

Canada's telecommunications equipment industry is one of the most important centres of innovation within the Canadian economy. As a result of their technological capability, Canadian producers are well placed to participate in the expected growth in worldwide demand for telecom products and to benefit from the global trend towards market liberalization. To succeed, however, Canadian firms will have to weather major adjustments arising from the current worldwide overcapacity in telecom equipment production, and from the competition among alternative technologies that are being developed to support service delivery on the information Highway and facilitate the convergence of telephony, broadcasting and computing.

In this environment, firms must be resilient and adaptable. Human resources are one of the important determinants of success. The Canadian industry would be well-advised to develop a human resource strategy that addresses concerns about the future availability of workers with the required mix of skills. Canadian producers may also benefit from alliances and other co-operative arrangements that allow them to build on their technological capabilities and strengthen their overall competitiveness. Co-operative arrangements may be of particular benefit to smaller Canadians firms who are most vulnerable to effects of market downturns or technological setbacks. Canadian firms should also consider how their marketing strategies can be better designed to meet requirements for success in the more dynamic regional and telecommunications equipment product markets.

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