The CANADA EAST-WEST CENTRE Ltd.

Public Policy Management Consultants

Telecommunications and Informatics:

Industry Policy Issues Respecting Ontario

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In preparing the report, the consultants drew upon publicly available information. Non-government research groups, corporations, and federal and provincial officials provided counsel on the issues and analysis involved. The report, however, was limited by the modest budget allocation; more work is required to develop a cooperative federal/provincial strategy in support of the telecommunications and informatics industries in Ontario. Given the rapid evolution of these industries, public policy must be dynamic and adaptive. This report, then, is intended as a contribution to the on-going assessment process.

The report was written by Dr. David Husband, President of the Canada East-West Centre, and Suzanne Blackwell, also of the Centre. The report reflects the views of the authors and it does not imply endorsement by the Department of Communications.

Executive Summary

This overview of the telecommunications and informatics industries in Ontario notes their remarkable growth over the past decade. This reflects, of course, the worldwide 'revolution' in communications technology, and the dramatic developments in the range of affordable end-products. Canada, indeed, has not kept pace with some countries, such as the United States and Japan, in being at the forefront of these developments. Still, the competitive position of domestic telecommunications and informatics industries is much stronger than frequently perceived.

The large negative trade balance in computer hardware and office electronic equipment is cause for policy attention, as is the difficulty in competing in the markets for packaged software. Canada, however, has a small economy relative to the United States, Japan and the European Community. As such, it must specialize in areas of demonstrated strength.

The telecommunications equipment industry in Ontario appears to display considerable strength, with Northern Telecom providing the backbone for the industry. Other Canadian companies, such as SPAR Aerospace, Gandalf Technologies and Mitel, have been successful in market niches. The Canadian domestic market is too limited to support internationally competitive firms, but deregulation, technological applications (eg. fibre optic land lines) and diversification into electronic office support functions could act as important growth factors for domestic telecommunications equipment manufacturers. Perhaps most importantly, trade liberalization with the United States, which is Canada's principal market, could prove very advantageous. The telecommunications services industry, as opposed to the equipment side, is heavily regulated; greater reliance on competitive markets - especially in the interconnect market - would have far-reaching impacts on telecommunications carriers.

The manufacture of informatics hardware (eg. computers and electronic office equipment) in Canada is dominated by U.S.-owned subsidiaries. International Business Machines and Digital Equipment Corporation account for the lion's share of Canadian output. Canadian manufacturers located in Ontario include GEAC Computers, Orcatech, Norpak and Nelma Data Corporation. The small scale of these companies, and their reliance on foreign suppliers for parts, has dictated focus on the specialized products field. Their position is tenuous, as witnessed by GEAC's recent financial woes.

Software development is a very risky venture, and Canadian firms have had relatively little success in competing in the rapidly growing market for packaged software. This market is largely occupied by the major manufacturers of hardware. Canadian firms such as SHL Systemhouse, Cognos and I.P. Sharp Associates, have concentrated on custom software. The software industry is characterized by numerous small-scale firms. Marketing and management problems frequently beset such firms. On the informatics service side the Canadian presence is much stronger. Ontario firms, such as Canada Systems Group and Crowntek, account for most of the domestic market for service bureau. SHL Systemhouse, DMR and Associates, and Cognos provide an extensive range of professional services, and are active participants in international markets.

The above comments preclude a simple 'black or white' statement about Canada's and, by implication, Ontario's competitive position in the telecommunications and informatics industries. Canadian manufactured products account for virtually all purchases by telecommunications carriers, and trade balance data attest to an improved competitive position for Canada. The telecommunications equipment industry has become increasingly export oriented. Digital switching and digital technology appear to be the most promising areas for investment. For small and medium-sized firms, keeping abreast of 'leading-edge' technology is a major problem.

The informatics sector has also displayed considerable competitive strengths. Although the hardware equipment side is largely foreign controlled, there are well-established manufacturers in Canada with worldwide markets. Canadian manufacturing of computer and electronic equipment has more than doubled during the 1980s, and exports have expanded at the same rate. Canada appears to have competitive strength in combining electronic office equipment with advanced telecommunications equipment. Export sales are also accounting for an increased portion of revenues for Canadian-based companies involved in computer services, particularly those engaged in supplying and developing software.

In general, then, the telecommunications and informatics industries in Canada appear to be reasonably well positioned to participate in the expected rapid growth in international demand. This optimistic view, however, is not a basis for complacency. International competition in high technology products is fierce. Canadian policy makers must pay very close attention to the factors that could make or break a strong presence in the highly lucrative telecommunications and informatics industries.

One of these factors is the degree of market-pull by other industrial sectors. On this score Canada appears to lag behind its major competitors in the adoption of new technologies. The Ontario Task Force Report on Employment and New Technology (September 1985) identifies technology leaders and followers. In the latter category are local governments and retail outlets. Technology diffusion is a major concern of industry participants.

Other concerns include the shortage of venture capital, tax rules in relation to R&D expenditures, marketing costs (especially in relation to software), regulation of the telecommunications industry, copyright rules for software, and shortcomings of government grants programs. In regards to the latter, this report has endeavoured to list the major programs of the Government of Canada and the Government of Ontario that apply to the telecommunications and informatics industries. The

difficulty in compiling such a list, and the paucity of information about them, points to the need for a thorough review of government assistance programs.

Such a review should be conducted in the context of a reasonably well-developed industrial policy framework. The Ministry of State for Science and Technology, in consultation with provincial representatives, is in the process of defining a national strategy to reinforce research and development, and technology diffusion in Canada. As a compliment to this, and so as to rationalize its internal decision-making process regarding support for the telecommunications and informatics industries, it is suggested that DOC consider the following elements of a planning process:

1. The Context for Policy Debate - DOC officials must operate within the overall fiscal framework of the Government of Canada, recognizing in particular the competition for scarce resources. Program proposals must demonstrate benefits in excess of opportunity costs (ie. the alternative benefits that could be derived from private sector expenditures or other public expenditures). One factor influencing such cost/benefit analysis is domestic economic trends, especially the relative international competitiveness of the telecommunications and informatics industries. Monitoring international developments must include assessment of what other governments are doing in support of these two industries and how this affects the trade framework. Of note is the considerable efforts of countries such as Japan, South Korea and Sweden to network with technology developments abroad.

2. Setting the Objectives - Industrial policy formulation by line departments ought to be consistent with the broad philosophy of the governing party. The Mulroney Government appears to favour a more market-oriented approach than has been past practice, in contrast to the Peterson Government in Ontario. Also, the Mulroney Government places a high priority on harmonious federal/provincial relations. In this context, the federal government might be advised to concentrate on broad framework policies (eg. tax policy and trade policy) supportive to the telecommunications and informatics industries. There are, however, persuasive arguments for a more targeted approach, for which Economic Regional Development Agreements could be appropriate mechanisms. Whatever the approach, DOC must develop clear industry objectives. It is suggested that the productivity and competitive performance of the telecommunications and

informatics industries should be the key strategic objective.

3. Instruments for Attaining Policy Objectives - The instruments should derive from a thorough understanding of the key factors that bear upon the industry or industries of concern. Three categories of instruments are identified: those that correct for market failure; those framework policies that influence the general climate for investment; and those that are pro-active and targeted. In respect to market failure, the most important concern is information on technological developments and technology diffusion to producers and end-users. The inadequacy of venture capital may also result from market failure. Framework policies include, as mentioned earlier, the tax regime and trade policy. Ambiguities and faults in the tax system impede R&D in Canada, and cause difficulty in attracting and holding key personnel. Canada's limited domestic market requires assured access to large foreign markets and, to this end, the Canada/U.S. trade negotiations are very important. Pro-active policies could include a grants program for generic technology research and/or the commercialization of generic research, greater commitment to information gathering and dissimination, special procurement provisions and other provisions to promote R&D in artificial intelligence, and additional resources for training of required personnel.

4. Priority Setting for DOC - Two categories of action are possible for DOC in regards to the telecommunications and informatics industries: initiatives under DOC authority; and initiatives that demand DOC input. In terms of actions under DOC budgetary authority, improving the information system may be the most useful direct action. As a second alternative, DOC could supplement the support for generic technology. In regard to initiatives that demand DOC input, tax reform and trade policy should be subjects of intensive review. Allocating departmental resources among these options is inevitably subjective, but the process of choice could be 'rationalized' by a weighting system covering the various factors that must be considered.

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1. Introduction

The terms of reference for this contract test the bounds of reasonable expectations, for a lot is requested with relatively little resource time. Telecommunications and informatics are extremely complex and demanding subjects, rapidly expanding and changing in their dimensions and implications. Fortunately, a wealth of literature provides considerable insight into the challenges ahead.[1] The task of this report is to highlight developments in Ontario, and the role federal and provincial governments ought to play in fortifying the telecommunications and informatics industries in that province. Particular attention is given to the software sector.

New communication technologies in recent years have resulted in sweeping changes in the economy of Canada and the world in general. There has been an increasing tendency to think in terms of the global economy where transactions take place almost instantaneously, flashed around the world by satellite. There is wide agreement that these advanced technologies are the new 'engines of economic growth'. Not only do they create new jobs but they also improve the productivity of labour and capital employed in traditional industries. While there are legitimate concerns about job displacement, there appears to be little relationship - at least over the medium to long term - between technological progress and national rates of unemployment.[2]

In recognition of the importance of the new telecommunications and informatics technologies, many governments have taken actions to promote the domestic development of such technologies. Japan's success is well known, and many observers have attributed this success to extensive and highly targeted government support. Most members of the European Community have also formulated national policies directed at fostering new technology development. Cooperative efforts among member countries of the European Community include the European Computing Services Association and satellite projects under the European Space Agency. The United States is still very much the

world leader in many of the new communications technologies even though the government has not developed any single, coordinated plan to provide aid to high-technology industries. Rather, the United States has tended to emphasize an investment climate less fettered by government intervention. The Defence Department, however, does provide several billion dollars in research and development funding every year, and defense procurement has greatly supported U.S. high technology industries.

Canada has taken a less pro-active approach than Japan or France but, nonetheless, it has had and continues to have numerous measures designed to strengthen its position in high-technology industries. Whether or not Canada should have a better articulated and more targeted approach has been the subject of considerable debate.[3] This question arises in our consideration of the scope for federal government assistance to the telecommunications and informatics industry in Ontario. The planning and program role of the Department of Communications in support of these sectors, and the necessary liaison with existing programs of the Government of Ontario, should be consistent with the general principles of industrial policy strategy.

The Government of Ontario has identified the need to encourage the telecommunications and informatics industries. The Speech from the Throne of April 22, 1986 announced the establishment of a Premier's Council "to steer Ontario into the forefront of economic leadership and technological innovation." This is just one of a list of initiatives of the Ontario Government aimed at improving technological innovation. The province is also the location of the majority of telecommunications and informatics businesses in Canada. Thus, at the outset, there appears to be considerable scope for the two levels of government to work together.

To provide a context for joint action, the following report commences with a brief description of the telecommunications and informatics industries. Market conditions in each of these sectors are then outlined, with special emphasis on the software

sub-sector. Ontario's competitive position in the telecommunications and informatics industries is reviewed in some detail, followed by an assessment of the 'market pull' of other industrial sectors in Ontario. Issues and concerns of the telecommunications and informatics 'community' are noted, juxtaposed to a review of current federal and provincial policies and programs. Finally, an industrial policy planning process is outlined, indicating possible areas of participation by the federal government - particularly by the Department of Communications.

2. Telecommunications and Informatics Industries Defined

It might be said that the only consistent fact about the telecommunications and informatics industries is that they are always changing. This creates some problems in defining exactly what is and what is not included in these industries. Defining the industries using Statistics Canada's Standard Industrial Codes (SIC) is inadequate. To illustrate this, the following SIC numbers describe some of the sectors in the telecommunications and informatics industries.

Sector	SIC
Communications Equipment	335
Telephone Systems	544
Telegraph and Cable Systems	545
Office and Store Machinery	318
Computer Services	853

Collectively, the communications equipment sector, telephone systems sector and telegraph and cable systems sector roughly correspond to the telecommunications equipment and services industry. The office and store machinery sector and computer services sector, however, encompass not only select parts of the informatics sector but also cash registers, vending machines and scales and balances. Some excluded sectors are: software, computer-aided design (CAD), computer-aided manufacture (CAM), cable manufacturers and fibre optics.

For the purposes of this study we disaggregate the telecommunications and informatics industries into five sectors: telecommunications equipment; telecommunications services; computer equipment - hardware; computer equipment - software; and computer services. Some may disagree with classifying software products as equipment, since the development of software is a service and the final product is equipment. (The Department of Regional Industrial Expansion includes software products under computer services). Disaggregation into five sectors, however, allows for greater precision in assessing market potential and international competitiveness.

Telecommunications equipment includes both familiar and new technologies. Examples of the former include telephones, radios and cable television. Examples of the later include fibre optics, local area networks (LANs), private automatic branch exchanges (PABX) and cellular telephones. A more extensive list of equipment and some of the services provided appear in Table 1.

One of the more important advances in telecommunications technology was the introduction of digital signals to transmit information. Digital signals transmit information in binary code (the voltage is either zero or one) whereas analogue signals transmit code in voltage of variable amounts. The use of digital signals is much more reliable. In addition, the digital signal uses the same binary code as computers, making it a major factor in the increasing integration of the computer and telecommunications industries.

Telecommunications services are all those services which transmit, emit or receive signals by wire, radio or other electromagnetic system or by any optical or technical system.[4] Examples include telephone services, telex, satellite broadcasts, cable television, and radio. The difference between telecommunications services and informatics services is that the former uses the electromagnetic spectrum to transmit information.

Informatics equipment includes the hardware and software used in the electronic processing, storage and retrieval of

Table 1

BREAKDOWN OF EQUIPMENT AND FUNCTIONS BY TELECOMMUNICATIONS SYSTEM

Telecommunications Systems	Equipment and Functions
1. Telephone	. Station Apparatus - telephone sets - key telephone systems - private branch exchanges . Local Transmission - twisted pair wire - multipair cable - coaxial cable - optical fibre cable . Local Switching - central office equipment including step-by-step, crossbar, stored program controlled (SPC) analogue and SPC digital switches . Long Haul Transmission - multipair cable - coaxial cable - microwave radio - optical fibre - satellite systems including satellites and control facilities and earth stations . Toll Switching - tandem switches including step-by-step, crossbar, SPC analogue and SPC digital switches
2. Record and Data Communications	. Station apparatus - teleprinters - keyboard/display terminals - acoustic couplers - private automatic computer exchanges - modems - facsimile devices - local area networks - communicating word processors . Switching and Transmission - packet switches - concentrators - multiplexers
3. Mobile Radio and Radio Paging	. Mobile units including vehicular and hand held . Base station equipment including transmittors and receivers, control/supervision equipment, antennas and operators . Cellular terminals . Cellular switches . Cell site equipment . Paging receivers . Mobile satellite systems
4. Cable Television	. Transmission - microwave systems and equipment - tower and antenna . Head-end and Local Distribution - amplifiers - down converters - signal processors - studio equipment - alarm monitoring equipment - character generators - modulators - coaxial cable - trunk and trunk bridgers - feeder line, line extenders and apartment amplifiers - taps - power supplies - test equipment and tools - pay T.V. equipment - videotex equipment . Subscriber Drops and Devices - drops and connectors - converters - descramblers - network addressing devices - recorders

information. On the hardware side are computers, automated teller machines, word processing equipment, printers, and electronic typewriters. Software is "a set of programs, procedures, rules and routines used to instruct the computer in performing specific functions."[5] The two main types of software are: systems software, which controls the sequencing and processing of programs (ie. operating systems, assemblers, compilers); and applications software, which are programs which perform specialized operations (ie. spread sheets, word processing).

Informatics services include consultants, processing services, the lease and rental of computer equipment, and computer service bureaux which offer a wide range of computer-related services (ie. data entry and analysis, systems support). Table 2 provides a list of various informatics equipment and services.

These brief definitions of the various sectors of the telecommunications and informatics industries are provided only to indicate the scope of the discussion to follow. Other studies provide a much more detailed and technical explanation of the industries involved.[6]

3. Market Conditions

The market analysis concentrates on Canadian-based companies with head offices located in Ontario. The large multinationals (International Business Machines, Digital Equipment, Sperry) are very competitive and will be mentioned only briefly.

3.1 Telecommunications Equipment

Ontario accounts for some 60 percent of Canada-wide telecommunications establishments, employment and shipments. The overall situation in the Ontario telecommunications equipment sector has been reviewed in Employment and New Technology in the Communications Equipment Industry, Appendix 9 to the Ontario Task Force Final Report, Employment and New Technology. It reported

Table 2

INFORMATICS INDUSTRY
TYPICAL PRODUCTS AND SERVICES

Computer and Electronic Office Equipment

- Computers
  - mainframe
  - mini
  - micro
  - array processors
  - supercomputers
- Peripherals
  - disc drives
  - tape drives
  - computer microfilm equipment (COM)
  - optical character readers (OCR)
  - printers
- User-level devices
  - point-of-sale terminals (POS)
  - banking terminals (including ATM's)
  - other application-unique terminals
  - teleprinters
  - intelligent CRT's
  - non-intelligent CRT's
  - hard-copy printers
  - key-to-tape and key-to-disk entry devices
  - graphics plotters
  - remote batch entry equipment (RBE/RJE)
- Word processing equipment
  - standalone
  - communicating
  - shared logic
- Electronic typewriters
- Multifunction terminals
- Videotex/teletext
  - information provider terminals or encoders
  - user terminals or decoders

Software

- Systems software products
  - systems operations (e.g. operating systems, DBMS, communications monitors, emulators, spoolers)
  - systems utilization (e.g. performance measurement, job accounting, computer operations scheduling, utilities)
- Systems implementation software products
  - languages
  - sorts
  - productivity aids
  - data dictionaries
  - report writers
  - project control systems
  - program library management systems
  - retrieval systems
- Applications software products
  - cross-industry or horizontal (e.g. payroll, inventory control, financial planning)
  - industry-specialized or vertical (e.g. demand deposit accounting, airline scheduling)
  - education and training coursewares
  - expert systems

Computer-Based Services

- on-line timesharing
- remote batch computing
- batch services
- input preparation and data entry
- information retrieval services, incl. videotex content
- household transaction services
- facilities management

that in 1981 telephone equipment made up 24 per cent of total shipments by communications equipment manufacturers in Canada. All other products each accounted for less than 10 per cent. Manufacturing shipments in Ontario grew from $427 million in 1971 to $976 million in 1982 (measured in 1971 dollars). Despite strong growth in domestic shipments and exports, Ontario has a significant negative trade balance in telecommunications equipment. (The Ontario Task Force Report cited above indicates a $444 million trade deficit in 1983 in communications equipment, but it should be noted that the Task Force definition of communications equipment encompasses somewhat more than just telecommunications.)

The Department of Regional Industrial Expansion (DRIE), in its competitiveness profile of the telecommunications industry,[7] commented that while Canadian suppliers are competitive in the U.S. market for large systems, they are not nearly as competitive in the lower cost products like telephones and small telephone key systems. The DRIE profile indicates that the larger suppliers (eg. Northern Telecom and B.C.'s Microtel) are very competitive with U.S. producers in such technologies as digital switches, packet switching, satellites and fibre optics. The general conclusion of DRIE is that Canadian telecommunications equipment suppliers are competitive vis-à-vis the United States but that the smaller companies will continue to need large investments to develop their products.

There is one main force in Canadian telecommunications equipment manufacture which dwarfs all others - Northern Telecom. In 1985 it was the second largest manufacturer in North America and seventh largest in the world. Revenues in 1985 were more than $4 billion and it claimed 70 per cent of the Canadian market. Northern Telecom, which is 50 per cent owned by Bell Canada Enterprises, also operates its own research facility, Bell Northern Research (BNR). In 1983 Northern Telecom spent an estimated $310 million on research and development.[8] The high degree of vertical integration which Northern Telecom enjoys

gives it a definite competitive edge over many other telecommunications equipment manufacturers both in Canada and abroad. Northern Telecom's broad range of products is listed in Table 3.

Other Canadian companies in the telecommunications equipment manufacturing industry have generally been successful in market niches. SPAR Aerospace is known for its satellite systems and had sales of more than $220 million in 1985. Research and development spending by SPAR has been supplemented by government funds, although the federal government's share has declined from a high of 45 per cent in 1979 to a low of 30 per cent in 1982.[9] In 1982, SPAR's total research and development expenditure was $4 million. Gandalf Technologies' main products include modems and private automatic computer exchanges (PACXs). Gandalf was reported to have operating revenues of more than $85 million in the fiscal year ended July, 1985; this was a 24 per cent increase over the previous year. Gandalf's spending on research and development in 1982 was $4.2 million, slightly more than that of SPAR even though SPAR's R&D is government supported while Gandalf's is not. Mitel is another competitor in the field of telecommunications equipment. Until recently, it appeared Mitel would become a major force in the North American market but it ran into management problems and has since been bought out by British Telecom. The Ranking Corporate Performance in Canada (Globe and Mail, Report on Business Magazine) showed Mitel slipping badly in profit terms in recent years. However, the company has developed some excellent products in the area of private branch exchange technology, has its own research facility, and may soon be back in the forefront of the industry.

According to a Department of Communications survey conducted in 1984,[10] the majority of mid-sized equipment manufacturers were found to be foreign-controlled whereas smaller manufacturers were primarily Canadian owned. Both the mid-sized foreign subsidiaries and the small Canadian firms tend towards products aimed at market niches or act as suppliers to the larger

Table 3

PRINCIPAL PRODUCTS OF NORTHERN TELECOM

Business Communications

Data packet switching networks
Basic and featured electronic key telephone systems
Electronic and digital PBX systems (combined voice and data)
Private and carrier network switching systems

Information processing equipment

On-line terminal systems
Data entry terminal systems
Distributed data processing systems
Remote batch terminal systems
Integrated voice and data terminals

Subscriber apparatus

Rotary dial, push-button and key telephones
Electronic and featured telephones
Style, decorator, and novelty telephones
Coin telephones
Hands-free speaker units
Repertory dialers
Modular hardware
Headsets
Specialty and accessory terminals

Cable

Telephone wires
Composite coaxial cables
Switchboard wires and cables
Pulp and paper ribbon insulated telephone cables
Polyolefin insulated telephone cables
Frame wires

Outside plant

Customer premises distribution systems
Central office protectors and connectors
Subscriber protection devices
Terminals and closures
Splicing connectors
Loading devices
Outdoor cross connect systems

Test Equipment

Transmission test equipment
Signalling and supervision test equipment
Service observation test equipment
Service analysis equipment
PCM carrier test equipment
Loop test equipment
Trunk test equipment
Data communications diagnostic test equipment
Data communications patching and switching equipment
Data communications remote access switching and patching equipment

Central office switching

Step-by-step systems
Crossbar switching systems
Electronic switching systems
Digital switching systems
Traffic operator position systems
Centralized automated loop reporting systems
Peripheral systems

Power equipment

Power plants
Ringing and tone equipment

Transmission

Analogue and digital carrier systems
Analogue and digital multiplex systems
Analogue and digital microwave radio systems
Voice frequency equipment and systems
Digital line transmission systems
Optical fibre transmission systems
Private network transmission systems
Special subscriber services

Source: Northern Telecom Limited Annual Report

equipment manufacturers. The difficulty for these mid- and small-sized firms is to win contracts with the telecommunications carriers, who generally rely on in-province suppliers or the well-established, large manufacturers. Other alternatives include breaking into the highly competitive international market or linking their products with internationally established firms. (Mitel had signed an agreement with IBM to supply data communication switches but it fell through when Mitel could not deliver on time.)

The earlier references to Canada/U.S. competitive conditions reflect the vital importance of the U.S. market. According to the DRIE report, "only the U.S. forms a truly open market for Canadian suppliers." Canada imposes tariffs of 18 percent or more for most telecommunications products (although a significant proportion of imports from the United States enter duty free), while U.S. rates are generally much lower (averaging only 7 percent). Non-tariff barriers in the United States have been considerably reduced in recent years, notably as a result of deregulation which now enables ownership by users of terminal equipment. The break-up of AT&T also greatly expanded the U.S. market for Canadian suppliers. Some 65 percent of Northern Telecom's shipments are U.S. oriented. The DRIE report states that "it is unlikely that Europe or Japan will become a major market for Canadian suppliers". In the long-term, newly industrialized countries are expected to be major potential markets. The Canadian domestic market is too limited to support internationally competitive firms, but deregulation, technological applications (eg. fibre optic land lines) and diversification into electronic office support functions could act as important growth factors for domestic telecommunications equipment manufacturers.

3.2 Telecommunications Services

The majority of revenues in the telecommunications services sector are generated by the telephone carriers. Revenues of

telephone carriers in 1983 were $8.5 billion, almost 94 per cent of the sector's total. The remainder of the telecommunications services sector (but excluding radio and television broadcasting) had revenues of $530 million in 1982. Most of this revenue was generated by providing leased circuits (27 per cent) and private telephone services (26 per cent).

Revenues of telephone carriers grew by a compound annual rate of over 13 percent between 1973 and 1983; in 1980-81 revenues increased by almost 18 percent. Long distance toll charges account for about half of total revenues in this sub-sector, while local service charges account for the remainder. Canada-wide employment was 105,354 in 1983. Other telecommunications carriers have experienced somewhat slower but still rapid revenue growth. Employment, however, has declined.

Radio, television and cable industry revenues have grown dramatically over the past decade; revenues totalled almost $2 billion in 1983. Employment has increased by more than 33 percent since 1973. Growth of the broadcasting industry has stimulated the market for telecommunications equipment and other services.

The supply of telecommunications services in Canada is by municipally-, provincially- or federally-regulated companies with monopolies in a particular region. The main suppliers of switched public voice services (ie. telephones) are members of Telecom Canada, "an unincorporated association of the largest telephone company operating in each province".[11] Telesat Canada is also a member of Telecom Canada, and provides satellite transmissions. The federal government controls 50 per cent of Telesat, while the remaining 50 per cent is evenly divided between Bell Canada Enterprises Inc. (25 per cent) and all other carriers. Teleglobe Canada is wholly owned by the federal government and provides overseas international telecommunications links. CNCP Telecommunications, jointly owned by Canadian National Railways and Canadian Pacific Ltd., holds the monopoly in public message services (ie. telegrams). Other

telecommunication services include data networks: Datapac, operated by Telecom Canada; Infoswitch, operated by CNCP; and Globedat operated by Teleglobe Canada to allow overseas connection of data networks.

As mentioned at the beginning of this section, most telecommunications services are regulated by either the province of operation or the federal government. The Canadian Radio-Television and Telecommunications Commission (CRTC) is the federal government regulating body. It ensures that rates charged are reasonable and that no "unjust discrimination" or "undue preference or advantage" is shown in providing telecommunications services.[12] The list of CRTC regulated carriers includes: Terra Nova Telecommunications; Bell Canada; British Columbia Telephones Co.; NorthwesTel; CNCP Telecommunications; Telesat Canada; and cable companies.[13]

Until recently, federally-regulated carriers were required to offer all their services at rates set by the CRTC. However, in 1984 the CRTC decided that enhanced services (electronic message and mail services and other value-added services) could be supplied on a competitive basis. This decision is expected to increase competition in the wide range of enhanced services and encourage new innovations. This is one indication of the increasing trend towards deregulation and expanded competition. Another was CNCP's application to the CRTC in August 1985 to interconnect with Bell Canada and B.C.Tel to provide competitive long distance voice and data services. Although the application was turned down, it is highly likely that similar requests will be made in the future.

Any changes that might occur in the regulation of the telecommunications services will have far-reaching impacts on all telecommunications carriers. In terms of the current regulatory framework, though, the competitive side of telecommunications services is still a very small part of the overall industry. Opportunities for increased competition lie mostly in the applications of new technology such as fibre optic cables for

integrated voice, data and video transmissions, cellular radio telephones, facsimile transmission, and the expansion of the interconnect market.

3.3 Informatics Equipment - Hardware

The Ontario government's Final Report of the Ontario Task Force on Employment and New Technology included an appendix on the office, store and business machinery industry. Although this is a much broader classification than informatics hardware equipment, it gives some indication of the state of the industry since electronic computers and parts accounts for more than half of the group's total shipments in Ontario. The report states that in 1981 electronic computers and parts shipments were worth more than $600 million. Shipments for the group in total experienced an average annual growth rate of more than 14 per cent from 1977 to 1981. This is mainly attributed to the growth in output of electronic computers and parts, especially word processing equipment and bar code scanning equipment. The recession caused a decline in shipments in 1982, while capacity utilization (recorded for all of Canada) dropped dramatically from over 90 per cent in 1981 to under 60 per cent in 1983. In comparison to the U. S. manufacturers, the value added per dollar of labour employed in Ontario has been averaging 50 to 60 per cent less during the 1970s and early 1980s. The trade balance in office, store and business machinery in Ontario has been negative for several years and this deficit has widened with the rapid growth of the electronic computer and parts industry.

The presence of Canadian-controlled hardware manufacturers is very weak. The market is dominated by mainly U.S.-owned multinationals operating subsidiaries in Canada, such as International Business Machines (IBM) and Digital Equipment Corporation (DEC). IBM's subsidiary in Canada had 1984 revenues of $3.1 billion. The next highest earnings were recorded by DEC with 1984 revenues of $470 million. This is a reflection of the ability of these two companies to establish industry standards.

For example, IBM has established a standard for mainframe computers and, to a lesser extent, in micro (personal) computers; DEC has established a standard in mini computers. Although many of the Canadian plants of foreign-controlled companies have world product mandates, most of the research and development work is performed at head offices.

Canadian owned manufacturers of informatics hardware are much smaller in scale. GEAC Computers, a manufacturer of specialized computers and terminals, had 1984-85 revenues of $72 million;[14] 50 per cent of GEAC's sales in 1984 were for export[15]. AES Data Ltd. of Montreal produces mainly word processing hardware and had 1981 revenues of $173 million.[16] Canadian manufacturers located in Ontario include Orcatech (1985 sales of $3.1 million), Norpak (1981 sales of $7 million), Nelma Data Corporation (1981 sales of $7.6 million) and, until recently, Comterm Inc. (1981 sales of $9.5 million).[17] Most of these companies experienced declining sales in 1984.

Canadian manufacturers of computer hardware rely on foreign markets both for their supplies and sales. Only Northern Telecom and Mitel have production capability in large or very large scale integrated circuits (LSI, VLSI) and these are generally custom made and for in-house use. The remainder of the Canadian industry must rely on foreign supplies, much of it from the Japanese or neighbouring countries, in order to manufacture their product. The finished product is often destined for the U.S. where price competition is very aggressive. In 1984, nearly 90 per cent of Canadian shipments were destined for export markets.[18]

The market for computer hardware is expected to continue to undergo rapid expansion but, for the most part, will remain under the control of the large multinationals. The opportunities for Canadian hardware manufacturers will remain in the specialized products field. The future of the market will depend very much on what IBM does since in the short run, at least, its products will remain the standard.

One very recent development that will have a definite impact on Canadian manufacturers is the agreement between the United States and Japan to give American semiconductor producers greater access to the Japanese market. The agreement also includes measures to reduce the dumping of Japanese chips in the U.S. (and other) market. The agreement will probably result in higher prices for chips. The higher prices will hurt Canadian manufacturers of computer hardware, who are already operating under very small margins and are unable to pass on cost increases in the extremely competitive market. In contrast, South Korean chip manufacturers, who are unable to compete at the $2 per chip price, are expected to become a major supplier if prices increase to $4 per chip. It is also expected that the Japanese producers will 'move up market' and start production of the higher capacity chip which is not covered by the agreement.

3.4 Informatics Equipment - Software

Software development is extremely labour- and knowledge-intensive. It is also a very risky venture. The length of time to develop new software is very unpredictable, and may take so long that the product is out of date before it is ready for sale. In some cases, the lack of good software has held back advances in employing hardware. The cost is another deterrent - both to developers and prospective buyers.

Software was first marketed as part of the hardware, or "bundled" with the equipment and was included at no extra cost. It was not until IBM "unbundled" the software that the industry really started to grow. The large hardware manufacturers continue to dominate the software market. They have access to the necessary staff and funds, as well as the markets, which are all essential in producing a popular piece of software. IBM had 30 per cent of the software market in Canada in 1981.

The large hardware manufacturers have tended to produce package software which can be used on an entire line of their equipment. The market for package software is growing very

rapidly. The price can be kept low because of the greater number of sales. This is in contrast to custom software which is developed for a single user, making it much more expensive. Canadian software developers are more prominent in the custom software market. It is difficult for them to match the reputations and the marketing budgets of the package software producers.

Few barriers to entry apply to the new and fragmented software industry, even though large equipment manufacturers control a significant portion of the market. There are several successful software firms in Canada. Some of the larger firms include: SHL Systemhouse (1984-85 revenues of $48.7 million), Cognos (1984 revenues of $26 million), GEAC Computers (1984-85 estimated revenues of $14 million from software), and I.P. Sharp Associates. Cognos has developed a database system called Powerhouse that is marketed by Hewlett-Packard and sold around the world. Numerous small firms characterize the software industry. In 1984 there were approximately 2200 software firms across Canada, of which more than 1000 were located in Ontario.[19]

The Ontario Task Force on Employment and New Technology did not explicitly include producers of software in its appendix on the computer services industry. However, many of the firms investigated sell their own software products. Two studies prepared by the Ontario Ministry of Industry, Trade and Technology provide some facts on the software industry in Ontario. The Ontario Software Industry: An Industry Profile[20] contains the results of a 1984 survey of Ontario firms in the software industry. The study indicated that the average size of firms is small; 77 per cent of respondents employed 25 or fewer workers. A more recent account of industry participants is found in Computer System Sources 1986/87, published by the Ontario Ministry of Industry, Trade and Technology. It lists more than 800 Ontario producers of computers, word processors and components, software and services, and management consultants. Approximately 70 percent of these reported having fewer than 20

employees. Almost three-quarters reported from head offices in Toronto and about 20 percent from the Ottawa region. The listing is not comprehensive, since it was assembled from survey forms mailed out to larger, well-known firms and those who requested to be included in the survey.

Not only are software firms small by number of employees but also by measure of revenues. More than half of the respondents in the Ontario Software Industry survey reported total revenues of less than $500,000. However, it is not the small independent firms who account for the lion's share of revenues in the software industry. The hardware manufacturers tend to be more prominent. Although badly out-of-date, 1981 figures collected by Evans Research Corporation indicate that six of the top ten software firms in terms of revenues were mainly manufacturers of computer hardware. As mentioned earlier, IBM held 30 percent of the Canadian software market in 1981. Further, there is a growing tendency for hardware manufacturers to buy out the independent software companies, in an effort to offer total systems to their clients. These vertically integrated companies represent a powerful force in the market. Their strong revenue base allows them to invest in extensive marketing of the products. Marketing costs of software are often four times that of the development costs.

The Ontario software companies reporting in the survey did not appear be oriented towards the export market. Although not all respondents reported the value of their exports, more than half of those who did exported less than $25,000 worth of software products.

Another study conducted for the Ontario Ministry of Industry, Trade and Technology, Ontario Software Industry: Challenges and Choices, provides further information on the industry. Highlights of the study's findings include:

- the industry is made up of many small and medium sized firms;

- the industry is highly fractured (market share is widely held);
- products and services are highly differentiated;
- it is a young industry, about 16 years old;
- the barriers to entry are low;
- there are no significant economies of scale in production;
- smaller firms have an edge in producing customized software;
- there are significant economies of scale in marketing and distribution of software; and
- two-thirds of the market is held by foreign-controlled companies.

These points suggest that the most competitive route for the Ontario software industry will continue to be in custom software production. Small firms are generally more effective in developing custom software; such software requires far fewer funds to market since it generally is aimed at only one customer. Custom software, however, is losing market share to packaged software.

One other source which provides some further information on the software industry is Software: An Emerging Industry. This study, completed in 1985 for the Department of Regional Industrial Expansion, draws on 1980 and 1981 figures collected by Evans Research Corporation. While the data are 5 - 6 years old, the study's assessment of the strengths and weaknesses of the Canadian software industry are still applicable. Table 4 presents the list of strengths and weaknesses in the software industry in Canada.

3.5 Informatics - Services

Informatic services firms include those offering electronic data processing (EDP) services (i.e. service bureaux), those offering development services (professional consultants who are often involved in developing software), and those who sell and/or lease EDP equipment. According to Statistics Canada figures from

Table 4

Main Strengths and Weaknesses of the Canadian Software Industry

Strengths	Weaknesses
A developing packaged business sector; a nascent AI industry; expertise in custom software in resources, energy, telecommunications, finance and training and education.	Small domestic market, with 68% of Ontario's software market the domain of US subsidiaries; limited exports.
Proximity to the largest English speaking market in the world for software, the US.	Highly fragmented in structure; a few big companies but mainly small ones.
Proximity to the Asean region, the area of the world with highest consistent growth rates.	Absence of sufficient capitalization; with many companies experiencing severe and constant cash-flow problems.
On a world scale, several first rate universities with expertise in computer science.	Lack of marketing expertise; weak venture capital markets; conservative banking industry.
A stable economy and political system.	Absence of federal support in a recessionary period; imposing of conflicting tax rulings on software; absence of tax/fiscal and R&D incentives given to traditional manufacturers and software producers in other countries.

1983, 847 of the 1836 companies in the industry were located in Ontario. Ontario firms accounted for more than half of the $1.4 billion in total operating revenues. More than 96 percent of the industry was Canadian-controlled in 1982.

The industry is dominated by a few large computer service bureaux offering a wide range of data processing and related services. Service bureaux accounted for almost one half of the industry's total revenues in 1983. Service bureaux were initially in the business of offering processing time on large main frame computers. This service was in high demand when the cost of purchasing one's own computer was prohibitive for most private companies. With the introduction of smaller, more affordable and capable computers the demand for this service has declined dramatically. As a result, service bureaux have been changing their structure to offer other services such as on-line access to data bases, management of clients computer facilities, and software support.

Major Ontario firms in the industry include Canada Systems Group (CSG) with 1985 total operating revenues of $138.9 million, Crowntek (formerly Datacrown) with 1984 revenues of $131 million, and I.P. Sharp Associates. Large hardware manufacturers also operate service bureaux. The top four companies in Canada in 1983, however, were strictly service bureaux and all were Canadian-owned.

There are considerable costs involved in establishing EDP service bureaux. These costs, plus the dominance of the market by a few large companies, has created some barriers to entry. The high set-up costs also make it difficult to establish branches overseas. Thus, while Canadian-controlled service bureaux have a large share of the domestic market, their performance in export markets is weak.

Professional services make up another sector within informatics services, and is the second largest source of revenue. It accounted for approximately $350 million of the total industry revenues. Three major firms in this field are SHL

Systemhouse (1985 revenues of $48.7 million), DMR and Associates (1985 revenues of $43 million), and Cognos (1984 revenues of $26 million, partially attributable to software sales). Evans Research Corporation estimated that in 1983 Systemhouse and DMR and Associates accounted for slightly less than half of all professional services revenues. Despite this seemingly high concentration of market share, a recent study by DRIE reported the industry to be fragmented and that barriers to entry are relatively low.[21] The report described firms offering professional services as "small yet highly innovative [which] has led to the development of internationally competitive products and services".[22] The competitiveness of Canadian computer consultants has been well established in international markets and Canadian firms are often recognized for their well-trained, highly-skilled personnel.

4. Ontario's Competitive Position and Industry Potential

Since Ontario's telecommunications and informatics industries are so influenced by U.S. market conditions, most of the following elaboration on relative competitiveness is couched in terms of Canada/U.S. comparisons. This emphasis is particularly important in light of the Canada/U.S. trade negotiations. Table 5 indicates Canada/U.S. trade in electronics products, while Tables 6 and 7 indicate trade in selective items with Canada's major trade partners. Identification of industry potential must also include reference to newly developing countries, so as to reflect technological and market developments on a more global scale.

A 1985 report prepared by Ontario's Ministry of Industry, Trade and Technology[23] categorized Canada's communications equipment industry as 'sensitive' or vulnerable to freer trade with the United States. In contrast, a recent study prepared for the Select Committee of the Ontario Legislature on Economic Affairs concluded the following about the telecommunications equipment industry:

Table 5

Canada - U.S. Trade in the Electronics Sub-Sector
($ Canadian thousands, 1983)

	Cdn Exports	Cdn Imports	Trade Balance
Commercial & Tele-communications Equip.	611,244	534,322	76,922
Consumer Products	137,315	228,086	(90,771)
Electronic Components	451,676	1,191,566	(739,890)
Computers & Office Machines & Equip.	1,071,395 *	2,910,945	(1,839,550)
Controls & Instruments	189,732	264,907	(75,175)
Total Electronics	2,461,362	5,129,826	(2,668,464)

Source: Winham et. al., Canada - U.S. Sectoral Trade Study, prepared for the Royal Commission on the Economic Union and Development Prospects for Canada, April, 1985.

Table 6

Exports of Selective High-Technology
(millions of dollars, 1984)

Commodity	U.S.	Japan	EC	Other	Total
Office Machines	1057	23	167	130	1377
Electrical Products:					
T.V.s, radios, phonographs	173	0	1	3	177
Other telecommunications and related equipment	1630	21	193	505	2349
Electrical lighting and distribution equipment	277	1	19	78	375
Total:	3137	45	380	716	4278

Source: Statistics Canada, Summary of External Trade

Table 7

Imports of Selective High-Technology
(millions of dollars, 1984)

Commodity	U.S.	Japan	EC	Other	Total
Office Machines:					
Electronic Computers	3752	114	113	127	4106
Other office machines	125	77	30	29	261
Electronic Products:					
Telephone & telegraph	184	41	3	42	271
Televisions and radios	296	198	11	330	834
Electronic tubes & semi-conductors	1259	47	37	85	1428
Other telecommunications equipment	1004	804	95	238	2141
Switch-gear & protective equipment	87	3	25	23	139
Industrial control equip.	107	1	6	4	119
Other electric lighting distribution equipment	310	8	18	45	382
Auxiliary electric equip.	551	10	8	6	574
Total:	7675	1303	346	929	10523

Source: Statistics Canada, Summary of External Trade

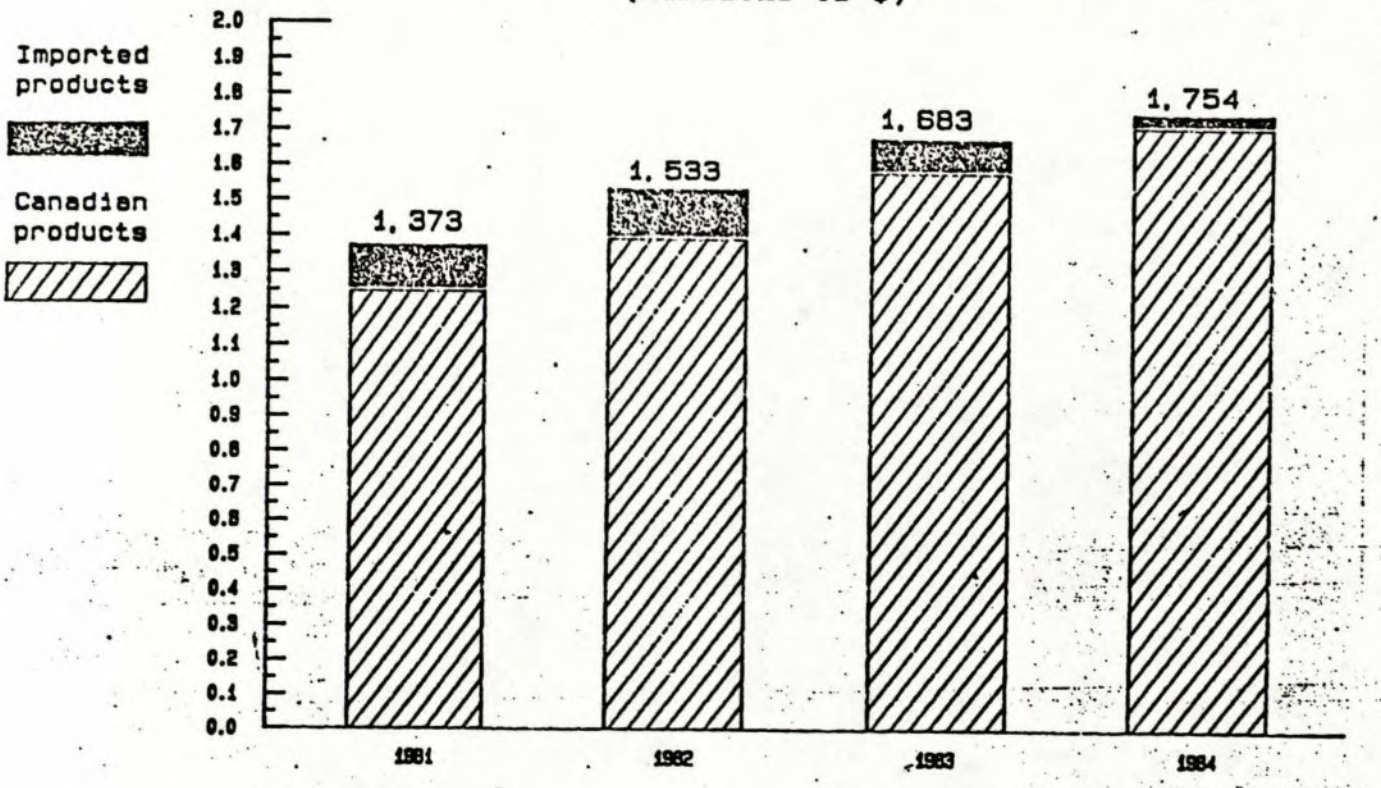
> Since the Canadian industry is strong in the domestic market and has steadily improved its market share in the U.S., Canada need not fear the elimination of tariff and non-tariff barriers. The benefits to Canada from greater access to U.S. markets well exceed any potential loss of domestic markets due to the elimination of Canadian tariffs or the easing of the user/supplier relationship in Canada.[24]

Figure 1 indicates that Canadian manufactured products account for virtually all purchasing by telecommunications carriers. Figure 2 indicates Canada's shipments and exports have grown at rates comparable to those experienced by the United States, West Germany, France and the United Kingdom. The fact that Canadian exports have increased considerably more rapidly than Canadian shipments attests to a strengthening export orientation of the telecommunications equipment industry. Indeed, trade balance data attest to an increasingly competitive position for Canada. The Canadian trade balance in communications equipment (calculated as total exports minus total imports, divided by the sum of exports and imports) improved dramatically between 1966 and 1982.[25]

While Ontario's competitive position is not explicitly addressed in the above remarks, the dominance of Ontario in the telecommunications equipment industry[26] suggests that the national figures reflect Ontario's situation. It should be noted that during the early 1980s Ontario's growth in demand for telecommunications equipment was less than recorded nationally. Since 1984, however, Ontario's rapid economic growth has stimulated a resurgence in equipment expenditures. The switching and transmission equipment sub-groups, particularly digital switching and digital technology transmission, have been experiencing rapid growth (15 percent annually). Station apparatus sales (which comprises all equipment installed at customer locations) have grown at only about 6 percent annually, although data communications equipment sales have shown an impressive performance. The mobile radio sub-sector is also very dynamic. Expenditures on outside plant equipment, largely for

Figure 1

Total Demand by the Canadian Telecommunications Carriers
Distribution by Source of Supply
(millions of $)

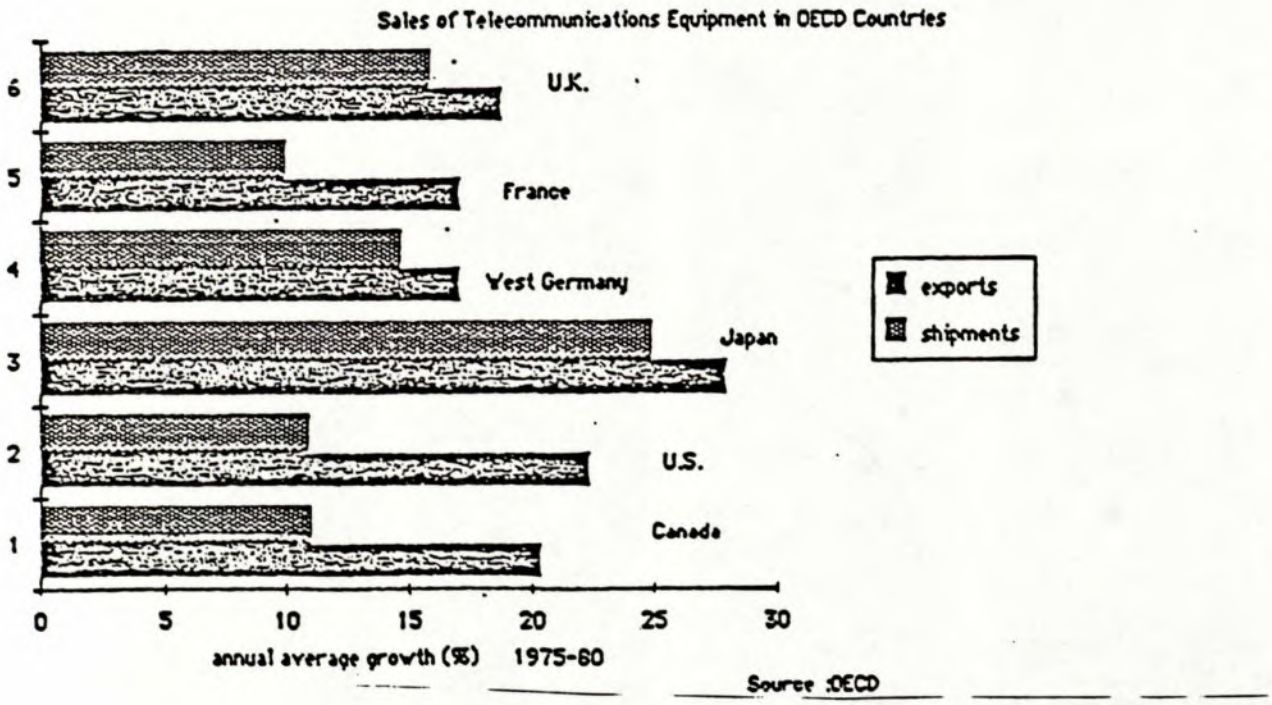


Rates of Growth

	Total demand %	Canadian product demand %	Imported product demand %
1981-1982	11.5	11.3	16.6
1982-1983	9.8	13.6	-10.0
1983-1984	4.2	5.2	-10.0

Source: The Telecommunications Equipment Demand of the Canadian Telecommunications Carriers, 1981 - 85

Figure 2



Source: A.R.A. Consultants, Canada - U.S. Free Trade in High-Technology Products.

copper cable and underground cable, have fluctuated sharply and appear to be very sensitive to general economic conditions. For the telecommunications equipment industry overall, digital switching and digital technology appear to be the most promising areas for investment. Canada has considerable strength in the manufacture and development of fibre optics, switching and electronic office and communications equipment. Sustained economic growth will encourage carriers to modernize their installations, and users to adapt to the most sophisticated products.

While firms like Northern Telecom and Mitel are well placed to participate aggressively in market expansion both domestically and internationally, many of the smaller and medium-sized telecommunications equipment manufacturers lack the financial resources to undertake research into "leading-edge" technology. Technology acquisition, therefore, is a major concern for Canadian firms. This problem is expected to intensify, for U.S. interests are pressing hard for better protection of intellectual property. Also, the United States is challenging vertical integration such as practiced by Bell Canada, Northern Telecom and Bell Northern Research. If successfully challenged, telecommunications research in Canada could be greatly hampered. As things currently stand, however, the industry appears to be in a strong competitive position.

The informatics sector has a very different configuration, being as it is so dependent upon major U.S.-based multinational corporations for domestic supply and exports. Ontario's Ministry of Industry, Trade and Technology report on the employment effects of freer trade categorized office and store machinery manufacturers as 'sensitive' or vulnerable. Again, however, the study prepared for the Select Committee of the Ontario Legislature on Economic Affairs concluded in a different vein. The study noted that such companies as IBM, Control Data Canada Ltd. and NCR, "have established manufacturing operations of computer equipment in Canada on a rationalized basis within their

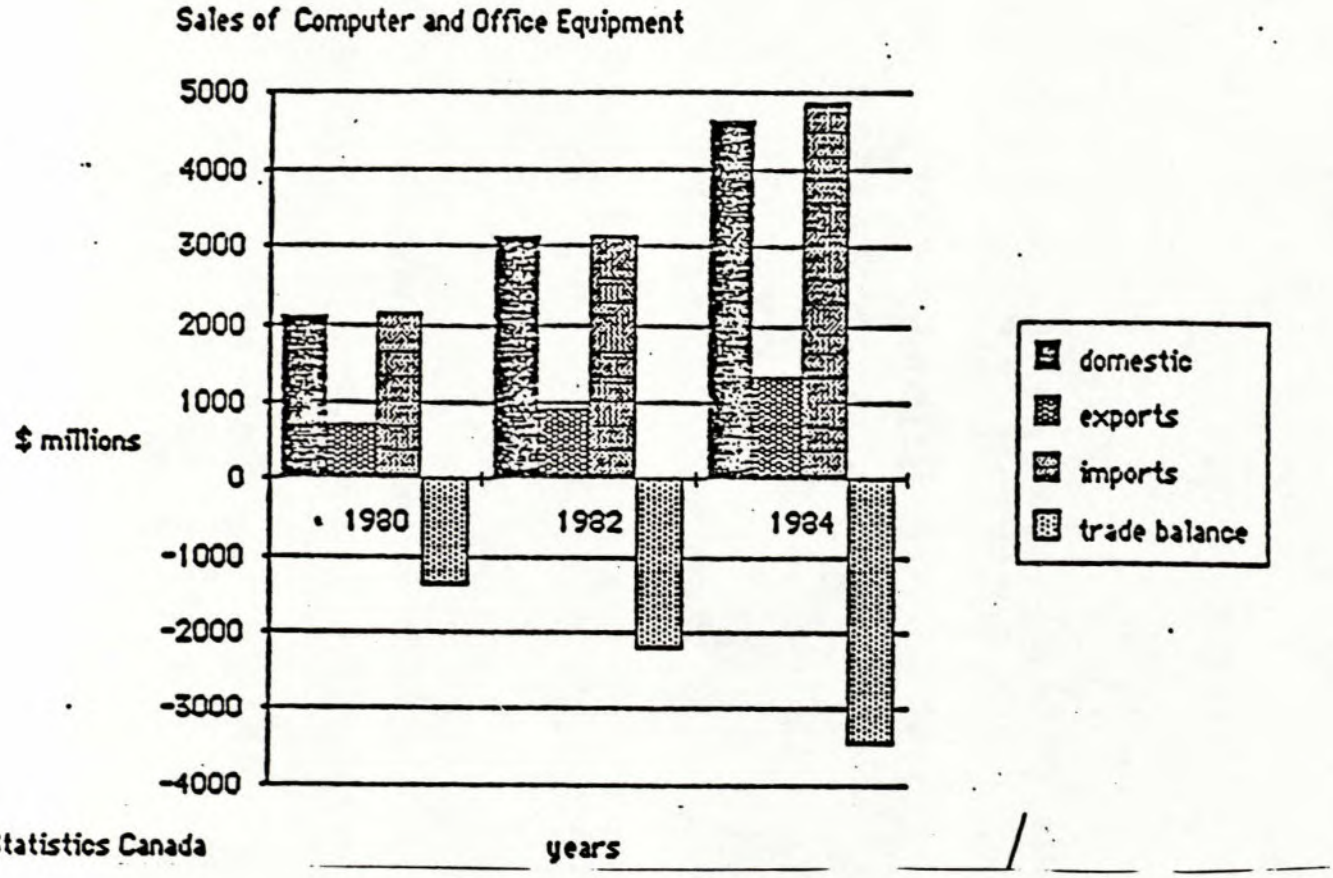
worldwide operations". Further, Canadian firms have developed indigenous technology and supply capability. Canada, according to this study, has comparative strength in combining electronic office equipment with advanced telecommunications equipment; AES Data and MICOM have been innovators in word processing equipment and have a strong presence in both the domestic market and export market.

Figure 3 indicates that Canadian manufacturing of computer and electronic equipment more than doubled between 1980 and 1984. While exports showed approximately the same rate of growth as domestic shipments, imports grew even more rapidly causing the trade balance to widen to more than a $3 billion deficit. It is the magnitude of this imbalance that suggests to some observers that Canada is rapidly losing out in the informatics field. Canadian exports to the United States, though, increased by 175 percent between 1978 and 1983, whereas imports from the United States increased by less than 150 percent. Although there can be little doubt that we are behind the United States, recent trade developments suggest that Canada is holding its own if not narrowing the gap somewhat.

There are real worries about competition from Asian Pacific countries, such as Japan, South Korea and Taiwan. Figure 4 indicates that Japan is gaining a strong hold on the world's rapidly expanding high-technology markets. A recent survey article in The Economist (August 23, 1986) concluded that U.S. companies have managed to increase their market share of three high-technology industries: communications and electronics; office automation; and ordnance. Nonetheless, the article notes that Japanese manufacturers are emerging as America's fiercest competitors in such lucrative areas as computers, telecommunications and home and office automation.

Figure 5 demonstrates that several other Asian Pacific countries have also dramatically increased their manufacturing export capability. Clearly, newly industrializing countries can readily adapt quite sophisticated technology. This has enhanced

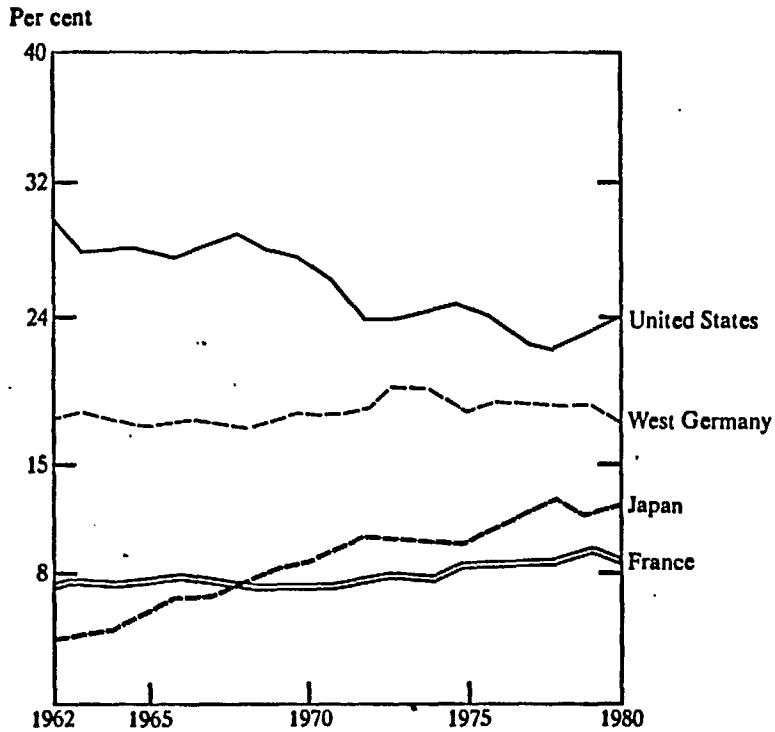
Figure 3



Source: Statistics Canada

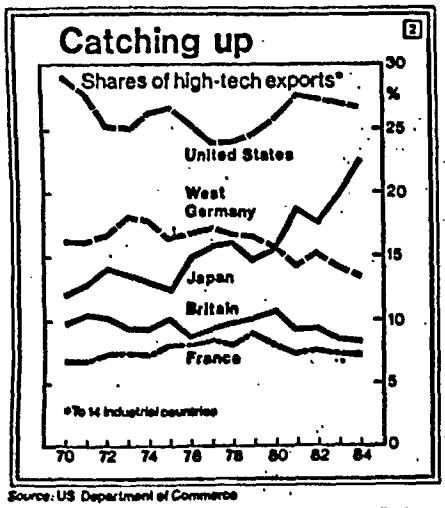
Figure 4

Market Shares of High-Technology Exports



Source: Department of Commerce/International Trade Administration, from U.N. Series D Trade Data, as cited in U.S. Department of Commerce, International Trade Administration, *An Assessment of U.S. Competitiveness in High Technology Industries* (Washington, D.C.: U.S. Department of Commerce, February 1983), p. 9.

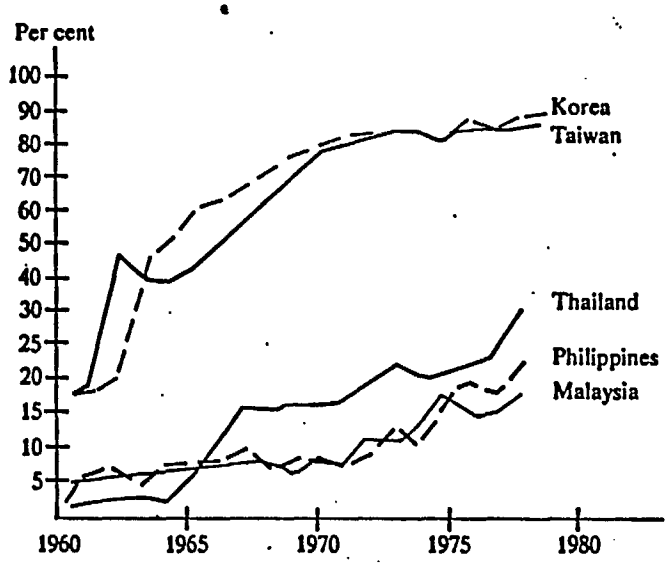
Figure 4A



Source: "High Technology Survey," The Economist, August 23, 1986.

Figure 5

Manufactured Exports as Share of Country's Total Exports, 1960–1979



Source: Miyohei Shinohara, Industrial Growth, Trade and Dynamic Patterns in the Japanese Economy (Tokyo: University of Tokyo Press, 1982), p. 100.

Source: Report of the Royal Commission on the Economic Union and Development Prospects for Canada, Volume One, p. 158.

the possibility of transferring production from high-cost developed countries to low-cost developing countries. For manufacturers of computer hardware based in North America, low off-shore labour costs demand extraordinary productivity measures in order to remain competitive.

Export sales are accounting for an increased portion of revenues for Canadian-based companies involved in computer services, particularly those engaged in supplying and developing software.[27] Table 8 indicates general data on the computer services industry, the dominance of Ontario, and the importance of the U.S. market. Cognos Inc., Systemhouse and Sydney Development Corporation are the major Canadian software firms and they have achieved international competitiveness in certain market niches. Lack of management, marketing skills, and market intelligence are problems common to many of the small firms, reflecting to some extent the fragmented nature of the software industry. According to DRIE's report on computer services,[28] the software industry also suffers from higher costs for imported hardware. The DRIE report contained the following comments on international competitiveness:

> The software sub-sector will also continue to show high growth levels provided the move towards developing specialized and vertical market niches is maintained. Being non-capital intensive this sector has the flexibility to achieve this with relative ease. It is doubtful, however, if Canada's software sector can overcome its lack of competitiveness in most areas of the saturated horizontal packaged software market, particularly in the U.S.

The professional services sub-sector of the computer services industry is also considered to be fully competitive. Export expansion is an active pursuit of the largest professional services firms in Canada. The data processing firms, in contrast, are preoccupied with reorienting the types of services they offer. An industry shake-out is underway which should lead to an improved ability to compete internationally.

In general, then, telecommunications and informatics industries in Canada appear to be reasonably well positioned to

Table 8

The Computer Services Industry*

1. Principal Statistics	1980	1981	1982
Establishments	1,036	1,392	1,752
Employment	17,538	20495	22,137
Gross Revenue	1,105	1,400	1,630
- software	345	475	640
- data processing	550	655	700
- consulting	210	270	310
Exports $M	50	60	73
Domestic Sales	1,055	1,325	1,535
Imports	n/a	n/a	n/a
Canadian Market	n/a	n/a	n/a
Exports - % of shipments*	5.0	5.4	7.0
Imports - % of Domestic Market	n/a	n/a	n/a

2. Regional Distribution - 1982	Atlantic	Que	Ont.	West
Establishments - % of total	3.0	19.6	45.3	32.0
Employment - % of total	2.1	19.4	56.0	22.8
Shipments* - % of total	1.8	19.8	55.8	22.7

3. Foreign Trade		U.S.	E.E.C.	Asia	Others
Imports - % of total	1981	80		All others - 20	
	1982	-		n/a	
Exports - % of total	1981	75		All others - 25	
	1982	-		n/a	

4. Major Firms

1. Canada Systems Group
2. Datacrown
4. Systemhouse

Source: Statistics Canada/Evans Research Corporation

n/a not available

* Includes processing services, professional services, and software products.

participate in the expected rapid growth in international demand. This observation is counter to the generally perceived impression of weakness, which may originate from drawing simple conclusions from Canada's large trade deficit in computers and office equipment. Overlooked by these observers is the fact that domestic shipments of the telecommunications and informatics industries have grown impressively, as have exports. The optimistic view expressed in this report is consistent with the findings of Data Resources of Canada, which show that total unit costs of Canadian electrical products manufacturers are - on an exchange-rate-adjusted basis - 5 percent lower than in the United States.[29]

5. 'Market Pull' of Other Industrial Sectors in Ontario

Many of the advances made in the telecommunications and informatics industries have resulted from demands for new products and services. Since this has been an important factor in stimulating the growth of the telecommunications and informatics industries, an analysis of 'market pull' is relevant to public policy considerations.

Generally speaking, there is no industry which cannot gain, if only in a small way, from new or increased use of some telecommunications or informatics technology. This view was expressed in a recent article in Harvard Business Review; "the new technologies of communications have the power to change the competitive game for almost all companies of all sizes."[30] However, many companies are unable or unwilling to jump on the technology band-wagon. Most cite cost or lack of available financing as the cause for their delay. There are also those who are either unaware of the technology available or of the application of the technology to their operations.

The previous sections of this study have shown that the Canadian telecommunications and informatics industries are quite competitive in many areas with other industrialized nations. Despite this, however, the rate of and extent of adoption of

these technologies by other industries in Canada lags behind that experienced elsewhere. The Economic Council of Canada found that, "new technology diffuses slowly into Canada from other countries [and] diffuses slowly from firm to firm and from region to region within the country."[31] Table 9 shows how Canada compares with other OECD nations in the use of industrial robots. The number of industrial robots in Canada is only 1 percent of the number employed in Japan and less than 5 percent of the number in the United States. A recent Globe and Mail article reported that while Japan employed about 350,000 numerically controlled machines Ontario industries were using only 2500.[32]

Table 9

WORLD CENSUS OF INDUSTRIAL ROBOTS

JAPAN	67,300
UNITED STATES	14,500
WEST GERMANY	6,600
FRANCE	3,380
ITALY	2,700
BRITAIN	2,623
SWEDEN	2,400
BELGIUM	859
CANADA	700
SPAIN	516

Source: Japan Industrial Robot Ass'n.

Source: Globe and Mail, August 5, 1986.

It is quite fortunate that the recent Ontario Task Force on Employment and New Technology supplies a survey of selected manufacturing and service sectors. Appendix 4, Employment and New Technology in Ontario's Manufacturing Sector: a Summary of Selected Industries, and Appendix 12, Employment and New Technology in Ontario's Service Sector: a Summary of Selected Industries both provide quite recent information on the types of new technologies which are being used and which are planned for adoption in the future.

The industries surveyed were selected on the basis of their share of Ontario's work force. In aggregate, the industries employed more than 70 percent of the total work force in 1981. The list of industries from which companies were selected appear in Table 10, (the numbers in brackets are the Standard Industrial Codes at the three-digit level).

Table 10

Manufacturing		Services	
Iron and Steel	(291)	Chartered Banks	(701)
Metal Coating & Stamping	(304)	Trust Companies	(701)
Hardware, Tool & Cutlery	(306)	Life Insurance	(721)
Misc. Metal Fabricating	(309)	General Insurance	(721)
Misc. Machinery & Equip.	(315)	Insurance Brokers	(735)
Office & Store Machinery	(318)	Federal Government	(909)
Communications Equipment	(335)	Provincial Government	(931)
Aircraft & Aircraft Parts	(321)	Municipal Government	(951)
Plastic Processing	(165)	Telephone Systems	(544)
		Telegraph & Cable	(545)
		Food Stores *	(631)
		General Goods Stores *	(642)
		Computer Services	(853)
		Management Consultants	(867)

* Information based on interviews only

Source: Report of The Ontario Task Force on Employment and New Technology, Appendix 3.

From the above list of industries, a total of 93 manufacturing firms and 87 companies supplying services were surveyed. A minimum size, based either on revenues or employees, was required in order to be considered for the sample. Although this practice might be expected to cause some bias in those industries which are dominated by many small companies (ie. computer services), all the results are reported to be at least 90 percent reliable.

The findings of the survey most relevant to this study are those indicating which technologies each industry has and/or plans to adopt in the future. The technologies selected by industry respondents are summarized in Tables 11 and 12. Table 11 presents general results for all the manufacturing industries

Table 11
Manufacturing Sector

GENERAL CATEGORIZATION OF TECHNOLOGIES BY TIME PERIOD

'Already Here' Technologies (Widely Adopted Already)	'Near Term' Technologies (Widely Planned for 1985 to 1990)	'Mid Term' Technologies (Widely Planned for 1990 to 1995)
• Computer Aided Design (CAD)	→	
• Computer-Aided Engineering (CAE)		CAD/CAM Integration →
• Products with Installed Microprocessors (SIC 318, 335)	→	
• Multifunctional Machines (SIC 318,335)	→	
• Computerized Financial Systems • Computerized Inventory Control • Computerized Order Entry	→	
	• Manufacturing Resource Planning (MRP) • Automatic Shop Floor Data Collection • Computerized - Maintenance Planning and Control - Process Control - Testing and Inspecting	
• Numerically Controlled Machines (NC) • Computerized NC (CNC)	→	
	• CAD Directed CNC	→
	• Flexible Manufacturing	→
		• Computer Integrated Manufacturing (CIM)
• Automated Conveyors/ Vehicles	• Computerized Conveyors/ Vehicles • Automated Warehouse • Automated Storage and Retrieval	→
• FAX Link With HO/Plant • Computer Link with HO/Plant	→	
	• Computer Link With	

Table 12
Service Sector

TECHNOLOGY DRIVE OF SPECIALIZED TECHNOLOGIES BY INOUSTRY CLUSTERS BY TIME-PERIOD

	'Already Here" to 'Near-Term'	'Near' to 'Mid' Term
Banks and Trust Companies	- Electronic Funds Transfer (EFT) - Automatic Teller Machines (ATM) - Automatic Debit/Credit Systems - Automatic Cheque Verification - Securities Transfer/Stock Folder Services - Computerized Trust/Pension Management - Home Banking	- Point of Sale Network - Pay by Phone - Computerized Loan Qualification Approval
Insurance Carriers and Insurance Brokers	- On-line Policy/Client Data Bases - Computerized Insurance Needs Analysis - Computerized Contract Generation - Electronic Claims Processing - Automatic Insurance Verification - Broker Management Systems	- Computerized Rating/Understanding - On-line Terminal for Group Insuranc Customers
Federal, Provincial, and Local Government	- On-line Client Oata Bases - Direct Data Entry from Field - Electronic Processing of Service Requests - Computer-Aided Mapping - Computer-Aided Project Management	- Electronic Service Delivery Bases - Computer-Aided Design (CAO) - Computer-Aided Engineering (CAE)
Telecommunications	- Computerized Service Order Processing - Computerized Client Accounts - Remote Maintenance - Customized Telecommunications Systems - PABXs - Electronic Mail - Satellite Microwave Systems - Fibre Optics - FAX with Built in Microprocessors	- Voice Synthesis Applications - Voice Recognition Applications - Voice Mail
Retail Food and General Merchandise	- Electronic Cash Registers - Point of Sales Scanners - Optical Scanners - Computerized Inventory Control - Computerized Ordering Systems	- Credit Card Verification - T.V. Shopping - Computerized Sales Aids - Automated Warehousing - Automated Transfers and Set-up - Automatic Teller Machines (ATM) - Electronic Funds Transfer
Computer Services and Business Consultants	- Installed Customized Software Systems Installed Customized Hardware Systems On-line Client Access to Data Bases On-line Interactive Systems with Clients 4th Generation Computer Languages Video Conferencing Electronic Filing	- Integrated Work Status - Home Terminals

whereas Table 12 gives a more detailed review of the service sector response.

Telecommunications technologies were reported as already existing in many of the companies. Such technologies as facsimile (FAX) and computer links to either head offices (HO) or customers were common to most manufacturers surveyed. In the service sector private automatic branch exchanges (PABX) and electronic mail were present in many firms or planned in the near future. In addition, many other respondents reported plans for using video conferencing within the next decade.

Technologies relating to informatics were found to be planned for further into the future than telecommunications technologies. Most manufacturing firms reported having some form of computerized financial system and some also had computerized inventory control systems. However, computer-aided design, manufacture and engineering (CAD, CAM, and CAE) and their integration were not expected to become widely-employed until the late 1980s to early 1990s. Firms in the service sector appear to make more extensive use of computer equipment, especially that related to office automation. In many cases, plans for the future included using local area networks (LANs), artificial intelligence and voice activated computers.

The iron and steel manufacturers reported either that they already had or were soon planning to have many of the technologies listed in Table 11. Aircraft and aircraft parts manufacturers also reported having many of the technologies already in use at their plants. A strong demand for some of the listed technologies was expected from communications equipment manufacturers, as well.

Compared to the manufacturing industries surveyed, all the service industries showed extensive use (current and planned) of almost all of the technologies listed in Table 12. However, the federal and provincial government respondents exhibited the strongest response. Trust companies appeared to have the most comprehensive plans to adopt technologies beyond 1990.

Estimated investment plans are another indication of which industries expect to adopt new technologies. The percentage of investment related to new technology is shown for each of the manufacturing industries in Table 13, and for each of the service industries in Table 14. Separate figures are given for investment in structures and buildings, and investment in machinery and equipment. Investment plans were also divided into two time periods: from 1985 to 1990 and from 1990 to 1995.

Among manufacturing industries during the next 5 years, iron and steel manufacturers expect to devote the highest percentage of investment in structures and buildings to new technology-related features. Communications equipment manufacturers estimated they would spend more than one-third of their total investment in structures and buildings on new technology-related products in the 1990 to 1995 period. New technology-related investment in machinery and equipment would make up about three-quarters of the total made by office and store machinery manufacturers in both time periods. Only miscellaneous machinery and equipment manufacturers reported that the percent of investment in machinery and equipment related to new technology would be less than one-half over the entire 10 year time frame. This group also reported that all of their total capital investment would be in machinery and equipment.

The percentage of investment by service industries in structures and buildings related to new technology averaged far lower than for the manufacturing industries. Only the suppliers of telegraph and cable systems expected to invest more than 15 percent in new technology related structures, (they estimated 38 percent of investment would go towards new technology). This industry also estimated that it would invest 95 percent of their total investment in machinery and equipment in new technology. New technology investment in machinery and equipment was expected to account for more than 80 percent of the total spent by the chartered banks and trust companies. In contrast, local government and food store respondents estimated that the percent

Table 13
Manufacturing Sector

Firms' Capital Investment Plans in Ontario

SIC	Industry		Estimated Investment in Structures and Buildings		Estimated Investment in Machinery and Equipment	
			As a Percent of Total Capital Investment	Percent Related to New Technology	As a Percent of Total Capital Investment	Percent Related to New Technology
291	Iron and Steel	1985 to 1990	22	48	78	54
		1991 to 1995	17	20	83	47
304	Metal Coating and Stamping Industry	1985 to 1990	24	11	75	44
		1991 to 1995	29	12	71	42
308	Hardware, Tool and Cutlery Manufacturing	1985 to 1990	50	1	50	57
		1991 to 1995	56	1	44	55
309	Miscellaneous Metal Fabricating Industries	1985 to 1990	19	22	81	54
		1991 to 1995	22	23	78	47
315	Miscellaneous Machinery and Equipment Manufacturers	1985 to 1990	0	1	100	42
		1991 to 1995	0	2	100	44
318	Office and Store Machinery Manufacturers	1985 to 1990	0	0	100	74
		1991 to 1995	0	0	100	75
335	Communications Equipment Manufacturers	1985 to 1990	17	33	83	50
		1991 to 1995	17	34	83	55
321	Aircraft and Aircraft Parts Manufacturers	1985 to 1990	20	31	80	59
		1991 to 1995	6	19	94	53
165	Plastic Processing	1985 to 1990	30	2	70	51
		1991 to 1995	10	10	90	56
	Average of Reporting Firms	1985 to 1990	21	15	79	54
		1991 to 1995	15	12	85	53

Table 14
Service Sector

Organizations' Capital Investment Plans in Ontario

SIC	Industry		Estimated Investment in Structures and Buildings: As a Percent of Total Capital Investment	Estimated Investment in Structures and Buildings: Percent Related to New Technology	Estimated Investment in Machinery and Equipment: As a Percent of Total Capital Investment	Estimated Investment in Machinery and Equipment: Percent Related to New Technology
701	Chartered Banks	1985 to 1990	10	3	90	84
		1991 to 1995	11	5	89	87
701	Trust Companies	1985 to 1990	8	13	94	80
		1991 to 1995	0	0	100	86
721	Life Insurance	1985 to 1990	8	3	94	66
		1991 to 1995	23	1	78	66
721	General Insurance	1985 to 1990	58	4	42	58
		1991 to 1995	12	3	88	74
735	Insurance Brokers	1985 to 1990	37	0	63	73
		1991 to 1995	10	0	91	66
909	Federal Government	1985 to 1990	16	0	84	88
		1991 to 1995	18	0	84	83
931	Provincial Government	1985 to 1990	5	4	95	62
		1991 to 1995	4	3	96	75
951	Local Government	1985 to 1990	88	2	12	23
		1991 to 1995	80	8	10	25
544	Telephone Systems and Interconnects	1985 to 1990	10	0	90	84
		1991 to 1995	6	12	94	65
545	Telegraph and Cable Systems	1985 to 1990	2	38	88	95
		1991 to 1995	3	38	97	95
831	Food Stores (1)	1985 to 1990	25	10	75	25
		1991 to 1995	25	10	75	25
642	General Merchandise Stores (1)	1985 to 1990	n.a.	n.a.	n.a.	n.a.
		1991 to 1995	n.a.	n.a.	n.a.	n.a.
853	Computer Services	1985 to 1990	11	8	89	88
		1991 to 1995	11	8	89	69
867	Management and Business Consultants	1985 to 1990	0	0	100	70
		1991 to 1995	0	0	100	71
	AVERAGE FOR REPORTING ORGANIZATIONS	1985 to 1990	35	5	85	88
		1991 to 1995	36	5	64	86

(1) Based on expert interviews only.
n.a. - not applicable

of investment in machinery and equipment related to new technology would be less than one-quarter.

The results of the survey indicate technology leaders and technology followers.[33] Technology leaders who plan to invest significant percentages of their total investment in new technologies will likely have the greatest impact on the telecommunications and informatics industries. Manufacturing industries expected to have a higher demand for telecommunications-related technologies include the iron and steel, and aircraft and aircraft parts industries. Service industries expected to have a higher demand for telecommunications-related technologies include chartered banks, trust companies, federal and provincial governments, and telecommunications carriers. Technologies related to the informatics industry would include almost all those listed in Table 11 and essentially all listed in Table 12. In the manufacturing sector, companies in the following industries are expected to have significant market pull on informatics industries: iron and steel, aircraft and aircraft parts, communications equipment, and office and store machinery. Those in the service sector would all appear to have quite extensive pull on the supply of informatics equipment and services. Exceptions to this are local governments and food stores. Chartered banks, telecommunications carriers, and those offering computer services are expected to have the greatest influence on the market.

All of the remaining industries in the survey have the potential to increase their demand for telecommunications and informatics technologies. Those industries which are expecting positive growth in the future are especially well positioned to take advantage of new technologies. According to the survey, these would include the plastic processing, metal stamping and coating, and hardware, tool and cutlery industries. Respondents in all three of these industries showed very low levels of new technology adoption. The expected percentage of investment in

new technology by the plastic processing firms is particularly promising. On the service sector side, management consultants and insurance brokers are areas where increased use of telecommunications and informatics technologies is both feasible and desirable.

One final set of results from the Ontario Task Force's survey relevant to this study is the factors which could slow down or increase a firm's rate of technology adoption. The most important factor that could impede the adoption of new technology in manufacturing industries was reported to be poor economic conditions. Those in the service sector more often cited the inability to finance new technology. Respondents from both sectors reported that the cost of new technology was also an important factor. The most important forces that drive companies to adopt new technology were reported to be competitive pressures and expected increases in productivity. Lower costs and the customers' demands for changes were also found to be significant factors.

The survey of the Ontario Task Force did not include the automotive industry. It is important to include this industry in a discussion of market pull since it is a major employer in Ontario and it is one of the most frequent users of computer-related technologies. The industry makes extensive use of numerically controlled machines (NC), computer aided design and manufacture (CAD/CAM), and computerized inventory control (for 'just-in-time' delivery of parts).

Two recent announcements by industry participants suggest that the demand for new technologies will continue to intensify. In late March, 1986, General Motors Canada announced it would spend $2 billion to modernize its two auto assembly plants in Oshawa.[34] In a joint venture between GM Canada and Suzuki, a further $500 million will be spent on building a new automobile manufacturing plant in southwestern Ontario.[35] The plant is to be modelled after one operating in Japan and can be expected to employ a large quantity of computer-driven equipment.

Small businesses were excluded for the most part from the survey by the Ontario Task Force on Employment and New Technology. There is a gap in information, which may be serious where a significant proportion of an industry sector in Ontario is accounted for by small businesses. Small businesses are generally not extensive users of high technology even though they stand to gain the most from some applications. It is particulary difficult for these small firms to raise the resources necessary to invest in new technologies. Further, before deciding to invest in a high technology product or service most firms would have to undertake expensive research into the available options. In addition to these barriers, there is also the view held by many small companies that they are not large enough to justify the expenditure. This was the view expressed by more than 40 percent of the 623 manufacturing industry representatives interviewed in a 1985 study commissioned by the Ontario technology centres.[36] The Ontario Government's technology centres are having some success in changing this view, by providing information to small businesses about what technologies are available and how these might be applied. It is quite likely that small businesses will begin to show a much greater demand for telecommunications and informatics technologies as the products and services become more common among larger firms. However, they will probably continue to lag behind others in the adoption of newly developed technologies.

6. Issues and Concerns

The issues and concerns of industry representatives have been well documented in previous reports prepared for DOC[37], and in articles by other organizations.[38] What follows is a very brief digest of some of the key issues and concerns.

... Shortage of Venture Capital ...

According to a survey of Ontario's software industry[39], attracting venture capital is one of the most serious problems.

Some 60 per cent of the survey respondents felt it was important or very important for the government to help software companies to link up with venture capitalists. The shortage of venture capital is a problem for other sub-sectors of the telecommunications and informatics industries. A study by the Institute for Research on Public Policy concluded that it is

> "unrealistic to expect Canadian venture capital firms to fill the equity financing gap created by the investment preferences of established financial institutions...[there] is the potential need for policies that promote internal investment funds...".[40]

Another study, however, warned that, "there is no simple, objective method of determining whether the shortage is money or of credible ideas and demonstrated management skills on the part of small firms".[41]

... Tax Rules ...

Two significant problems are, first, tax credits for R&D which can only be used by profitable companies, and second, the definition of R&D for tax credit purposes. In regards to the latter problem, Revenue Canada has issued new guidelines for comment by industry interests. It is vital that outstanding tax issues be resolved. Many companies face considerable uncertainty as to their profitability and viability because of the ambiguities in tax interpretation. The single most important initiative for the government, according to the survey of Ontario software industry representatives, is to provide research and development tax credits. Tax breaks should also apply to end-users of Canadian products.

... Marketing Costs ...

The marketing start-up costs of software products frequently account for a third to a half of the total costs of introducing a new product. Poor marketing expertise exhibited by many firms exacerbates this problem. Industry representatives feel that it is important or very important for the government to: organize and subsidize regular trade missions; develop a catalogue of

products made in Ontario; assist companies in researching international markets.

... Regulation of the Telecommunications Industry ...

Member companies of Telecom Canada and other telephone companies currently have a monopoly in the provision of switched public voice services within their designated operating territories. Deregulation, such as allowing interconnection rights, in this and other fields of telecommunications services could profoundly affect the degree of competition. Common carriers, faced with competition in the provision of private line voice and data services, enhanced services, and perhaps long-distance telephone services, can be expected to invest in equipment which will permit them to be price competitive and to offer new, innovative services. The regulatory framework also includes the permitted degree of vertical integration and procurement practices.

... Copyright Rules for Software ...

Pirating of products is a serious problem for packaged software producers. Unlike books, a $500 software package can be copied in only seconds on to a $1 diskette. While many producers have placed 'copy-protect' codes in their software, several factors have diminished their usefulness: a) large corporate clients find it expensive to use the software since they must purchase a copy for each user; b) software which enables copies to be made of copy-protected software appear almost as fast as the original software; and c) it is expensive to make software copy-protected. Already the three largest publishers of microcomputer software in the United States (Ashton-Tate, Lotus Development Corp., and Microsoft Inc.) have announced plans to permit corporate clients to make several copies from one software package.

Legal protection against the copying of software is provided under Canada's copyright laws. A Federal Court of Canada decision in late April, 1986 classified software as a "literary work" thereby providing it protection similar to that afforded to

books. There has been some debate since as to whether this decision will have an impact on the treatment of software for tax purposes. At present, the method of taxing software and software development is not clear, a problem which is of great concern to the software industry.

... Government Grant Programs ...

The next section of this report notes the difficulty in compiling information about federal and provincial programs that pertain to the telecommunications and informatics industries. The Minister of State for Science and Technology working paper, Science, Technology and Economic Development (1985) suggested that consideration be given to coordinating the administration of all government support programs for high-technology industries. Reform of current administrative arrangements is particularly important for small firms, many of which cannot afford the costs of finding out about and applying for government assistance. The Ontario survey of software producers found that respondents cited government paperwork and government-related administration (bureaucracy) as a serious problem. Both the Lamontagne Senate Report, A Science Policy for Canada, and the Report of the Task Force on Federal Policies and Programs for Technology Development (the Wright Report) recommended that government grant programs be streamlined in order to simplify application processes and to shorten response time.

... Technology Diffusion and Market-Pull ...

A number of concerns relate to this topic, including foreign ownership, the role and direction of government R&D, and university funding. Also of concern are the tax regime, regulatory rules, the Patent Act, the adequacy of venture capital, government procurement practices, and the degree of international networking. MOSST, in conjunction with provincial officials, is in the process of defining a national strategy to enhance technology diffusion and market-pull. Noted by some critics is the heavy degree of funding support for Canadian participation in the U.S. space station program, to the apparent

detriment of funding for other high-technology projects. The list of programs under the direct responsibility of the Department of Communications (see Table 15, section 7.1) also appear to be heavily concentrated in the support of space technology, particularly satellites.

7. Current Federal and Provincial Support

7.1 Federal Policies and Programs

The Government of Canada has stated that it is committed to the advancement of science and technology and is in the process of developing a national policy in conjunction with the provinces. The Minister of State for Science and Technology and the provincial and territorial ministers responsible for science and technology agreed in a meeting in February 1985 to develop a comprehensive National Policy on Science and Technology. This was followed by more informal meetings and, in June 1986, the National Forum on Science and Technology Policy was held. The proceedings of the Forum are expected to be released in early October 1986 by the Science Council of Canada. An earlier paper, Science, Technology and Economic Development, A Working Paper (MOSST, February 1985), outlines some priorities which were identified at the meeting in February 1985. Included in the list were:

- increase private sector investment in innovation;
- accelerate the rate of diffusion of technology/information;
- redefine the role of government research and development; and
- recognize the importance of academic research and development.

It is expected that the National Policy will address these issues.

In the absence of a comprehensive national policy, various federal departments have initiated programs which, at least in a modest way, promote the advancement of high technology. Several studies review technology-oriented programs and technology

development in Canada.[42] Rather than repeat this work, this section provides a listing of some of the current federal programs which promote technological advancement. A more complete catalog of programs is presently being assembled by the Ministry of State, Science and Technology Canada. Their previous listing, The Government of Canada's Support for Technology Development, 1984, contains programs which were established under previous governments, some of which are no longer operational.

Table 15 presents the major programs undertaken by the Department of Communications, the Department of Regional Industrial Expansion, the Department of External Affairs, the National Research Council, and the Department of Supply and Services. There are other programs which could apply to firms in the telecommunications and informatics industries, such as export financing by the Export Development Corporation. It is difficult, however, to identify what proportion of the budget for such programs applies to the industries of interest in this report. The level of program funding noted in Table 15 is from the 1986-87 Budget Estimates; in the case of new programs, an approximate figure was provided by a government official.

In recent years several programs have been dropped or combined in an effort to simplify and improve the effectiveness of the programs. For example, the Technology Inflow Program is a combination of the Catalytic Seed Fund (Department of External Affairs) and the International Collaboration Assistance Fund for Research on New Information Technologies (Department of Communications). The Department of Supply and Services Source Development Fund has been eliminated, as has the Scientific Research Tax Credit Program. Further, the entire structure of employment programs offered by the Canada Employment and Immigration Commission has been changed. Within the Department of Communications, the Telidon Exploitation Program and Office Communication Systems program have also ended.

TABLE 15

Federal Government Programs

Initiatives	Purpose	Funding 1986-87 ($ million)
Dept. of Communications:		
Communications Research Centre (CRC)	research in communications technologies	various programs
Canadian Workplace Automation Research Centre (CWARC)	studies in office automation	10.13
Space Industry Development (SID)	assist Canadian suppliers of satellite systems	10.5
Mobile Satellite Program (MSAT)	develop mobile satellite system for Canadians	(see note)
Satellite Communications Applications Program (SCAP)	development of satellite communications	1.7
Payload and Spacecraft Development & Experimentation Program (PSDE)	participation in European Space Agency's similar program	(not yet approved)
Olympus	develop multipurpose satellite platform	15.0
(Note: MSAT: $260 million invested by Telesat Canada; $50 million over 7 years invested by Federal Government)		
Dept. of Regional Industrial Expansion:		
Industrial and Regional Development Program (IRDP)	financial assistance to private sector projects	220.9
Technology Opportunities in Europe Program (TOEP)	support for Canadian companies to participate in EUREKA	20.0
Dept. of External Affairs:		
Program for Export Market Development (PEMD)	develop and increase export of goods & services	30.0
Defence Industry Productivity Program (DIPP)	develop defence-related industries, fund R&D	164.7
Technology Inflow Program (TIP)	assist technology acquisition from abroad	1.0 (approximate)

TABLE 15

Federal Government Programs

Initiatives	Purpose	Funding 1986-87 ($ million)
National Research Council:		
Industrial Research Assistance Program (IRAP)	increase R&D capability in industry	50.8
Program for Industry/ Laboratory Projects (PILP)	transfer technology from government to industry	26.2
Dept. of Supply and Services:		
Unsolicited Proposals (UP)	funds R&D projects proposed by private sector to meet government needs	15.0

It is important that decisions about future initiatives be made with full knowledge of existing programs as well as past programs. The two-year lag in updating the MOSST catalogue indicates the inadequacy of readily available information on federal support programs.

7.2 Provincial Policies and Programs

Like the Federal Government, the Government of Ontario has recognized the need for government action to encourage the development of high technology. The following statements from the Speech from the Throne (April 22, 1986) illustrate this:

> The agenda for the next decade that is set forth today offers a framework for long-term achievement...
>
> ...We must master the new standards of a world economy characterized by an intense competition focused on services, knowledge, information and new technology...

The Throne Speech and the 1986 Ontario Budget (May 13, 1986) announced several new programs as well as changes to older programs. Some details on these programs are presented in Table 16. Because it has proven to be extremely difficult to get a listing of all current Ontario Government programs related to technology, Table 16 should not be considered an exhaustive list. The problem of finding an up-to-date list of programs was even more serious at the provincial level than at the federal. Few provincial department officials had a thorough knowledge of their own department's programs and one commented that the list of programs offered was changing too fast to be kept up with. This raises the question of how such programs can be used effectively if the information is not readily available to potential users.

A study carried out by the Ontario Ministry of Industry, Trade and Technology, The Technology Challenge: Ontario Faces the Future (June 1984), has a chapter which discusses the technology-related programs and activities of the Ontario Government. Several of the programs discussed, however, are no

TABLE 16

Ontario Government Programs

Initiatives	Purpose	Funding 1986-87 ($ million)
Premier's Council	make recommendations to Cabinet	1,000 over 10 years
Ontario Investment Network	joint venture with Ontario Chamber of Commerce, provide venture capital network	0.1 (start-up funds)
Ministry of Industry, Trade and Technology:		
Pacific Rim Outreach Program	3 year program to send 45 young people to Pacific Rim to learn the culture & business practices	
Capital Projects Ambassadors	bring in 20 young engineers and consultants from abroad to work and receive on-the-job training	
Ontario International Corporation	facilitate the export of goods and services through government contracts and arrangements	
Technology Attachés	search out critical new technologies appropriate for transfer to Ontario firms	
Ontario Development Corporations	provide loan guarantees, etc. to establish and expand secondary manufacturing firms	
- New Ventures	loan guarantees to newly-established businesses	10.0
- Innovation Ontario	provide pre-venture capital assistance to small businesses	
Technology Centres	6 technology centres located across Ontario to promote, inform and assist secondary manufacturers to apply new technology to their production	

TABLE 16

Ontario Government Programs

Initiatives	Purpose	Funding 1986-87 ($ million)
Ministry of Revenue:		
Small Business Development Corporation	provide investment funds for projects undertaken by small businesses; expanded to include service sector businesses (ie. computers)	30.0
Ministry of Education:		
Microcomputers for Educational Use in Ontario Schools	funding to school boards for the purchase of approved hardware and software	30.0 (approximate)

longer operational. For example, the IDEA Corporation started in 1981 was wound down June 30, 1986, and BILD Technology Initiatives which had a budget of nearly half a billion dollars are also no longer in operation. The process of discovering which of the programs listed in the 1984 study are still in use and which is a very arduous task.

The corner stone to the Ontario Government's new approach to technology development is the Premier's Council. It is the first of its kind in Canada. The 28 member council has been given the mandate to make recommendations to Cabinet which will help "steer Ontario into the forefront of economic leadership and technology innovation."[43] To assist in achieving this goal, a $1 billion fund to aid technology development has been established of which at least half will be new monies. The Throne Speech outlined the following four tasks which will be undertaken by the Council.

- Establishment of broad provincial priorities in support of critical industries and technologies, to concentrate our resources on areas of specialization and avoid duplication.
- Encouragement of the most productive investment in basic research, applied research and technology transfer.
- Development of approach to maximize the effectiveness of this province's investment in technology centres, innovation centres, and the Ontario Research Foundation.
- Establishment of distinguished chairs in science and entrepreneurship at Ontario Universities.

An article in the Toronto Star, "Ontario high-tech council shows promise, expert says" (August 23, 1986) indicated that the Premier's Council has the potential to succeed in its goals where other similar councils have failed.

8. An Industrial Policy Planning Process

The terms of reference for this study include the following:

> Outline a planning process or methodology that can be used by the Division of Industry Development (DDI) in the future to determine its industrial development policies and strategies in Ontario in a manner that is

> sensitive to factors that pertain to both the telecommunications and informatics industries and to other domestic industrial sectors that constitute potential markets for telecommunications and informatics products and services.

Presumably, the Department of Communications is interested in a practical step-by-step process of decision-making, rather than a complex methodology that may be difficult to apply. Outlined below are some of the major elements of a planning process. Consistent with the invitation to bid on this contract (DOC letter dated January 30, 1986), the intention is "to give the Division preliminary advice on the objects proposed for full investigation under a full-fledged study."

8.1 The Context for Policy Debate

... The Fiscal Framework ...

At the outset, it may be advisable to assume zero-budget accounting and assess federal initiatives from the perspective of economic opportunity costs. While the more normal bureaucratic procedure may be to search for ways of spending a pre-determined budget allocation, the dictates of deficit reduction argue for a more rational approach for federal intervention. Even aside from the current problems of deficit containment (The Citizen, August 27, 1986, featured the expected $2 billion increase in the deficit over the Budget target of $29.5 billion), the apparent need for greater efficiency in resource allocation generally in the economy demands that much greater attention be paid to alternative uses of funds.

... The Competition for Scarce Resources ...

Frequently overlooked by line departments is the notion of scarce resources in the Canadian economy, whether labour, capital or natural resources. Also overlooked is the fact that by drawing upon these resources, so as to fund and implement a government program, less resources are available for alternative public or private sector pursuits. The government initiative may well yield higher returns to society than alternative uses, but

this ought to be demonstrated. It is the lack of such demonstration that so often results in a jaundiced assessment by central agencies (eg. Finance and the Treasury Board). The opportunity cost (ie. the alternative benefits that could be derived from private sector expenditures or other public expenditures) must be lower than the expected benefits from the proposed initiative.

One dimension of the planning process, therefore, is sensitivity to the requirement for efficiency in resource allocation. The interrelationship between departments in achieving governmental goals (DOC is but one player of many in advancing the interests of the telecommunications and informatics industries) and the competition for funds calls for a much more careful interdepartmental scrutiny of project proposals. In turn, the proposing department must be in a position to anticipate the questions and comments raised. This has implications for staffing and contracting-out for such groups as the Division of Industry Development, for they must have the capability of articulating their responsibilities in a broader context than the specific mandate.

... Monitoring Domestic Economic Trends ...

One aspect of this broader context, at least for DOC's Division of Industry Development, is monitoring domestic economic trends. A recent article ("Ontario's trade on a shaky base," Globe and Mail, May 12, 1986) concluded as follows:

> The provincial economy continues to grow, but it is not going anywhere new. And new is what the future is about.

The article notes that Ontario's deficit in high-technology trade has doubled since 1979, and that but for the auto industry, Ontario's trade is making virtually no progress. While the article contains many contentious points of view, the thrust of the article may be a good deal more useful than exhortations about the importance of high technology. In this latter regard, the DOC document titled Policy Papers on Communications for Canada's Growth, (Second Theme Sourcebook: Volume One, May 1986)

is rich in cliches and imperatives but wanting in content. It stands in marked contrast to the more measured and much briefer report titled Ontario Economic Prospects Paper: Communications Industry Component (DOC, 1985).

Evans Research Corporation provides an excellent series of reports on developments in the telecommunications and informatics industries, including an annual survey. Nonetheless, there appear to be important gaps in understanding the relative strengths of these industries and the progress of user industries in adapting to the latest technology. Perhaps the greatest misunderstanding arises in respect to competitiveness. The Science Council of Canada and the Economic Council of Canada, until recently, tended to offer quite different perspectives on competitiveness and Canada's participation in high-technology industries. The earlier pessimism of the Science Council, and its call for an extensive pro-active response, has gradually modified. In turn, the Economic Council of Canada has identified (in The Bottom Line, 1983) problems associated with technological adaptation and diffusion in Canada.

A report of the Organization for Economic Co-operation and Development (OECD) provides an interesting discussion of the differing perspectives of competitiveness.[44] Here in Canada the question of competitiveness has been dramatized by the Canada/U.S. trade negotiations. The 1985 report released by the Ontario Ministry of Industry, Trade and Technology (Assessment of Direct Employment Effects of Freer Trade for Ontario's Manufacturing Industries) gave the impression that a large proportion of domestic industry is uncompetitive. As indicated earlier, however, there appears to be little, if any, foundation for the report's categorization. Articles and books by Professor Donald Daly of York University proport to give a more analytic basis for pessimism about Canada's competitive position.[45] Daly asserts that high unit labour costs in the manufacturing sector (15.5 percent above U.S. levels in 1984) make Canada uncompetitive in world markets. His research, however, has been

severely criticized by others in the economics profession.[46] The following excerpt from a Department of Finance memorandum states Canada's competitive position much more accurately:

> By 1985 the differential between Canadian and American common currency aggregate unit labour costs levels in manufacturing had fallen to under 10 per cent. Moreover, the depreciation of the Canadian dollar in the first half of 1986 may well have reduced the differential even more. A recent Data Resources study prepared for the Department of External Affairs found that in terms of unit total factor costs, a more comprehensive cost concept than labour costs, 21 of 25 Canadian industries had lower costs than comparable industries in the United States in 1984. The continued depreciation of the Canadian dollar since 1984 has probably increased Canada's cost advantage in these 21 industries and may have reversed Canada's cost disadvantage in the other four industries. Canadian manufacturing is currently very price competitive in U.S. markets.[47]

It is vitally important that Canada's strengths and weaknesses are monitored on an annual basis. In respect to the telecommunications and informatics industries, particular attention to Ontario's situation is warranted by the concentration of manufacturing in that province. The Division of Industry Development in DOC should invest resources in gaining a clear perspective of competitiveness in these industries and in 'market-pull' from other industries. Joint participation in keeping current the work of the Ontario Task Force on Employment and New Technology is one possibility, with extensions of the research to cover additional areas of concern.

... Monitoring International Developments ...

Parallel with on-going examination of domestic trends, international developments must be thoroughly assessed. Again, there is a wealth of information available but relatively little that appears to be drawn together for public policy formulation purposes. Departmental officials require a boiling-down of the main articles, studies and reports that cross their desk. Since this is true at both the federal and provincial levels of government, sharing of these digests makes sense. The high level

exchange of information for purposes of the Canada/U.S. trade negotiations is an interesting example.

Japan and South Korea offer possible models of what might be done to improve the information base for Canadian public and private sector participants in the telecommunications and informatics industries. Japan has promoted the acquisition of new technology from abroad through a variety of means, including the provision of translations of foreign technical literature, the regular dispatch of large missions abroad, international exchanges of academics, industrial co-operation agreements, and the licensing of pilot plants. The Agency of Industrial Science and Technology is responsible for Japan's technology-acquisition arrangements at the government level. The Japan External Trade Organization is the government's commercial intelligence service. Both organizations are very well financed and staffed. Also, Japanese companies invest heavily in technological acquisition. South Korea's technology-acquisition effort is similar to that of Japan's. Of particular interest is the Korean Technological Development Corporation, a technology venture capital company that promotes close associations between foreign sources of high technology and Korean manufacturers. Sweden and France also have a well developed infrastructure for technology acquisition.

Canada must network effectively with technological developments abroad, but this requires - particularly in light of the small size of our economy - public sector participation. While some elements of information gathering are proprietary (ie. the benefits can be 'captured' by a readily identifiable group of beneficiaries), the cost of such information may require economies of scale that are not realizable in a domestic economy. Other elements of information gathering are generic and encourage free-riding (ie. the benefits accrue to a wide group of beneficiaries and there are few if any practical means for excluding the use of the information from those that refuse to contribute to its cost of gathering). In either case, investment in information gathering will be sub-optimal unless public funds

are employed. This relates to public funding of generic R&D, for information gathering cannot normally continue unless something is offered in exchange. To quote the Macdonald Royal Commission Report, "Canada should maintain a network of contacts with experts in other countries and should establish a more frequent Canadian presence in new technological developments."[48]

Monitoring international developments must also include assessment of what other governments are doing in support of their domestic telecommunications and informatics industries, and how this affects the trade framework. Some countries are obviously in the business of engineering comparative advantage. Such tactics are increasingly being challenged as unfair trade practices but, as the following quotes illustrate, their use is widespread:

> Governments are using several other measures to aid their high technology sectors. These include government procurement policies that give preference to domestic products such as computers and telecommunications; relaxation of regulations to permit collaboration among high-technology firms; setting of technical standards which favour the products of domestic firms such as advanced ground transportation systems; and export credits to industries such as aircraft and nuclear energy.
>
> Collectively, these policies and practices can be viewed as a kind of "technological nationalism" which substitutes competition between countries for competition between companies.
>
> Some countries may have little recourse but to turn to government-led programmes which marshal their limited capabilities and resources and focus them on technological targets.[49]

Whether the appropriate response is similar targeting of support is highly debatable for, as argued by the Macdonald Royal Commission, there is little evidence (even in the case of Japan) of successful targeting. Whatever the response, however, Canadian policy-makers should be well briefed on the pro-active policies and programs of other countries.

8.2 Setting the Objectives

... Consistency With Governing Party Philosophy ...

The federal system leads to the possibility of competing views between the two levels of government on industrial policy, including how best to support the telecommunications and informatics industries. Although broad generalizations inevitably belie specific actions, it would appear that the Peterson Administration in Ontario is more inclined to a pro-active industrial policy approach than is the Mulroney Administration in Ottawa. The Premier's Council, for example, will provide the Ontario Cabinet with recommendations on strategic directions to benefit the provincial economy. It will also advise Cabinet on the investment of a $1 billion special technology fund to be allocated over the next decade. In the words of Premier David Peterson, "In order for Ontario to be a world-class competitor in international markets, we need a process to speed the uptake of new technology by our industries."[50]

In contrast, the Mulroney Government appears to share the conclusion of the Macdonald Royal Commission that a more market-oriented approach to industrial policy is desirable. A discussion paper prepared by the North-South Institute summarized the current status as follows:

> There has been a shift in emphasis in recent government adjustment programming, away from sectoral and community-based approaches, and toward measures available on an economy-wide basis. Although elements of sectoral and community-based approaches will continue, recent attention seem to have been focused on developing or reworking adjustment programs that will apply to all sectors of the economy.[51]

There is sufficient malleability in this reorientation to allow for special treatment of high-technology industries, but to date there is little evidence of a dedicated priority approach to them.

The Department of Communications may wish to argue the case for such a dedicated approach. To quote The Economist:

> ...to understand what the future holds...means looking closely at the frontiers of modern electronics. for the country that commands the three most crucial technologies of all - semiconductors, computing and communications - will most assuredly command the mightiest industrial bandwagon of the twenty-first century.[52]

While Canada cannot pretend to lead either the United Sates or Japan in these technologies, it can decide that these technologies are core ones for its economic future. It should be noted that a research paper by Professor Richard Harris of Queen's University counseled the Macdonald Royal Commission against over-reliance on market forces.[53] Harris concluded that there is a reasonable probability of success in distinguishing between winners and losers, that selection must be made in order to fulfill regional employment objectives and to obtain entry into specific markets, and that scale economies will often require that the development of a new product or process be undertaken by a single firm. In the view of Harris, Canada's regional character and limited domestic market demands a targeted policy approach.

This line of argumentation is persuasive to many observers, and should be considered in the context of a possible Economic Regional Development Agreement (ERDA) between Ontario and Canada respecting the telecommunications and informatics industries. Since these industries are not in trouble, except in highly selective sub-sectors, and are located in prosperous regions of the province, an ERDA mechanism would not normally be supported by DRIE or the Federal Economic Development Coordinators. The case for such a mechanism, then, must be couched in more generic terms. Further, the case must be demonstrably consistent with the general policy approach of the Mulroney Government.

The Department of Communications might be well advised to cite A New Direction for Canada: An Approach for Economic Renewal, presented by the Honourable Michael Wilson in November 1984. As the Minister of Finance noted (pages 25 - 27 of the document):

> If we are to be competitive, we must become effective in applying leading edge technologies in producing goods and services. ...Government must play its part, by creating the climate and fostering the entrepreneurial spirit needed to realize increased innovation and to ensure its widespread application. ...Given our commitment to expenditure restraint, we must seek better use of existing industrial incentives as well as non-fiscal measures to improve the effectiveness and market relevance of Canadian R&D efforts.

... Harmony in Federal/Provincial Relations ...

An important objective of the Mulroney Government is better harmony in federal/provincial relations. Indeed, the Conservative Administration has championed harmony in federal/provincial relations as an important condition for promoting growth in the private sector. Also, the Conservative Administration views the web of regulations, subsidies and other forms of intervention built up over the years as detrimental to private sector growth. Introducing a more market-oriented framework while promoting federal/provincial relations is a complex business but, so far, there has been significant progress.

Regulation of the telecommunications industry has been clouded by jurisdictional problems. Two sets of federal/provincial meetings earlier this year have laid the groundwork for debate, but a consensus has yet to emerge. In other areas related to science and technology, several federal actions have created concern for provincial governments. The rigorous expenditure restraint program has cut into funding for energy alternatives, R&D and the National Research Council. The Manufacturing Technology Institute was dropped (budgeted at $23 million) and cutbacks have been announced for other institutes, including the Science Council of Canada. Limitations on Established Program Financing (the EPF arrangements) are claimed to be highly detrimental to the financial position of universities, where a good deal of research is undertaken. More positively, a working paper on Science, Technology and Economic

Development was released in May 1985, and in December 1985 the Minister of Finance named a group of advisors who are to make recommendations on taxation matters related to scientific research. The Minister of Finance also announced, in his February 1986 Budget, a more secure funding base for the three granting councils (NSERC, NRC, SSHRC) and matching provisions for private sector contributions to the councils. On balance, however, the federal government appears open to the charge of failing to meet the following election promises:

- double R&D expenditures within the first mandate;
- strengthen the link between public and private research and to coordinate efforts with the provinces; and
- help Canadian companies export new technologies abroad.

Because provincial governments, notably the Ontario Government, have placed considerable emphasis on improving Canada's technology record, the federal government is courting castigation for its failure to give high priority to such fields as telecommunications and informatics. The Department of Communications, then, should give special attention to the federal/provincial dimension of industrial policy measures. From this perspective, an ERDA agreement between Ontario and Canada may be worthy of consideration. The danger, however, is that the scale of the agreement might be paltry, causing industry representatives to be irked by the tokenism. Further, the initiative could pale in relation to the $1 billion 10 year commitment already announced by Premier Peterson. As a final caution, demands by other provinces for similar ERDA agreements could diffuse effort in the fields of telecommunications and informatics, hampering specialization and rationalization.

Aside from current political objectives, attention to the interrelationship between federal and provincial policies and programs is an obvious requirement. An earlier section of this report provides a brief digest of federal/provincial initiatives in Ontario, but a fuller appreciation of the interrelationships should be part of the industrial policy planning process. This

is not to suggest, however, that the two levels of government should necessarily always act in concert. Competition between the federal and provincial governments, in terms of searching for ways to best assist the telecommunications and informatics industries, may result in a better package of support than collusion. In this regard, the federal government could decide to stress framework policies and measures, leaving it to the Ontario Government to pursue targeted support for selective sub-sectors and firms.

... Industry Objectives ...

A key element in the planning process is establishing a clear set of objectives for the industries of concern. The telecommunications and informatics industries, although closely related, have significant structural differences hence the objectives may have to be differentiated. The following remarks outline possible overarching objectives, including comment on what should not be considered as objectives.

Conventionally, industry objectives are couched in very general terms:

- reduce or eliminate a negative trade balance;
- a reasonable share of world export trade;
- stimulate the growth of the industry so as to create jobs; and
- ensure the economy is a world-class competitor in international markets.

While these objectives have some merit, they suffer from confusion of purpose and lack operational content. Worry about shares of world trade, or negative trade balances, for instance, reflect a superficial view of international trade developments and the fundamental basis for trade. Comparative advantage, not absolute advantage, determines trade among nations. From an operational viewpoint, the above illustrations of objectives fail to highlight the essential purpose of industrial policies - the collective label given to government efforts to promote the

growth , productivity and competitive performance of the Canadian economy.

> ...the fundamental strategic objective of industrial policy must be enhanced productivity growth and a stronger competitive position. Accomplishing these objectives means, in turn, strengthening the environment for the efficient allocation of resources and adjustment to new realities. It also means strengthening the basic factors in the economic processes of production and marketing.[54]

For any given industry, the above strategic objective means attention to both the supply side and demand side for the products of that industry. Due to the limitations of the domestic market, attention to market-pull may not offer great promise for productivity growth and a stronger competitive position of the telecommunications and informatics industries per say, but the spin-off benefits could still be considerable. The domestic market is typically the cutting edge for firms, prior to expansion into export markets. Also, attention to market-pull could ensure that user industries are at the "forefront of economic leadership and technology innovation".

Another implication of the recommended strategic objective is attention to adjustment policies. Some observers attribute the high level of unemployment to technological displacement. As commented earlier, over a wide geographic area and over the medium to long-term, there appears to be little relationship between the rate of technological progress and the rate of unemployment. On the contrary, a report by the Ministry of State for Science and Technology has found that high R&D industries tend to be more labour intensive than capital intensive and states that, "the relationship between R&D efforts, economic growth and employment is generally accepted as a positive one".[55] Further, there does not appear to be much currency in the view that the world economic system is changing so rapidly as to challenge traditional relationships between the demand for labour, labour-force growth and productivity trends. Nonetheless, there is a good deal of anecdotal evidence to

support the view of job loss due to technological displacement, and this anecdotal evidence has encouraged organized labour to resist, in some cases, the forces of change.

There can be little doubt that technological progress is rapid, and that a well-formulated adjustment policy would ease technological adaptation. The need for a highly adaptive and flexible labour force is increasingly evident. Clearly, then, the strategic objective of enhanced productivity growth and competitiveness has many ramifications.

8.3 Instruments for Attaining Policy Objectives

The identification of instruments for attaining the policy objectives derives from a thorough understanding of the key factors that bear upon the industry or industries of concern. Perhaps the most all encompassing factor is general economic conditions. The 1981-82 recession created serious problems for a number of firms involved in telecommunications and informatics, particularly the latter. The broad consensus among economists is that the next decade should witness a much more stable environment for growth than was the case in the 1970s and early 1980s, although there are a number of worries (eg. the U.S. trade deficit, international indebtedness, weak commodity prices) that could cause a recession to reoccur. From the perspective of this report, however, the more important question is the pace of technological progress and whether traditional economic relationships will continue to hold true. The causes and nature of technical change are poorly understood. For some critics there is a surprising lack of interest and commitment of resources - at least in Canada - to understanding better the relationships between technology, industrial structure, and competitiveness. The Department of Communications could assist in addressing this information gap, either through its internal resources or through commissioned studies and other means for informing the Canadian public.

The instruments that could be employed in support of the telecommunications and informatics industries in Ontario are grouped below into three categories: those that seek to correct for market failure; those framework policies that influence the general climate for investment; and those that are pro-active and targeted.

... Correcting for Market Failure ...

A recent study by the Institute for Research on Public Policy begins by asking whether the Canadian government should intervene at all:

> The economic basis for government intervention in industrial processes ultimately lies in the existence of "market failures." These occur when one or more conditions that preclude the efficient allocation of resources by private transactions are present. When market failures for a set of economic activities are insignificant, a strong presumption exists that government policy will not improve allocative efficiency, although it might help realize other public policy objectives.[56]

Although the IRPP study addresses only the software industry, its findings are instructive for the telecommunications industry and other sectors of the informatics industry. Several sources of market failure are cited:

- Inappropriabilities, where it is difficult or impossible to charge users of specific services directly according to use. R&D activities of a generic type give rise to this problem, and warrant government subsidy. Software piracy is referred to as a more minor source of market failure.

- Inadequate information, due to its cost of gathering, the ease of dissemination, the difficulty of proprietary ownership, and economies of scale in market research and intelligence activities. A possible solution is to have some government agency disseminate information at a marginal cost.

- Economies of scale, when significant, can lead to a natural monopoly at the expense of competitive suppliers. Regulation of the telecommunications industry is frequently justified on these grounds.

- Inadequate pooling of risk, reflecting failures in private capital markets. Inefficiency in Canadian venture capital markets may have its origin in the tax code, regulatory

restrictions on financial institutions and barriers to competition.

- Merit goods, where an activity or product is intrinsically beneficial for society. This notion is invoked regarding the quality of jobs in high technology sectors as compared to jobs in other sectors of the economy.

The IRPP study notes that the policy response can either be on the supply side or demand side, and directed either at specific firms or generally available to all firms. Selection among these alternatives must depend on the relative supply/demand side conditions and the ease of distinguishing among claimants.

... Framework Policies ...

Clearly, a wide variety of policies will directly or indirectly affect the telecommunications and informatics industries, including tax law, R&D policy, trade and export policy, training policy, the regulatory framework and copyright policy. Only the first three of these are briefly commented upon below, as numerous other studies have addressed framework policies in some depth.

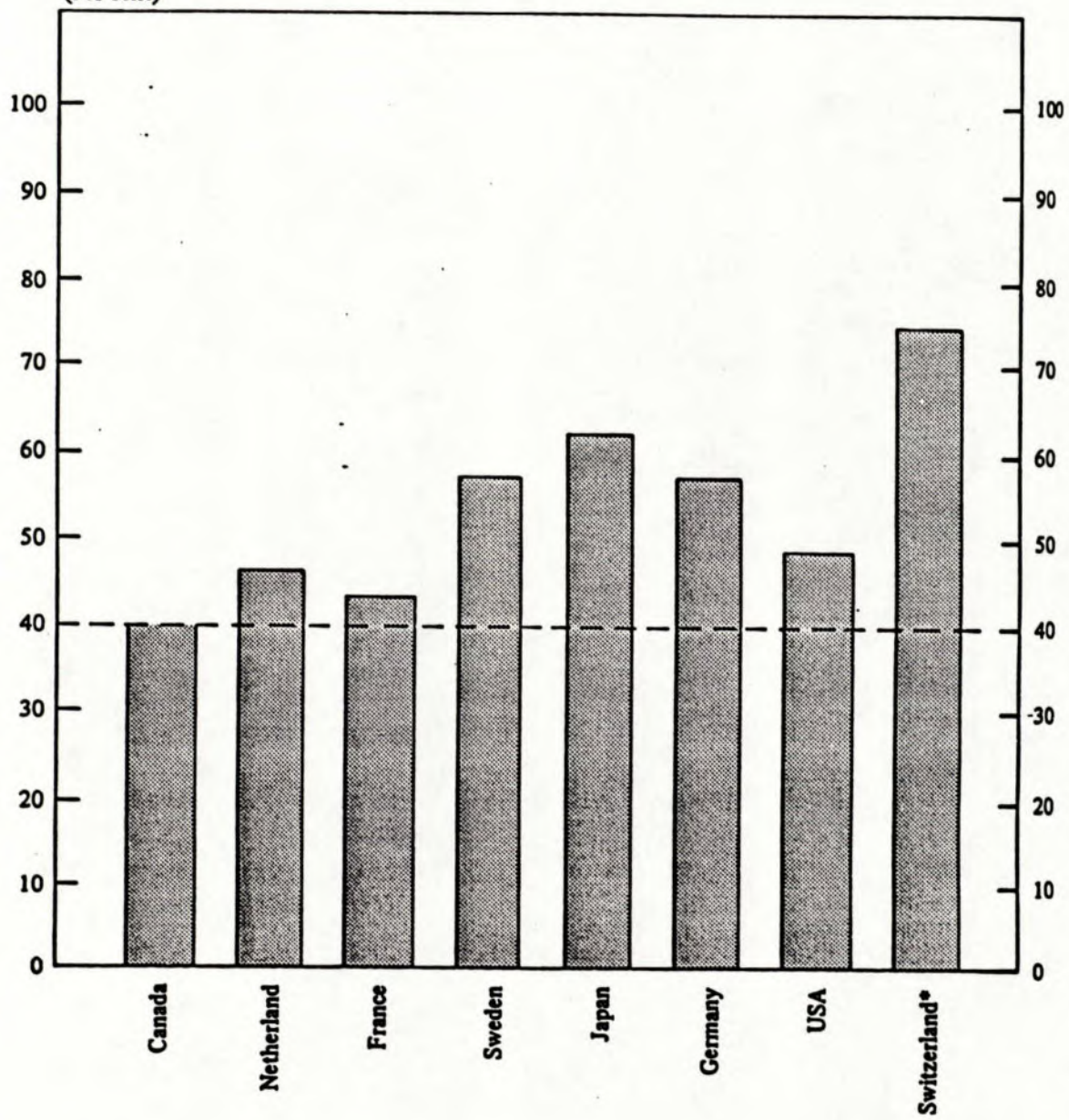
- Tax law, which is one of the most important determinants of economic growth over the longer term, and for influencing the allocation of resources. The current corporate income tax system, for example, takes little account of the degree of risk associated with a given rate of return and is, therefore, biased in favour of 'safe' investments. The taxation of computer software costs, and the distinction between research and development, has long been a contentious issue.[57] In light of the Honourable Michael Wilson's announcement of a comprehensive tax review, the Department of Communications and industry representatives should advance their views on required changes to "ensure that Canada maintains a tax system that is competitive with that of the United States".[58]

- R&D policy in Canada, according to the Chairman of the Canadian Advance Technology Association, is very weak: "Ottawa's fiscal activities to promote research and development have been devoid of strategy or direction, and what is minimally required is a federal strategy which identifies and defines specific technologies to be developed and how companies are to pursue R&D."[59] Figure 6 illustrates that Canada's R&D effort by the private sector is poor relative to other OECD countries. R&D policy in Canada need not go so far as to single-out favoured

Figure 6

Proportion of Private Funding of R&D for Selected OECD Countries 1981

(Per cent)



* Data for 1979

Source: O.E.C.D., *Science Resources Newsletter* No. 8, 1984

technologies but, given the limited size of the economy, it would seem apparent that an extra commitment will be required to keep pace with other countries. So far, however, "governmental taxation/fiscal programs to aid software, microelectronics, and other high technology industries have been less forceful than those in many countries".[60]

- Trade and export policy, which constitute a critical part of industrial policy. Representatives of the telecommunications and informatics industries appear to be broadly supportive of freer trade with the United States, and the trade initiative should be an active component of federal/provincial planning in respect to these two industries. Since marketing is such a vital dimension of breaking into export markets, and represents such a high proportion of the overall costs of developing and bringing a product to market (particularly in the case of software), government support for marketing may be in order.

... Pro-Active Policies ...

The degree of government commitment to promoting growth of the telecommunications and informatics industries, and the diffusion of their products to domestic users, importantly determine how far the administration will go in applying pro-active policies. As a line department responsible for consumer/industry interests, the Minister of Communications must determine - in conjunction with her cabinet colleagues - the appropriate scale of participation. Three general options are:

- minimal participation, with only 'window dressing' pro-active measures;
- moderate participation, with several pro-active measures designed to reinforce complimentary framework policies; and
- extensive participation, with an 'all-out' slate of pro-active measures.

The second and third options would benefit from a statement of intent, signaling the degree of political will being marshalled to accomplish the governmental objectives.

As mentioned earlier, the Department of Communications is but one player of many in influencing the fortunes (or misfortunes) of the telecommunications and informatics industries. If the government is willing to make an exception to

its more market-oriented industrial policy strategy, or if it considers that there is evidence of serious market failures (eg. information gathering and dissemination), then there must be top-down direction to galvanize bureaucratic action. In fact, a statement of intent would be appropriate even if framework policies are the major 'tour de force'. The taxation regime, for example, weighs heavily in investment decisions; a statement of commitment to supporting high technology industries should influence the Department of Finance in its examination of tax reform possibilities.

Many pro-active measures could be listed; the following selection reflects response to the issues and concerns cited earlier in this report.

- A grants program for generic technology research. The Department of Communications could sponsor, perhaps in conjunction with the Ontario Government, a research grants program in the fields of telecommunications and informatics so as to ensure Canadian participation in new technological developments. An ERDA type mechanism could help encourage specialization by Ontario in certain areas of research, and minimize duplication of research by other provinces.

- A discretionary grants program for the commercialization of generic research. Such a program could act as a partial response to the alleged failure of venture capital markets in Canada, and the difficulties of medium and small-sized firms in raising capital. The program could also address the high cost of international marketing.

- Augmentation of the gathering and dissemination of information respecting technological developments in the telecommunications and informatics fields. Japan, South Korea, Sweden, and other countries exhibit considerable public-sector participation in this vital function. Given Canada's heavy reliance on technology imports, and the need for extensive networking among the scientific community, greater investment in the information function would seem warranted. The Department of Communications could, for example, parallel the U.S. Department of Commerce, which provides a regular information bulletin on the latest software applications and the firms involved.

- Establishment of standards. The Department of Communications could set out standards about languages, operating systems and communications protocols which might

have to be met when hardware and software are being designed to meet a bidding specification.

- Stock option provisions to encourage equity investment in high risk technology ventures. Extension of the Quebec stock saving plan, which provides favoured tax treatment for equity investments in firms headquartered in Quebec, could considerably increase the interest of Canadians in the telecommunications and informatics industries. Small firms currently find that they have to considerably dilute their ownership in order to raise equity capital. Adherence to GATT provisions may preclude applying stock option plans only to Canadian companies, in which case the software industry (which has a relatively high degree of Canadian ownership) could be reserved for special tax treatment. Firms such as Mitel claim that more favourable tax treatment of stock option plans is important in attracting and holding key personnel.

In regards to the software industry, the IRPP report (Wills et. al.) includes the following recommendations:

- A national spending schedule to support R&D in artificial intelligence, greater use of procurement, and government adoption of artificial intelligence as a strategic technology.

- Firms should be allowed to decide whether software development costs are to be capitalized as a depreciable asset or expensed. Software development costs should be given the R&D exemptions, and an R&D tax rebate should be established for firms with no taxable income. Separate R&D facilities should not be a condition of claiming R&D exemptions. Both applications and systems software should be eligible for a 100 percent write-off. A partial tax holiday should apply to domestic and offshore sales of artificial intelligence products.

- Both copyright and trade secret provisions should be applied to software.

- The government should examine the necessary means to ensure that Canada has sufficient personnel for advanced software production and education. Tax provisions should encourage firms to contribute to university research centres. The government should establish a governmental branch devoted to software education and training.

- The export incentives of other countries should be closely monitored. Intermediate inputs used in software production, such as artificial intelligence workstations and other technologies, should be freed of all tariffs and import duties. The program for export market development should be

increased and the Department of External Affairs should set up a program to get offshore market information to Canadian software suppliers. Long-term loans should be available to software producers for the purpose of undertaking market development and distribution activities.

8.4 Priority Setting for the Department of Communications

Many, if not most, of the instruments for policy action noted in section 8.3 lie outside the Department of Communications' areas of influence or responsibility. Trade policy, for example, is the domain of External Affairs and the Trade Negotiations Office. In considering which 'levers' to try to pull, DOC must decide which concerns are most pressing and where it is likely to have the most success in moving the system.

From this perspective, two distinct set of initiatives would appear in order: first, those under the budgetary authority of the Department and, second, those that demand DOC input into government initiatives that vitally affect the telecommunications and informatics industry.

... Initiatives Under DOC Budgetary Authority ...

The potentially most useful direct action on the part of DOC may be in improving the information system, both for producers and users of technology related to telecommunications and informatics. A relatively modest budget allocation annually could go a fair distance in helping to network producers and users, and in drawing more effectively upon technological developments internationally. Since DOC already houses considerable expertise, it should not take a great deal more to enhance two-way consultation. The program commitment must be long-term, however, so as to convince both the sources of information and the users of information that DOC is going to serve as a first-rate clearing house.

On the assumption that budgetary provisions only allow for one initiative, DOC could, as an alternative, consider a program of supplementing the support for generic technology. In light of the regional nature of the country, yet the need to focus

Canadian efforts on well-defined fields of specialization, DOC could use a grants program to encourage specialization. This is tantamount to picking the 'winners', which will inevitably entail some disappointments. Nonetheless, Canada's R&D effort must be strengthened and DOC could provide leadership in the fields of telecommunications and informatics.

... Initiatives That Demand DOC Input ...

The two obvious initiatives are trade policy and tax reform. Above it was stated that DOC is unlikely to have much influence over broad trade policy. DOC can and should, however, contribute to the particulars of GATT and Canada/U.S. trade negotiations. DOC can assist the telecommunications and informatics industries in understanding the implications of these negotiations. Further, DOC should assist these industries in identifying areas of opportunity following trade liberalization. It is possible that a Canada/U.S. trade accord will begin to be implemented in 1988. DOC should devote resources to trade policy and the interests of the telecommunications and informatics industries.

Tax reform is another pressing concern. In May 1985, Canada's Minister of Finance and the President of the United States both put forward proposals for reforming the corporate income tax system. In each case the proposals called for a broadening of the tax base and the elimination of investment tax credits. The U.S. proposals, however, also included indexation of depreciation allowances and inventory cost. An analysis of the Canadian and U.S. proposals[61] indicates that, if both of the proposed systems were implemented, the Canadian real effective tax rate on equity-financed investment in machinery and equipment would be substantially higher than the U.S. rate. Currently, Canadian manufacturers have a tax advantage in this regard.

Since May 1985, the U.S. tax reform proposals have been considerably broadened and a sweeping reform of the personal and corporate income tax system is about to be implemented. Finance Minister Wilson has indicated he will table broad-based reforms in his next budget, expected February 1987. The Department of

Communications should take this opportunity to clear-up the tax issues that have so troubled the telecommunications and informatics industries. Resources should be devoted to understanding the U.S. measures, and the implications for Canadian competitiveness.

... Choosing Among Alternative Options ...

The pro-active measures noted above, and others that might be suggested by DOC officials and/or provincial officials, are difficult to rank in priority. Many factors, including political considerations, will bear upon the final selection. While this study has endeavoured to set-out the major points that ought to be considered, subjective evaluation and weighing is inevitable. To help in 'rationalizing' the choice process, and so as to allow for closer inspection on how individual officers arrive at their choice, the Division of Industrial Development, DOC, may wish to consider a system proposed for Transport Canada.[62] The proposed decision system is based on the Kepner-Tregoe decision analysis method.[63] Appendix B provides an illustration of the method applied to three alternative knowledge-based systems for airline safety.

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Appendix A

Terms of Reference

Appendix "D"

Government of Canada / Gouvernement du Canada

Statement of Work — Consulting and Professional Services

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36100-6-4195

Work to be done:

Identify issues and concerns facing the telecommunications and informatics industries, particularly the software sectors, in Ontario.

Determine the competitive position of Ontario companies in those industries.

Determine in an exploratory fashion the 'market pull' of other industrial sectors in Ontario that could be increasing their use of telecommunications and informatics products and services in order to improve their productivity and international competitiveness.

Based on these considerations, identify those sectors/sub-sectors within the telecommunications and informatics industries, particularly software, in which DDI should take a particular interest.

Identify opportunities for intervention by DOC and other federal departments to support the development of these sectors/sub-sectors, in liaison with existing programs of the Government of Ontario.

Outline a planning process or methodology that can be used by DDI in the future to determine its industrial development policies and strategies in Ontario in a manner that is sensitive to factors that pertain to both the telecommunications and informatics industries and to other domestic industrial sectors that constitute potential markets for telecommunications and informatics products and services.

Appendix B

Illustration of Decision Tables for Project Selection

decision statement	Identify N most effective transportation applications of knowledge-based systems technology								Sheet 1 of 8	
Objectives Whatever I choose should:		alternatives a Advance Fault Diag. Expert System			b Emergency Evacuation Advisor			c Emergency Recovery Advisor		
must		info		go/no	info		go/no	info		go/no
Prototype in next 5 years		Successful application in NUCLEAR REACTOR		Go	advice and some physical aid facilities		Go	some limited RECOVERY functions		Go
Benefits must be visible		with graphic interface, etc.		Go	robot distributed across aircraft's body		Go			Go
Transport Canada's mandate		maybe		Go	yes		Go			Go
want	wt.	info	sc.	wt. sc.	info	sc.	wt. sc.	info	sc.	wt. sc.
Benefits	10	Beyond FAULT TREE ES Highly fault tolerant	10	100	If only one litre can be saved	10	100	Any rapid approach will be worth considering	10	100
Feasibility	9	Technology widely adopted elsewhere	10	90	Can be extended from the "recorded message" approach	9	81	Ample evidence of usefulness	9	81
Testability	10	Very highly visible results	9	90	Very high	10	100	Easily tested	10	100
Marketability	8	Performance very convincing	9	72	Needs good demo	9	72	Development necessary before attempt to sell	9	72
Canadian Content	9	Not particularly Canadian	5	45	Many lives have been lost on this continent alone	7	63	Why can't Canada take the lead in this one?	6	54
Urgency	9	Slow but steady introduction expected	6	54	No reason to wait	10	90	Will benefit from further technological development	8	72
Repeatability	8	High	7	56	Reliability important so that it works when needed	5	40	Hope not used often	4	32
TC's Interests	10	Not a high priority issue Not well known yet	6	60	Constantly shown interest in safety	8	80	"Potential safety tool"	6	60
Industry's Interests	10	Will take a while to be understood	4	40	May lose users if something done soon	8	80	Idea not acceptable yet	4	40
		total		607			706			611

Use the same level of expertise and time on each, then look at 'probability' and 'seriousness'

alternative: Emergency Evacuation Advisor	P	S
adverse consequences		
Misleading guidance given by the system in action will result in reduced credibility	1	5
Advisor itself damaged in accident due to improper fault-tolerant design	2	3
Inadequate sensor coverage causing inappropriate reasoning and advice	2	4
best balanced choice		

alternative: Emergency Recovery Advisor	P	S
adverse consequences		
Damaged advisor generating inappropriate recovery sequence due to lack of fault-tolerance	2	5
Insufficient coverage of emergency cases	3	1
best balanced choice		