DEPARTMENT OF COMMUNICATIONS

A REVIEW OF TELECOMMUNICATIONS AND INFORMATION SYSTEMS TECHNOLOGIES IN CANADA

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Mike Kedar

KVA Communications and Electronics Co.

1. A Review of Telecommunications and Information Systems Technologies

Client : Department of Communications
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A Review of Telecommunications and Information Systems Technologies

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1.0 STUDY OVERVIEW

1.1 The Purpose of the Research

The purpose of this study is to:

1) conduct an initial assessment of the Canadian high technology industry engaged in research, development, manufacturing and marketing of telecommunications and information systems.

2) try and determine Canada's current and future potential within the worldwide telecommunications and information systems industries.

3) attempt to identify those high technological areas within telecommunications and information systems which have the greatest potential for growth and provide the best opportunity for Canadian industries to succeed.

4) identify incentives to better enable Canadian companies to compete within domestic and international markets.

5) create an on-going evaluation tool, in the form of a standardized questionnaire and database, to be used by Government to provide inputs necessary in the formulation of industry support policies and the development of industry incentive schemes.

1.2 A Summary of Methodology

Research information for this report was obtained through the following sources: an industry survey (questionnaire), personal and telephone interviews with leaders in the industry and a review of current literature in the form of studies and reports, trade magazines and newspapers.

The industry survey served as the focal point of the data collection and formed the basis for selecting high impact technology systems and subsystems. Prior to issuing the industry survey, personal interviews were conducted with the following major companies:

Bell Canada	Marconi
Bell Northern Research	Miller Communications
Canada System Corporation	Mitel
CNCP	SPAR
CANCOM	System House

to obtain their views on a number of issues relevant to the study, including:

<u>Technology classification</u> - to ensure the classification list prepared by KVA was complete and to obtain feedback on its structure and design.

<u>Company data, past and future</u> - to discuss the type of data needed for the study and to ensure companies willingness and ability to divulge such information, particularly financial data and marketing and sales strategies.

<u>Technology trends</u> - to obtain an initial appreciation of the trends projected by these companies and to ensure all issues were adequately addressed in the questionnaire to follow.

<u>Canadian competitive position</u> - to discuss current Canadian strengths and weaknesses and their impact on Canada's international competitive position, as well as future strategies to sustain and enhance the Canadian position.

<u>Government policies and incentives</u> - to discuss the types of policies and programs in existence and their effectiveness and to obtain views on future potential government undertakings.

These interviews resulted in valuable inputs that were incorporated in developing the questionnaire.

The final version of the questionnaire is included in Attachment I. The questionnaire was designed based on four areas of inquiry, as follows:

1. Identify the high growth technologies and high growth companies.

2. Measure the characteristics of high growth companies involved in telecommunications and information technologies.

3. Identify the segments of the telecommunications and information technologies industry which will experience the greatest growth, and

4. Evaluate alternative policies and programmes which the government may choose to adopt to encourage and enhance the competitive position of Canadian companies involved in telecommunication and information systems technologies, both domestically and internationally.

Organization of the Questionnaire

To serve this purpose, the questionnaire was divided into six sections. Each section dealt with one or all of the four areas of inquiry.

The first section, **Company Background**, describes the company. Of special importance are the size and quality of products and/or services. Our analysis determined which of these are most often associated with high growth.

The second section, **Markets and Competition**, explored the position of the company within the market, including market share and customer base diversity. A major part of the study focused on describing and evaluating the conditions which encourage rapid company growth.

The third section, **Marketing and the Competitive Environment**, shifted the perspective of enquiry from the position of the company in the market, to the marketing activities of the company. Most important, was the evaluation of the companies ability to manage Canadian advantages and disadvantages in the international market. This section was based on the premise that astute marketing will prove a key element to the success of Canadian companies in international trade. As a result, the position of Canadian companies is described and, in turn, the competitive factors which contribute to rapid growth.

The fourth section, **Research and Development**, evaluated a basic assumption that high investment in research and development is essential to the rapid growth of companies involved in telecommunications and information systems. Here, the results of Canadian R&D, the way in which R&D funds are invested and the sponsors of R&D activities were assessed. This again was related to company growth. By so doing, both the general importance of R&D to market success and the specific areas which contribute most to that success were identified.

The fifth section, **Technology Trends**, switched the emphasis from evaluating the factors which affect company success, most importantly marketing and R&D, to identifying the product areas which likely will experience the greatest growth over the next decade. In so doing, areas of development which would result in the greatest returns to the Canadian economy, were identified.

The sixth and final section, **Government Incentives**, served two purposes. On the one hand, it gauged the relative importance, actual and potential, of government support to the telecommunications and information systems industries. On the other hand, it specified the explicit forms of support which business judged to be most important. By so doing it provided a guide for selecting cost efficient export incentives.

The aggregated results of the questionnaire are included in Attachment II.

A mailing list of approximately 2,000 Canadian companies involved in the areas of telecommunications and information systems was compiled from a number of sources, including:

Dun & Bradstreet
Lakeview Publications
DSS
STATS Canada
MSST

The questionnaire was mailed to approximately 2,000 Canadian companies and the response rate was extremely favourable: out of 738 surveys returned 400 were completed and usable.

From data obtained through the 400 surveys, nine technologies or services were selected as having the greatest potential for growth, for Canada's telecommunications and information systems industry. The selected areas are classified as high impact technologies and constitute the central focus for the remainder of the report.

Information in the form of studies and reports was obtained from various federal and provincial departments, including:

FEDERAL GOVERNMENT

CRC - Communications Research Centre
DOC - Department of Communications
CPDL - Canadian Patents and Development Ltd.
CIDA - Canadian International Development Agency
ECC - Economic Council of Canada
IDRC - International Development Research Centre
RIE - Regional Industrial Expansion
SC - Statistics Canada
SSC - Supply and Services Canada
SCC - Science Council Canada
STDC - Standards Council of Canada
MSST - Ministry of Science and Technology Canada
NRC - National Research Council

Additional information in the form of trade publications and newspapers was obtained through a search of the Canadian Business and Current Affairs database for information on current (Jan '85 - Aug. '85) developments within the nine high impact technology areas.

Having identified the nine high impact technologies from the initial survey and completed a thorough literature search, interview guidelines, (refer to Attachment III), were created for each technology. The purpose of these guidelines was to assist in subsequent personal and telephone interviews with companies who replied to the initial survey and identified their involvement in at least one of the nine high impact technologies. Copies of the initial survey and the interview guidelines were mailed to each company prior to the interview. The purpose of these interviews was to validate and supplement the findings obtained from the initial survey and through the literature search. Personal and telephone interviews were conducted with one or two companies in each of the nine high impact technologies and included the following companies:

1)	Office Automation:	AES Data
2)	Local Area Networks:	Crowntek Inc., Develcon Ltd. University of Waterloo
3)	Electronic Mail:	AES Data
4)	CAD/CAM/CAE:	I.P. Sharp & Assoc., Bunt McRae Assoc.
5)	Expert Systems:	Cosigma Inc., Interact R&D Corp.
6)	HDTV:	no interviews conducted
7)	Videotex:	Air Canada, Electrohome
8)	Wide Area Data Networks:	Gandalf
9)	Satellite Ground Networks:	SPAR, Telesat

Relevant views obtained from these interviews were then incorporated into appropriate sections of the report.

Information obtained through the survey, personal and telephone interviews and various studies and reports, trade publications and newspapers were used to aid in the formulation of conclusions and recommendations regarding the past, present and future status of Canada's telecommunications and information systems industries in the areas of the nine selected high impact technologies.

1.3 Report Organization

To present this research, the report has been divided into six major sections: 1) Study Overview, 2) The International Market, 3) The Canadian Environment, 4) Telecommunications and Information Systems - High Impact System Technologies, 5) Telecommunications and Information Technology Subsystems, 6) Conclusions and Recommendations.

- The first section, **Study Overview**, presents the purpose of the report, the study methodology and the report organization.

- The second section, **The International Market**, analyzes the past, present and future status of the international telecommunications and information systems market. Of major importance to the future direction of Canadian technological developments are the technological trends occuring within the areas of telecommunications and information systems. Among other factors analyzed are major international companies, world market sales, the status of international competition, R&D efforts of telecommunications and information systems companies, the transfer of technology, and lastly, planning and financing growth.

- The third section, **The Canadian Environment**, is further subdivided into the following sections: 1) Characteristics of Companies Surveyed, 2) The Nature of Markets and Competition, 3) The Nature of Foreign Trade and Competition, 4) Research and Development Efforts, 5) Marketing Efforts, 6) Identifying and Describing the High Growth Companies, 7) Identifying the High Impact Telecommunications and Information Systems Technologies, and lastly, 8) The Role of Government Incentives in Stimulating High Impact Technologies.

The first subsection, **Characteristics of Companies Surveyed,** is an analysis of those Canadian companies surveyed who form an integral part of the Canadian telecommunications and information systems industry. Among the parameters analyzed are company size, their primary economic focus, major product lines and lastly and most significant, the issue of Canadian control.

The second subsection, **The Nature of Markets and Competition,** evaluates the present status of the Canadian telecommunications and information systems market in terms of the size and type of clientelle and who the major players are that presently dominate this market.

The third subsection, **The Nature of Foreign Trade and Competition,** looks at Canada's participation in foreign trade and analyzes the relation between foreign trade and competition, the effects of foreign competition on Canadian companies and the effects of market factors on foreign competitors.

The fourth subsection, **Research and Development Efforts,** evaluates the R&D effort of those Canadian companies surveyed. Among the parameters analyzed are the resources devoted to R&D, the factors contibuting to R&D investment, the functional focus of R&D in Canada, the source of R&D funding and the substantive focus of R&D efforts. The result will be to determine the scope and the depth of the R&D environment within Canada's telecommunications and information systems industry.

The fifth subsection, **Marketing Efforts,** evaluates the marketing efforts of those Canadian companies surveyed. Among the factors analyzed are the resources Canadian companies utilize in marketing, the non-competitive and competitive factors which contribute towards investment in marketing and the relation between R&D and marketing.

The sixth subsection, **Identifying and Describing the High Growth Companies**, focuses on the nature of high growth companies, analyzing them in terms of past and future growth, their characteristics and the factors responsible for their high growth.

The seventh subsection, **Identifying the High Impact Telecommunications and Information Systems Technologies**, discusses the criteria used in the selection of the high impact technologies, identifies those areas of Canadian expertise and identifies the systems and subsystems which could impact favourably on the Canadian economy and Canadian companies.

The last subsection, **The Role of Government Incentive in Stimulating High Impact Technologies**, addresses the issue of Government incentives and their importance in stimulating high impact technologies, discusses those characteristics of companies which tend to favour Government incentives and the views of current exporters with regards to Government incentives and evaluates alternative incentive programs.

- The fourth section, **Telecommunication and Information Systems - High Impact System Technologies**, discusses each of the nine selected high impact technologies in detail. The analysis includes a brief technical description of the technology in its current form, but the primary focus is on the economic activities and performance of Canadian industries in both the Canadian and International markets.

- The fifth section, **Telecommunications and Information Technology Subsystems**, discusses where relevant, technical and economic issues concerning those subsystem technologies which form an integral part of the much larger systems as identified in the fourth section.

- The sixth and final section, **Conclusions** and **Recommendations** presents conclusions drawn from material presented in the previous four sections and recommendations directed towards improving the economic future for Canada's telecommunications and information systems industries.

2.0 The International Market

2.1 Overview

Major advances in telecommunications and information processing technologies have broadened the range of services available; a trend that will continue with the push towards an integrated world information network. The success of this trend will depend largely on the effect of two major factors: cost and better distribution systems.

Cost trends continue to go downwards, as evidenced by the considerable reduction in switching, transmission and processing costs as a result of very large scale integrated circuit (VLSI) technology, and by the reduction in costs of serving remote locations through satellite and associated earth stations.

Geographically, there is a tremendous difference between the systems, equipment and services available from one region of the world to another, despite the recognized role of telecommunications and information processing systems in support of social, economic and political activities. Further economic growth is directly related to growth in the demand for telecommunications and informatics; thus the labelling of the 80's and 90's as the 'information age'. This disparity in geographical balance will continue to decline in light of technological advances that make worldwide networks a realizable goal.

2.2 Technological Trends

Advances in telecommunication and information processing technologies is dependent on microelectronics technology, which makes possible reductions in cost and improvements in performance. Illustrative of this are the reductions in the cost over the past two decades of information storage on digital magnetic recording devices of over 40% compounded annually and that of semiconductor computer memory by 28%. (1)

Figure 2.2.1 illustrates the development of integrated circuit design, actual and anticipated, over the period 1970 to 2000 and shows how the basic capacities of both the memory and logic gate functions have expanded in contrast to the decreasing costs.

TOWARDS CHEAPER, SMALLER, MORE POWERFUL "CHIPS"

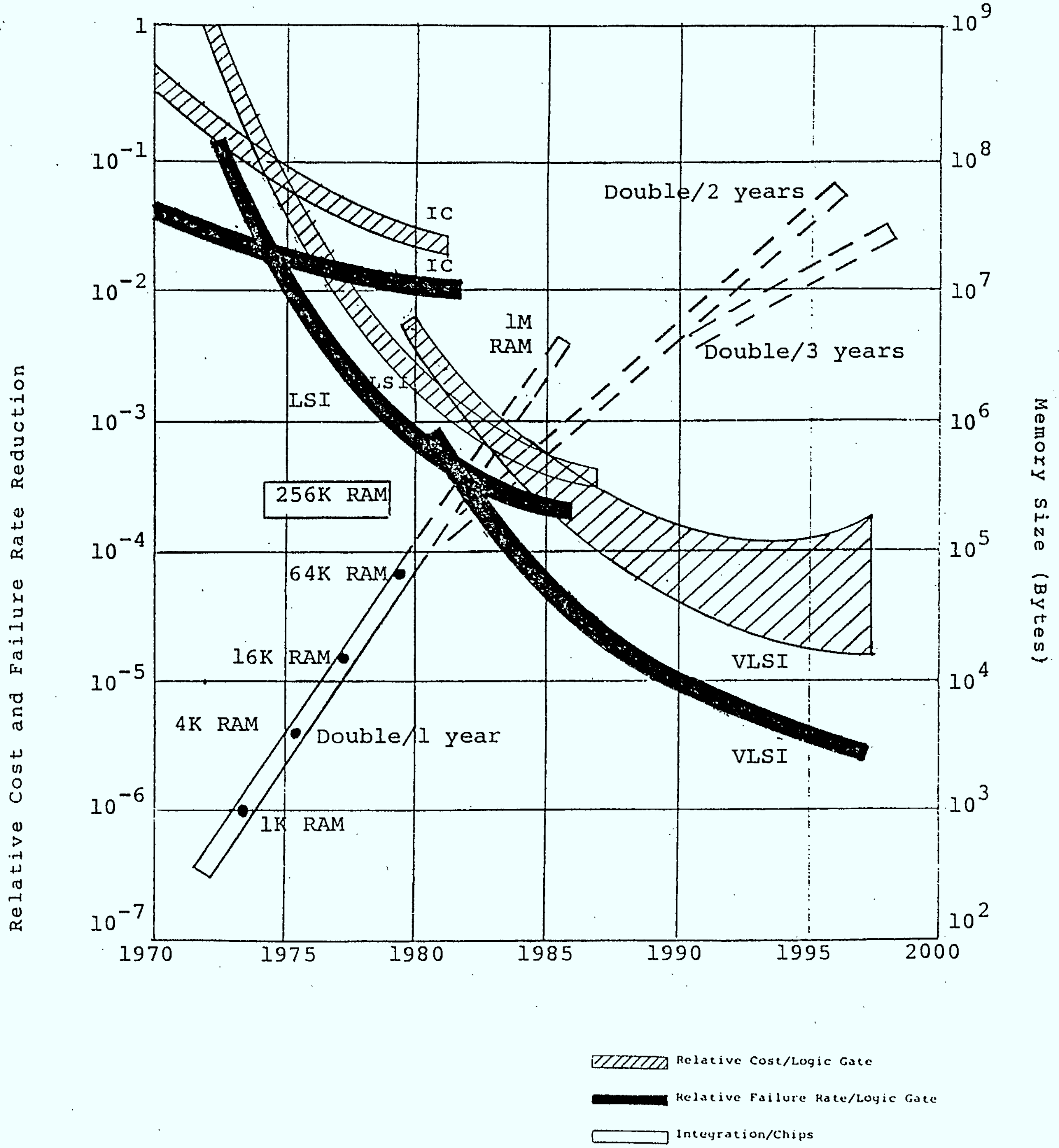


Fig. 2.2.1

Source: World Communications , Oct. 1983.

Milestones in the development of microprocessor chips that have had significant impact on telecommunications and informations systems technologies include:

1) Recent development of several 32 bit microprocessor chips, reflecting current state-of-the-art in Very Large Scale Integration (VLSI) technology. This development was only possible with the use of computer aided design (CAD) techniques which are a key factor in development as designs become larger, more complex and customized.

2) Development of the 256 kilobit random access memory (256K RAM) which quadrupled the capacity of previously available devices.

3) Development of computer controlled laser-activated techniques allowing faulty chip elements to be susbstituted with spare elements and thereby greatly increasing chip yields.

4) Development of a Very High Speed Integrated Circuits (VHSIC) permitting electron movement at close to the speed of light. The US Defense Department's Advanced Research Projects Agency expected to produce such a chip in 1985.

5) Developments in the use of light to carry information, particularly fibre optic systems, expected to further reduce costs and increase bandwidth.

The result of these milestones has been an increasing trend towards digital integrated systems that offer greater bandwidths for transmission of voice, data and video; linking of local services into systems and between systems; distributed processing systems and increased speed in information flow. Underlying these trends is the development of the appropriate software to improve network flexibility.

Figure 2.2.2 illustrates the trend toward the integration of computer and communications technologies from the birth of computers in 1950 through the year 2000.

The verticle axis shows the development of computer systems over time. It depicts the progressive evolution of the technology from single function computers to multifunction computers, through centralized processing to distributed processing.

The horizontal axis shows the parallel development of communications systems. Beginning with 1950, it depicts the dominance of voice communications via telephone. It then illustrates the evolvement and differentiation of **communication content** (voice, data, facsimile, and video), **switching technology** (crossbar, space division, and time division), and **transmission form** (analog, digital, and digital network).

The two axes converge in integrated computerization and communication around the turn of the century. This convergence will be characterized by time sharing and optical transmission in an Integrated Services Digital Network (ISDN). We illustrate it in Figure 2.2.3. This network will permit incorporation of all telecommunications and information processing technologies. These will include technologies as diverse as radio, television, computers, satellites, integrated circuitry, optical transmission, digital communications, and man-machine interface. The network will link any subscriber to any other subscriber worldwide.

GROWING UNIFICATION OF COMPUTERS AND COMMUNICATIONS

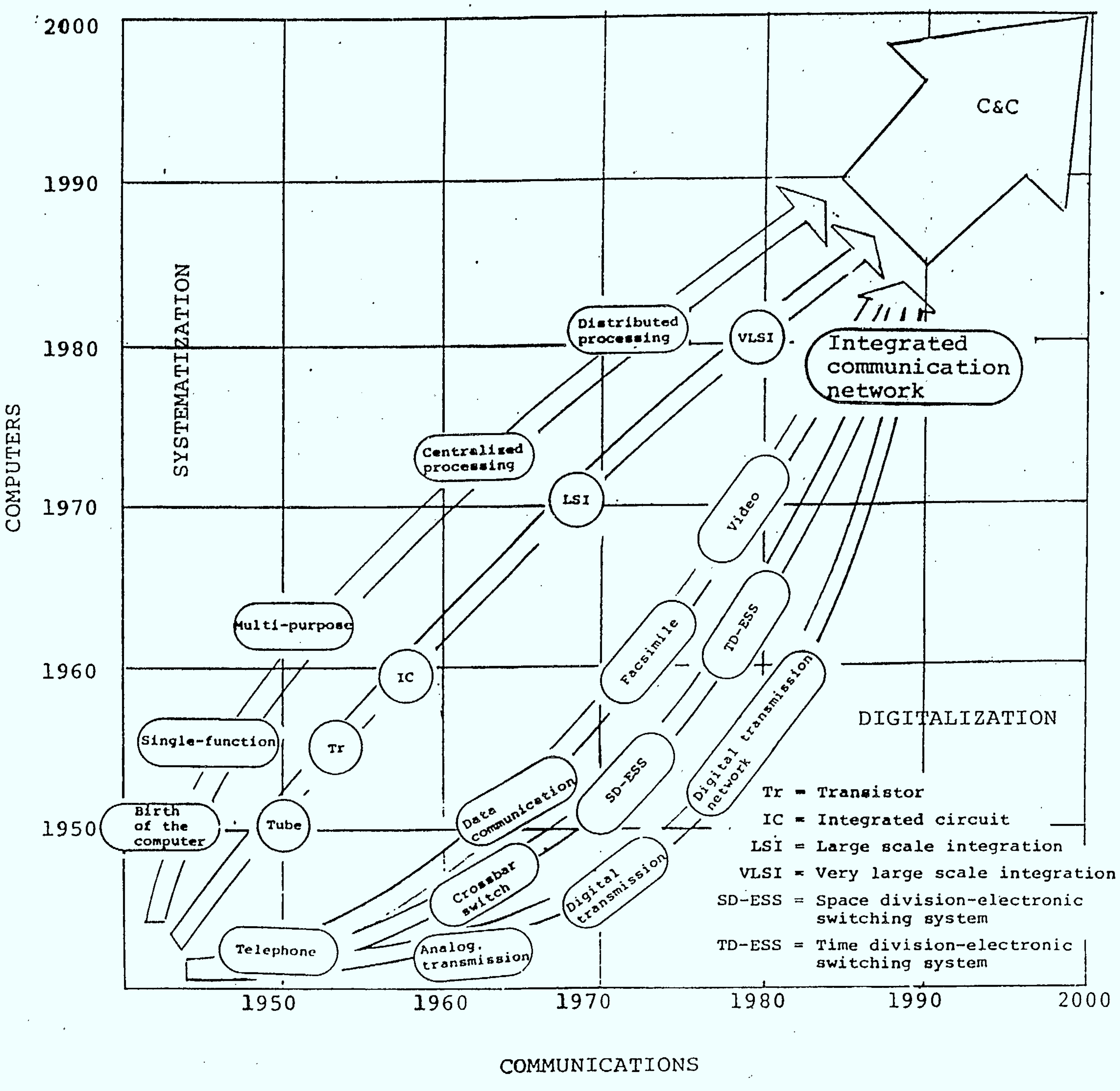


Fig. 2.2.2

Source: World Communications , Oct. 1983

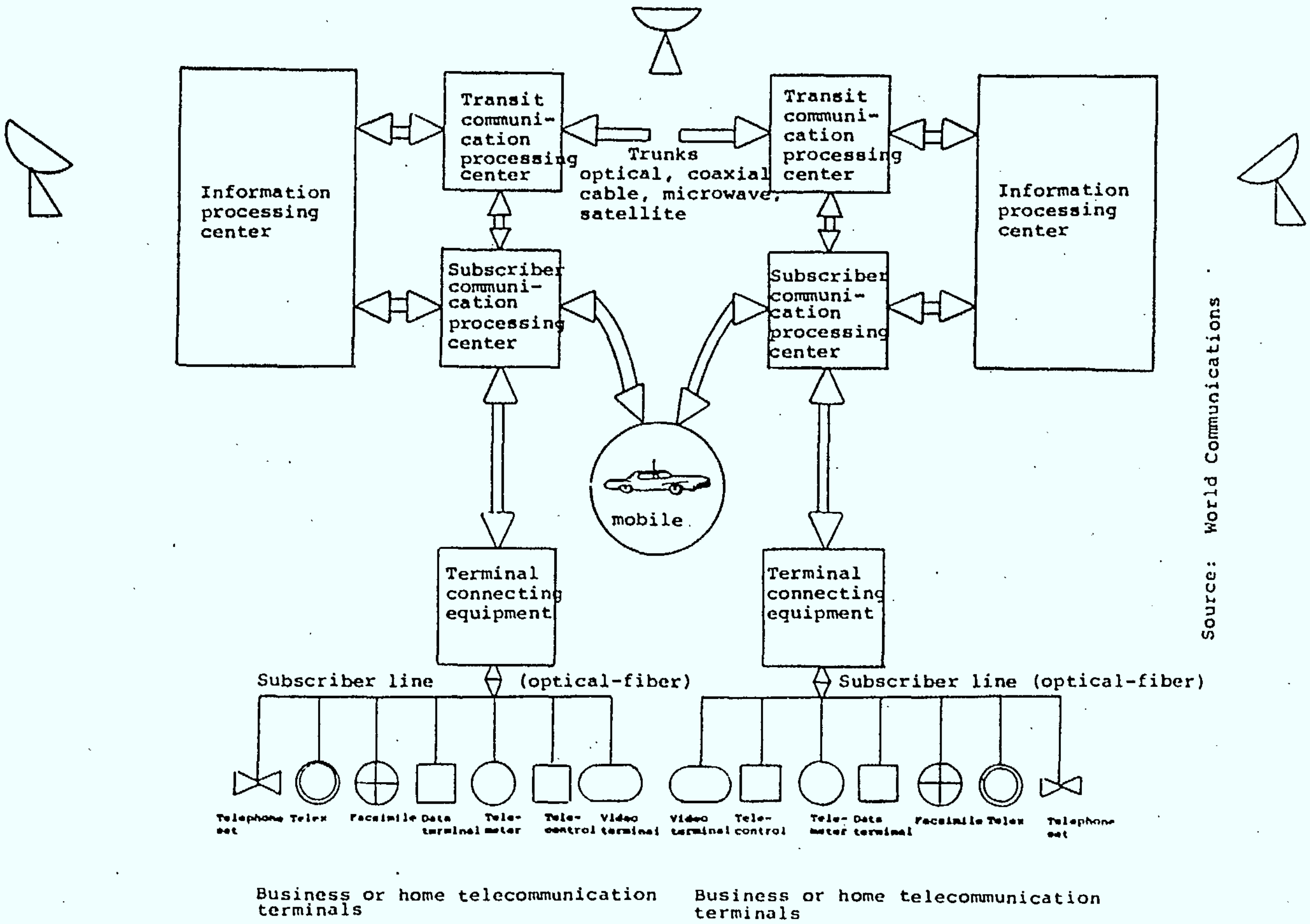


Fig. 2.2.3

Source: World Communications, Oct. 1983

The ISDN of the 21st Century will emerge through the contributions and cooperation of a diversity of organizations and people. These will include:

Governments - which, for many nations, will provide financing and which for all will form the regulatory milieu in which ISDN will evolve.

Manufacturers - which will supply the terminal, transmission and switching equipment.

Research institutions - which will develop and integrate the system components.

Carriers - which will provide the service of transmitting user information through the system and which, also will provide new services of enhancing that information into forms more valuable to the user.

Financial institutions - which, with governments, will provide the investment capital for the manufacturers, the carriers, and, to an increasing extent, the research institutions.

Users - who will purchase the communications services and the associated transceiving equipment.

2.3 Major International Companies

Within the Telecommunications and Information Processing Industries, companies may be classified within the following major groupings:

1) Telecommunication and information processing service providers.
2) Equipment manufacturers.
3) Software producers and designers.
4) Manufacturers of components and specialized materials.
5) Consultants and contractors.

The major multinational companies as listed in the attached table, generally fall within all the five classifications. Relevant information about these major international companies is included in the table.

Table 2.3.1
Major International Telecommunication Companies

Company	International Market	Sales	Systems & Services	Manufacturing Facilities	Employees	R&D	World World Ranking	Principal Growth Areas	Home Country
IBM Ltd.	worldwide	Total revenue of $45 billion in 1984 74% of mainframe market 34% of mini-computer market 28% of micro-computer market	Supplier of data processing products to the information processing industry				First in the information processing industry	1) Mainframes 2) minicomputers and microcomputers	U.S.
3M Company		Of four business sectors - Electronic & Information Technologies Sector had 1982 sales $26 billion (30% of total company sales)	1) IC interconnects 2) Electronic test & measurement eqpt for communications networks 3) teleprinters, digital facsimile 4) broadband local area networks	In 31 countries		Employs 5,500 in North America Japan, Brazil & Europe			U.S.
ITT	Includes 96 countries	Total 1982 - $23 billion(US)	1) Switching & transmission equipment 2) Terminal equipment		300,000 worldwide	Total 1982 - $1.2 billion(US) Employs 25,000 in R&D	First in Telecommunications eqpt.	Integrated digital communications	U.S.
Thomson CSF Communications	Includes 100 countries	Total 1982 - $27.2 billion Francs (47% in export trade)	1) Public Telecommunications 2) Radiocommunications 3) Business Communications 4) Data Processing Systems & Software	31 factories worldwide	81,000 worldwide	Total 1982 - 5 billion Francs (10% of total sales) Employs 13,000 in R&D	Fifth in Telecommunications eqpt.	Transport, Processing & Storage of Information	France
Siemens AG Communications Group	Includes 128 countries	Total 1982 - $16.5 billion(US) Communications & Components and Data Systems 36%	1) Public switching systems 2) Transmission networks 3) Private & Special Purpose Communications Networks 4) Communication Terminals 5) Safety & Security Systems	In 28 countries	324,000 worldwide	Total 1982 -$1.4 billion (US) (8% of sales) Employs 30,000 in R&D 10% on basic research 90% product development	Third in Telecommunications eqpt.	Digital transmission eqpt. Office communication technology	Germany
NEC Corp.	Includes 140 countries	Total 1982 - $4.8 billion(US)	1) Communications (37%) 2) Computers (23%) 3) Electronic devices (24%) 4) Home Electronics (12%) 5) Misc. (5%)	In 12 countries			Seventh in Telecommunications eqpt.	Integrated computer & communications networks	Japan

Northern Telecom Ltd.	worldwide	revenues in 1984 exceeded $4.3 billion	1) integrated voice & data communications systems 2) switching, transmission and subscriber equipment 3) application of digital and optoelectronic telecommunications technologies	46 manufacturing plants worldwide: 27 in Canada 14 in the U.S. 1 in Ireland 1 in Brazil 1 in the U.K. 2 in Malaysia	47,000 worldwide	a major portion in R&D expenditures: $1.2 billion between 1983 and 1987 towards the OPEN World Program	6th in design & manufacture of telecommunications equipment	1) central office switching systems 2) business communications systems	Canada
CIT Alcatel (a member of the CGE group)	Includes 80 countries - especially strong in North America & Europe	1982 - $1.8 billion (30% outside of France)	1) Time division switching equipment 2) radio communications 3) transmission equipment		40,000 (6,000 outside France)		World leader in digital subscriber switching systems.	1) Equipment for optical fibre cable distribution systems & Integrated Services Digital Network (ISDN) 2) Office Automation equipment	France
Telettra S.P.A. (organization of several national Italian companies		Largest telecom manufacturer had 1982 sales of $365 million (US) For total organization (66% of products & services are exported)	1) Turnkey systems worldwide	7 countries	Italy's largest privately owned telecom manufacturer employs 8,000	Employs 3,000 in R&D		1) Caters to a multiplicity of markets 2) Provides systems for public, private and military sectors	Italy
GTE Corporation	US and 18 countries in N.A., L.A., Europe, Middle East and Far East		Three of four business groups engaged in telecommunications	In 8 countries		40 R&D laboratories in US, Canada, Italy & Belgium Employs 3,000 in R&D			U.S.
Control Data Corporation			1) Large scale computer systems 2) Peripheral equipment 3) Worldwide & data services network 4) CAD/CAM						U.S.

2.4 World Sales - Past and Future

The telecommunications and information processing industry employs millions of people. It has experienced, and will continue to experience, above average growth rates.

Figure 2.4.1 illustrates the growth in world demand for information products from 1982 through 1992. It presents growth as an industry total and for each of three major industry segments:

-- software
-- telecommunications equipment, and
-- data processing and peripherals.

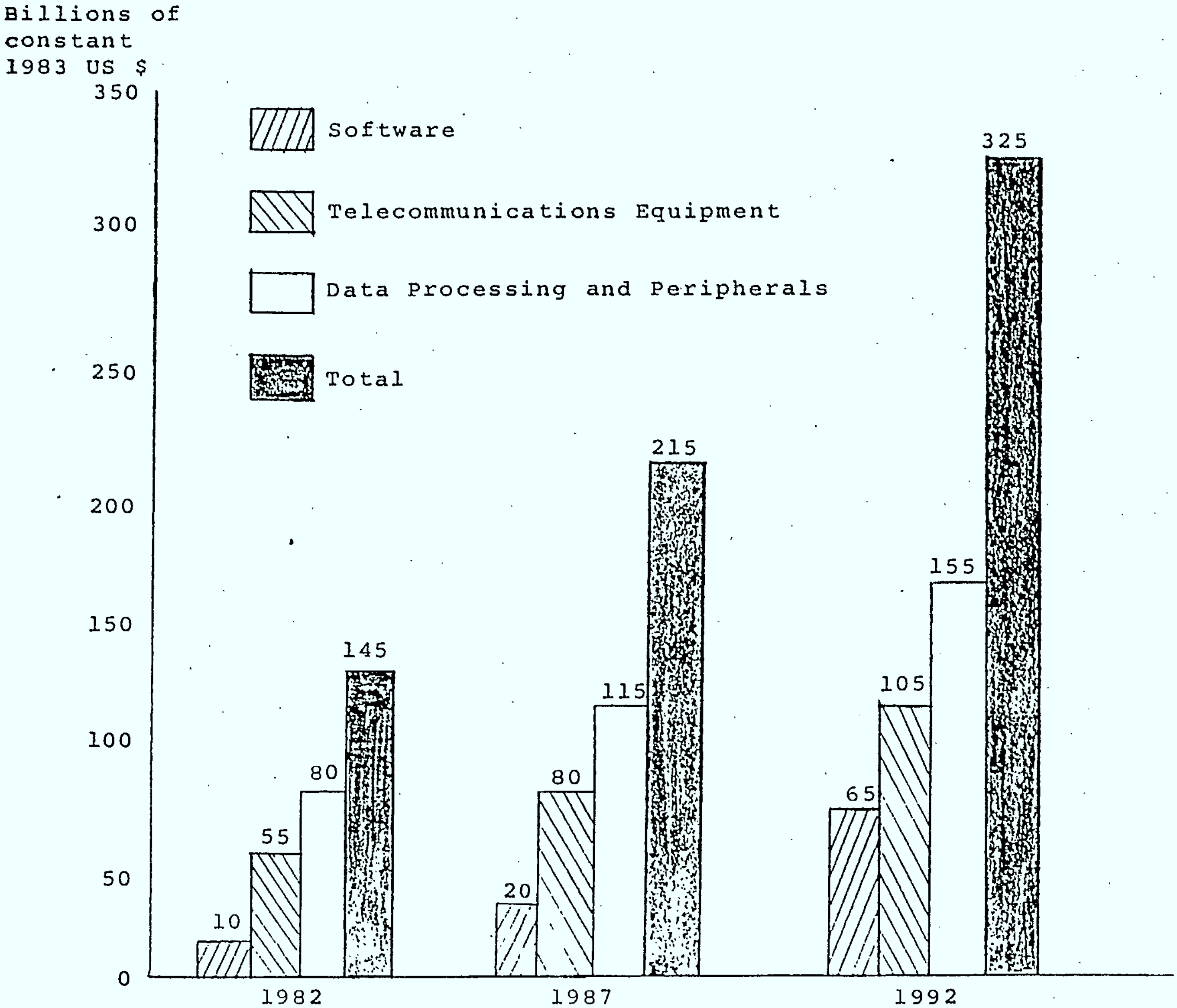
This shows the total world market for information products (excluding services) increasing from $145 billion (US) in 1982 to $325 billion (US) by 1992. These values are in constant 1983 dollars. They represent a real compounded growth rate of eight to nine percent per annum.

Figure 2.4.2 presents the same information but represents the dollar value and market share between the US and the remainder of the world. Throughout this decade the US market will continue to represent 40 to 50 percent of the world demand and, if anything, will become an increasing part of the total.

FIGURE 2.4.1

WORLD DEMAND FOR INFORMATION PRODUCTS

1982 - 1992

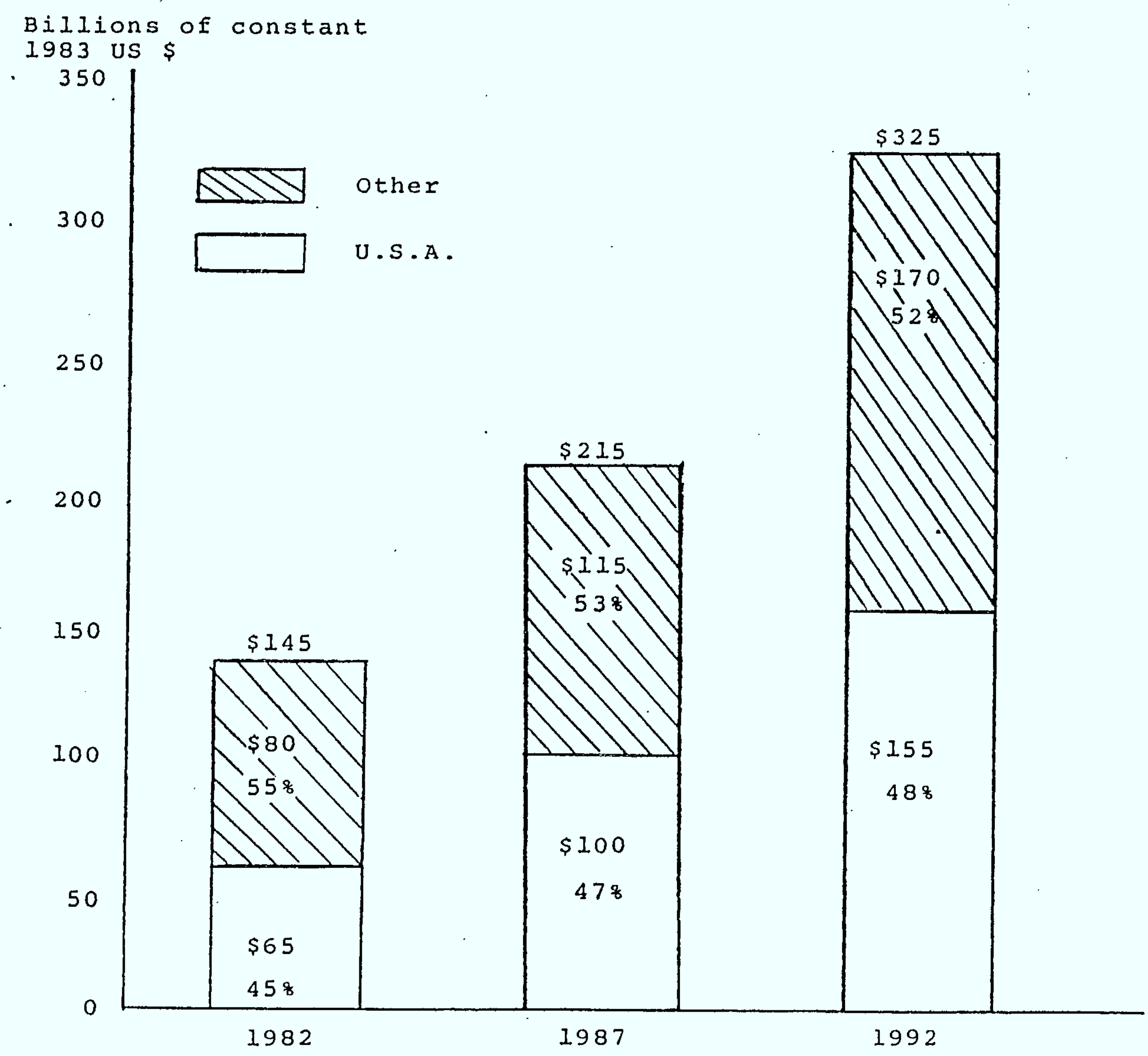


Source: World Communications, Oct. 1983

FIGURE 2.4.2

U.S. SHARE OF INFORMATION PRODUCTS MARKET

1982 - 1992



Source: World Communications, Oct. 1983

2.5 Competition on an International Scale

With the continued blurring of boundaries between communications and computers, competition for major markets has developed between traditional suppliers of telecommunications equipment, traditional suppliers of information processing equipment, aerospace companies and providers of communication services. Competition among carriers is also developing in countries where deregulation is occurring. Specialized companies of small and medium size are offering planning, installation and software development services that once were the sole domain of large telecommunication and information processing companies.

The telecommunications equipment industry has been dominated by a few large firms controlling a majority of the home market share, usually as the result of a close association with one major carrier in each country, namely the telecommunications service provider. Deregulation is expected to impact this situation particularly in the US, Canada and the UK, where trends toward deregulation are more prevalent.

The world market in telecommunications equipment represents about 30% of the total output of electronics based products and accounts for 10 to 15% of world sales of electrical engineering products. With regard to the telecommunications equipment itself, about one-third of the sales consists of switching equipment, one third of transmission equipment and one-third terminal equipment (primarily telephone handsets).

Table 2.5.1 shows the largest manufacturers of telecommunication equipment in the world in 1981. The top four manufacturers accounted for over half of the world sales while the top thirteen accounted for over 75%. All companies are substantially multinational in their operations.

Table 2.5.1

Sales of Telecommunications Equipment
by the 13 Largest Manufacturers in the World

Company	Country	Total Sales 1981	Total Sales Telecommunications Equipment 1981
		(US $ billion)	
Western Electric	United States	13.01	13.01
ITT	United States	17.31	5.48
Siemens	Fed.Rep.of Germany	15.29	4.60
L.M.Ericsson	Sweden	3.20	3.20
GTE	United States	11.03	2.20
Northern Telecom	Canada	2.14	2.14
Thomson Group	France	7.83	1.91
NEC	Japan	4.82	1.68
Philips	Netherlands	8.38	1.34
CGE(Cit Alcatel)	France	16.96	n.a.
Plessey	United Kingdom	1.96	0.85
CGE	United Kingdom	10.10	0.78
Italtel	Italy	0.62	0.62
TOTAL		112.65	n.a.

Source: World Communications, Oct. 1983

Of these 13 companies, North American companies accounted for 59% of total sales, West European companies for 37% and one Japanese firm for 4%. With the entry of non-traditional telecommunication companies such as IBM, Wang, Control Data, DEC, Mitel, Rolm, Xerox, 3 M, Harris Corp. etc. in North America and Fujitsu, Matsushita, Mitsubishi and Toshiba from Japan, North American and Japanese industries are expected to increase in relative strength and size compared to West European industries.

Table 2.5.2 projects the relative world market share for these four subcategories of information processing products from 1983 through 1993. Computers, comprising 42 percent of the total are, at present, the largest subcategory; their share will fall to 32 percent by 1993. Terminals will decline slightly in relative importance, moving downward from 15 percent of the product total in 1983 to 12 percent in 1993. Peripherals will hold steady with a market share hovering between 32 and 34 percent. In contrast to the stable or declining shares of the above, the market shares for software will more than double, growing from nine percent in 1983 to 23 percent in 1993. This trend identifies software as a major growth product.

Table 2.5.2

Information Processing Market Share by Product

	1983	1988	1993
Computers	41.7%	34.8-37.2%	31.1-32.5%
Terminals	14.7%	12.2-13.5%	11.1-12.5%
Peripherals	34.5%	31.5-32.1%	33.2-33.3%
Software	9.1%	18.1-19.1%	23.4-24.3%

Source: Price Waterhouse, Jan. 1985

Table 2.5.3 lists the largest worldwide manufacturers of information processing products in 1983. Worldwide sales of the top 20 companies in 1983 totalled $74.4 billion (US). Of this amount, IBM held $34.7 billion or 47 percent. The remaining 19 companies held $39.7 billion or 53 percent. Sales of second ranked Digital Equipment, at $4.8 billion, paled beside those of IBM, by far the largest manufacturer in the world. It is evident that the information processing industry is dominated by multinationals primarily headquartered in the US.

Table 2.5.3

PRINCIPAL SUPPLIERS

Largest Worldwide Manufacturers of Information Processing Products

(1983, including services and supplies, in billions of US $)

IBM	34.7
Digital Equipment	4.8
Burroughs	4.0
Control Data	3.5
NCR	3.5
Sperry Computer Systems	2.8
Fujitsu	2.5
Hewlett-Packard	2.5
NEC	1.8
Honeywell Information Systems	1.7
Wang	1.7
Hitachi	1.6
Olivetti	1.3
Siemens	1.3
Xerox	1.3
ICL	1.2
Apple	1.1
Bull	1.1
Nixdorf	1.0
Storage Technology	1.0

Source: Price Waterhouse, Jan. 1985

Despite the fact that the telecommunications and information processing industries sustain higher growth than other sectors in the economy, several factors are contributing to increased competition amongst suppliers.

The consulting firm of Arthur D. Little has listed four of these.

First is the increasing developmental costs associated with high technology products. The burden of supporting these costs is forcing manufacturers to seek larger markets.

Second is a changing competitive situation which requires accelerated product innovation as product lifetimes lessen. This situation is being exacerbated as the boundaries between the formerly distinct industries of telecommunications, information processing, and office systems become increasingly blurred.

Third is the deregulation and liberalization of the carrier market. In the United States, in particular, the break-up of AT&T has severed the historical supplier tie between Western Electric and the Bell Operating Companies. This has opened an enormous market ranging from central office switches for the carriers, themselves, to single line telephone sets for residential customers.

Fourth is the change in procurement policies and laws favouring in-country manufacturing. This is opening formerly closed and semi-closed markets to competition and, in so doing, forcing traditional suppliers to deal with decreased protectionism. Penetrating former protectionist barriers will become critical for certain companies, particularly with regard to products where development costs are inordinately high. Under these circumstances, gaining a satisfactory return on investment may depend entirely on export trade.

To overcome protectionist barriers, companies are adopting and can be expected to adopt two marketing strategies. On the one hand, they will look toward forming joint ventures and manufacturing arrangements with companies local to protectionist countries. On the other hand, they will direct their efforts toward market segments least subject to traditional protectionist efforts. Private office automation in contrast to central office switches exemplifies this.

A concomitant of protectionism has been the evolution of separate equipment and transmission standards for different national telecommunications networks. For a fully competitive international telecommunications market to mature, the national systems must be compatible internationally. As compatability develops, it will lead to higher volume production runs by equipment manufacturers and concomitant price reductions.

Comparison of the prices in protectionist European markets to those in the open US market illustrates this mechanism. As late as 1982, European prices for central office switches were 60 to 100 percent higher than those in the US and prices for transmission equipment were 40 percent higher.

2.6 Research and Development Efforts

In the 1970's over 85% of the world's expenditure on R&D and over 70% of the worlds scientists and engineers were employed by the following six countries: US, USSR, FRG, France, Japan and the UK. Further, a study by UNCTAD (United Nations Conference on Trade and Development) in 1972 revealed that 93% of the patents worldwide were held by multinationals centered in the following five countries, US, FRG, UK, Switzerland and France. More recent data indicates this situation has not changed substantially. In 1982, these same countries accounted for 85% of external patent applications.(3)

In the 1985 EMF Report on International Competitiveness, the effect of the research and development effort was summarized as follows: "a country's overall investment rate (R&D) must be regarded as an important indicator of its longer-term economic health and thereby of its international competitiveness."

The level of R&D effort is considered a major contributing factor to the growth of companies that undertake R&D and to industry growth in general, particularly in high-technology industries. Higher R&D expenditure is believed to lead to an accelerated process of technology transfer and a greater receptivenes to technological advances.

2.7 Technology Transfer

Technology transfer as defined by the UNCTAD is "the transfer of systematic knowledge for the manufacture of a product, for the application of a process and for the rendering of a service."

The need for technology transfer, particularly between developed and developing countries, is strongly supported by leaders in the telecommunication and information processing industries. With the escalating costs of R&D, worldwide pooling of technological effort would minimize unproductive duplication. Further the trend towards the development of an integrated global network unquestionably requires the transfer of technological information particularly to third world countries. Technology transfer in many countries will open the door to domestic market development.

2.8 Planning and Financing Growth

Major players in the telecommunications and information processing industries continue to press for more open competition. World competition, left to the push and pull of the market, would readily attract the financing required to support it.

In industrialized countries the growth of telecommunications and information systems are largely self financing in that the user pays for the services provided. Developing countries often do not have sufficent investment funds required to cover the high startup costs. Companies wishing to develop export markets with developing countries often require assistance from their own national governments, to arrange the terms and conditions that will make possible a viable export market.

2.9 Conclusion

Telecommunications and information systems are and will continue to be rapid growth industries. The convergence of communications and computers continues to advance towards the development of international networks and services.

Countries that are now investing the resources necessary to make global networks a reality will experience continued economic growth. Canada, continues to play a minor role in the development of telecommunications and information systems on an international basis. Northern Telecom is the only Canadian company of any significance to gain mention in the literature regarding major international players. However, even Northern pales in comparison to some of its competitors. The remainder of this report focuses on the role of Canada and Canadian companies and the areas where a Canadian significance, within certain constraints, is achievable.

The International Market

Bibliography

1) Le Monde Economique, International Publications, "World Communications: New Horizons/New Power/New Hope", 1983.

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3.0 The Canadian Environment

The preceding section describing the international market was derived primarily through a literature search. As a complement, this section on the Canadian environment is drawn from the views and opinions of 400 respondents to a detailed survey questionnaire.

A major goal of this survey is to identify telecommunications and information systems technologies which offer Canadian companies the greatest growth potential. We describe these technologies and their international and Canadian markets individually in later sections. This present section provides an overview of the survey data.

3.1 Characteristics of Companies Surveyed

This phase of the research characterizes the 400 Canadian companies involved in telecommunications and information systems technologies which responded to the survey.

These companies were guaranteed strict confidentiality of their individual replies. Because of this, we present their replies only in aggregated form.

Company characteristics fall into four broad categories. These are:

- company size as measured by number of employees and annual revenues,
- primary economic focus as measured by area of concentration (telecommunications or information systems), and type(s) of business activity (manufacturing, distribution, and others),
- Canadian economic control as measured by Canadian ownership and Canadian product content, and,
- product lines.

3.1.1 The Definitions of Telecommunications and Information Systems

Telecommunications as defined in this study refers to "any transmission, emission, or reception of signs, signals, writing, images or sounds, or intelligence of any nature by wire, radio, optical or other electromagnetic systems."(1) The definition of information in this study, as extracted from the Oxford Dictionary, is "knowledge communicated concerning some particular fact, subject or event; that of which one is appraised or told; intelligence; news".

Currently, telephone networks are used overwhelmingly for the transmission of voice communication in analog form. Computers and computer networks are used overwhelmingly for the processing of data in digital form.

Since 1977, and the introduction of the first digital central office telephone switch by Northern Telecom, the telephone network has moved toward digital form. As this modification from analog to digital continues, the telephone network will have a growing capability to transmit any kind of digital information. This will include numerical, textual, visual and voice. For purposes of transmission, voice will be reconfigured from its 'normal' analog form to digital form.

This evolving digital capability of the telephone network will enable it to provide the processing and sorting capabilities of computers. As we have already observed, telephones and computers will become increasinly integrated. This will lead to the realization of a global information network.

3.1.2 The Size of Companies

The most relevant and convenient measures of the size of companies are the number of employees and the annual revenues. As we show below, the two measures are closely related. For this reason, we use only the former in the remainder of our analysis.

Number of Employees

Figure 3.1.2.1 describes the number of employees of the companies which participated in the survey.

The plurality of companies are small, having less than ten employees (43 percent). The majority have less than 20 employees (57 percent).

Larger businesses, those which employ 100 or more employees, comprise 17% of responding companies. This is substantially greater than figures published by Statistics Canada.

FIGURE 3.1.2.1
SIZE OF CANADIAN COMPANIES BASED
ON NUMBER OF EMPLOYEES

NUMBER OF EMPLOYEES(1)	PERCENT
One to Ten	43
11 to 49	31
50 to 99	8
100 or more	17
d.k., n.a.(2)	0
Total Percent(3)	100%
Total n	(400)

1) From Question A-4: "How many fulltime equivalent employees does your company have for its Canadian operations?"
2) Didn't know, not acknowledged.
3) May not sum exactly due to rounding.

Thus, responses to the survey suggest either that telecommunications firms tend to be larger than the national average or that larger firms are disproportionately interested in the outcome of this survey and, therefore, more willing to participate in it.

We believe that, at least in part, the latter factor has contributed to the disproportionately higher response of larger firms. This is fortuitous. As our later analysis shows, it is the larger businesses which will make the greatest contribution to Canada's position in the international telecommunications and information systems markets.

Annual Revenues

A review of the annual revenue (fiscal year 1984) of these companies illustrates even more clearly their differences in size.

One half (51%) earned revenues of less than one million dollars. One third (38%) earned revenues of one to 24 million dollars. Of the remaining companies, 5% earned revenues of 25 to 99 million dollars; an additional 5% earned revenues of 100 million dollars or more.

FIGURE 3.1.2.2
SIZE OF CANADIAN COMPANIES BASED
ON ANNUAL REVENUE (1984)

REVENUE - 1984(1)	PERCENT
Less than 1 million	51
1 million to 24 million	38
25 million to 99 million	5
100 million or more	5
d.k.,n.a.	2
Total Percent(2)	100%
Total n	(400)

1) From Question A-5: "For your last fiscal year, what were your total company revenues in Canadian Dollars from its Canadian operations?"
2) May not sum exactly due to rounding.

Because of their size and commensurate resources, these latter one in ten companies, those with revenues in excess of 25 million dollars, are positioned to make the most significant **direct** contributions to Canada's position in the international telecommunications and information systems markets.

Accordingly, we suggest that governmental incentives, if any, be developed with these larger companies in mind. In making this suggestion, we do not discount the value of smaller companies. Rather, we believe that their contributions can be best made **indirectly** through their subcontracting relationships to the larger firms. Alternatively, should the government choose to provide direct incentives irrespective of company size, we suggest that they be administered as two parallel programs, one directed toward larger concerns and the other directed toward smaller ones.

Figure 3.1.2.3 presents the relationship between annual revenues earned and the number of employees.

At one extreme, among companies with under one million dollars in annual revenue, 80 percent employed 10 or fewer persons. At the other extreme, among companies with 50 million dollars or more in annual revenues, all employed 100 or more persons.

FIGURE 3.1.2.3
COMPARISON OF THE NUMBER OF EMPLOYEES
AND ANNUAL REVENUES
(1984)

NUMBER OF EMPLOYEES(1)	ANNUAL REVENUE (1984)(2)		
	<1.0M	1-50M	50M+
One to Ten	80	7	--
11 TO 99	20	66	--
100 or more	--	27	100
Total percent(3)	100%	100%	100%
Total (388)(4)	(200)	(164)	(24)

1) From Question A-4: "How many fulltime equivalent employees...."
2) From Question A-5: "For your last fiscal year,...."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 12 did not answer one or both questions.

This close relationship between annual revenue and employment shows that either measure is equally indicative of company size. As such, our further analysis will use annual revenues in that they are a direct economic measure.

Summary

In sum, we have used annual revenues and employment to measure the size of companies, disproportionately larger companies replied to the survey. This suggests their greater interest in the international market and, as we show later, the greater contribution they will make.

Annual revenues and employment are closely related. We use the former in our subsequent analysis.

Given the disproportionate importance of larger firms, our subsequent sections assess the market factors that have contributed to their growth and success.

3.1.3 The Primary Economic Focus

As technology continues to advance, the once well defined boundary between telecommunications and information systems becomes less and less clear.

One has to look only at some of the largest multinational companies to witness product and system integration of telecommunications and information. Such giants as IBM and Wang not long ago were clearly viewed as belonging to the information systems side. Yet now they have company mandates that bring them into direct competition with telecommunications companies such as AT&T, GTE, and Northern Telecom.

We continue to distinguish between various aspects of telecommunications and information systems, even with this study. Nonetheless, with technological advance, we acknowledge the difficulties of such a distinction.

The Telecommunications - Information Systems Distinction

Respondent companies were requested to classify their activities within the telecommunications and information systems categories as defined above. Results are presented in Figure 3.1.3.1 below.

FIGURE 3.1.3.1
THE PRIMARY ECONOMIC FOCUS OF RESPONDING COMPANIES

PRIMARY FOCUS(1)	PERCENT
Information systems	44
Telecommunications	26
Both	26
d.k.,n.a.	2
Total percent(2)	100%
Total n	(400)

1) From Question A-2: "Does your company primarily engage in..."
2) May not sum exactly due to rounding.

Already, one-quarter (26%) of the companies consider themselves involved in both telecommunications and information systems. We anticipate that over time greater proportions will do so. Nearly one half (44%) classify themselves as engaged primarily in information systems. Ancillary data show that of this group, 15% provide software as their primary product or service; 7% provide computer systems products or services; 5% provide computer hardware. A list of the major products and services offered by these respondents is included in Attachment IV. An additional one in four (26%) companies classify themselves as engaged primarily in telecommunications.

A comparison of the revenues earned by the companies within the three classifications shows no striking differences. Within all three, there is a mixture of small, medium and large companies. The largest companies (revenues of more than $50 million) are evenly distributed among the three.

The Activities of the Companies

The primary activities of these companies is illustrated in Figure 3.1.3.2 below. Because companies were asked to circle all applicable categories, the total exceeds 100%.

From 40 to 51% of companies reported four major classes of activity - distribution and sales (51%), service (48%), research and development (47%) and manufacturing (40%).

FIGURE 3.1.3.2

THE FUNCTIONAL ACTIVITIES OF RESPONDING COMPANIES

CLASS OF ACTIVITITY(1)	PERCENT
Distribution and sales	51
Service organization	48
Research and development	47
Manufacturing	40
Common carrier	6
Other	13
Total percent(2)	--
Total n	(400)

1) From Question A-1: "In which of the following telecommunications, information activities or related areas does your company engage?"
2) Multiple responses. Total will exceed 100 percent.

To better use these data in our later analysis, we have reclassified companies into four prime activity categories according to their R&D involvement. This reclassification encompasses whether or not the company is engaged primarily in manufacturing or service and whether or not it undertakes R&D efforts. Figure 3.1.3.3 presents this reclassification.

FIGURE 3.1.3.3
THE PRIMARY FUNCTIONAL ACTIVITIES
OF RESPONDING COMPANIES

CLASS OF ACTIVITY(1)	PERCENT	
Manufacturing, no R&D	11	
Manufacturing, some R&D	29	
		40
Service, distribution, sales, no R&D	41	
Service, distribution, sales, some R&D	18	
		59
d.k.,n.a.	2	
Total percent(2)		100%
Total n		(400)

1) From Question A-1: "In which of the following telecommunications, information activities or related areas does your company engage?"
2) May not sum exactly due to rounding.

A major characteristic stands out. R&D is predominantly associated with manufacturing rather than service companies. Out of 40% of companies engaged primarily in manufacturing, 29% undertake R&D; 11% do not. Conversely, out of 59% of companies engaged primarily in service, distribution, and sales, 18% undertake R&D, 40% do not. In that R&D usually is product focused, this pattern should not be surprising.

The fact that 11% out of 40% of manufacturing organizations do not engage in R&D may suggest at first that these companies are vulnerable to competitors who are actively involved in the R&D process. This, however, may not be so.

Further examination of the data shows that the majority of these companies are small, reporting less than $1 million in annual revenues. As such, they may be manufacturers of relatively simple devices or components produced for larger firms. Thus, while some of these companies may be able to benefit from R&D incentives, such incentives may be irrelevant for many.

Summary

The trend towards integrated telecommunication and information systems can be evidenced in the survey sample, where a significant proportion of respondents classify themselves within both industries. Of those companies surveyed, who classify themselves within the information systems industries, the most significant number provide software products and services. Since the greatest growth in telecommunications and information systems industries is expected in software, an opportunity exists for Canadian companies to expand in this field.

3.1.4 The Question of Canadian Economic Control

One of the primary purposes of this study is to assess technologies with which Canadian companies can favourably compete in the world market.

A Canadian company is regarded as one in which the control of the company rests with Canadians, as opposed to a Canadian subsidiary of a foreign company.

An additional part of the Canadian control question is the aspect of Canadian content. Canadian content is important since it may affect procurement policies of the three levels of government (federal, provincial and local) and measures the full impact of the final product upon the Canadian economy. Our definition of Canadian content is based on the standard set by the Canadian General Standards Board.

Canadian Ownership

Figure 3.1.4.1 illustrates the national ownership of responding companies. The vast majority (90%) are Canadian owned. While this figure appears most encouraging, the remaining 10% must be examined more closely to determine their proportionate contribution to the overall industry.

FIGURE 3.1.4.1
THE NATIONAL OWNERSHIP OF RESPONDING COMPANIES

NATIONAL OWNERSHIP(1)	PERCENT
Canadian owned	90
Foreign owned	6
Both	4
d.k.,n.a.	1
Total percent(2)	100%
Total n	(400)

1) From Question A-3: "Is your company..."
2) May not sum exactly due to rounding.

Of the foreign owned companies, 70% are involved primarily in manufacturing. Of these companies, 46% undertake related R&D activity in Canada. The remainder carry out R&D activities, if any, primarily in their home country.

Of the largest companies (more than $50 million revenues, 1984), one-third were wholly foreign owned. These suggest a heavy participation of foreign owned multinationals in the Canadian telecommunications and information systems industries.

We discuss this aspect more fully in our later sections on competitive review.

Foreign participation can be viewed from two perspectives. On the one hand, it can be viewed as contributing to a weakening of Canadian industry by displacing manufacturing which otherwise could be provided by Canadian companies. On the other hand, it can be viewed as strengthening the infrastructure of the Canadian telecommunications and information systems industries.

Given the growing integration of the world economy, we believe it more fruitful to view foreign participation in the latter perspective. This notwithstanding, in that these companies profit from the Canadian economy, we believe that government actions which encourage their full continued development of the Canadian telecommunications and information systems infrastructure may be appropriate. Such actions might take the form of encouraging continued capital investment in Canada, and, especially, development and expansion of Canadian R&D facilities.

Canadian Product Content

Figure 3.1.4.2 reports the Canadian content of the major product line of responding companies. Two-thirds (64%) of the companies surveyed indicated that the Canadian content of their major product or service was 61% or more. Somewhat under one-third (29%) place it at 60% or less.

FIGURE 3.1.4.2
THE CANADIAN CONTENT OF THE MAJOR PRODUCT
OF RESPONDING COMPANIES

PROPORTION CANADIAN CONTENT(1)	PERCENT
Nil to 20%	8
21% to 40%	8
41% to 60%	13
61% or greater	64
d.k., n.a.	6
Total percent(2)	100%
Total n	(400)

1) From Question A-7: "What is the percentage of Canadian content of your major product based on the dollar cost?"
2) May not sum exactly due to rounding.

The fact that 29% of firms report Canadian content of less than 60% emphasizes the extent of integration of the Canadian and world economies.

We believe that it would be counter productive for the government to discourage this trend. Rather, we suggest that it be encouraged with the provision that foreign companies make fair contributions in terms of capital and R&D investments.

3.1.5 Major Product Lines

Canadian companies provide a diversity of products and services for telecommunications and information systems. This section reports on the major products and services currently provided by the companies represented in the sample. Later sections will deal with the major growth areas.

The Major Product Lines

Respondents were requested to list their major products or services based on revenue contribution. Companies were then classified in terms of their most significant product or service offering. We summarize this classification in this section. It is presented in detail in Attachment IV.

The largest group represented within the sample (27%) are companies offering computer hardware, software, or a combination of both in the form of systems. The next largest group (25%) represented companies which provided telecommunications and information systems sales and services for products of other vendors. Consultants made up 9% of the total sample. The remaining 39% was a mixture of manufacturers or research institutions.

The Effect of Company Size

In general, large, medium, and small companies are engaged in providing all classes of product or service offerings. A major exception was in computer software, hardware, and systems.

Fifteen percent of companies reported software as their major revenue source. Of these, four-fifths are small in size. As companies grow in size, they are more likely to offer integrated computer products and services. One-half of the firms that provide computer hardware are medium sized companies. Over one half (55%) of those that provide computer systems are medium to large.

The Effect of Type of Business

We also related the type of business to the major product or service offered. In so doing, we looked for a particular product classification that might be associated with one business type over another. The only striking difference appears to involve the Service companies which provide some R&D. One-half of these firms provide software. Given this, it can be assumed that their R&D is related to software development.

Summary

These findings point to the significance of the software industry to Canada. A variety of firms are involved in software development and R&D. As these companies grow, their natural progression will be towards providing more integrated products and services.

Implications for Government Policy

The classification of companies based on size and major product lines suggest two important considerations for Canadian policy.

The first consideration points to promoting the Canadian software industry, comprised mostly of small companies. Indirectly, such policies would also promote expansion into integrated computer systems as small Canadian companies achieve growth.

The second consideration points to encouraging expansion of R&D to ensure the continued competitive position of Canadian companies.

The findings suggest the following considerations for Government:

- Devise policies that will promote Canadian expertise in software. These policies could include incentives to encourage university promotion of software development and to attract graduate students into the field. At the same time, specific market segments should be assessed that could provide the greatest opportunity for Canadian companies in the software industry.

- Further assess the impact of R&D on the competitiveness of Canadian companies and devise policies that will promote R&D activity. Special consideration might be given to encouraging foreign owned firms to provide greater contributions to Canadian R&D.

3.2 The Nature of Markets and Competition

Our previous section identified the companies included in the survey and classified them according to size and major product line. This section explores the position of these companies within the market. We pay particular attention to customer base and diversity of clientele. We examine these since both may be determinants of market share.

3.2.1 The Size of Clientele

The size of the customer base has implications for the number of companies competing in the market and on their marketing strategies. In market segments characterized by relatively few customers, we would expect relatively few competitors. Likewise, we would expect these competitors to employ marketing strategies targeted at specific customers. Also, we would expect the location of these customers to be more relevant to marketing strategies than in market segments with a diverse customer base.

Number of Customers

Figure 3.2.1.1 illustrates the size of the customer base. One-third (36%) of the companies surveyed derive the bulk of their revenue from a relatively small base of 9 or less. Approximately the same proportion (32%) derive the bulk of their revenue from 10 to 49 customers. One-fourth (26%) draw the bulk of their revenues from a customer base of 50 or more.

FIGURE 3.2.1.1

THE SIZE OF CUSTOMER BASE

Size of Customer Base(1)	Percent	
One to four	16	
5 to 9	20	
		36
10 to 19	14	
20 to 49	18	
		32
50 to 99	8	
100 or more	18	
		26
d.k.,n.a.		5
Total percent(2)		100%
Total n		(400)

(1) From Question B-2: "How many clients provide 70% of your revenues?"

(2) May not sum exactly due to rounding.

These data allude to the differing characteristics of the telecommunications and information systems market segments. On the one hand, are segments in which many customers point to more free competition. In these segments, success likely will come to those companies which can produce innovative quality products and which can market those products relatively effectively. On the other hand, are segments in which few customers point to the approximation of an administered market. In these segments, success likely will come to those companies which maintain close liaison with their customers needs and design products and services most responsive to meeting unique customer needs.

These divergent types of market segments may respond differently to different types of government encouragement. On the one hand, Canadian companies engaged in more competitive markets may be better served by government encouragement to R&D and marketing. On the other hand, Canadian companies engaged in more administered markets may be better served by government sponsored financial incentives.

Such possibilities suggest that government incentives to the Canadian telecommunications and information systems industries be carefully considered in light of these different market structures.

Figure 3.2.1.2 reports the share of company revenue derived from the 'largest customer'. Of the companies surveyed, one in three (32%) derive two-fifths or more of their revenue from their largest customer. Approximately one-half (48%) derive 10 to 39 percent. Only 15% derive nine percent or less of their revenue from their largest customer.

FIGURE 3.2.1.2

THE SHARE OF REVENUE DERIVED FROM LARGEST CUSTOMER

Share of Revenue from Largest Customer(1)	Percent	
60% or more	16	
40 to 59%	16	
		32
20 to 39%	23	
10 to 19%	25	
		45
5 to 9%	9	
4% or less	6	
		15
d.k.,n.a.		6
Total percent(2)		100%
Total n		(400)

(1) From Question B-3: "What percent of your total sales does your largest customer provide?"

(2) May not sum exactly due to rounding.

These patterns are consistent with those of the preceding figure. Some Canadian telecommunications and information systems companies operate in relatively competitive markets. Others operate in relatively administered markets. This is consistent with our view that incentives to stimulate the telecommunications and information systems industry will be most effective if they account for these divergent market structures.

To understand the further implications of these data, we first place them in the perspective of company size and type of business.

The Effect of Company Size

With the exception of a highly specialized technology or a monopolist/oligopolist industry user, one generally would expect that as the size of a company increased, its customer base would increase in proportion. A comparison of company size and customer base confirms this general pattern. As revenues increase, customer base grows proportionately. Among small companies (less than $1 million revenue), 46% derive the bulk of their revenue from less than 9 customers. Among medium companies ($1 million to $49 million revenue), this proportion declines to 34%. Among large companies ($50 million plus) it drops to 17%.

The Effect of Type of Business

One would expect fewer clients for organizations engaged in R&D activities for outside clients than for those engaged in purely sales/service activities.

R&D activities by their nature entail a unique, rather than general, focus. R&D activities by their nature are expensive. Because of this, firms engaged in R&D for outside clients would tend to have fewer rather than many clients. This relationship would not hold in the case of manufacturing firms. This would be because most, if not all, of their R&D efforts would be on their account rather than those of outside clients.

To verify this expectation for service organizations, we have examined how service companies which engage in R&D and those which do not differ in terms of client base.

Service companies which provide R&D have the smaller client base. One in two (50%) derive the bulk of their revenues from nine or less customers. This is twice the one in four (27%) service companies with no R&D which derive most of their revenues from nine or less customers.

In sum, service companies which provide R&D services typically derive the major share of their revenue from a smaller client base.

This pattern might suggest that smaller R&D companies would be particularly vulnerable to market competition. This would be the case should their services be evaluated solely on a price basis. However, by their inherent natures, R&D service companies hold unique relationships with their clients. Their provision of services often centre around highly personalized relationships between the company and its clients. Thus, while these companies must keep abreast of the trends in the industry to retain and enhance their customers bases, doing so is an inherent part of the services these companies provide.

3.2.2 The Type Of Clientele

Depending on the nature of the company and its relative market position, certain clientele may be more attainable and marketing strategies targeted at such clientele may prove to be more effective. Factors such as company size and type of business likely will influence the type of clientele.

In the next sections, we examine class of customer and the relative revenues each contributes to the telecommunications and information systems industries.

Class of Customer

Respondents were asked to report the proportion of their revenues "provided by customers belonging to each...(of six categories)". The six categories, and the revenues deriving from them, were, in turn, classed into three broader groupings--commercial, consumer, and governmental.

Figure 3.2.2.1 lists the class of customer, the amount of revenues each contributes to the Canadian telecommunications and information systems industries, and the proportion of that revenue to the total.

FIGURE 3.2.2.1

THE REVENUE PROVIDED BY DIFFERENT CUSTOMER CLASSES

CLASS OF CUSTOMER(1)	PERCENT		REVENUE (MILLIONS)	
Service industries	17		880	
Manufacturing industries	12		616	
Transportation	9		467	
		38		1,963
Consumers	21		1,067	
		21		1,067
federal government	13		657	
Local/Provincial Government	6		300	
		19		957
Other		23		1,220
Total(2)		100%		$5,216

(1) From Question B-4: "What percent of your revenue is provided by customers belonging to each of the following categories?"
(2) May not sum exactly due to rounding.

Encompassing service industries, manufacturing industries, and transportation, the broad grouping commercial clientele provides $1,963 million in annual revenues to the telecommunications and information systems industries or 38% of the total. As such, the commercial clientele comprises the most important customer segment. The consumer clientele provides $1,076 million in annual revenues or 21% of the total. As such, it ranks as the second most important customer segment. The government clientele, encompassing federal, provincial, and local, provides $957 million in annual revenue, or 18% of the total. Of the classes of government, the federal is the more important, purchasing more than twice the proportion of telecommunications and information systems products and services than local and provincial governments combined (13% versus 6%). Other classes of customers contribute $1,220 in annual revenues to the telecommunications and information systems industries or 23% of the total.

These findings place the role of government procurement for the telecommunications and information systems industries into perspective. Government procurement may be important to many companies since it can provide an opportunity to install, test, and refine first service offerings. Furthermore, such procurement is often viewed favourably within the marketplace, providing companies with an advantageous marketing tool. Nonetheless, in the overall perspective, the commercial and consumer markets are each larger. As such, it is in these areas that Canada's telecommunications and information systems industries must succeed.

The Effect of Company Size

Comparison of company size and class of customer, revealed no significant differences between small (less than $1 million), medium ($1 to 49 million), and large ($50 million plus) companies and the proportion of revenue derived from each customer class. In particular, there was no apparent preferential treatment by local/provincial or federal governments that might provide an advantage to a particular firm size.

The Effect of Type of Business

Figure 3.2.2.2 presents the proportion of revenue derived by each type of business from each class of customer.

FIGURE 3.2.2.2

THE RELATIVE REVENUE PROVIDED BY

CUSTOMER CLASS AND TYPE OF BUSINESS

CLASS OF CUSTOMER(1)	TYPE OF BUSINESS(2)		
	MANUFACTURING	SERVICE (no R&D)	SERVICE (some R&D)
Service industries	15	17	24
Manufacturing industries	18	6	12
Transportation	7	12	2
	40	35	38
Consumer	15	29	1
	15	29	1
Total government	19	5	19
Local/provincial government	4	5	21
	23	10	40
Other	21	26	20
	========	========	========
Total percent(3)	100%	100%	100%
Total n(4)	(152)	(156)	(70)
Total revenues(5)	$2,414	$2,384	$ 419

(1) From Question B-4: "What percent of your revenue ...?"

(2) From Question A-1, "In which of the following telecommunications, information activities or related areas does your company engage?"

(3) May not sum exactly due to rounding.

(4) Total in 378 of the total 400 respondents, 22 did not respond to one or both questions.

(5) Total revenues = $5,216 millions

In general, each type of business derives a similar proportion of its revenue from commercial customers. Manufacturing businesses derive 40% of their revenues from commercial customers, non R&D service businesses derive 35%, R&D service businesses derive 38%.

However, for consumer customers, the differences are substantial. Manufacturing firms gain 15% of their revenue from the consumer market. Non R&D service firms gain 29%. In contrast, R&D service firms gain virtually none of their revenue (1%) from this class of customer.

In the case of governments, the differences, likewise, are substantial. Manufacturers draw a larger proportion of their revenue (19%) from the federal government, than do non R&D service companies (5%). Both draw approximately equal proportions of revenue from local and provincial government (4% and 5%, respectively). More interesting, however, are the differences in customer base of R&D service companies and others.

The R&D service companies draw 40% of their revenues from governmental customers. This is almost twice the 23% of revenues earned from government by manufacturing companies and four times the 10% of revenues earned from government by non R&D service companies. Revenues of the R&D service companies come approximately evenly from the federal government (19%) and local/provincial government (21%). However, the 21% of relative revenues from local/provincial governments is four to five times the relative proportion that either manufacturing companies (4%) or non R&D service firms (5%) report. This high proportion suggests that R&D service firms play an important role in advising local and provincial governments in defining and meeting their telecommunications and information systems needs.

Summary

Together, the three levels of Canadian government provide about one-fifth (18%) of the revenues for companies in the telecommunications and information systems industries. As such, governments, as a customer base for the telecommunications and information systems industries, in general, are less important than either the consumer or, especially, the commercial classes.

However, when class of customer is examined by type of business, we find that governments comprise the most important class of customer for R&D service firms. Local and provincial governments, rather than the federal government, make the greater contribution to the revenues of such companies. We interpret this to mean that R&D service firms play an important role in advising local and provincial governments in defining and meeting their telecommunications and information systems needs.

This pattern suggests that one means of stimulating R&D in the telecommunications and information systems industries would be through encouraging local and provincial governments to continue their use of outside R&D service firms.

We have not yet identified the further roles which government plays as a client of the telecommunications and information systems industries. These roles and their implications are analyzed in further sections.

3.2.3 Market Dominance

A central concern of this study is the success of Canadian telecommunication and information systems companies within the international markets.

As outlined in Section 2.0, **The International Market,** with the single exception of Northern Telecom, the major international players are located outside of Canada.

While no other Canadian companies can be classed as major international players, there are significant opportunities for Canadian companies to dominate in specific market segments.

We begin this section by identifying the extent to which telecommunications and information systems companies have achieved a major share of the Canadian market and, therefore, potentially can be used as a model for other companies.

Market Share

Figure 3.2.3.1 reports the Canadian market share of responding companies of which 36% did not know or did not acknowledge their market share. Most likely, these companies have a minimal share of the market which is unknown to them.

Of the remaining companies, almost one-half (48%) hold 19% or less of the Canadian market. We assume that their participation in the international market is insignificant.

Fifteen percent hold 20% or more of the Canadian market. We consider these as potential international competitors. Further examination of this group revealed that of this 15%, only a small proportion (20%) either are foreign owned or have participating foreign ownership. The remaining 80% are wholly-owned Canadian companies. They comprise 12% of our total sample.

Our following sections identify these Canadian companies, and in turn, analyze the factors that have contributed to their success.

FIGURE 3.2.3.1

THE COMPANY SHARE OF CANADIAN MARKET

MARKET SHARE(1)	PERCENT	
NIL TO 4%	36	
5 TO 9%	6	
10 TO 19%	6	
		48
20 TO 39%	4	
40 TO 59%	3	
60% OR MORE	8	
		15
d.k., n.a.		36
Total Percent(2)		100%
Total n		(400)

(1) From Question B-8: "If you know your share of the Canadian market, is it ...?"

(2) May not sum exactly due to rounding.

3.3 The Nature of Foreign Trade and Competition

Our previous section reviewed the position of Canadian companies within the Canadian market. This review examined the types of business, the types of clientele that provide the major sources of revenue, and the major competitors.

This section extends that analysis to review competition on an international basis: focuses on Canadian companies that have established foreign trade, their clientele, and their competitors.

3.3.1 Participation in Foreign Trade

As part of their natural growth, successful Canadian businesses enter foreign markets, the US in particular.

This is especially the case for the telecommunications and information systems industries. The US provides approximately 50% of the demand for telecommunications and information systems products and services worldwide. Europe is a smaller market. It is more difficult to penetrate due to differing standards between North America and Europe for many telecommunications and information systems products.

In addition, national PTTs, in general, have procurement policies which favour local vendors.

It is generally accepted that the Canadian market is too small for any company to sustain growth. Canadian companies that have already penetrated a foreign market are therefore of particular interest to this review. The factors that have advantaged and disadvantaged these companies will be relevant to other Canadian companies which eventually may be involved in foreign trade.

The Extent of Foreign Trade

Figure 3.3.1.1 shows the relative percentage of revenues reported by responding companies for the domestic and major foreign markets. The bulk of revenue (70%) is derived from trade within Canada; the remaining 30% is generated through foreign trade.

The US, a major trading partner, accounts for two-thirds of this remainder or 18% of the total. Other countries account for one-third or 10% of the total. Most of the other countries cited as major foreign markets are European.

FIGURE 3.3.1.1

THE SHARE OF REVENUE DERIVED FROM FOREIGN TRADE

COUNTRY	SHARE OF REVENUE FROM MAJOR MARKETS(1) PERCENT
Canada	71
U.S.	19
Other	10
Total percent(2)	100%
Total n(3)	(388)

1) From Question B-1: "What percent of your revenue is generated in the following major markets?"
2) May not sum exactly due to rounding.
3) Based on replies by 388 respondents of the 400 total.

Given the importance of the US as a foreign market, penetration of the US will be central to the ultimate success and growth of many Canadian telecommunications and information systems companies.

In further sections, we review the factors that have contributed to the success of Canadian companies in foreign markets. We include marketing strategies and government policies. As part of our review, we analyze the potential application of these marketing strategies and government policies to Canadian companies in general.

The Effect of Company Size

A comparison of company size to involvement in foreign trade reveals not unexpectedly that small companies (less than $1 million) are less involved in foreign trade than are medium or large ones.

Small companies report that 88% of their trade is within Canada. Of their trade conducted outside of Canada, most is with the US (9%). No meaningful difference is reported in the foreign trade of medium and large firms. Both conduct approximately 70% of their trade in Canada. Of their 30% foreign trade, two-thirds is with the US.

The fact that medium sized firms do as much foreign trade as large firms, confirms a previous assertion that the relatively small size of the Canadian market requires entry into foreign markets to sustain growth.

Thus, Canadian policies must focus on assisting companies in their endeavors to penetrate foreign markets, particularly the US.

The Effect of Type of Business

Figure 3.3.1.2 relates the type of business and the extent of foreign trade. Businesses have been categorized as in previous sections: Manufacturing; Service (no R&D); Service (some R&D).

Of the three categories, Manufacturing companies are most involved in foreign trade with just under one-half of their business (49%) taking place in foreign countries, two-thirds of which occurs in the US. Service companies with no related R&D, earn approximately the same level of revenues as manufacturing companies, however, a minimum is derived from foreign trade. Almost all of their business (88%) is in Canada. This compares favourably with MSST 1985 statistics which indicate that, "Canadian exports can be roughly described as 85% merchandise and 15% services." (1)

Of the companies primarily involved in Service, those who undertake some related R&D, have a much higher level of foreign trade compared to their counterparts who undertake no R&D. Therefore, while the more R&D intensive companies are the most likely candidates to seek foreign markets for their products and services, it is the manufacturing sector which holds the greatest promise for sustaining Canadian company growth through foreign trade expansion.

FIGURE 3.3.1.2

THE EFFECT OF TYPE OF BUSINESS
ON THE EXTENT OF FOREIGN TRADE

Major Market(1)	Type of Business(2)					
	Manufacturing		Service (no R&D)		Service (some R&D)	
	Revenue	Percent	Revenue	Percent	Revenue	Percent
Canada	1378.39M	51%	2386.00M	88%	325.46M	77%
U.S.	892.55M	33%	154.57M	6%	71.81M	17%
Other	418.07M	16%	156.93M	6%	27.23M	6%
	--------	----	--------	----	-------	----
Total	2689.00M	100%	2697.50M	100%	424.50M	100%
Total n(3) (394)						

1) From Question B-1: "What percent of your revenue....."
2) From Question A-1: "In which of the following...."
3) Of 400 total respondents, 6 did not answer one or both questions.

Respondents have also identified the need to enter foreign markets in order to sustain growth and to have access to larger client bases, such as can be provided in the US.

The Federal Government has been identified as a significant source of business, particularly for companies that have strong foreign competitors.

These findings suggest the following considerations for government support of the Canadian Telecommunication and Information Industry:

- Devise policies to stimulate proliferation of Canadian products and services to the U.S. and other world markets by stimulating marketing research to identify market niches.

- Devise policies to stimulate widening of existing foreign market bases by promoting joint ventures in countries where local market protection is pervasive.

Bibliography

1) Ministry of State Science and Technology, "Research, Development and Economic Growth," 1985.

3.4 The Research and Development Effort

Research and Development as a means of generating innovation can result in the expansion of high-tech industries. Policies designed to promote co-operative R&D, direct government research activities, introduce tariff and bilateral trade agreements, and to promote government procurement to help local industry, have been introduced by the US and EEC countries. Canada too has been reviewing its industrial policy with the goal of promoting more export in the high-tech sector. Many of the policies to-date have resulted from the threat of the Japanese whose industrial policy is often cited as a successful example of "one that encourages growth industries through a process of planning, consultation, and financial stimulus to research and development."(1)

One measure of a countries overall economic health is its investment in R&D. In Canada, "Business leaders generally agree that our national level of R&D is insufficient."(2) Other measures include patent applications and the balance of trade. In Canada, patent applications are at least one order of magnitude lower than our major international competitors and despite an overall record high, balance of trade, the export/import ratio for most categories of technical goods is very disappointing.

In the next sections we assess the importance attributed to R&D, the factors that have contributed to R&D investment and the focus of Canadian R&D efforts in the telecommunications and information systems industries, based on the survey sample.

3.4.1 Resources Devoted To R&D

Economic growth depends largely on the successful development and application of new technologies. This development, in turn, depends on the level of R&D investment which leads to opportunities for new and improved products; improvements that are necessary if Canada is to maintain and expand her share of world markets. Further, the strength of Canada's R&D effort will determine her ability to adapt new technologies created beyond her borders.

The importance that is attributed to R&D will largely determine the resources Canadian companies are willing to devote to the R&D effort. The next section examines these factors and their relationships.

The Importance Attributed to R&D

As reported in Figure 3.4.1.1, of the companies surveyed only 6% consider R&D as having no importance to their company's growth, while almost one-half (46%) of the respondents consider R&D **extremely important.**

FIGURE 3.4.1.1
THE IMPORTANCE ASCRIBED TO
RESEARCH AND DEVELOPMENT

LIVEL OF ALLOCATION(1)	PERCENT	
Extremely important	46	
	-------	46
Very important	22	
Somewhat important	22	
Not at all important	6	
	-------	50
d.k., n.a.	3	

Total percent(2)		100%
Total n		(400)

(1) From Question D-2: "Overall, how important do you consider research and development in contributing to your company's growth?

(2) May not sum exactly due to rounding.

We may conclude that Canadian companies recognize the relevance of R&D, however, of more importance is whether this recognition is supported through resource allocation. According to the Minister of State, Science and Technology, while the national level of R&D is recognized as insufficient, "It remains a paradox, however, that they (business leaders) consider their own company's R&D investment to be adequate".(1) The resources devoted to R&D are examined next.

The Resources Devoted to R&D

Figure 3.4.1.2 shows the revenues devoted to R&D by responding companies. Of the companies surveyed, 41% devote 5% or less of their revenue to R&D. The remaining companies invest 6% or more while one-third (32%) allocate 15% or more of their revenues to R&D. Relating this to previous results, it would appear that a discrepancy exists between the perceived importance of R&D and the level of investment.

FIGURE 3.4.1.2

COMPANY INVESTMENT IN RESEARCH AND DEVELOPMENT

REVENUE DEVOTED TO RESEARCH AND DEVELOPMENT (1)	PERCENT	
Less than 3%	32	
3 to 5%	9	

		41
6 to 8%	8	
9 to 11%	8	
12 to 14%	6	
15% or more	32	

		54
d.k., n.a.		5

Total percent(2)		100%
Total n		(400)

(1) From Question D-1: "For your last fiscal year, what percentage of the total revenues of Canadian operations were devoted to research and development?"

(2) May not sum exactly due to rounding.

The correlation of the above two factors was further investigated to measure the extent of the discrepancy. For the most part, the companies who devote substantially more to R&D also consider R&D to be more important to their companies growth. On the other hand, those that devote less revenue do not consider it as important, as evidenced by the fact that all of the companies that attributed no importance to R&D devote 5% or less of their revenue to R&D.

The companies that devote a significant proportion of revenue to R&D (15% or more) will be of specific interest in later sections when we evaluate the focus of this R&D effort.

Summary

Although Canadian companies may perceive R&D as having the same important effect on their company's growth, their levels of R&D investment may differ significantly. The Government must stress the vital relationship between R&D and economic growth if Canada is to sustain growth in telecommunication and information industries and remain internationally competitive.

3.4.2 The Factors Contributing to Investment in R&D

Economic incentives, such as a chance to increase a company's competitive edge in the marketplace, must be perceived before any real investment in R&D will be undertaken. In this section, the factors that have created this incentive for the companies surveyed are reviewed.

The Effect of Company Size

Figure 3.4.2.1 relates the effect of company size to the level of R&D investment. Almost one-half of the small companies surveyed devote 15% or more to R&D. While this amount is significant to a small company, it is not significant in the overall context of the telecommunictions and information systems industries. In fact, investment in R&D by all of the small companies surveyed, represents only 1.6% of the total R&D reported by the entire survey sample.

It is evident that as company size grows the proportion of revenue committed to R&D declines. Whereas, 43% of the small companies devote 15% or more to R&D, 26% of medium sized companies devote the same amount and none of the large companies devoted as much.

FIGURE 3.4.2.1
THE EFFECT OF COMPANY SIZE ON THE
LEVEL OF R&D INVESTMENT

REVENUES DEVOTED(1) TO R&D	COMPANY SIZE(2) 0 - $1.0 M	1 - $49.9M	$50.0 M
0 - 5%	40%	44%	80%
6 - 14%	17%	30%	20%
15% +	43%	26%	0%
	----	----	----
Total Percent(3)	100%	100%	100%
Total n(4)	(375)		

1) From Question D-1: "For your last fiscal year ...."
2) From Question A-5: "For your last fiscal year ...."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 25 did not answer one or both questions.

The Effect of Type of Business

We would expect that Manufacturing and Service organizations would devote the most resources to R&D, since these companies classified R&D as a prime activity of their operation. As illustrated in Figure 3.4.2.2 this is in fact correct. Of the Manufacturing companies surveyed, 45% devote 15% or more of their revenues to R&D and 65% of the Service organizations devote a similar amount. None of the companies reported as Distribution Services classified R&D as a prime area of involvement, and this is reflected in the results.

If a company classifies R&D as a prime activity, we can assume that its effect on company growth will be more pronounced than for a company that attributes less importance to R&D. Therefore, the level of R&D activity is more critical to Manufacturing and Service companies. It is these companies that must be encouraged to sustain R&D growth and as determined in the previous section, particularly larger companies that fall within these categories.

Service companies in this survey include primarily software producers, engineering consulting firms, system integrators and value-added companies that are not engaged in large scale manufacturing but this does not exclude small custom assembly and integration.

Summary

The US is the largest foreign market and is known to generate almost 50% of the worldwide demand for telecommunications and information systems and products. As such, it is an important market for Canadian companies involved in these industries. Most medium to large sized firms operating in Canada and primarily involved in manufacturing have already made some entry into the US market. Any measures that can enhance the penetration of these companies into the US, will be beneficial to Canada as a whole.

The key is to determine the most effective measures that could be taken. Such a determination should find its basis in a review of the factors that have contributed to successful US market penetration by existing Canadian companies.

The best example of such a success is Canada's largest telecommunications manufacturer, Northern Telecom. NT's success in the US has been dependent on two factors:

1) Marketing,
2) New Product Development.

In the US, competition has led NT to be more market and marketing oriented with greater emphasis on working with the customer. Customers often provide direct input to new product developments.

In addition, as sales build up, NT has established manufacturing plants and research labs; creating an effective distribution network. To ensure its continued success in the US market, which is more price sensitive, NT is in the process of automating its manufacturing facilities; a move that will allow it to cut overhead costs. Therefore, should the market dictate reduced prices, NT will be in a position to respond.

As is clear from NT's example, effective measures will include those that assist Canadian companies in marketing and distributing their products and services in the US.

3.3.2 The Interplay of Competition and Foreign Trade

In order to review policies and factors that may encourage and enhance foreign trade, it is necessary to understand the effect competition has on the companies involved in foreign trade and specifically, the market factors that have contributed to the success of Canadian companies in foreign markets. The most important of these factors are reviewed below.

<u>The Effect of Customer Base</u>

Figure 3.3.2.1 illustrates the extent of foreign trade for companies with differing sized client bases. Companies with relatively few customers (1 to 9) do the majority of their trade outside of Canada and in fact, do more trade in the US (43%) compared to Canada (37%). Companies with larger sized customer bases do relatively more trade overall, and of which at least three-quarters is in Canada.

In terms of absolute dollars, companies with small (1 to 9) and large (50 or more) customer bases do the most foreign trade. We interpret this to mean that companies are either very specialized or have attained a significant size.

For those medium and large sized companies for which foreign trade is dependent on a relatively small customer base, loss of any individual customer could have severe ramifications on the profitability of these companies. For those companies with much larger customer bases, we must also conclude that a significantly higher ratio of large customers are to be found in the US as compared to Canada. Therefore, Canada must ensure that its policies and programs do not affect the competitiveness of her foreign trading companies and their ability to retain their established clientele.

FIGURE 3.3.2.1

THE EFFECT OF CUSTOMER BASE ON THE EXTENT OF FOREIGN TRADE

Major Markets(1)	Number of Customers(2)					
	1 to 9		10 to 49		50 or more	
Canada	337.87M	37%	1035.32M	84%	2182.66M	74%
U.S.	390.11M	43%	136.79M	11%	496.21M	17%
Other	189.53M	21%	65.89M	5%	286.64M	10%
Total	917.50M	100%	1238.00M	100%	2965.50M	100%
Total n(3) (381)						

1) From Question B-1: "What percent of your revenue......"
2) From Question B-2: "How many clients provide 70% of your revenues?"
3) Of 400 total respondents, 19 did not answer one or both questions.

The Effect of Market Dominance

One measure of market dominance as discussed before is the number of competitors a company faces in the marketplace. In general, as the product life cycle matures, few major competitors will remain as a result of shakeouts and mergers.

This is also evidenced in the telecommunications and information systems industries. Of all the revenues reported by the respondent companies only 8% are earned by companies with 50 or more competitors. Companies with a small (1 to 9) or medium (10 to 49) number of competitors, show no significant difference in the amount of foreign trade undertaken. Specifically, each does approximately 70% of their business in Canada and two-thirds of the remainder in the US.

Summary

One of the attractions of the US market is its larger customer base made up of a significantly greater proportion of larger customers. Therefore, large Canadian companies are dependent on trade in the US, as are very specialized companies who cater to a small client base. The number of competitors within the various segments of telecommunications and information systems industries appears to be limited and has no significant bearing on the ability of a company to enter a foreign market.

3.3.3 The Presence of Foreign Competitors

Foreign competitors in the Canadian market will impact the ability of Canadian companies to first establish themselves within Canada prior to entering foreign markets. Marketing and distribution costs to enter a foreign market can be substantial, particularly in the US where Canadian companies must face their foreign competitors on their home turf. It is important that these companies attain the required size to enable them to effectively enter other markets, this progress could be impeded if foreign competitors already dominate the Canadian market. The make up of foreign competitors is reviewed below.

The Nationality of Major Competitors

Respondents compete with companies of various nationalities as reported in Figure 3.3.3.1. By far the greatest competition comes from US firms. It is not only the number of US companies that is of importance but also their size. In relation to Canadian companies, they are generally much larger and therefore have substantially more resources, both human and industrial, to devote to R&D, marketing and distribution. Further, they have already established themselves in a home market that is several times larger than the Canadian market. US companies present the greatest challenge to Canadian companies in terms of both domestic and international competition.

FIGURE 3.3.3.1

THE NATIONALITY OF MAJOR COMPETITORS

NATIONALITY(1)	PERCENT
Canadian	59
United States	30
Japanese/Far Eastern	3
European and other	2
d.k., n.a.	6
Total percent(2)	100%
Total n	(400)

1) From Question B-5: "Are your major competitors...."
2) May not sum exactly due to rounding.

The Effect of Company Size

A comparison of company size to the presence of foreign competitors clearly shows that as the size of the company increases more and more competition is provided by US companies. Of the small companies (<$1 million) surveyed two-thirds of their competition is from Canadian firms while 30% is from US firms. Medium sized companies ($1 to 49 million) compete with more US companies on a percentage basis (36%) and large firms, compete on a 40% basis with US companies. There is also competition with companies from other countries but the percentage is too low as to show statistical difference between the various sized companies.

As companies grow to take more of the international market, they find the stakes become high enough to arouse the formidable forces of the multinationals, whose economic powers can smother innovation and technical excellence.

The Effect of Type of Business

Just as it was noted earlier that the type of business impacts the extent of foreign trade (more foreign trade by more R&D intensive companies, particularly manufacturers), a comparison of business type to the presence of foreign competitors also shows a similar relationship.

Companies primarily involved in Manufacturing receive substantial competition from foreign competitors, most significantly the US (52%). US competition outweighs Canadian competition by 10%; further confirmation of the significant presence of US companies. Service (no R&D) companies experience the least competition from foreign competitors, representing only 18% of their total competition and originating primarily from the US. Service (some R&D) companies also experience significant competition from foreign competitors but not to the same extent as the Manufacturers. In relation to their total competition, 41% originates from Canadian competitors.

Summary

Most of the competition faced by Canadian companies is from US based companies. The larger the company, the greater the threat of US competition. In pursuing markets within the US, Canadian manufacturers in particular, and those with medium to large operations, face the greatest competition.

3.3.4 The Effect of Market Factors on Foreign Competitors

So far we have reviewed the extent of Canadian companies foreign trade, the presence of foreign competitors and the effects of foreign trade and competition. Viewing things from a different perspective, it would be useful to assess the market factors that foreign competitors have had to deal with in their penetration of the Canadian market. The effect of these market factors are discussed below.

The Effect of Customer Base

Relating the size of the customer base to the major competitors shows that companies who consider the US as the major source of competition, operate from smaller customer bases. Of these companies, 44% have a customer base of less than 9. Comparing this to companies who responded with Canadian companies as their major competitors, only 35% have a customer base of less than 9.

Thus US companies in penetrating the Canadian market have done so effectively and have no doubt provided stiff competition to their Canadian counterparts. Canadian companies because of their relatively smaller size have pursued specific segments of the market (niches) reflected in their overall lower customer bases.

The Effect of Type of Clientele

Figure 3.3.4.1 compares the revenue (both relative and absolute) generated by various clientele for the three classes of major competitors; Canadian, US and Other. Of the companies that compete either primarily with US companies or other foreign competitors, it would appear that these companies receive a higher percentage of their revenue from the federal government. This we attribute to the Governments preference to buy Canadian and provide important business opportunities for Canadian companies.

FIGURE 3.3.4.1

THE EFFECT OF TYPE OF CLIENTELLE ON FOREIGN COMPETITION

CUSTOMER CATEGORY(1)	MAJOR COMPETITORS(2)					
	Canada		U.S.		Other	
Federal	264.50 M	11%	318.70 M	16%	66.01 M	17%
Local/Prov	168.38 M	7%	105.77 M	5%	13.18 M	3%
Transport	59.87 M	2%	372.79 M	18%	33.31 M	8%
Service	409.77 M	17%	205.87 M	10%	157.01 M	40%
Manufac	307.79 M	12%	243.92 M	12%	61.33 M	15%
Consumers	535.94 M	22%	325.58 M	16%	44.82 M	11%
Other	730.25 M	29%	468.38 M	23%	20.85 M	5%
Total	2476.50 M	100%	2041.00 M	100%	396.50 M	100%

Total n(3) (361)

1) From Question B-4: "What percentage of your revenue ...?"
2) From Question B-5: "Are your major competitors ...?"
3) Of 400 total respondents, 39 did not answer one or both questions.

The Effect of Market Dominance

Relating the number of competitors to their nationality indicates that companies whose primary competitors are US companies, have a fewer number of overall competitors. In particular, of the companies that responded that the US is their major competitor, 57% have 9 or less competitors for their major product or service. For those companies whose major competitors are other Canadian companies, 50% have 9 or less competitors.

This we attribute to the significant size and presence of US companies in Canada. Although a number of smaller US companies also operate within the market, Canadian companies are probably less aware of them and consider their presence far less threatening.

Summary

Canadian companies are aware of the presence of large US competitors who appear to dominate both the Canadian and US markets. Canadian companies have typically pursued particular market segments in order to effectively compete with US companies. Further, Canadian companies that compete primarily with foreign competitors, particularly the US, appear to receive preferential treatment from the Federal Government which provides a significant proportion of their revenue.

The Implications for Government Policy

To review the findings of this section, respondents have clearly identified the challenge of US competitors both within the Canadian home market and in the US market.

FIGURE 3.4.2.2
THE EFFECT OF TYPE OF BUSINESS ON
LEVEL OF R&D INVESTMENT

REVENUE DEVOTED (1) TO R&D	TYPE OF BUSINESS (2)		
	Manufacturing	Distribution Service	Service
0 - 5%	24%	72%	24%
6 - 14%	32%	18%	12%
15% +	45%	10%	65%
	----	----	----
Total Percent(3)	100%	100%	100%
Total n(4)	(381)		

(1) From Question D-1: "For your last fiscal year ...."
(2) From Question A-1: "In which of the following ...."
(3) May not sum exactly due to rounding.
(4) Of 400 total respondents, 19 did not answer one or both questions

The Effect of National Ownership

In relating the effect of national ownership to the level of R&D investment, the results indicate that of the companies surveyed reporting 15% or more R&D investment, 97% are Canadian owned. Several factors contribute to this result; first, Canadian owned companies make up 90% of the sample, of which a significant proportion are small companies. The foreign owned companies are typically larger in size and as previously indicated, devote a lower percentage of revenue to R&D in comparison to smaller companies. Second, of the foreign owned companies, 67% reported 0 to 5% R&D investment as much of their R&D is done in their home country.

Summary

The findings of this section point to a need to encourage higher R&D investment by large Canadian companies particularly those that belong to the Manufacturing and Service sectors. It also points to the possible need to subsidize small companies for R&D related activities in order to sustain their relatively high R&D investment levels.

3.4.3 The Functional Focus of R&D Efforts

Prior to reviewing the specific technology areas where R&D funds are applied, the functional focus of R&D is first reviewed. Specifically, by focusing on the various R&D categories, we can determine those that receive the greatest funding, and the factors that have encouraged investment in these areas.

The Relative Funds Allocated to R&D

Figure 3.4.3.1 shows the allocation of R&D funds between the various categories as reported by the respondents. Most of the R&D funds are devoted towards new product development or improving existing products (75%). Basic research and development receives minimal funding (9.2%) as does market research and development (6.9%). In terms of the revenue reported, the overall allocation to R&D represents 5.3%. Basic Research and market development together, receive less than 1% of the reported revenues.

FIGURE 3.4.3.1

THE FUNDS ALLOCATED TO R&D

R&D FOCUS (1)	ALLOCATION	
	Millions	Percent
1) New product	146.1	53.1%
2) Improving Existing Products	59.5	21.6%
3) Basic Research	25.2	9.2%
4) Market Research and Development	18.9	6.9%
5) Quality Assurance and Control	17.1	6.2%
6) Other	8.6	3.1%
	-----	-----
Total(2)	275.4	100%
Total n(3) (393)		

(1) From Question D-3: "For your last fiscal year, what percent of the above research and development funds (refers to Q D-1) did you allocate to each of the following functions."
(2) May not sum exactly due to rounding.
(3) Of 400 total respondents, 7 did not answer the question.

The level of R&D investment in the areas of new product development and improving existing products has enabled Canadian companies to establish a reputation for providing new and innovative products to the marketplace. However, a common concern is that Canadian companies do not have the ability to successfully bring their innovative products into the marketplace. This inability may be a reflection of the low investment in market research and development.

Canada is not a country known for its achievements in basic research. However, basic research is a very capital intensive undertaking and carries far greater risks than does other R&D efforts. Canadian companies have proven that they can adopt and absorb basic research provided by other countries and utilize such research to produce viable products. **In this regard, the involvement of Canadian companies in basic research may be far less critical than their involvement in other research areas and the focus of Canadian R&D should centre on product innovation and marketing.**

The next section reviews the factors that have encouraged companies to focus their R&D efforts on the functional areas as outlined above.

The Effect of Company Size

Figure 3.4.3.2 relates the effect of company size to the allocation of R&D funds. Clearly company size appears to have little effect on the relative level of funding allocated to each category. In all cases, new product development receives the most funding followed by improving existing products.

Of greater significance is overall contribution to R&D as related to company size. As noted earlier, although small companies allocate a larger percentage of revenue to R&D, it is evident that the greatest proportion of R&D funds are spent by large and medium companies (97%). As was previously shown, 47% of the responding companies are medium to large in size. Although, large companies make up only 6% of the sample, they account for 67% of the reported R&D funds. Clearly, large companies can have the greatest impact on the industries overall R&D investment level and as such should be encouraged in their R&D investment growth.

FIGURE 3.4.3.2

THE EFFECT OF COMPANY SIZE ON THE FUNCTIONAL ALLOCATION OF R&D FUNDS

R&D FOCUS (1)	COMPANY SIZE (2)					
	0 - $1.0 M		1 - $49.9M		$50.0 M	
Basic	0.67 M	8%	2.78 M	4%	21.74 M	12%
New	4.40 M	52%	43.95 M	56%	97.76 M	52%
Improved	1.87 M	22%	18.40 M	24%	39.28 M	21%
Quality	0.62 M	7%	5.24 M	7%	11.28 M	6%
Market	0.79 M	9%	6.23 M	8%	11.86 M	6%
Other	0.10 M	1%	1.45 M	2%	7.03 M	4%
Total(3)	8.44 M	100%	78.04 M	100%	188.95 M	100%

Total n(4) (332)

(1) From Question D-3: "For your last fiscal year................."
(2) From Question A-5: "For your last fiscal year................."
(3) May not sum exactly due to rounding.
(4) Of 400 total respondents, 68 did not answer one or both questions.

The Effect of Type of Business

Relating the type of business to the level of R&D investment shows that companies that classify themselves in the Service Industry spend a proportionally larger percentage of revenue on basic research than do Manufacturers or Distribution Service companies. In fact, 38% of their allocated R&D funds are spent on basic research. The other two business types allocate R&D funds in a manner similar to that reported above; primarily on new product development and improving existing products.

The Effect of R&D Investment

In relating the percentage of revenue allocated to R&D and the focus of the R&D effort, we found that companies, no matter what their level of investment, spend significantly more on new product development and on improving existing products than on any other area. However, of the remaining R&D investment categories, companies that spend 5% or less of their revenue on R&D, appear to allocate more to market research and development and less to new and improved product development than do companies that invest more than 5%. Such an allocation may prove more effective particular for companies with a limited R&D committment. In later sections we review the effectiveness of R&D investment and of investment in marketing to company growth.

Summary

The findings point to the need to encourage R&D investment by large companies and particularly in the areas of new product development and improving existing products. The effectiveness of R&D investment in market research and development needs to be further assessed and is addressed in later sections.

3.4.4 The Sources of R&D Funds

The means by which companies finance their R&D efforts will have a significant impact on the level of that funding. Because of the longer timeframes associated with realizing the benefits of R&D, investment in R&D is much riskier than in other areas, again impacting the level of investment. In the next sections we review the sources of R&D funding and the factors that effect the level of funding attributed to each source.

<u>The Sources of R&D Funds</u>

Figure 3.4.4.1 illustrates the sources of R&D funds as reported by respondents. The primary source of R&D funds is from the company. Of particular interest is the amount of funding provided by the Government, which represents only 7% of the total.

FIGURE 3.4.4.1

THE SOURCES OF RESEARCH AND DEVELOPMENT FUNDS

SOURCE OF FUNDS (1)	R&D FUNDS FROM SOURCE Millions	Percent
1) Company Financed	226.21 M	80.1%
2) Parent/Affiliate Financed	21.65 M	7.7%
3) Government Financed	19.75 M	7.0%
4) Customer/Client Financed	13.69 M	4.9%
5) Other	0.91 M	0.3%
Total(2)	282.30 M	100%
Total n(3) (329)		

(1) From Question D-4: "For your last fiscal year, what percent of your research and development was ..."

(2) May not sum exactly due to rounding.

(3) Of 400 total respondents, 71 did not answer the question.

The Government must be perceived as having a firm committment to R&D if Canadian companies are expected to increase their level of R&D efforts. While we agree that the focus of the R&D efforts should lie with the private sector, the Government can increase its role as a source of funds.

The Effect of Company Size

There are no significant findings in relating the size of the company to the sources of R&D funds. Despite the company size, the primary source of funding is the company (or parent) itself. Medium sized companies receive somewhat more funding from the government on a percentage basis than do large or small companies. This we attribute to the fact that large companies are less likely to rely on Government sources for funding and small companies may simply not be as successful in attaining such funds.

The Effect of Type of Business

Relating the type of business to R&D sources again shows that the prime source of funding for all business types is the company (or parent) itself.

Of interest is the amount of Government financing which is significantly larger for the Manufacturers, who receive 9% of their funding from the Government compared to 3% for Distribution Services and 4% for Service organizations.

The Effect of R&D Investment

Interestingly enough, all companies receiving parent company financing for R&D spend less than 5% of their revenues on R&D. This we attribute to the fact that a substantial amount of the R&D efforts are carried out by the parent company itself. Otherwise the source of funding is still primarily the company and no other significant differences were observed.

Summary

The primary source of R&D funding lies with the private sector. The Government is not considered a major source of funds but of the funds provided, manufacturing companies and companies of medium size receive relatively more than do other companies.

3.4.5 The Specific Focus of R&D Efforts

One of the prime goals of this study is to select high impact technologies for further study. In part, this selection is based on the responses of the sample to a comprehensive list of technologies and applications in which respondents listed the areas where R&D activity was taking place. However, this was not the only consideration in making the selection. Because of this we have chosen to defer the discussion on the specific focus of R&D efforts to Section 3.7, where it is discussed in the context of the overall selection process.

The Implications for Government Policy

The findings of the research and development efforts suggests the following implications for Government:

- Initiate consultations with industry and university representatives to discuss government R&D policies and processes.

- Review tax incentives for R&D, particularly those targetted at specific technologies or specific segments of the telecommunications and information systems industries.

- Review the ways in which cooperative research may be facilitated.

- Review grant programs which are most important to small companies particularly those in their start-up stage.

- R&D in this study was defined as activities undertaken by industries which are not **directly** refunded under short term business practices. The categories considered were:

  - New Product R&D
  - Improving Existing Products R&D
  - Basic R&D
  - Market R&D
  - Quality Assurance & Control R&D
  - Others

It is clear from interviews with industry leaders that in the telecommunications and information systems industries, the term R&D requires better definition. The rate of technology development influx from Japan, the US and Europe requires constant adaptation and up-keep by Canadian industries. Is trying to catch up or stay up to-date considered R&D? The costs of design and manufacturing of products based on state of the art technologies is, in our opinion, the price of being in business and should not be classified as R&D. The emphasis as far as Government grant and tax incentives should rather be on Canadian innovations, Canadian market research and associated longer term research.

Bibliography

1) Ontario Economic Council, "Positive Industrial Policy: The Implications for R&D", Yehuda Kotowitz, 1985.
2) MOSST, "Science Technology and Economic Development, A Working Paper", 1985.

3.5 The Marketing Effort

Effectively marketing a product involves identifying appropriate market segments and delivering a product which responds to the perceived needs of the various target groups. The experience of the telecommunications and information systems industries has been that the technology will not sell itself. It must be appropriately packaged, and priced, it must offer diversity and choice, and use effective communication and distribution networks to inform, motivate and service the market. There are a number of alternatives available to companies in developing marketing strategies. Of particular importance are competitive and non-competitive factors that determine the most effective strategy and encourage investment in marketing. The marketing efforts and the factors that effect these efforts are examined below.

3.5.1 Marketing Resources

The resources that a company devotes to its marketing efforts and the effective utilization of these resources are two major determinants of how successful the company will be in selling its product or services. In the next section we review the marketing investment as reported by responding companies.

<u>The Resources Devoted to Marketing</u>

Figure 3.5.1.1 illustrates the resources devoted to marketing and sales. Clearly three categories emerge in terms of resource allocation; small (less than 5%), medium (5 to 14%) and large (15% or more). Interestingly, there is an almost even split between the number of companies that invest at each level. In the next section we examine this split more closely, distinguishing between the

competitive and non-competitive factors that have contributed to this distribution and assessing the companies effectiveness in the marketplace as a result of their marketing endeavours.

FIGURE 3.5.1.1

RESOURCES DEVOTED TO MARKETING AND SALES

PERCENT OF REVENUE (1) ALLOCATED	PERCENT	
Less than 5%	32	
5 to 14 %	38	
15% or more	25	
		95
d.k., n.a.	4	
Total percent (2)		100
Total n (400)		

1) From Question C-1: "For your last fiscal year, what percent, if any, of its total revenues did your company devote to marketing and sales?"
2) May not sum exactly due to rounding.

3.5.2 The Non-Competitive Factors Contributing to Investment in Marketing

Market exchanges which take place occur in a larger framework known as the marketing system. A marketing system is defined as the set of significant institutions and flows that connect an organization to its market. It is made up of two basic elements: the company and the market.

The effectiveness with which marketing tasks are performed depends largely on how thoroughly the major components, operating characteristics and relationships making up the marketing system are understood.

In this section we review the first basic element of the marketing system; that of the company. In particular, factors that relate to the company size, type of business and ownership are examined to determine their effect on the marketing strategy employed by various companies.

<u>The Effect of Company Size</u>

Figure 3.5.2.1 relates the company size to the relative investment in marketing and sales. Small companies devote relatively less to marketing and sales than do medium to large size companies. Whereas 41% of small companies devote less than 5% of revenue to marketing, only 26% of medium sized companies and one-third of large sized companies devote the same. As the company size increases, the company boundaries will also increase, resulting in higher allocations.

FIGURE 3.5.2.1

THE EFFECT OF COMPANY SIZE ON THE
MARKETING AND SALES INVESTMENT

PERCENT OF REVENUE (1)	COMPANY SIZE (2)		
	0 - $1.0 M	1 - $49.9M	$50.0 M
0 - 4%	41%	26%	33%
5 - 14%	33%	49%	50%
15% +	27%	26%	17%
	----	----	----
Total Percent(3)	100%	100%	100%
Total n(4) (376)			

1) From Question C-1: "For your last fiscal year.................."
2) From Question A-5: "For your last fiscal year.................."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 24 did not answer one or both questions.

The Effect of Type of Business

Relating the effect of type of business to the allocation of revenue to marketing and sales, shows no significant differences between the various types of businesses. All three types including Manufacturing, Service, and Distribution Services have a fairly equal distribution of companies that devote small , medium and large amounts of resources to marketing.

The Effect of National Ownership

National ownership also appears to have little impact on the resources devoted to marketing, although it should be pointed out that the sample is substantially dominated by Canadian firms. However, the distribution of foreign owned firms or firms with foreign participation shows the same even distribution as was observed for Canadian firms.

Summary

Non-competitive factors have little effect on the allocation of company resources to marketing. Rather, it must be the competitive factors which will influence the company's choice of target markets, marketing intermediaries, product mix and marketing mix and which will inevitably determine the investment required.

3.5.3 The Competitive Factors Contributing to Investment in Marketing

Three different forms of competition can be distinguished. The first is generic competition, which entails other products and services that might satisfy the same customer needs; the second is product-form competition which refers to specific versions of products or services that might be competitive and the last is enterprise competition which refers to specific organizations that are competitive producers of the same product or service. Since this review entails a wide variety of telecommunications and information systems products and services it would be impractical to review the first two forms of competition and their effect on marketing investment. Rather we have chosen to concentrate on enterprise competition and to assess the allocation of resources to marketing based on this criteria.

The Effect of Competition Abroad

Figure 3.5.3.1 relates the effect of competition abroad to investment in marketing. The results indicate that companies who spend 15% or more of their revenues on marketing derive substantially more of their revenues abroad than do companies who spend less than 15%. In fact, these companies derive 49% of their revenue from foreign trade compared to companies who invest 5 to 14% (27%) and companies who invest less than 5% (26%). It is evident that marketing costs rise with the level of export activity. Penetration of foreign markets requires substantially higher allocations to marketing than does selling within Canada. This explains the extreme difficulties faced by small, and of particular concern to us, medium sized companies in entering foreign markets.

FIGURE 3.5.3.1

THE EFFECT OF COMPETITION ABROAD ON
INVESTMENT IN MARKETING AND SALES

MAJOR MARKETS (1)	PERCENTAGE OF REVENUE ALLOCATED (2) TO MARKETING AND SALES		
	Less Than 5%	5 - 14 %	15% or More
Canada	74%	73%	51%
U.S.	15%	18%	35%
Other	11%	9%	14%
Total(3)	100%	100%	100%

Total n(4) (379)

1) From Question B-1: "What percentage of your revenue is generated..."
2) From Question C-1: "For your last fiscal year ...."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 21 did not answer one or both questions.

The Effect of Customer Base

The effect of customer base has a similar effect. The larger the customer base the more revenue that is allocated to marketing and sales. Of the companies that spend 5% or less on marketing, 53% of their revenues are derived from clientele consisting of 9 or less customers. Companies that spend 6 to 14% derive only 36% of their revenue from a small customer base (9 or less) and of the companies spending 15% or more only 26% derive revenue from the same customer base size.

This again places smaller companies at a relative disadvantage since targetting products or services to a small customer base is relatively more risky than to a larger target base. This risk must be assessed in light of the higher costs of marketing to a larger customer base.

The Effect of Major Competitors

Major competitors have a noticeable impact on the level of investment in marketing and sales as illustrated in Figure 3.5.3.2. Of the companies that spend 14% or less on marketing, two-thirds of them consider their major competition to originate from Canadian companies. However, of the companies who spend 15% or more, one-half (48%) consider foreign competitors as their major competition.

FIGURE 3.5.3.2

THE EFFECT OF MAJOR COMPETITORS ON THE
LEVEL OF INVESTMENT IN MARKETING AND SALES

MAJOR COMPETITORS (1)	PERCENTAGE OF REVENUE (2) INVESTED IN MARKETING		
	Less Than 5%	5 - 14 %	15% or More
Canada	66%	68%	32%
U.S.	28%	26%	27%
Other	7%	5%	42%
Total(3)	100%	100%	100%

Total n(4) (365)

1) From Question B-5: "Are your major competitors ...."
2) From Question C-1: "For your last fiscal year ...."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 35 did not answer one or both questions.

For Canadian companies to compete in areas that are dominated by foreign competitors will require a larger investment in marketing. Canadian companies already consider themselves at a relative disadvantage in comparison to foreign competitors and this added dimension only makes their competitive situation less tenable. Smaller Canadian companies will probably require assistance in their marketing endeavours particulary in foreign markets if they are to be competitive. Alternatively, Canadian companies can pursue market segments that are not dominated by foreign competitors. These markets are of course hard to come by.

The Effect of Number of Competitors

The number of competitors also has a noticeable effect on the level of marketing investment. As the number of competitors increases the level of investment also increases. Of those companies that spend 5% or less on marketing, 62% compete with 9 or fewer competitors. Of the companies that spend 6 to 14%, 51% compete with few competitors and for those who spend 15% or more, the companies with few competitors make up only 42% of that sample.

As illustrated in the previous section, the most desirable position for Canadian firms may be in market segments that do not bring them into direct competition with foreign companies and particulary market segments that have few competitors. These segments we would expect to be dominated by large multinationals.

The Effect of Market Share

Market share also has a noticeable effect on the level of marketing investment as illustrated in Figure 3.5.3.3. Of the companies that have 60% or more of the Canadian market, one-half spend less than

5% on marketing. Of those companies with 5 to 59% of the Canadian market, the majority spend 5 to 14% on marketing. Of the companies with a small market share (less than 5%), revenues are allocated almost equally between the three categories which is possibly due to the size of the sample and the variety of products and services offered by them. However in general, as market share increases two effects must be taking place. First, the number of competing companies is declining and as previously stated we would expect this effect to drive down the cost of marketing. Second, the size of the customer base is increasing which should drive up the cost of marketing. Therefore the first effect must outweigh the second where a large market share is involved.

The overall effect is to make it more difficult for other companies to enter or compete in the market once a large share is held by any particular company.

FIGURE 3.5.3.3

THE EFFECT OF MARKET SHARE ON THE
LEVEL OF INVESTMENT IN MARKETING AND SALES

MARKET SHARE (1)	PERCENTAGE OF REVENUE (2) INVESTED IN MARKETING		
	Less Than 5%	5 - 14 %	15% or More
Less than 5%	60%	52%	56%
5 - 59%	20%	41%	31%
60% or more	20%	7%	13%
	----	----	----
Total(3)	100%	100%	100%

Total n(4) (250)

1) From Question B-8: "If you know your share of the Canadian Market is it ..."
2) From Question C-1: "For your last fiscal year ...."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 150 did not answer one or both questions.

Summary

All of the competitive factors examined have some effect on the resources that must be devoted to marketing if a firm is to remain competitive. The findings have pointed to the possible need of assistance to medium sized companies in their marketing efforts, particularly if these firms are to be encouraged to grow through export.

3.5.4 The Tie Between R&D and Marketing

Relating the level of funds companies allocate to R&D and marketing is illustrated in Figure 3.5.4.1. Of the companies surveyed, 50% allocate the same amount or more to marketing as they do to R&D. The remaining 50% devote more resources to R&D than they do to marketing. Of interest is the substantial amount of revenue that is allocated by 12% of the companies surveyed to both R&D and marketing (30% or more).

Companies must choose the most effective allocation of their resources. Allocation to R&D is generally considered to have longer term impacts than marketing allocations. It is apparent that at least 50% of the companies in weighing the benefits of R&D versus marketing levels have chosen the longer term benefits of R&D.

FIGURE 3.5.4.1

THE RELATION OF INVESTMENT IN R&D TO INVESTMENT IN MARKETING

PERCENTAGE OF REVENUE (1) INVESTED IN R&D	PERCENTAGE OF REVENUE (2) INVESTED IN MARKETING		
	Less Than 5%	5 - 14 %	15% or More
5% or Less	50%	45%	32%
6 - 14%	19%	26%	20%
15% or more	31%	29%	48%
Total(3)	100%	100%	100%
Total n(4) (376)			

1) From Question D-1: "For your last fiscal year ...."
2) From Question C-1: "For your last fiscal year ...."
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 24 did not answer one or both questions.

Implications For Government Policy

The findings suggest the following implications for Government:

Devise policies that will assist medium sized companies in penetrating foreign markets including:

1) marketing subsidies and grants to aid in establishing distribution channels
2) assistance in assessing foreign markets, their cultural, economic and political differences that would affect the marketing of products and services
3) assist Canadian firms in establishing joint venture operations that would make foreign markets more accessable

Government policies, particularly in the area of export market research, could also be extremely effective for large companies.

3.6 Identifying and Describing the Fast Growth Companies

So far, we have characterized responding companies in terms of their size, type, ownership, mode of operation, products and services, and competitiveness.

In this section, we extend that discussion to identify the characteristics of companies which have experienced exceptional growth in the past and which project such growth in future.

With knowledge of these characteristics, the government can direct future programs specifically toward them.

3.6.1 Company Growth - Past and Future

The Extent of Company Growth

Figure 3.6.1.1 shows the extent of company growth over the past five years and respondent anticipation of growth over the next five years.

FIGURE 3.6.1.1
THE EXTENT OF COMPANY GROWTH

ANNUAL GROWTH	PAST(1) (PERCENT)	FUTURE(2) (PERCENT)
5% or less	18	10
6% - 15%	22	28
16% or more	51	58
d.k., n.a.	9	4
Total percent(3)	100%	100%
Total n	(400)	(400)

1) From Question B-9: "What has been your company's average annual growth rate over the past five years?"
2) From Question B-10: "Considering your resources, your domestic competition, and your foreign competition, what realistic average annual growth rate, if any, do you anticipate for your company annually over each of the next five years?"
3) May not sum exactly due to rounding.

In comparison to other sectors of the economy, growth in the telecommunications and information systems industries has been above average in the past five years. Respondents anticipate that it will remain so over the next five years. One half (51%) of respondents report average annual growth rates of 16% or more for the past five years. The future appears even more promising. Over one-half (58%) expect annual growth rates of 16% or more.

The past growth of responding companies has been far greater than that of the Canadian economy as a whole.

These data confirm the premise of this study that the telecommunications and information systems sectors can provide exceptional economic growth for Canada as a whole.

<u>The Tie Between Past and Future</u>

We show above that one-half of telecommunications and information systems companies report past growth rates of 16% per annum and that somewhat more anticipate such growth in the future. The similarity of these proportions suggests that those companies which historically have experienced high growth will continue to do so in the future.

Figure 3.6.1.2 confirms this. Among companies which reported 16% or more annual growth over the past five years, five out of six (86%) anticipate that it will continue over the next five. In contrast, among companies which have reported lesser rates of growth over the past five years, one-third or fewer (33% to 24%) anticipate achieving 16% or more growth during the near future.

FIGURE 3.6.1.2

THE RELATION BETWEEN PAST AND FUTURE COMPANY GROWTH

FUTURE GROWTH(1)	PAST GROWTH(2)		
	5% or less	5 - 15%	16% or more
5% or less	33	14	2
6 - 15%	33	62	12
16% or more	33	24	86
Total(3)	100%	100%	100%
Total n(4)	(72)	(84)	(200)

1) From question B-9: "What has been your company's average annual growth rate over the past five years?"
2) From question B-10: "Considering your resources, your domestic competition, and your foreign competition, what realistic average annual growth rate, if any, do you anticipate for your company annually over each of the next five years?"
3) May not sum exactly due to rounding.

These patterns indicate that should the government choose to provide direct incentives to established companies, one of its criteria for doing so should be past growth. Companies which have demonstrated high growth in the past should be rewarded for their success. Funds directed toward companies which have not demonstrated high past growth likely would be wasted.

3.6.2 The Characteristics of Fast Growth Companies

Clearly, many of the companies surveyed have experienced high growth in the past. In this next section we identify the common characteristics of these high growth concerns - those with compounded annual growth of 16% or more.

The Company Size

Relating company size to past growth indicates that medium sized companies and to a lesser extent smaller sized companies, have experienced the fastest growth.

Of the small companies, 54% experienced high annual growth. Of the medium sized companies, 63% experienced such growth. Among the large companies, 33% experienced high annual growth.

Obviously, larger companies have greater difficulties in achieving growth rates comparable to those of medium and small companies. It is far easier to increase revenues by 16% or more from a one million dollar base than from a one billion dollar base. Thus, the relationship between company size and growth is more complex than meets the eye.

In light of the impediments to rapid growth inherent to the largest companies, the greatest success of the medium sized companies can be placed in perspective.

The medium sized companies are at an advantage over the largest companies because their smaller size facilitates faster relative growth. They are likely at an advantage over the smallest companies in that they have progressed beyond the high likelihood of failure inherent to small companies in their start-up phase.

This interpretation of the high growth characteristics of medium sized companies supports our previous recommendation - that should the government choose to provide incentives directly to individual concerns, that it do so using the criterion of demonstrated past growth.

<u>The Type of Business</u>

Figure 3.6.2.1 relates type of business to past growth. Depending on type of business, 47% to 62% report high growth rates. These differences are not substantively meaningful.

FIGURE 3.6.2.1

THE EFFECT OF TYPE OF BUSINESS ON
PAST GROWTH RATES

PAST GROWTH(1)	TYPE OF BUSINESS(2)		
	Manufacturing	Distribution Service	Service
5% or less	19	21	35
6 - 15%	19	32	15
16% or more	62	47	50
Total(3)	100%	100%	100%
Total n(4) (400)			

1) From question B-9: "What has been your company's average annual growth rate over the past five years?"
2) From question A-1: "In which of the following................"
3) May not sum exactly due to rounding.
4) Of 400 total respondents, 150 did not answer one or both questions.

Summary

Smaller and, especially, medium sized companies have experienced the fastest growth rates in the past. This can be attributed, in part, to the greater flexibility of these companies in adapting to changes in the telecommunication and information systems environment.

3.6.3 The Factors Contributing to Rapid Growth

This section undertakes a preliminary examination of those factors which most contribute to rapid company growth.

As we have discussed earlier, we pay special attention to two of these - investment in research and development and relative expenditures for marketing.

In addition, we examine the effects of a number of other factors. These include quality, service, price, and government policies.

The Effect of Research and Development Investment

In this section, we review the effect of research and development investment on rates of growth.

Of companies that invested less than 5% of their annual revenues in research and development, 51% experienced high growth rates - those of 16% or more. Of companies that invested 6% to 14% in research and development, 60% experienced high growth rates. Of those that invested 15% or more in research and development, 63% experienced high growth rates. Overall, companies with the highest investment in research and development are 12 percentage points more likely to experience the highest growth rates than are companies which make the lowest investment.

While the general effect of research and development on company growth is discernible, it is not as strong as we had initially assumed.

This does not mean that research and development is relatively inconsequential to company growth. If it were, we would not see such vast investments in it. Given this, we take that our finding of the modest general effect of research and development on company growth does not mean that research and development are relatively unimportant. Rather it means that research and development likely has its greatest impact only under certain specific conditions.

These conditions likely can be discerned from the characteristics of telecommunications and information systems companies. As we have already discussed, these are the size of the company, the type of business, and, especially for the purposes of this research, the extent to which it has entered the international market.

We believe it plausible that further analysis would clarify the explicit conditions under which research and development investment contributes to company growth. With this clarification, the government would be better able to develop incentives to stimulate this contribution.

The Effect of Marketing Effort

In this section, we turn to the effect of marketing effort on company rates of growth. We show that the general effects are more pronounced than are those of research and development.

Of companies that invested less than 5% of their annual revenues in marketing, 47% experienced high growth rates, those of 16% per annum or more. Of companies that invested 6% to 14% of their revenues in marketing, 59% experienced high growth rates. Of those that invested 15% or more in marketing, 73% experienced high growth rates.

Overall, companies which make the highest marketing expenditures are 26 percentage points more likely to experience the highest growth rates than are companies which make the lowest marketing expenditures.

Given the above, we can conclude that investment in marketing has a more pronounced general effect on company growth than does investment in research and development.

This notwithstanding, as with research and development, the effects of marketing may differ under various conditions of company size, type of business, and involvement in international markets. As is the case with research and development, we believe it plausible that further analysis would clarify these conditions.

Additional Factors

The survey requested respondents to rank the effects of nine additional factors which may contribute to "revenue growth". These varied from product quality to government incentives. In requesting rankings, the question included marketing and research and development. This was done to provide a prospective for the other factors.

Respondents ranked each of nine on a four point scale, "extremely," "very," "somewhat," or "not at all important." The results are illustrated in Figure 3.6.3.1.

FIGURE 3.6.3.1

THE IMPORTANCE ATTRIBUTED TO SPECIFIC FACTORS AFFECTING COMPANY GROWTH

THE GROWTH FACTOR (1)	LEVEL OF IMPORTANCE Extremely Important	Very Important	Somewhat Important	Not at All Important (2)	Total (3) Percent	Total n
Quality	60	34	3	2	100	(400)
Service	52	34	9	5	100	(400)
Marketing	42	40	13	4	100	(400)
R&D	34	28	25	13	100	(400)
Price	28	40	28	4	100	(400)
Capital Investment	25	34	27	13	100	(400)
Competition	20	39	33	7	100	(400)
Government Tax Policy	21	28	31	20	100	(400)
Government Incentives	16	22	34	29	100	(400)
Other	8	3	1	87	100	(400)

1) From Question B-11: "Listed below are a number of factors which might or might not affect your company's revenue growth. Please indicate the relative importance of each to your company's revenues over the next five years."

2) Including d.k., n.a.

3) May not add to exactly 100 due to rounding.

The most important factors are the non-price elements of quality and service. Sixty percent and 52% of respondents, respectively, rate these as "extremely important". The primary importance attributed to these identify them as the **sine qua non** of successful international Canadian competition.

This primary importance suggests that government incentives include steps which enhance the quality assurance (design reliability) and quality control (manufacturing reliability) procedures. One low cost, albeit long term, step in this direction would be through funding chairs of quality assurance and quality control at Canadian institutions of higher education.

The second most important factors are marketing and research and development. Forty-two percent and 34% respectively, rate these as "extremely important". The fact that company executives rank marketing above research and development in terms of its contribution to company growth confirms the findings of our preceding sections.

The third factors are price (28%), capital investment (25%), and competition (20%). Comparison of the importance given quality versus price is especially significant. More than twice as many executives consider quality "extremely important" than so consider price (60% versus 28%). This identifies the exceptional importance of quality as a Canadian advantage in the telecommunications and information systems industries. In so doing, it also indicates that direct subsidies of telecommunications and information systems exports likely would not be cost effective.

The fourth factors are government tax policies and government incentives. Cited as "extremely important" by 21% and 16% respectively, these are considered the least relevant factors which contribute to the general growth of telecommunications and information systems companies.

This means that such policies and incentives have not been of key importance in the past in stimulating the growth of telecommunications and information systems companies. However, this past experience does not mean that government incentives either have been or need be ineffective. Rather, it suggests that to be effective, such incentives must be applied in a directed manner.

The issue of government roles is a critical one for Canadian businesses. Because of this, we have devoted an entire section of this report (Section 3.8) to review it in detail.

<u>Summary</u>

The findings of this section indicate that the three most important factors contributing to company growth have been quality, service and marketing. Research and development ranks fourth in general importance, behind marketing.

Marketing and service require establishing the appropriate distribution. This is probably one of the greatest challenges facing Canadian companies, particularly in export markets.

Government policies and incentives have not been considered extremely effective in stimulating past growth. Nonetheless, we believe that they could be valuable in the future if directed toward specific areas such as marketing and distribution and limited to companies with proven records of success.

3.7 Identifying the High Impact Telecommunications and Information Systems Technologies

3.7.1 The Criteria for Selecting High Impact Technologies

While the general purpose of this study is straight forward, selecting the explicit criteria by which to identify high impact technologies is less so.

This notwithstanding, the common themes to the original study outline point to three selection criteria. These are:

1) technologies in which Canadian industry possesses an expertise or in which **Canadian expertise** can provide competitive advantages in the world market;

2) a **favourable economic impact of the technologies** upon Canadian industry, and,

3) technologies with which Canadian companies can **favourably compete in the world market.**

In essence, these criteria parallel those established by the Japanese government in formulating its post World War II policy of economic rebirth. It has been pursuit of this policy which has led Japan to its present position of world economic power.

Each of these criteria are discussed in the sections which follow.

3.7.2 Identifying the Areas of Canadian Expertise

Identifying those areas in which Canadian expertise can provide a competitive advantage requires three steps.

First, those respondents who are competent to judge the expertise Canada can bring to the world market must be identified. These would include respondents of those companies which sell their products and/or services abroad.

Second, the degree to which, if at all, these respondents view Canada's position in the world market as favorable or unfavorable must be clarified.

Third, the specific advantages Canadian companies can bring to world trade and, conversely, the specific disadvantages from which they suffer must be ascertained.

Each of these steps are reviewed below.

Involvement in the World Market

The most basic measure of participation in the world market is whether or not a company sells "its products and/or services in other countries or just in Canada".

Figure 3.7.2.1 reports the extent to which responding companies so participate. Just over one half (51 percent) sell in Canada only; approximately one half (48 percent) sell in other countries. Not unexpectedly, the United States is Canada's most important trading partner for telecommunications and information systems equipment, as in general. Almost one third (30 percent) of responding companies sell primarily to the United States; almost one fifth (18 percent) sell elsewhere.

In sum, one half of Canadian companies sell abroad. We designate the respondents representing these as competent to judge the expertise which Canada can bring to the world market.

FIGURE 3.7.2.1

THE PARTICIPATION IN WORLD TRADE

NATIONAL MARKETS(1)	PERCENT	
Canada only	51	
		51
United States(2)	30	
Other	18	
		48
d.k., n.a.		2
Total percent(3)		100%
Total n		(400)

(1)From Question C-2: "Does your company sell its products and/or services in other countries or just in Canada?"
(2)Including companies which sell in both the United States and other foreign markets.
(3)May not sum exactly due to rounding.

The Perceived Competitiveness of Canadian Firms

As illustrated above, Canadian telecommunications and information systems companies engage widely in the world market. This notwithstanding, more often than not, those that do so view themselves at a disadvantage.

Figure 3.7.2.2 illustrates the pervasiveness of this belief. Among Canadian companies which compete in foreign markets, one-half (47 percent) perceive that their "non-Canadian competitors have the general advantage"; two in five (42 percent) see foreign and Canadian companies as competing "equally". Only five percent attest to a Canadian advantage.

This five percent, by their own estimation, constitute the most successful Canadian competitors in the world market. As such, the geographical areas in which they compete and their views on what constitute Canadian trading advantages are of special importance.

FIGURE 3.7.2.2

PERCEIVED RELATIVE COMPETITIVENESS OF CANADIAN FIRMS IN FOREIGN MARKETS

PERCEIVED RELATIVE ADVANTAGE(1)	PERCENT
Non-Canadian companies have advantage	47
Compete equally	42
Canadian companies have advantage	5
d.k., n.a.	6
Total percent(2)	100%
Total n(3)	(189)

(1)From Question C-3: "Within foreign markets, do your non-Canadian competitors have the general advantage, do Canadian companies have the general advantage, or do they compete equally?"
(2)May not sum exactly due to rounding.
(3)Based on the n=189, or 48 percent, of respondents who in Question C-2 report selling their "products and/or services in other countries ... (not) just in Canada".

Figure 3.7.2.3 relates the major geographical markets in which these companies compete to what they perceive as the relative advantages of Canadian vis-a-vis foreign trading concerns. A glance shows no substantive differences. Among companies which compete primarily in the United States, 46 percent ascribe an advantage to American companies while only six percent affirm a Canadian advantage. Among companies which compete primarily in other countries, 48 percent ascribe an advantage to the foreign companies while only four percent see a Canadian advantage. These commonalities of disadvantage in the United States and elsewhere suggest that the impediments to successful Canadian export are by and large general and not specific to particular foreign markets.

FIGURE 3.7.2.3

PRIMARY AREA OF WORLD TRADE RELATED TO PERCEIVED COMPETITIVENESS OF CANADIAN FIRMS

PERCEIVED RELATIVE ADVANTAGE(1)	MAJOR FOREIGN MARKET(2)	
	UNITED STATES	OTHER
Non-Canadian companies have advantage	46	48
Companies compete equally	42	41
Canadian companies have advantage	6	4
d.k., n.a.	6	7
Total percent(3)	100%	100%
Total n(4)	(116)	(73)

(1)From Question C-3

(2)From Question C-2

(3)May not add to exactly 100 due to rounding.

(4)Total n=189. Based on 189 respondents who in Question C-2 report selling their "products and/or services in other countries...(not) just in Canada".

The Factors Affecting Canada's Position in World Markets

To evaluate the factors which affect Canadian competitiveness abroad, the questionnaire presented respondents engaged in foreign trade with a list of 19 factors which could influence the nation's competitive position. These factors ranged from "product innovation" and "product quality" to "size of sales force" and "wide distribution". Respondents were asked to evaluate each of these factors on a five point scale. This scale ranged from "Major Canadian Advantage" at one extreme, to "Major Canadian Disadvantage", at the other.

Figure 3.7.2.4 presents these evaluations. The differences are striking. Without question, Canada's major advantages centre on her "product innovation" (46 percent cite as a major advantage) and her "product quality" (39 percent). "Product service and support" are also important (cited by 17 percent as a major Canadian advantage). Overall, these replies indicate that Canada's exporters see Canada's trade strength coming from her superb technical abilities.

In contrast, these same exporters perceive Canada's major disadvantages as centering on limitations to "wide distribution" (28 percent), "size of sales force" (28 percent), "promotion advertising" (25 percent), "financing" (25 percent), in general, and "government financial support" (20 percent), in particular. In short, Canada's exporters see Canada's trade weaknesses as stemming from the limitations in her marketing resources and, in particular, the financial backing to her export efforts.

In contrast to the above is the neutral effect ascribed to pricing. Thirteen percent of telecommunications and information systems exporters consider pricing a major Canadian advantage; while 10 percent consider it a major Canadian disadvantage. This neutral effect of pricing underscores that the strength of Canadian exports centres on innovation and product quality. As such, providing the absolutely lowest price is not essential for developing and maintaining a Canadian stance in the world market. Conversely, Canada's strengths do not lie in those realms of communications and information systems where price competition is key, as exemplified by consumer electronics.

Our findings above point to at least five views which the Government may consider to stimulate Canadian exports. These are:

1) Preferential tax credits to Canadian nationals employed by Canadian companies abroad to encourage wider foreign distribution of Canadian products and development of an overseas Canadian sales force.

2) Preferential tax credits to such marketing efforts by Canadian companies, themselves, to encourage the overseas marketing of Canadian products.

3) Financial assistance in financing foreign sales (ie. in the form of preferential tax credits and/or preferential lending rates for qualifying companies and/or products).

4) Avoidance of direct price subsidies, given that price is not critical to the success of Canadian communications and information systems exports.

5) No encouragement for the export of products, such as consumer electronics, for which price competition is critical.

6) Encouragement for the export of products that focus on smaller customer based markets which are more easily serviceable.

These factors will be reviewed and compared to the results of Section 3.8 in which the role of Government incentives is examined.

FIGURE 3.7.2.4

FACTORS AFFECTING THE COMPETITIVENESS
OF CANADIAN COMPANIES IN
FOREIGN MARKETS

THE COMPETITIVE FACTORS(1)	MAJOR CANADIAN ADVANTAGE	MINOR CANADIAN ADVANTAGE	EVEN(2)	MINOR CANADIAN DIS-ADVANTAGE	MAJOR CANADIAN DIS-ADVANTAGE	TOTAL PERCENT3	TOTAL n4
Product innovation	46	17	31	5	1	100%	(189)
Product quality	39	20	40	2	--	100%	(189)
Product service and support	17	14	35	25	8	100%	(189)
Pricing (of product)	13	29	32	17	10	100%	(189)
Management capability	6	24	55	13	2	100%	(189)
Ability of sales force	2	8	62	20	7	100%	(189)
Compatability with future standards	7	14	70	8	2	100%	(189)
Discriminatory foreign regulations	1	3	52	33	12	100%	(189)
Compatability with existing standards	6	14	72	7	2	100%	(189)
Restrictive Canadian regulations	1	4	64	23	8	100%	(189)
Foreign duty barriers	1	3	54	30	13	100%	(189)
Marketing Expertise	3	13	42	30	12	100%	(189)
Corporate/brand image	5	10	35	32	19	100%	(189)
Government regulatory support	2	4	54	23	19	100%	(189)
Government financial support	2	12	42	24	20	100%	(189)
Financing (of product)	3	4	42	27	25	100%	(189)
Promotion/advertising	2	4	38	32	25	100%	(189)
Size of sales force	2	3	32	35	28	100%	(189)
Wide distribution	3	4	27	39	28	100%	(189)
Other	2	--	94	--	4	100%	(189)

From Question C-4: "Listed below are a number of factors which may influence the success of companies in your major foreign markets. Please indicate the extent to which each factor is an advantage or disadvantage for your own Canadian co.

Including d.k., n.a.

May not sum exactly due to rounding.

Based on n=189, or 48 percent, of respondents who in Question C-2 report selling their "product and/or services in other countries ... (not) just in Canada."

Summary

One in two respondents represent communications or information system companies which sell in the United States or other foreign markets.

Approximately one half of this group perceive that "non-Canadian competitors have the general advantage" in the world communications and information systems market; five percent attest to a Canadian advantage.

The major Canadian trade advantages come from Canada's superb technical abilities. The major Canadian trade disadvantages stem from the limitations in her marketing resources and the financial backing to her export efforts. Pricing is seen as neither an advantage nor a disadvantage.

These factors suggest that government initiatives to stimulate Canadian world trade in communications and information systems should center on encouraging the foreign marketing and the financing of these exported goods and services.

3.7.3 Identifying the General Technologies with Favourable Economic Impact

Identifying technologies which will have a favourable economic impact upon Canadian industry reduces to identifying those which will exhibit two characteristics.

First, and foremost, they must be technologies which will exhibit high growth rates.

Second, they must be technologies which can be expected to sustain that growth to a point at which the revenues generated from their sales could have a meaningful effect on the Canadian economy.

This latter point is especially important for the purpose of planning long term economic policy. A technology growing at a compounded annual rate of 20 percent which promises eventual annual sales of $1,000,000,000 presents a far more attractive object for national investment than does a technology growing at a rate of 30 percent but which will peak at annual sales of but $100,000,000.

In the first phase of data collection, no attempt was made to place precise dollar values on the eventual market of each separate technology. In lieu of this, the questions were worded to provide a proxey for identifying those communications and information systems technologies which will provide the greatest opportunities for Canadian economic growth. This wording requested respondents to indicate the growth they would "anticipate over the next five years". As such, respondents who input a 30 percent or greater compounded annual growth for any technology would be pointing to a minimum four-fold increase in that market over that time.

In addition to twin criteria of high and sustainable growth, one may reasonably argue that additional criteria for identifying high impact technologies may include the social benefits those technologies may provide. Such social benefits would include:

- the expansion of Canadian employment,
- the improvement in the educational or skill level of the Canadian labour force, and,
- the creation of jobs in economically distressed areas such as the Far North or the Maritime provinces.

In no way do we discount such social benefits. However, we believe that an over emphasis on these concerns may distract attention from the long term national gains inherent to stimulating a rapidly growing high technology telecommunications and information systems industry. Such industry will benefit the entire Canadian economy. In so doing, it inevitably will contribute to expansion of employment, increases in educational attainment, improvement in labour force skills, and, through its secondary effects, creation of additional jobs throughout Canada, including those jobs in the distressed areas.

Identifying the General High Growth Technologies

Two items were incorporated in the questionnaire to identify high growth technologies.

The first item asked respondents to estimate the annual growth they anticipated in a half dozen general processing modes, each associated with data, video and voice, respectively. This question also requested respondents to estimate the likely growth in two areas of software.

The second item asked respondents to estimate the annual growth for 16 specific classes of equipment. This item was subdivided into two groupings. The first grouping encompassed a variety of switches. The second grouping encompassed other types of equipment. Respondents views toward the general areas of high technology are discussed in this section. Their views concerning the specific classes of equipment are discussed in the one which follows. In interpreting replies to these items, two observation are in order.

First, the questionnaire instructions admonished respondents to **"Leave the answer blank"** for those cases in which they "may have no opinion". Because of this, respondents self selected themselves to answer only those items for which they held a view concerning the likely growth. Depending on the item, these respondents numbered 38 to 59 percent of the total.

Second, for the most part, respondents will be intimately involved with the communications and information systems areas to which they reply. Because of this, many will report a more optimistic view of the market potential for these areas, than likely market growth over the next years will warrant. This means that in interpreting their estimations of growth the **relative** ranking they ascribe to different technologies will prove more valid than the **absolute** growth.

Figure 3.7.3.1 describes the growth expected for functional processing modes with regard to data, video, and voice. It also includes two aspects of software. Two general patterns emerge.

FIGURE 3.7.3.1
THE ANTICIPATED INTERNATIONAL MARKET GROWTH IN
TELECOMMUNICATIONS - INFORMATION SYSTEMS AREAS

AREA(1)	ANTICIPATED ANNUAL GROWTH					
	NIL TO 9%	10% TO 19%	20% TO 29%	30% TO 39%	NO RESPONSE	TOTAL PERCENT
Application software	4	9	15	32	41	100%
System software	5	10	19	20	46	100%
Data input	7	16	14	12	51	100%
Data transmission	5	13	17	20	46	100%
Data switching	7	11	13	15	53	100%
Data processing	6	18	16	14	47	100%
Data storage	6	13	14	16	50	100%
Data output	8	16	12	11	53	100%
Video input	12	15	8	4	61	100%
Video transmission	11	17	8	6	58	100%
Video switching	13	16	6	4	62	100%
Video processing	12	13	9	6	60	100%
Video storage	12	10	8	8	62	100%
Video output	12	12	10	4	62	100%
Voice audio input	17	14	6	5	58	100%
Voice audio transmission	16	15	6	5	58	100%
Voice audio switching	16	15	5	6	58	100%
Voice audio processing	13	12	8	6	61	100%
Voice audio storage	14	12	8	6	60	100%
Voice audio output	15	14	7	4	60	100%

Total n=400 (2)

(1) From Question E-2: "Listed below are a number of telecommunications, information systems, and related areas. Please indicate the annual international growth you anticipate over the next five years in each one...."

(2) Out of a total n = 400 respondents, 152 to 237, or 38 to 59 percent, answered these items.

First, respondents unquestionably anticipate that the greatest growth will be in software, including systems and, especially, for applications. Twenty and thirty two percent, respectively, anticipate 30 percent or more annual growth over the next five years. Not only is software seen as the most rapidly growing of the areas, but this view is held by especially large proportions of respondents, 217 and 237 out of the 400 total. For other technology areas, the number replying ranged from 152 to 215.

Second, of the remaining three realms of information -- data, video, and voice -- data as a class , is viewed as the fastest growing. Depending upon processing mode, 11 to 20 percent see data applications growing by 30 percent or more annually over the next five years. For video and voice information, the corresponding proportions are 4 to 8 percent.

In sum, in the view of respondents, software and data applications will experience the greatest growth. Video and voice will experience the least.

Figure 3.7.3.2 aggregates the proceeding information to estimate the average growth respondents anticipate for each of the six functional modes. This average is independent of whether the information involved is data, video, or voice. Software is included as a comparative benchmark.

FIGURE 3.7.3.2

A SUMMARY OF THE ANTICIPATED INTERNATIONAL GROWTH OF FUNCTIONAL PROCESSING MODES

FUNCTIONAL PROCESSING MODE (1)	ANTICIPATED ANNUAL GROWTH (2) NIL TO 9%	10% TO 19%	20% TO 29%	30% TO 39%	NO RESPONSE	TOTAL PERCENT (3)	TOTAL n
Software (4)	4	9	17	26	44	100%	(400)
Storage	11	12	10	10	57	100%	(400)
Transmission	11	15	10	10	54	100%	(400)
Processing	10	14	11	9	56	100%	(400)
Switching	12	14	8	8	58	100%	(400)
Input	12	15	9	7	57	100%	(400)
Output	12	14	10	6	58	100%	(400)

1) From Question E-2.
2) The average of replies to the three classes of transmission for each of the six processing modes.
3) May not sum exactly due to rounding.
4) We use software as a comparative benchmark.

This aggregation underscores the overriding importance of software. Almost one in two (44 percent) see it growing by 30 percent or more per year. Eight to 10 percent see storage, transmission, processing, and switching growing by 30 percent or more. Six and 7 percent see output and input growing at this rate.

Overall, these patterns reiterate the exceptionally rapid growth which respondents anticipate for software. Conversely, they substantiate that input/output technologies will experience the least growth. Storage, transmission, processing, and switching will fall in between.

Figure 3.7.3.3 again reaggregates the same information, this time to measure average growth respondents anticipate for each class of transmission -- data, video, and voice. The replies are unequivocal. Respondents hold that data communications will experience twice the growth rate of either video or voice. On average, 15 percent see data growing at 30 percent or more per year compared to 5 percent, respectively, who hold that video or voice will do so.

In sum, the major communications growth areas will centre on the general classes of software and data applications.

FIGURE 3.7.3.3

A SUMMARY OF THE ANTICIPATED INTERNATIONAL MARKET GROWTH IN DATA, VOICE, AND VIDEO TRANSMISSIONS

CLASS OF TRANSMISSION	ANTICIPATED ANNUAL GROWTH(2) NIL TO 9%	10% TO 19%	20% TO 29%	30% TO 39%	NO RESPONSE	TOTAL PERCENT	TOTAL n
Software(3)	4	9	17	26	44	100%	(400)
Data	7	15	14	15	50	100%	(400)
Video	12	14	8	5	61	100%	(400)
Voice	15	14	13	5	59	100%	(400)

1) From Question E-2.
2) The average of replies to the six functional processing modes for each of the three classes of transmission.
3) We use software as a comparative benchmark.

The Implications for Government Policy

To review the findings of this section, respondents have clearly identified a number of general high growth technologies.

First and foremost will be software applications. Respondents see these as growing at twice the rate of other general areas.

Second, with the three major categories of data, video and voice, data will experience close to twice the growth rate of either video or voice.

Third, functional (processing modes), storage, transmission, processing, and switching technologies will experience greater growth; input and output technologies will experience the least.

These patterns suggest the following considerations for Government policy.

First, given the critical position of software, the Government should evaluate a policy commitment toward enhancing Canada's computer science and software literacy. Such a policy might envision the following:

-- educational subvention to attract students of computer science into public school teaching,

-- for schools who retain qualified computer science teachers, grants to purchase computer equipment for instructional purposes,

-- university scholarships to attract top highschool students into undergraduate computer engineering programs,

-- university fellowships to attract top university graduates into graduate level computer engineering programs,

-- tax credits to companies to encourage the enrollment of personnel in graduate level computer engineering and software courses,

-- tax credits and/or subventions to companies and universities to encourage executive-faculty exchange programs in the computer sciences and engineering and,

-- establishment of a Crown commission to study the question of Canadian computer literacy and the additional steps the Government can take to increase that literacy.

All of the suggestions above are premised on the assumption that as part of a policy to stimulate Canada's position in the world market for telecommunications and information systems, the Government would be willing to consider investment in Canada's human capital as well as her industrial capital.

Second, the Government should consider developing a strategy based on a better understanding of the human functions that technology will emulate, organizational structures technology must integrate into and the hardware advances that new products and services can take advantage of.

3.7.4 Identifying the Technologies with Which Canada Can Favourably Compete in the World Market

The preceeding section identifies the general areas of communications and information systems technologies which will experience the greatest future growth.

First and foremost is software. This area is unique from others in two aspects. On the one hand, respondents anticipate that it will grow up to twice as fast as any other technology area. Second, Government intervention to stimulate Canada's software capability would require investment in Canada's human capital as distinct from her industrial base.

Following software in importance are the more traditional groupings of high technology hardware. The more important include storage, transmission, processing and switching, especially as they relate to data.

<u>Identifying Specific High Growth Technologies</u>

In this section the focus is shifted from general classes of applications to explicit system and subsystem technologies. The selection of the high impact technologies to be investigated further was based primarily on the analysis of the Research & Development and the Technology Growth Trends (Sections D and E) of the questionnaire results.

Section D - Research and Development

This analysis is primarily based on the extent to which respondent companies devote resources to their research and development effort in each technology area.

Two approaches were followed in analysing the data. In the first approach, responses were sorted based on a weighted average of the percentage of respondents involved in each area and the degree of involvement. The weighting chosen was 80% for the areas designated as much R&D involvement and 20% in areas of some involvement. Other weightings were also reviewed but showed no significant deviations from the results obtained based on an 80%/20% weighting.

From Table 3.7.4.1 it appears that the following technologies or areas receive the most R&D funding:

Systems - office automation
Local area networks
Systems - electronic mail
Signal processing
CAD/CAE/CAM
Switches - digital
Expert Systems
Networks - controlled access

Table 3.7.4.1
R&D Involvement in Selected Technology Areas

Area (1)	Much %	Some %	None %	Total %	Weighted
Systems - office automation	20	18	62	100	19.6
Networks - local area	10	18	72	100	11.6
Systems - electronic mail	6	19	75	100	8.6
Signal Processing	7	10	83	100	7.6
CAD/CAE/CAM	6	14	80	100	7.6
Switches - digital	7	8	85	100	7.2
Expert Systems	5	14	81	100	6.8
Networks - controlled access	6	8	86	100	6.4
Networks - satellite ground	5	6	89	100	5.2
Error Correction	4	10	86	100	5.2
Software	6	1	93	100	5.0
Videotex	4	8	88	100	4.8
Switches - integ. voice/data	4	8	88	100	4.8
Image Processing	4	8	88	100	4.8
Systems - automatic location	4	6	90	100	4.4
Other	5	1	94	100	4.2
Narrow Band Modulation	3	8	89	100	4.0
Encryption	2	10	88	100	3.6
Voice Recognition	2	10	88	100	3.6
Robotics	2	7	91	100	3.0
Networks - fibre optic	2	7	91	100	3.0
Systems - intelligent bldgs	2	7	91	100	3.0
Teletext	2	6	92	100	2.8
Switches - integ. v/d/v	2	6	92	100	2.8
High Resolution TV	2	3	95	100	2.2
Networks - satellite space	2	3	95	100	2.2
Language Translation	1	6	93	100	2.0
Radio	2	1	97	100	1.8
Visual Recognition	1	5	94	100	1.8
System - Alarm & Control	2	0	98	100	1.6
Image Processing	2	0	98	100	1.6
Networks - laser beam/optica	1	4	95	100	1.6
Teletex	1	4	95	100	1.6
Switches - optical	1	4	95	100	1.6
Computer Hardware	1	0	99	100	0.8
System - Storage & Retrieval	1	0	99	100	0.8
Slow-scan TV	0	3	97	100	0.6
Components	0	1	99	100	0.2
Total n (400)					

1) From Question D-5

The results of Table 3.7.4.1 were then compared to the revenue dollars allocated to Research and Development in each particular area. The assumptions used to derive the R&D contribution were as follows:

1) Total R&D expenditure based on the percentage of company revenue allocated to R&D.
2) Revenue allocations for R&D were divided between the areas listed as "much" and "some" on an 80%/20% basis. Where a respondent listed more than one area as "much" or "some", the total revenue allocated was divided equally between all areas indicated.

Table 3.7.4.2 lists the technologies and areas in order of the amount of R&D dollars spent and the number of companies involved in each area.

Table 3.7.4.2
R&D Funding in Selected Technology Areas

Area (1)	Much $ (mil)	Some $ (mil)	Total$ (mil)	# Co Much	# Co Some
Systems - office automation	16.5	2.2	18.7	80	72
CAD/CAE/CAM	13.2	2	15.2	24	56
Networks - satellite ground	11.5	1.6	13.1	20	24
Signal Processing	10.8	1.8	12.6	28	40
High Resolution TV	10.3	1	11.3	8	12
Networks - local area	7.8	2.8	10.6	40	72
Videotex	8.6	1.1	9.7	16	32
Systems - electronic mail	5	4.3	9.3	24	76
Voice Recognition	7	2.2	9.2	8	40
Switches - digital	7.2	2	9.2	28	32
Networks - controlled access	6.5	2.4	8.9	24	32
Switches - integ. voice/data	7.1	1.4	8.5	16	32
Error Correction	7.8	0.6	8.4	16	40
Encryption	6.5	1.8	8.3	8	40
Switches - integ. v/d/v	5.6	0.7	6.3	8	24
Narrow Band Modulation	5.3	0.3	5.6	12	32
Systems - automatic location	4.7	0.6	5.3	16	24
Language Translation	4.4	0.8	5.2	4	24
Image Processing	3.4	1.5	4.9	16	32
Networks - fibre optic	0.9	3.9	4.8	8	28
Expert Systems	0.7	3.4	4.1	20	56
Networks - satellite space	3.7	0.2	3.9	8	12
Teletex	1.1	2	3.1	4	16
Systems - intelligent bldgs	0.6	2	2.6	8	28
Networks - laser beam/optica	0.2	2.1	2.3	4	16
Robotics	0.5	1.6	2.1	8	28
Teletext	0.5	1.5	2	8	24
Switches - optical	0.2	1	1.2	4	16
Visual Recognition	0.4	0.7	1.1	4	20
Slow-scan TV	0.01	0.2	0.21	0	12
Other	27.6	1.2	28.8	20	4
Total n (400)					

1)From Question D-5

The category "other" which appears at the bottom of the list was further investigated and found to include several technologies or areas, none of which stood out individually. These specific areas are identified individually in Table 3.7.4.1.

The major differences between these two tables 3.7.4.1 and 3.7.4.2 are, expert systems, which receives minimal R&D funding and:

Networks - satellite ground
High definition TV (HDTV)
Videotex

which receive a relatively high proportion of R&D funding.

Section E - High Growth Areas

Respondents provided their opinion on the relative growth expected internationally in specific areas and technologies. The results were analyzed based on the opinions of all respondents and the opinions of experts only.

The results are summarized in Table 3.7.4.3 based on expert only opinion. Classifications are based on the highest opinion category. The highest growth areas include:

Data integrity/security
CO switch - digital
Data security
PBX - digital
Signal processing
Remote sensors/alarms
Integrated voice/data/video switch

Comparison of expert opinions to the opinion of all respondents were essentially the same with the exceptions of CO switch - fibre optic and digital monitors and displays, which also appeared quite high on the list.

Table 3.7.4.3

Annual Growth of Selected Technologies

Technology (1)	nil to 9%	10% to 19%	20% to 29%	30% or more	No Resp	Total %
Expert Opinions						
Data Integrity	0	0	4	4	91	99
CO Switch - Digital	1	2	2	3	92	100
Data Security	0	1	2	3	94	100
PBX - Digital	0	2	2	3	91	98
Signal Processing	0	2	2	2	94	100
Remote Sensors/Alarms	0	2	2	2	94	100
Switch - Integ v/d/v	0	1	2	2	94	99
CO Switch - Fibre Optic	0	0	1	2	96	99
Digital Monitors/Displa	0	2	1	1	96	100
Optical Character Reade	0	0	0	1	98	99
PBX - Fibre Optic	0	0	0	1	98	99
Videodiscs	0	0	0	1	98	99
Other	0	0	0	1	98	99
PBX - Analogue	2	2	0	0	95	99
Picturephone	0	0	0	0	99	99
CO Switch - Analogue	2	1	0	0	95	98
Photocopiers	0	0	0	0	99	99
Total n (400)						

1) From Question E-3

System/Subsystem Technology Selection

Specific technologies and areas of high potential growth were selected based on their expected growth internationally and the level of R&D expenditure by Canadian companies. From the R&D results, it is clear that there is a great deal of expenditure devoted to research at the system or application level. The following systems or applications stand out as potential high growth areas:

- Office Automation
- Local Area Networks
- Satellite Ground Networks
- Videotex
- CAD/CAE/CAM
- High Resolution Television
- Expert Systems
- Electronic Mail
- Wide Area Data Networks

In rationalizing the survey results, we decided not to include remote sensors/alarms because of the minimal R&D expenditure in this area and the fact that it is an established technology. We also decided that expert systems should be included despite the low R&D expenditure because this technology is still in its infancy and is expected to have significant potential in the longer term. Electronic Mail was also included because of its association and probable inclusion in office automation and LAN technologies.

Within these systems, there are specific subsystems which also have a high growth potential. They include:

- integrated digital switches
- software
- signal processing
- controlled network access
- data encryption
- transmission media - fibre optics

Further sections deal with each of these areas individually.

Tied to the findings of the previous sections, these patterns point to a favourable world market potential for a full range of Canadian designed and manufactured fibre optic and digital communications switches, especially ones configured to handle data transmissions. This market offers especially high promise in light of the virtual complete conversion of all existent wireline telephone switches from analogue to digital within the next generation.

The Further Implications For Government Policy

The conclusions of the preceeding section suggest that Canada's advantage in the world trade for communications and information systems likely will revolve around a more limited range of innovative product lines rather than a wider range of general equipment.

The identification of these High Impact Telecommunication and Information technologies would suggest that further in-depth studies would be called for to determine the most effective ways to provide Government support. The detailed in-depth studies should concentrate on how to enhance Canadian products and services national and international market share for each of these technologies. In addition to on-going dialogue associated with supplier/customer relations and associated with Government use of these technologies, a special on-going interaction is needed between Government technologies assessment and policy makers and the individual Canadian industry groups. Specific recommendations in this regard are provided in section 6 of the report.

3.8 The Role of Government Incentives in Stimulating High Impact Technologies

The role of the Government may foster or retard the development of high impact technologies by Canadian firms. Further, it can promote the market's development, affect the market development timing, or even alter the shape of the market. Policies that promote subsidies, grants, tax incentives, trade barriers, regulations or any of the other numerous possibilities available to Government must be carefully considered in light of their potential impact as outlined above. We have reported that Government policies and tax incentives in the past have been viewed as somewhat ineffective by the companies included in the survey. In this section we focus on specific policies and programs that may be beneficial in stimulating high impact technologies and that have gained the endorsement of the respondents.

3.8.1 The Importance Attributed to Government Incentives

The importance attributed to past and future government trade incentives is illustrated in Figure 3.8.1.1. As noted earlier, such incentives have not been considered important in the past as relected by the 61% of respondents who attribute little or no significance to them. Of greater interest is the shift in perceived importance that government incentives could have on future capabilities to compete in foreign markets. Of the companies surveyed 58% consider future government incentives as extremely or very important.

FIGURE 3.8.1.1
THE GENERAL IMPORTANCE OF GOVERNMENT
TRADE INCENTIVES

IMPORTANCE	PRESENT(1)	FUTURE(2)
Extremely important	22	31
Very important	18	26
	40	58
Somewhat important	22	17
Not at all important(3)	39	26
	61	43
Total percent(4)	100	100
Total n	(400)	(400)

1)From Question F-1: "Overall, how important do you consider current government assistance, programs, and policies in contributing to your company's present ability to compete in foreign markets?

2)From Question F-2: "How important do you believe revised and expanded government assistance, programs and policies could be in contributing to your company's future ability to compete in foreign markets?"

3)Including d.k., n.a.

4)May not sum exactly due to rounding.

3.8.2 The Characterisitics of Companies Favouring Government Incentives

The most important test of the effectiveness of government incentives is their endorsement by the companies who are supposed to benefit from them. In this section we review the characteristics of the companies who have indicated their need for government incentives and in a later section focus on the specific views of exporters who have the greatest potential of growth within the telecommunications and informations systems industries.

The Effect of Company Size

All companies, despite size, feel government incentives are important. However, a larger percentage of small and medium sized companies (65%) indicated a more pressing need, compared to larger sized companies. It is understandable that small and medium sized companies would benefit the most from incentives that promote foreign trade. Large firms may be relatively more self-sufficient and rely less on government intervention as compared to the others.

The Effect of Type of Business

Of the types of business surveyed, Manufacturing feel government incentives are the most important, with 81% citing incentives as extremely or very important. Service organizations are next with 70% citing the importance of incentives. Distribution organizations attribute the least significance to incentives with less than half (44%) citing them as important. This we attribute to the R&D committments of these companies and to the higher degree of export trade undertaken by the first two categories.

The Effect of Marketing Efforts

As marketing efforts increase there is a slight increase in the perceived importance of government incentives. For those investing less than 5% of revenue in marketing, 62% feel incentives are important. For those investing 5 to 14% in marketing, 65% feel incentives are important and for those investing 15% or more, 74% acknowledge incentives as important. However, there is a marked difference in those that feel incentives are extremely important as indicated by 48% of the companies investing 15% or more revenue to marketing. In comparison, 34% of those companies investing 5 to 14% acknowledged an extreme importance and only 31% of those companies investing less than 5% acknowledged the same. As reported in earlier sections, companies that export products and services invest relatively more in marketing than other companies and it is this effect that is being reported.

The Effect of Company Growth

As expected, those that anticipate the highest growth see the greatest need for government incentives. Of the highest growth companies (16% or more per annum), 74% feel incentives are important. In comparison, 56% of the medium growth companies (6 to 15% per annum) feel incentives are important and only 33% of the companies with growth rates of 5% or less feel government incentives are important.

Summary

The companies that are in need of effective government incentives are those identified in previous sections as providing the greatest potential for Canadian economic growth. These companies are medium to large sized, engaged in some form of export and primarily belonging to the manufacturing sector.

3.8.3 The View of Current Exporters on Government Incentives

Since the government incentives being reviewed focus specifically on stimulating high impact technologies through export, we have isolated the responses of the export companies and compare their input to that discussed above.

<u>The Effect of Export Activities</u>

Figure 3.8.3.1 reports the opinions of exporters regarding government incentives. It is evident that their opinions have added significant weight to the overall opinions discussed above. Seventy-five percent of all export companies feel government incentives are important to their companies activities.

FIGURE 3.8.3.1

EXPORT ACTIVITIES AND THE IMPORTANCE OF FUTURE GOVERNMENT INCENTIVES

EXPORT COUNTRIES (1)	IMPORTANCE OF FUTURE GOVERNMENT INCENTIVES (2)				
	Extremely Important	Very Important	Somewhat Important	Not at All Important	Total (3) Percent
U.S.	44	32	11	13	100
Other	49	25	20	5	100
No Export Activity	17	22	20	41	100
Total n (400)					

1) From Question C-2: "Does your company sell it's products..."

2) From Question F-2: "How important do you believe..."

3) May not sum exactly due to rounding.

The Effect of Company Size

As was found from the opinions of all respondents, size itself is not a major factor in determining the importance of government incentives.

The Effect of Type of Business

Of the export companies surveyed, 86% of the Manufacturing companies feel government incentives are important compared to 77% of the Service companies and 65% of the Distribution Service companies.

The Effect of Marketing Effort

We have already noted the importance of government incentives to marketing efforts of exporters in particular. Of significance is the response of exporters who invest 15% or more in marketing. Of these companies, 65% feel government incentives are **extremely** important.

The Effect of Company Growth

Company growth has a significant influence on the views of export companies regarding the importance of government incentives. Almost all (85%) of the highest growth companies feel incentives are important, compared to 67% of the companies anticipating moderate growth and 50% of the companies projecting low growth.

Summary

Government incentive programs and policies must be aimed at promoting export and at assisting export companies in achieving their potential within the international marketplace.

3.8.4 Evaluation of Alternative Incentive Programs

Respondents were provided a list of specific government trade incentives and were asked to comment on their relative level of importance. Figure 3.8.4.1 summarizes the results. Of the specific incentives listed those ranking highest include:

- tax credits for product R&D
- tax credits for capital investment
- tax credits for foreign market development
- skilled work force
- tax credits for venture capital investment

Of interest is the lack of importance attributed to creating an ongoing industry/government forum. It is our opinion that properly implemented, such a forum could be extremely beneficial to both government and industry. We feel that industry would support such a forum if presented in a more detailed manner than was done in the survey questionnaire.

FIGURE 3.8.4.1

THE IMPORTANCE ATTRIBUTED TO SPECIFIC GOVERNMENT TRADE INCENTIVES

The Nature of Incentive (1)	LEVEL OF IMPORTANCE Extremely Important	Very Important	Somewhat Important	Not at All Important (2)	Total (3) Percent	Total n
Tax credits for product R&D	43	22	6	29	100	(400)
Tax credits for capital investment	36	22	16	27	100	(400)
Tax credits for foreign market development	27	25	15	33	100	(400)
Skilled Work Force	22	28	12	38	100	(400)
Tax credits for venture capital investment	23	19	19	39	100	(400)
Low Interest Loans	25	14	8	53	100	(400)
Tax credits for pure research	22	14	18	46	100	(400)
Tax credits for foreign advertising	20	19	20	41	100	(400)
Patent protection of product innovations	18	17	19	45	100	(400)
Assisting finance of export inventories	17	17	18	47	100	(400)
Supporting Canadian interests regarding standards	14	22	22	42	100	(400)
Coordinating univ/govt. R&D with Canadian companies	12	17	27	45	100	(400)
Manufacturing automation	11	20	20	49	100	(400)
Promoting compatible standards with export markets	10	21	25	43	100	(400)
Facilitating formation of export consortia	9	12	27	48	100	(400)
Providing seminars on export markets	6	17	29	48	100	(400)
Creating an ongoing industry/government forum	6	22	26	45	100	(400)

1) From Question F-4: "Listed below are several possible incentives which government could consider for stimulating Canadian exports. How important would each be for your own company's ability to become more competitive in foreign markets?"

2) Including d.k., n.a.

3) May not add to exactly 100 due to rounding.

Comments provided concerning the industries outlook on Government incentives is summarized in Table 3.8.4.2. The comments are generally concentrated in the following main areas:

- Support the Canadian small business sector
- Support of R&D - more tax incentives less grants
- Support to exporting companies - more tax incentives less grants
- Improve program availability - "one-stop shopping"
- Improve information exchange between Government/industry
- Increase Government purchasing of Canadian products and services
- Increase Government support in vocation and training of qualified professional resources
- Create incentives to keep Canadian talents in Canadian industries
- Reduce regulation and monopolies - promote competition

It is interesting to note that of all existing Federal programs the greatest interest was in C.C.C.'s programs and EDC's PEMD (Program for Export Market). Table 3.8.4.3 provides a summary of programs (1982) most applicable to the Telecommunications and Information industries.

The point made by many respondents of "one-stop shopping" is well taken when analyzing the complexity of the various Federal and Provincial programs.

The analysis of comments received through the survey and individual interviews is included in our recommendations (Section 6.0 of the report.)

GOVERNMENT ALTERNATIVE INCENTIVES PROGRAMS

Table 3.8.4.2

New Initiatives, Programs, Policies:

- Government purchasing power to be directed to smaller, innovative Canadian companies.
- Incentives for Canadians to invest in Canadian companies - Tax credits.
- Reduce Tax from export sales.
- Reduce F.S.T. on imported components used in production of finished exported goods.
- Increase E.D.C. activities and expand P.E.M.D. and P.P.P. programs.
- Various agencies and Government programs such as: PEMD, CIDA should collaborate and advise on upcoming opportunities - improved communications.
- Creation of satellite based trade missions. Government Information Centre to be linked via satellite to all Embassies for on line exchange: Canadian capabilities update, new opportunities for Canadian sales.
- Creation of a one-stop shopping for Govt. Asst. in the area of high tech. Too many seemingly uncoordinated provincial and federal programs a deterant for applications.
- Any incentive must be measured in terms of returns to the economy - better evaluation and follow up of Government assistance to ensure channelling of funds to appropriate projects.
- Clearing house for technical resources. A program to help companies find suitable technical personnel.
- R&D incentives in form of tax credit. Interest free loans, grants or any other form of assistance should be selective to high impact technologies.

Problems and Possible Solutions

- Remove trade barriers on high tech products. Specifically on components to be used in exported finished goods.
- Software copyright laws. Industry is hurting though piracy.
- Reduce red tape in certification process CSA, DOC, UL, etc.
- Organize standards for MODEMS - Data network.
- Need support in bidding process for 3rd world projects.
- Government grants must be selective. No need to develop products which are protected by high import duties. Support should be focused on innovation that can be sold world over.
- Promote joint venture for product/service development - common Canadian front in seeking international contracts.
- Monopoly in telecommunication carrier services is stifling industry growth, and maintaining a much higher service cost. **Allow competition and disallow cross subsidy** by monopolies - Telecom Canada affiliates in Data and computer services are cross subsidized by monopoly telephone services.
- Export start-up guidelines and assistance - too many smaller companies don't take export initiative due to lack of experience.
- Reduce Government assistance to low productivity companies.
- Less regulation in telecommunications, promote competition.
- Provide help for small companies in their dealings with commercial banks.

Low Interest Loans For:

- R&D.
- Market development.
- Financing foreign contracts working capital on long term foreign projects.
- Purchasing - test equipment, lab upgrading, manufacturing automation CAD/CAM - expert - Robotics.
- Canadian foreign aid in form of financing 3rd world telecommunication & information projects.
- Marketing costs and advertising of Canadian products domestically and abroad.
- Innovative start up companies in high impact technologies.
- Lower interest loans from EDC for export similar to Japanese and European programs.
- Software development special applications.
- Business expansion - primarily in export activities.
- Hiring technical staff.

New Initiatives, Programs, Policies:

- New programs for two major high impact areas: 1) Software Development
  2) System Integration - Turnkey Contracts.

- New programs to allow access to Govt. data bases on domestic and international opportunities. Each eligible company could be linked via a data network to Govt. data base.

- Financial support for new products (if proven to have export potential) including:
  - R&D costs
  - Market introduction cost
  - CSA, DOC - standard certification

  to be refunded following successful market penetration.

- Provide export programs similar to assistance provided by foreign countries to competitors (Japan, U.S., Germany, France).

- Additional programs to assist high impact industries in hiring competent professionals.

- Keep technical talent in Canada!

- Improve facilities and support for Canadian sales personnel abroad. Provide a home away from home with logistic support from trade commissions and Canadian Embassies.

- Provide longer term financial support packages for R&D. With changes in year to year budget allocations no long term R&D planning is possible.

- New program to replace S.R.T.C. to stimulate Canadian investment in Canadian R&D.

Problems and Possible Solutions

- Improve lack of coordination between levels of Govt. Provide greater direction for cohesive Canada strategies to keep Canadian talents in Canada, and improve success rate in international contracts.

- Reduce Government in-house development. Contract out to Canadian small companies where possible.

- Reduce new tariff trade barriers. Provision for importing technologies without restriction where it can be integrated to a Canadian value added product or service.

- Clarification, and simplification on export licencing requirements for each country.

- Resolve difficulties with fragmented regulation of telecommunication services (Federal/Provincial) overlap of jurisdiction.

- Prepayment of F.S.T. makes it expensive to maintain unsold inventory. By reducing inventory to minimum, competitive edge is removed in short turn around contracts.

- Existing fiscal policy virtually precludes financial support for products under development. Industry committee should examine off-shore purchases to ensure comparable support.

- Reduce or eliminate duty on computer and software products. Industry requires computer products to develop high impact technologies, trade barriers slow automation, Canada's domestic hardware can't compete with imported equipment.

- Creation of an on going Industry Government forum for improved cooperation.

Low Interest Loans For:

- Prototype development.

- Capital equipment, initial cost of development.

- Establishment of foreign sale offices and/or assembly & packaging of Canadian exports on location.

New Initiatives, Programs, Policies:

- New programs for two major high impact areas: 1) Software Development
  2) System Integration - Turnkey Contracts.

- New programs to allow access to Govt. data bases on domestic and international opportunities. Each eligible company could be linked via a data network to Govt. data base.

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- **Keep technical talent in Canada!**

- Improve facilities and support for Canadian sales personnel abroad. Provide a home away from home with logistic support from trade commissions and Canadian Embassies.

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- Creation of an on going Industry Government forum for improved cooperation.

Low Interest Loans For:

- Prototype development.

- Capital equipment, initial cost of development.

- Establishment of foreign sale offices and/or assembly & packaging of Canadian exports on location.

New Initiatives, Programs, Policies

- Initiate program to improve confidence in Canada and world-wide in Canadian innovative R&D and Telecom & Info technologies total system capabilities.
- Initiate new programs to improve consultative process between Government, Industry and major users.
- Initiate new programs to reduce custom barriers and reduce Canadian industries migration into the U.S.
- Initiate Government catalog to promote and indicate to potential foreign buyer that Canadian products are used by the Government thereby building up confidence in Canadian products and services.
- Devise plan to develop Canadian unity in sectors of international Telecommunications and Information markets.
- More functioning for P.E.M.D. programs.
- Greater cooperation with NASA and ESA. Canadian space industry is excluded in many areas from export due to lack of agreements with these agencies.
- Formation of special agency to provide assistance to technical companies for a limited period during critical start-up phase.
- Programs to enable new companies to benefit from financial support based on merits of plans & management capabilities.
- Initiate a task force to review industries position in relation to free trade talks with the U.S.
- Similarly to Government policy's to increase purchasing of Canada products, regulated Monopolies should be regulated to buy Canadian products & services.

Problems and Possible Solutions

- Faster support for manufacture overseas where foreign conditions require local production. Spin-offs for Canadians substantial.
- Existing Government support program involve too much monitoring, red tape and paper work. Government judgment in technical matters is poor. Increase confidence by better communications and facilitate easier monitoring and management logistics.
- Canadian education is out of synch with industry needs. Need greater cooperation between Government, Industry and Educational institutions.
- Remove restriction of foreign investments in Canada. Greater incentives for investment below 50% control.
- Tax credit for R&D, capital investment and other segments of high impact industries is beneficial for established companies with proven track records. Tax credits could not help the start-up companies. Special programs for selective start-up high impact technologies is required.
- Much needed legislation to correct problem of unfair monopolistic competition in market place. Such legislation has existed in the U.S. for many years resulting in the health and growth of small businesses.
- Better "customer relations" dept. at DOC to facilitate obtaining information by companies wishing to develop new products.
- Government buying policy favours large U.S. companies; change policies to allow Canadian companies to compete on equal footing. Improve confidence in Canadian capabilities.
- In the mix of R&D done in Canada, the portion done in industry in comparison to Government labs & universities should be increased. Flow of workforce should be to industry not to Government or universities.

Low Interest Loans For:

- Product compatability engineering for adaptation for export market.
- Third world country purchases. Foreign aid in Canadian products and service rather than cash.
- Training and vocation.

New Initiatives, Programs, Policies:

Initiate a program to help exporting companies to finance bid and performance bonds.

- Initiate programs for introducing new technologies to the market place. Making new technologies practical and understandable by users in Canada and abroad. Education of the user.

Problems and Possible Solutions

- DSS 1036 terms/conditions re Government ownership of patents/technology is a deterent to Canadian defence industry.
- Local Canadian regulations make it difficult for small Co.'s to sell in Canada, i.e. Ontario Hydro standards, CSA standards, DOC standards, etc. More stringent in comparison to U.S., Europe and Far East.
- Closer scrutiny by the CRTC of the regulated carrier practices relative to the interconnect industry is required. Regulation should be changed to faster competition.
- Remove time limits on using funds. Make funding a given amount available without time limits.
- Dollar pegged to U.S. dollar does not permit competition in foreign markets when currency is allowed to fluctuate based on countries economic merits.
- Eliminate competition from within the Government. Provide private sector the opportunity to meet all Government needs.

FEDERAL PROGRAMS
Table 3.8.4.3

ADMINISTRATOR/ NAME OF PROGRAM	OBJECTIVE	ELIGIBILITY	TYPE OF ASSISTANCE
Research and Development -Industrial Research Assistance Program			
IRAP-C: Field Advisory Service	To improve effectiveness of managerial functions and production operations.	Firms and other organizations located in Canada.	Guidance provided on industrial engineering methods and techniques.
IRAP-F: Technical Information Service	To assist in solving of technical problems.	Firms and other organizations located in Canada.	Assistance in solving technical problems, answering of technical enquiries.
IRAP-H: Contributions to Firms Employing Undergraduates	To assist small firms to hire undergraduates to solve specific problems related to areas of production or product designs, quality control and production layouts.	Small manufacturing firms.	Contributions towards salaries of science, engineering, or technical students.
IRAP-L: Contributions to Laboratory Investigations	To assist small industries to contract problem solving investigations with appropriate research laboratories, institutes or consulting services.	Industries with less than 200 employees.	Contributions for up to 75% (maximum $6,000) of the contract.
IRAP-M: Contributions to Small Projects	To encourage small companies to solve specific technical problems by use of external R&D facilities.	Manufacturing companies employing up to 200 persons.	Contributions up to $30,000 to cover salaries of professionals and technicians working on approved projects.
IRAP-P: Contributions to Large Projects	To increase calibre and scope of industrial research in Canada.	Companies engaged in activities based on technology derived from physical and life sciences and engineering.	Contributions (with no regulated maximums) cover salaries of scientists, engineers, technicians and consultants.
-Program for Industry/ Laboratory Projects (PILP)	To assist in the application of research results from NRC laboratories to situations where there are important Canadian industrial opportunities.	Canadian companies with appropriate financial managerial, technical, manufacturing and marketing capabilities.	Funding by NRC of approved projects in whole or in part.

Source: Government Financial Assistance Programs in Canada J. Peter Johnson, C.A. Price (Price Waterhouse)

ADMINISTRATOR/ NAME OF PROGRAM	OBJECTIVE	ELIGIBILITY	TYPE OF ASSISTANCE
Research and Development Continued-			
Department of Supply and Services			
-Contracting Out: Science and Technology	To obtain a more even balance between the in-house and industrial performance of the government's requirements.	Canadian organizations with appropriate research and development facilities.	Appropriate government department funds the project.
Department of Industry, Trade and Commerce			
-Industrial Research Institutes Program (IRIP)	To improve communications between universities and industry.	Associations or institutes specifically formed to meet objectives of program.	Grants to cover salary and administrative costs during initial 7 years.
-Centres of Advanced Technology (CAT)	To provide funds to universities and other organizations to establish research programs in specific technological areas of interest to industry.	Universities and organizations with research capabilities.	Grants to cover salary and administrative costs during initial 7 years.
-Industrial Research Associations	To allow associations to be formed to conduct R&D on problems related to a specific industrial sector.	Canadian industrial sectors.	Grants to cover a portion of operating costs during formation years.
Export			
Export Development Corp. (EDC)	To facilitate and expand Canadian export trade with the intention of creating employment in Canada.	Companies operating and paying taxes in Canada and whose goods have at least 60% Canadian content.	Export credits insurance; long-term loans to foreign buyers or guarantees; foreign investment guarantees; performance related insurance and guarantees.
Canadian Commercial Corp. (CCC)	To assist in the development of trade between Canada and other nations.	Canadian exporters of goods and services.	Provision of export facilitating services to Canadian companies e.g. the development of government-to-government contracts and assumption of role of prime contractor on capital projects.

ADMINISTRATOR/ NAME OF PROGRAM	OBJECTIVE	ELIGIBILITY	TYPE OF ASSISTANCE
Export Continued- Department of Industry, Trade and Commerce:			
-Program for Export Market Development (PEMD)	To develop and increase the export of Canadian goods and services by sharing with the business community the financial risks of entering new foreign markets.	Manufacturing and service companies located and operating in Canada, exporting products and services with significant Canadian content.	Financial assistance on a cost sharing basis for projects as follows: -Specific project bidding -Market identification -Participation in Trade Fairs -Incoming buyers -Formation of export consortia -Sustained export market development -Export markets for agriculture, fisheries and food products.
-Promotional Projects Program (PPP)	To promote Canadian manufacturing capabilities, services and products in the marketplaces of the world thereby increasing the knowledge of foreign buyers about Canadian products and capabilities.	Canadian companies with export capabilities.	Cost sharing for programs organized by ITC.
Manpower Training/Job Creation Canada Employment and Immigration Commission -Canada Manpower Training Program			
(a) Institutional Program	To provide courses whereby individuals may acquire skills to obtain steady, satisfying jobs.	Persons who are one year beyond school leaving age and have not attended school for one year.	Tuition fees and travel and living allowances for attendance at courses ranging from 1 to 52 weeks.
(b) Industrial Program	To help employers fill positions with skilled workers and retrain existing workers.	Qualifying workers employed by Canadian companies.	Training costs inclusive of tuition fees, travel and living costs and a portion of trainees' and instructors' wages.
-Critical Trade Skills Training	To encourage development of tradesmen in skilled occupations which experience chronic shortages.	Qualifying workers employed by Canadian companies undertaking training in selected highly skilled blue-collar trades.	Training costs inclusive of tuition fees, travel and living costs and a portion of trainees' and instructors' wages.

ADMINISTRATOR/ NAME OF PROGRAM	OBJECTIVE	ELIGIBILITY	TYPE OF ASSISTANCE
Manpower Training/Job Creation Continued-			
-New Technology Employment Program	To encourage employment of scientific and technical personnel.	Firms with fewer than 300 employees; persons with scientific and technical academic backgrounds.	Contributions towards salary for up to 12 months.
-Canada Manpower Mobility Program	To match people and jobs to the benefit of workers and employers.	Unemployed and under-employed workers willing to travel to communities where their skills are required.	Grants to cover travel and living costs incurred to investigate or relocate to employment as follows: -Exploratory assistance -Relocation assistance -Travel assistance to temporary employment -Travel assistance to seasonal agricultural work -Trainee travel assistance -Special travel assistance
-Industrial Research Fellowship Program	To encourage highly qualified scientists and engineers to seek industrial careers.	Canadian citizens and permanent residents with a doctorate in science and engineering.	Contributions up to $22,000 annually toward salary for a 3-year period.
-University Research Fellowship	To assist in maintaining an adequate level of research and development in Canadian universities.	Canadian citizens and permanent residents with a doctorate in science or engineering.	Contribution towards salary ($25,850 in 1982) for a three-year period, renewable for another 2 years.
Department of Industry, Trade and Commerce			
-Small Business Loans	To facilitate the availability of intermediate and short-term credit to small businesses.	Firms engaged in manufacturing, wholesale or retail trade, construction, service businesses, transportation and communications with annual sales under $1.5 million.	Loans from private lenders at prime plus 1% guaranteed by the federal government; maximum loan amount and term are $100,000 and 10 years respectively.
-Machinery Program	To increase efficiency throughout Canadian industry by enabling manufacturers to acquire equipment not obtainable from Canadian producers at the lowest cost possible.	Canadian companies importing goods classified under specified tariff items which are not available from production in Canada.	Remission of duty.

ADMINISTRATOR/ NAME OF PROGRAM	OBJECTIVE	ELIGIBILITY	TYPE OF ASSISTANCE
Department of Industry, Trade and Commerce-Continued			
-Enterprise Development Program (EDP)	To provide financial support to medium and small sized Canadian businesses involved in high risk and innovative projects, or adjustment projects designed to increase efficiency and competitiveness that can be expected to provide economic benefit to Canada.	Individuals partnerships and corporations undertaking high risk projects and/or projects which represent a significant financial burden.	Innovative assistance: shared costs for up to 75% on projects involving: -Proposal development -Identification of new projects -Product development and design -Project exploitation, i.e. market studies -Productivity enhancement -Special assistance for specified industries -Protective contributions -Pollution abatement -Microelectronics utilization incentives. Adjustment assistance: loans or loan guarantees to finance restructuring of operations.
-Microelectronics Support Program	To encourage application of microelectronics in industry.	Canadian manufacturers.	Contributions up to 75% (maximum $100,000) towards costs of feasibility studies and/or application of microelectronic devices.
Federal Business Development Bank (FBDB)	To assist in establishment and development of business enterprises in Canada by providing financial and management services.	Small Canadian business.	Financial assistance: loans, loan guarantees and equity financing. Management counselling. Management training. Information services.
Small Business Development Bonds	To reduce interest costs of qualifying small business corporations.	Determined by type of organization, debt obligation and use of funds.	Interest associated with debt considered as taxable dividend to lender and non-deductible to borrower.

4.0 Telecommunications and Information Systems - High Impact System Technologies

4.1 Office Automation

4.1.1 Technical Description

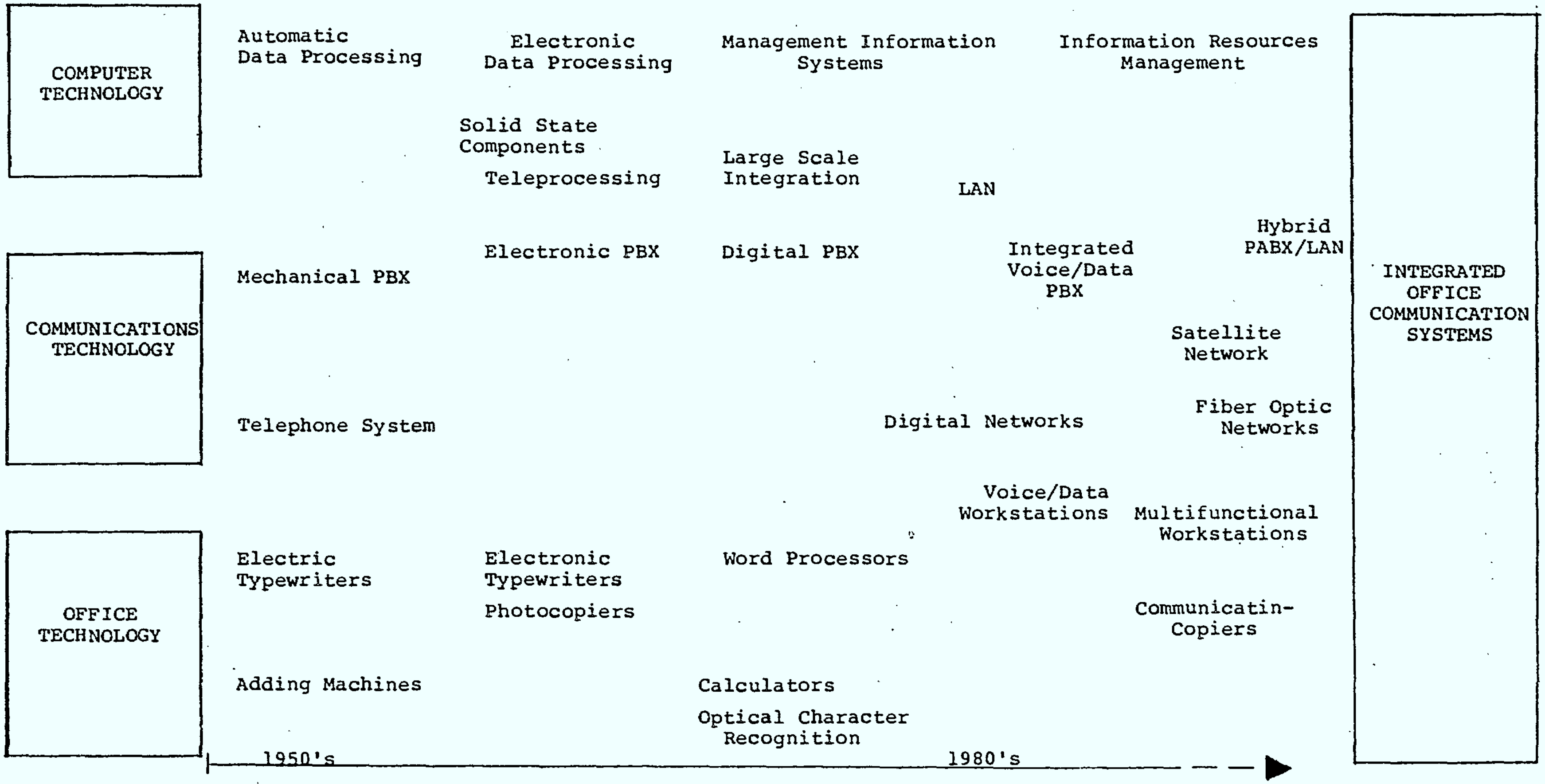
Office automation refers to an integrated office system and may be defined as a set of electronically connected components which integrate communications and information systems; allow distributed data processing, document generation, personal computing and decision support; and which satisfies the information access and processing needs of all office workers from executives to support staff. Figure 4.1.1 shows the evolution of office automation from three distinct areas: communications technology, office technology and computer technology, and identifies the various components which make up an integrated system.

The major components that an office automation system may include are:

a) LANs
b) Digital PBX's
c) Integrated Voice/Data PBX
d) Hybrid PABX/LAN
e) Voice/Data Workstations
f) Word Processors
g) Photocopiers
h) Networks - digital
  - fibre optic
  - satellite

Figure 4.1.1

MAJOR INNOVATION IN THE EVOLUTION OF INTEGRATED OFFICE COMMUNICATION SYSTEMS



Source: Technology Evaluation and Forecast,
Robertson Nickerson Ltd., March 1985.

Marketing Analysis

4.1.1 Demand Analysis

Factors of Change

Office costs continue to rise and while production has been steadily automated over time, the office environment has remained largely unaffected by changes in technology. This is because manufacturing productivity is more easily measured in terms of costs and resources compared to office productivity which deals with information flow, decision making and efficiency. However, the office environment is becoming more complex as a result of increased information flow. This has resulted in increased workloads and has made decision making a more difficult process.

Initial tools used to automate the office were directed at improving the efficiency of office support personnel, including secretaries, clerks, and assistants through equipment that generally performed a single function; word processing, communications, etc.

Now office automation is being directed at all levels within an organization, from top executives to middle managers to support staff. With the convergence of office equipment, computer and telecommunications technologies, the trend is towards an integrated office, where major office functions are incorporated into one system accessible from a single workstation.

Office automation promises many benefits, in particular, economic benefits will result from reduced data processing budgets and data communications costs; and increases in system capability, functionality and availability will result in improved productivity.

Areas of Major Growth

Areas of major growth include computer-based messaging systems (CBMS - electronic mail); portable intelligent terminals; voice, text, image and data storage; intelligent PBXs; smart LANs and integrated workstations. Companies that can provide fully integrated systems, incorporating all of the above and that can provide the associated service and support will attain the greatest growth. These companies will consist of the large multinationals involved in both the data processing and communications areas. Other companies will achieve growth by providing systems to smaller and medium sized companies in specific market segments, such as, small financial institutions, libraries etc. Still others will provide specific components for the office automation environment such as modems, multiplexers and application software.

Trends in office automation can be grouped into three development areas: multifunctional terminal systems, multifunctional switches and networks and multifunctional storage and processing systems. According to Arthur D. Little, "the decisive area for competitive position in the office automation industry will be the switches and networks area, not the terminal area." (1)

This view is supported by Stanley Jacobs, President of Stanley L. Jacobs Research Inc. of Montreal, who estimates that PCs accounted for about 63% of expenditures in office automation hardware in 1984, but by 1987 will only account for 30% of OA hardware expenditures. (2)

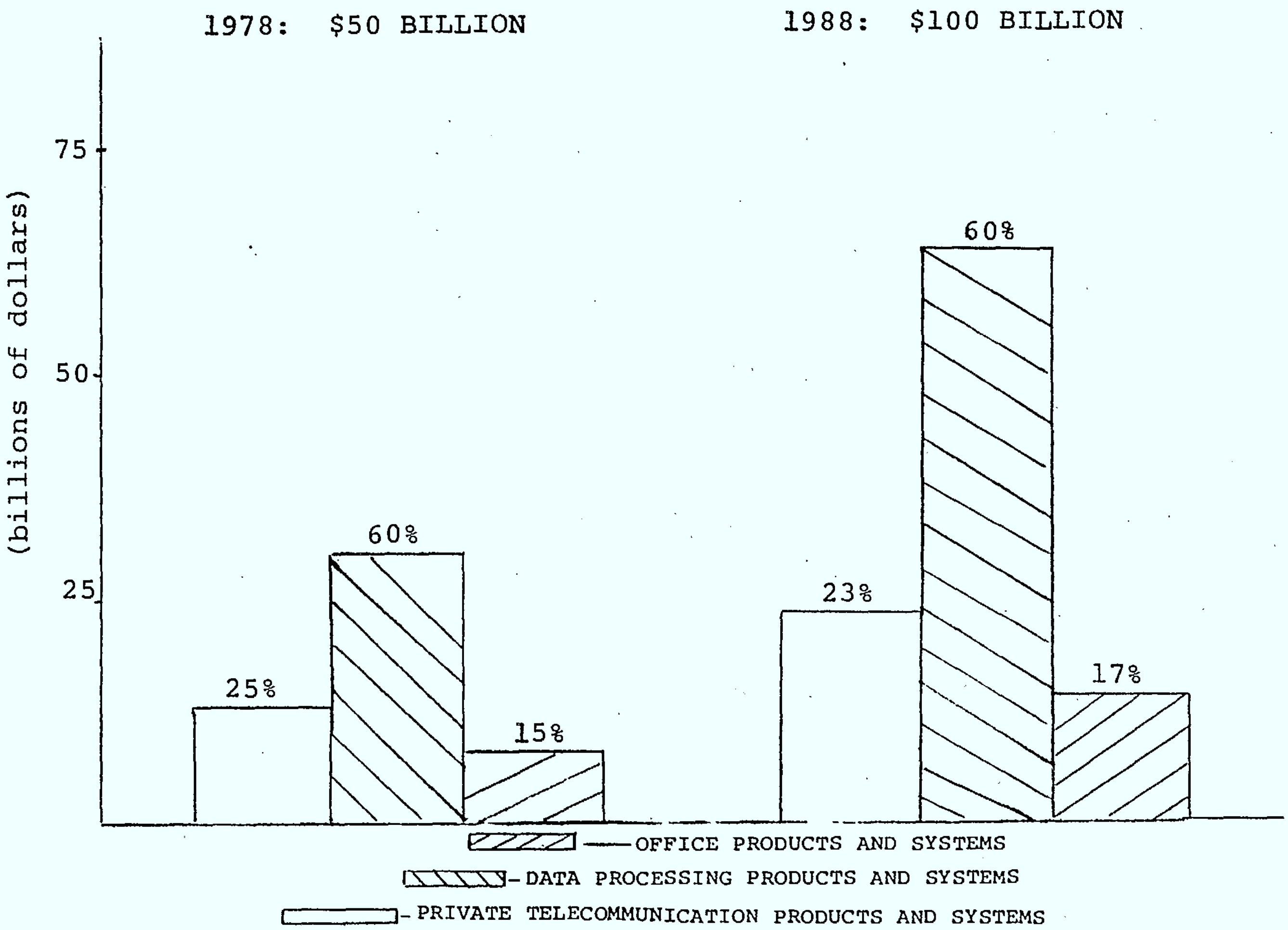
As noted, todays standalone office automation equipment will, in future, be incorporated with both LANs and electronic mail systems. While it is still relatively easy to examine these areas as separate entities, as has been done in this review, the boundaries between the three will become much less distinct in the future.

Growth Estimates

1) International Market

Figure 4.1.2 illustrates the 1978 and 1988 world market for private telecommunications, data processing and office products/systems. By 1988, the share of office products is expected to increase slightly to 17% of the total and account for $17 billion of the total 100 billion dollar market. The office products and systems included in this projection will be equipped with communications capabilities.

Figure 4.1.2 WORLD MARKET FOR PRIVATE TELECOMMUNICATIONS, DATA PROCESSING AND OFFICE PRODUCTS/SYSTEMS, 1978 and 1988



Source: Arthur D. Little, Inc.

More recent estimates by Quantum Science Corporation, suggest the world market for office automation products consisting of PC based, standalone and shared units will be close to $30 billion dollars by 1988 with the US accounting for $20 billion, Europe accounting for $9.5 billion and other countries making up the remainder.

According to Arthur D. Little Inc., the 1978 and 1988 market share of old and new products projects that by 1988, 45% of all product-system sales will consist of multifunctional products, representing the emerging office automation industry where processing, communications and office support capabilities are combined into multifunctional products and systems.

As the office automation industry emerges, projections for its potential size continue to increase. A comparison of Quantum Science corporation's $30 billion dollar estimate to the total world market for telecommunication and information processing products (see Section 2.0 - The International Market), suggest that office automation could account for 5% of the total. The number and variety of smaller markets available will provide ample opportunities for companies of all sizes to compete.

2) <u>Canadian Market</u>

Compared to the US and Europe, who will account for the majority of the demand in office automation products, the Canadian market is not considered significant. Further, Canadian companies will be competing against large international US companies such as IBM and AT&T in a limited Canadian market. Both of these factors suggest that sustained growth of Canadian companies can only be achieved through export, particularly to the US, and in selected market segments that do not bring these companies in head-to-head competition with the multinational leaders.

Northern Telecom, is Canada's one exception to the above generalization. NT is capable of competing with IBM and AT&T through large integrated system offerings to major users. Their 1982, five year R&D committment of $1.2 billion to their OPEN (Open Protocol Enhanced Networks) world concept is designed to place NT at the forefront of office automation.

4.1.3 Supply Analysis

International Market Share

According to A. Wohl, a consultant of Wohl Associates of Bala Cynryd, Penn., IBM will rank first in office automation systems, with AT&T ranking second for the remainder of the 1980s. The following five companies, in no particular order, are also expected to be leaders in this area: Apple Computer Inc. of Cupertino Calif., Digital Eqpt. Corp. of Maynard Mass., Data General of Westboro Mass, Hewlett Packard Co. of Palo Alto Calif., and Wang Laboratories of Lowell Mass.(3)

These predictions are based on an increasingly hostile and competitive environment for vendors, illustrated by recent announcements from three of the seven projected leaders. Data General Corp. announced disappointing sales in 4th quarter 1984, Apple Computer Inc. Cupertino, Calif. announced one week factory shutdowns to take up inventory slack and Wang Laboratories of Lowell, Mass. predicted lower earnings in fiscal 1985.

Northern Telecom will also be a major contender for significant share of the international market, particularly in the US. As an integrated system vendor, they are expected to do well despite stiff competition from IBM and AT&T.

The success of these companies will, in part, be due to the tendency of users to buy the company rather than the product. This, in part, is due to the shift in buying responsibility from individual departments to the MIS department, who traditionally purchase from large multinationals. Thus the trend may be set for a series of mergers since smaller, inexperienced companies may find it difficult to survive without being absorbed by a larger company.

Market Constraints

Competition can be affected by one or any of the following factors; economies of scale, transportation costs, competitive strategies (ie. brand name), user requirements, cultural barriers, regulatory environments and government policies. International competition in office automation systems is supported by all of these factors. There are no significant barriers to any company that has the financial resources to establish a good corporate citizen image in foreign countries, along with the necessary marketing and distribution networks.

The major constraint for most Canadian companies hoping to compete in the office automation market, in the US or in Europe, will be access to these markets along with the requirement for substantial marketing and distribution funds. A secondary constraint, concerns standards of which two exist today; IBM's SNA standards which are very strong in North America and CCITT X.400 standards which are very strong in the UK and Europe. Both standards will exist for a considerable time to come and the most successful companies will have to be compatible with both. This places a further financial constraint on smaller developing companies whose competitiveness may largely be determined by their ability to develop products compatible with both sets of standards.

4.1.4 Competitive Analysis

Major Supplier Strategies

There are five basic strategies available to suppliers depending on their product, market life cycle and competitive position: development, selective development, turnaround, abandonment and high risk subsidy development. According to Arthur D. Little, most European participants are in the selective development area and employ strategies consisting of specialization of selected products, market segments or technological innovation. Canadian companies too, are in the selective development area, with the exception of Northern Telecom who has the potential to become a supplier of integrated systems. Other Canadian companies will supply departmental sized systems to selected market segments or will supply commodities such as modems and multiplexers, and software.

Further, since the Canadian marketplace is insufficient to sustain any significant company in office automation systems, Canadian companies must look to the US and offshore. The US market is the largest in the world being approximately 20 times larger than the Canadian market.(4)

The largest office automation system suppliers are pursuing a development strategy that will net them the largest share of the office automation market.

In Canada, there are only a handful of companies that appear to have the resources to be effective international competitors. Of these Northern Telecom & AES Data appear to be the leaders. Northern Telecom has already established a presence in the the US and two other factors are expected to contribute to their success in office automation.

First, Northern Telecom's strategy is to develop an OPEN world concept that provides users with the maximum choice in equipment by allowing them to connect with either IBM or other systems. Secondly, they have signed technology agreements with major data processing manufacturers including Digital Eqpt. Corp., Wang Canada Inc., Sperry Canada, Data General and Hewlett Packard. This is viewed as a particularly appropriate strategy, considering the increasing dominance of data processing companies.

AES Data has already established its presence in the European market and is beginning to enter the US market. As is generally the case in the high-tech industries, entry into the US market requires a substantial amount of funding to establish the required distribution networks. On a national scale, competition with the leading US companies would not be possible in the foreseeable future. One reason is the importance of service and support required nationally by the largest OA customers. However, other market segments will provide sufficient opportunity for successful entry into the US market for departmental systems in small to medium sized firms.

Canadian Capabilities and Potential

Canadian companies participated in a $12.5 million program coordinated by the Department of Communications, in which integrated office systems were installed in several organizations involving all levels of staff from support to highest management. The program known as the Office Communications System Program (OCS) has allowed Canadian companies to develop and test integrated products and systems. Thus Canadian companies can offer, domestically and internationally, systems and products that have been thoroughly tested under live office conditions, thus providing some advantages to these Canadian companies.

There is no question that most Canadian companies cannot compete, at least in todays market environment, on the same basis with such international giants as IBM/Rolm, Apple, DEC, AT&T, etc., who are already well established and prepared to aggressiviely compete in the office automation market. These companies, as noted earlier are major system suppliers with the capabilities and resources to offer the level of consulting and network design required. The market is, however, sufficiently large to provide opportunities for Canadian companies in system development for smaller companies in specific market niches and for supply of certain commodities within the market.

Major Canadian Suppliers

Canadian suppliers of office automation equipment are listed below and categorized into their major market offerings.

Large System and Integrated Network Supply

NORTHERN TELECOM - based on the OSI model, and NTs Open World concept (Open Protocol Enhanced Networks is a five year business strategy announced in 1982, committing $1.2 billion in R&D and designed to place NT at the forefront of office automation) are offering digital private branch exchanges, high-speed local area networks, integrated voice and data networks and supporting software.

Departmentalized Sized Systems to Smaller Companies in Specific Market Niches

AES DATA INC. - an international organization headquartered in Canada. AES is 100% owned by the Canada Development Corporation. AES designs, manufactures and distributes office automation equipment including standalones, and shared or distributed office systems.

GEAC COMPUTER SYSTEMS CORPORATION LTD. - has been in business since 1971, designing and manufacturing integrated on-line processing systems. Their office automation systems are based on GOAST (GEAC Office Automation Support Tool) software which offers electronic mail and messaging, executive support (time planner, schedular, to do list, personal infominder, phone messaging), spreadsheet (U-Calc), records processing, text processing, spelling dictionary, on-line help and networking.

MICOM - supplies dedicated word processing systems and is moving into the supply of integrated office systems. Micom is expected to integrate its product lines with offerings by Philips, allowing it to become a selected market system vendor.

MITEL CORPORATION - has been in business for 11 years, manufacturing telephone switching systems (PABX's), special telephone sets, communication workstations and cost accounting equipment. Mitel offers fully integrated voice and data workstations offering electronic mail, wordprocessing and financial planning. Their SX-2000 Integrated Communication System provides automatic route selection, system message detail recording, toll control and numerous data communication features.

In 1984, gross R&D represented 21% of product sales. Mitel employs over 5800 people in manufacturing and has sales offices in 14 countries.

Mitel is primarily a PABX vendor and its success in office automation is questionable due to its lag in multifunctional workstation development and its lack of allegiance with any large data processing firm.

XIOS SYSTEMS CORPORATION - offers the office information system, Renaissance, based on the Unix operating system. The system can support various PCs of other manufacturers, as well as, word processors, printers and has local area network capabilities. Capabilities include word processing, spreadsheets, electronic mail, databases and connection to external systems.

CROWNTEK INC. - based in Toronto is introducing Prod/Net, a comprehensive office automation system, including electronic mail, electronic filing, time management and micro to mainframe link, terminal emulator, controller emulator and gateway.

Commodity Suppliers

COMTERM INC. - specializes in three main business areas including office automation systems, 3270 communication product and personal computers in education. Their office automation systems are LAN hardware and software based with IBM compatible PC workstations.

GANDALF SYSTEMS GROUP - a division of Gandalf Technologies Inc., offers a wide range of services, in addition to Colleague, a UNIX based office system. Colleague offers word processing, electronic mail and messaging, electronic filing, calculating and telephony. Services include consulting, hardware, software, communications, training, system implementation and support.

Software Suppliers

EMERALD CITY INC. - integrates six office functions into one office system, known as Emerald One, compatible with any hardware capable of supporting the UNIX operating system. The integrated system offers electronic mail, telephone messaging, document preparation and presentation and decision support capabilities including graphics and spreadsheets. While Emerald City designs and manufactures the systems, outside vendors market and distribute them.

OFFICESMITHS INC. - offers document-based management and application development facilities, with a multi-window operating environment, utliizing fourth generation software. The open system architecture allows integration of other software and operates with standard terminal interfaces.

Canadian Imports/Exports

The Canadian trade deficit in office automation systems is now approaching $3 billion a year.(5) Considering the levels of peripherals, semiconductors and storage devices already imported, and which are necessary components of office automation systems, this trend is expected to continue in the future.

Non-Canadian International Competitors

Figure 4.1.4 shows major participants in the office automation industry in Japan in 1981.

Figure 4.1.4

Major Participants in Office Automation in Japan, 1981

Major Product Line/Company	Involvement
Electric and Electronics Group	
Toshiba	Very Strong
Mitsubishi	Strong
Hitachi	Strong
Telecommunications and Computer Group	
NEC	Very Strong
Fujitsu	Very Strong
Oki	Strong
Office Equipment Group	
Ricoh	Strong
Canon	Strong
Casio	Weak
Seiko	Weak
Fuji-Xerox	Weak

Source: Arthur D. Little

Japanese firms are expected to form joint venture arrangements that would gain them access to wide distribution networks in the US.

In the US, the leading manufacturers of office automation are IBM/Rolm, AT&T, Wang, Apple, DEC, Data General, and Hewlett Packard.

Both the Japanese and American firms have the capabilities of becoming major system suppliers of integrated office automation networks and will be competing for the major share of the office automation market.

In Europe both IBM and Wang have considerable market presence. Within each European country, there is at least one 'local' company with considerable market presence ie. Siemens in Germany, Ericsson in Sweden and Olivetti in Italy. It should be noted that AT&T aquired a 25% stake in Ing. C. Olivetti & Co., which should enhance their European market penetration. Since European standards are more stringent than North American standards, exported equipment must undergo substantial testing and could pose a barrier for smaller companies wishing to enter this market. Further, distribution networks are as important in Europe, for both marketing and service and support, as they are in the US, which again place smaller firms at a relative disadvantage.

4.1.5 Summary

Office automation is nearing the end of its current embryonic technical cycle and users who used to purchase individual hardware features are now basing the buying decision on software and particularly, software directed at enhancing the office operation. It is expected that only very large companies capable of evaluating the needs and operation of a potential user will be true system integrators and system vendors. Other companies will concentrate on the special application areas and supplying components or software for systems supplied by larger vendors. Canadian companies for the most part are in this secondary position and their ultimate success may largely depend on the level of financial assistance that will be required to penetrate foreign markets.

The largest markets for office automation systems will be the US and Europe. Projections estimate the US market to be worth $20 billion by 1988. The Canadian market is expected to be one-twentieth this size. Canadian companies have indicated their greatest needs could be served through government assistance directed at enabling them to penetrate foreign markets through the establishment of appropriate marketing and distribution channels.

Office Automation
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4.2 Local Area Networks (LANs)

4.2.1 Technical Description

A local area network (LAN) may be defined as a communication network that facilitates the interconnection of a variety of data communication devices within a small localized area. Such data communication devices include computers, terminals, printers, telephones, word processors, photocopiers, etc. As the LAN is an integral component of office automation technology, its market is primarily directed at the office environment. LANs technolgy serves to improve the flow, the processing and management of large volumes of information within todays office environment and reduces the numbers and hence costs of computing hardware (computers and asociated peripherals) through the sharing of these resources.

The physical network of a LAN is within a few tens of kilometres and hence makes it ideal for use within single buildings or on university campuses or military bases to connect several buildings.

The evolution of LAN technology centres around three main areas: transmission media, network topology, and access method (protocols).

1) Transmission media

The three most commonly used transmission media used are:

a) Twisted Pair

Twisted pair is implemented where low bandwidth requirements are adequate.

b) Coaxial Cable

Coaxial cable, the most commonly used medium in present day LANs, offers reasonably high data rates, ease of line tapping for component addition, support of many devices and reasonable isolation from environmental interference.

c) Fibre Optics

Fibre optics provides a higher bandwidth than other media and can support voice, data and video transmission. Fibre optics has many unique advantages over other media such as: extremely high data rate, lighter weight, smaller diameter, noise immunity and security against tapping. Currently, the primary disadvantage of fibre optics is its high cost.

2) Network Topology (Refer to Figure 4.2.1.1)

The type of configuration used is dictated by the number of nodes per network, geographic scope, reliability required, and type of traffic. The linear, bus ring, star and tree configurations are the more commonly used network topologies.

3) Access Method (Protocol)

The network access method refers to the way a station gains access to the shared transmission medium and is part of the transmission protocol. There are basically three protocols developed for LAN's.

a) Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

The station listens to the traffic along the network and will transmit only when the network is sensed inactive.

b) Token Passing

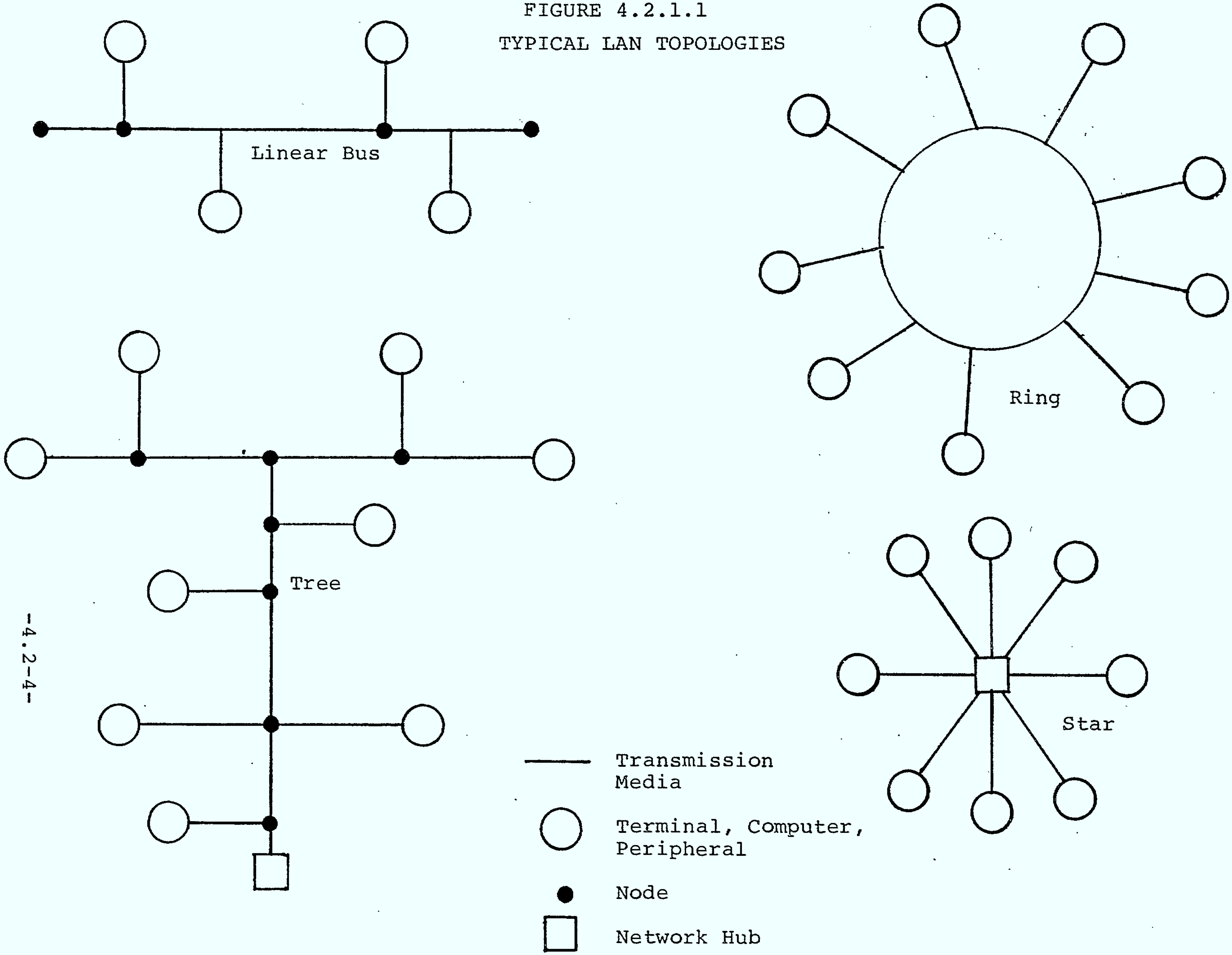
Token Passing utilizes the concept of a token which grants the station in possession of a token, the right to transmit. If a station finishes transmitting or has nothing to transmit, the token is passed on to the next station.

c) Slotted Ring

Slotted Ring is based upon a number of slots or fixed packets being sent over the network. A station transmits information by obtaining an empty slot and receives information if a received slot contains the station's address.

FIGURE 4.2.1.1

TYPICAL LAN TOPOLOGIES



4.2.2 Demand Analysis

Factors of Change

A look at the office environment of today, will reveal the many factors which contribute to the development and implementation of LAN products and services. Although LAN systems are a major component of the much broader category of office automation, the substantial development activity devoted to LAN technology alone lends itself to separate treatment.

Dramatic cost reductions in computing hardware has led to widespread use of personal computers. As a result, an increasing number of office workers are using computer terminals, word processors and personal computers and need to share resources such as drives and printers. As well, nearly every worker has access to a telephone.

As a result of the need for various departments and levels of hierarchy to share information and communicate with each other, the office of today is becoming increasingly burdened with the management of high densities of voice and data communications traffic.

The benfits of LANs in the office are now being realized. LANs reduce the number of peripherals normally required, and hence costs, through the sharing of resources: drives, printers, modems etc. As well, information can be shared through access to common storage devices rather than being re-entered.

There is, however, two major factors responsible for the less than projected implementation of LAN systems thus far in 1985. First, there has been a lack of licensing agreements on much of the available multi-user application software, resulting in non-use by the user for fear of prosecution, and secondly, there is currently a lack of available multi-user application software, as multi-user software is more difficult and hence, more time-intensive, to develop than stand-alone software. Additionally, copywrite protection is a more complex feature to implement for systems sharing software than for stand-alone system software.

Areas of Major Growth

1) Optical Fibre Transmission Media

Estimates indicate that transmission speeds exceeding 200 Mbps over a distance of several kilometres in future LANs will be required.1 Optical fibres will be a suitable transmission medium for the backbone of new generations of high speed LANS and will enable high speed data transfer in mainframe to mainframe applications. An estimated annual growth rate of 30% towards 1990 is projected for fibre-based LANs for use in computer and industrial applications.(1)

2) Fourth Generation LANs: Hybrid PBX/LANs

One major development in the rapid evolution of office automation is the integration of the two most common forms of office information: voice and data. Problems of cost-effectiveness, product compatibility and system reliability become apparent when voice and data communications are managed on separate networks. Integrated voice and data communications is viewed as a cost effective and logical approach to manage voice and data communications traffic and will meet the voice and data communications needs of the office of the future.

3) LAN Software

With the relatively recent introduction of Microsoft's new operating system, Microsoft Network, the development of application software for LANs will certainly be an area of major growth during the next several years.

LAN vendors, at the fall 1984 Comdex trade show, welcomed the announcement of Microsoft Network, which they expect will set an industry standard and compel third-party software vendors to develop applications software for their LANs. As Joseph Hughes, a representative of Corvus, stated at the Comdex show: "The Microsoft Network, which lets personal-computer users share information using Microsoft's MS-DOS 3.1 and 1.0 operating systems, will inspire the big third-party software players to start writing multi-user application software."(2) Robert Lefkowits, a software analyst for InfoCorp, predicted 1985 as a milestone year for LAN software developers and 1986 as the year LAN software will begin to appear on the market, noting that much of the software will be directed towards the user thereafter.(2)

Growth Estimates

1) International Market

Approximately 16,000 LAN systems have been installed as of mid-July 1984. According to US-based International Data Corp., the LAN market has experienced an annual growth rate of 65.7% and by 1988 the installed base of LANs will increase to over 100,000.(1) According to Strategic Inc., a US-based research firm, projects the North American LANs market will increase tenfold, from a 1983 base of $140 million to $1.4 billion by 1988.(3)

These growth rates can be attributed to the increasing use of LANs in the office environment, as most LANs today have been installed in universities and research facilities of corporations, coupled with an increasing use of fibre optic-based LANs which are expected to have a major impact upon the market in the latter half of this decade.

2) Canadian Market

According to Evans Research Corp., the 1985 Canadian LAN market was projected to be $10 million based on the connection of 18,000 nodes (a node being a cluster of several peripherals). Evans Research further estimated the market to increase to $40 million in 1987, with an installed base of 160,000 nodes, and $60 milion in 1989. Software costs account for approximately 75% of the projected $40 million in the 1987 LAN market.(4) The continued decrease in LAN hardware costs, due to advances in semiconductor technology, coupled with the increased use of LANs will significantly reduce the cost per node in the latter half of this decade. However, as vendors develop multi-user software for LANs applications which is more complex than standalone software, software costs are expected to account for a large portion of LAN costs.

4.2.3 Supply Analysis

Strengths

Canada's major strength lies in its technical resources fostered by the supply of capable graduates from Canadian universities and colleges.

Weaknesses

Canadian companies involved in LANs-related areas (development, implementation and software) have made note of several major weaknesses responsible for Canada's inability to penetrate and capture a substantial portion of the international LAN market.

Among these, a weak marketing infrastructure ranks as the most significant problem. Without an effective product distribution network in the US in the form of sales offices and/or manufacturing plants, Canadian companies incur high sales costs and cannot compete head-to-head with US-based giants like IBM.

Among other noted weaknesses were the absence of strong corporate entities in Canada (as there are no Canadian equivalents to an IBM), the lack of available venture capital and a general lack of pioneering, risk-taking and aggressive attitudes and weak marketing and market analysis skills on the part of most Canadian companies.

International Market Share

Canadian LAN vendors are not expected to have significant shares of the international LAN market. One Canadian company involved in the development and supply of LANs-related products estimated Canada's international market share will definitely amount to less than 1%.

The LANs market is expected to be dominated by traditional US giants in the information and data processing industries, and in particular, IBM, Ungermann-Bass, Corvus, AT&T, Xerox and Wang. Maureen Fleming, a senior analyst with International Resource Development Corp., a US-based market-research firm, predicted, with IBM's introduction of the PC Net in the first quarter of 1985, IBM would capture 40% of the LAN market while 30% would go to Ungermann-Bass' EtherNet, 10% to Corvus' Omninet and 10% to AT&T's UNIX-based LAN.(2)

Market Constraints

The major market constraint faced by Canadian LAN vendors is a weak marketing infrastructure. The majority of Canadian companies involved in the development, manufacture and implementation of LAN services and products lack an effective product distribution network in the form of sales offices and/or manufacturing plants in the international market. This lack of presence in the marketplace, makes it difficult to penetrate the market and compete head-to-head against US-based companies.

4.2.4 Competitive Analysis

Major Supplier Strategies

1) Northern Telecom's OPEN World Program

Northern Telecom identified its market strategy for the 1980's with its announcement, in 1982, of the OPEN (Open Protocol Enhanced Networks) World Program. The OPEN World Program, which will foster developments in areas including LAN systems, was designed to meet the requirements of a growing market for improved information management. To achieve this goal, Northern Telecom has committed $1.2 billion between 1982 and 1987 to the program to introduce new products while enhancing existing systems, such as the DMS and SL families of central office switching systems and business communications systems. The new generation of products, features and services will permit telephone systems, computer terminals, word processors and other advanced communications, data processing and office equipment products and systems to be integrated into a single information management system.

2) Flexibility

To accomodate the many makes of personal computers used in the offices of today, most LAN vendors are developing a generation of LANs with a capabilities to allow the interconnection of various devices. As Ian Angus, president of Angus Telemanagement Group, notes: "I think you will find that most of the vendors will allow the connection of quite a variety of personal computers. They're going to have to, or else they'll be left out in the cold. A purely proprietary LAN is a dead end."(5)

3) IBM Compatible LANs

Given the widespread use of IBM PCs in today's office environment and IBM's domination of the PC market, LAN vendors are developing IBM-compatible LANs. Robert Lekowits, a software analyst for InfoCorp, noted that the installed base for IBM networks and compatible networks is close to three million, whereas the installed base for UNIX networks is under 200,000, which is a 10-to-1 ratio. Therefore, most LAN vendors will need to develop IBM-compatible LANs.(2)

Market Niches

Given that US giants dominate in the development, manufacture and supply of LANs hardware, the development of operating systems and processing languages and the supply of LANs systems, only a few areas have promise for Canadian companies. Among these include products to interface peripherals to the network and applications software for LANs, particularly the latter, as the development of software packages for LANs applications is a relatively emerging industry.

Canadian Capabilities and Potential

Due to the dominant position held by US giants (ie. IBM, Ungermann-Bass, Corvus, AT&T, Xerox and Wang to name a few) in the LAN market, the absence of strong corporate entities in the semiconductor and other computer-related technology areas in Canada and a weak marketing infrastructure on the part of most Canadian companies, Canada cannot successfully compete, head-to-head, with these major suppliers of LANs products and services. However, Canadian LANs may consider joint ventures with these dominant equipment suppliers.

Rather than commit time and resources into the research and resource intensive areas of hardware (semiconductor technology) and software (development of operating systems and processing languages), Canadian companies should consider developing, as third party software firms, value-added application software for existing industry standards. The LANs software applications market is not as yet product saturated (refer to the previous discussion concerning Microsoft's new operating system) and competitive as the hardware market. However, indications are that LANs application software would impact the market in 1986 and therefore increase the implementation of LAN systems. Given that the development of applications software is not as research intensive as other LANs-related areas (ie. development of LAN hardware and system software) and Canada has a sound base in its technical resources of graduates from universities and colleges, development of application software may be the most successful LAN-related areas for Canadian companies.

Although Canadian companies may need to consider niche markets in the area of LANs technology, their success in these markets will not be realized without an effective product distribution network in the international market. Currently, this is the major concern of most

Canadian companies involved in the development and implementation of LANs products and services. Canadian companies continually mention the high cost of sales, the lack of presence in the market (sales offices and/or manufacturing plants) and 'buy American' policies of most potential US clients as major reasons for their lack of penetration and success in the international LAN market. Given this situation, Canadian companies look to the federal government for assistance in the form of programs and funds designed to provide direction and a means to bring products to market.

Major Canadian Suppliers

Several Canadian companies involved in the development and/or supply of LAN systems include:

BMB Compu' Science

BMB has developed the Imaginet LAN.

Crowntek Inc.

Crowntek has developed Prod Net, a micro-to-mainframe network system, which integrates a LAN for IBM PCs with mainframe data processing.

Develcon Electronics Ltd.

Develcon has developed DEVELNET, a LAN configured as a star network using twisted pairs. DEVELNET links terminals, minicomputers and mainframes of various manufacturers and has the capability to interconnect a number of various networks.

DY-4 Systems Inc.

DY-4 develops Ethernet LAN cards and LAN controllers.

Net One Data Corp.

Net One Data has developed Easynet, a CSMA/CD bus LAN using twisted pairs, which has the capability to link various CP/M devices from Xerox, Televideo, NCR, Control Data, Kaypro and others.

Northern Telecom Ltd.

Northern Telecom, a leading designer and manufacturer of telecommunications equipment including integrated voice and data communications systems, will have commited $1.2 billion between 1982 and 1987 to its OPEN World Program. Developments under this program include incorporating a LANs capability to Northern Telecom's SL-PBX with speeds of upwards to 2.5 Mbps, significantly faster than usual PBX speeds of 56 kbps.

Non Canadian International Competitors

1) AT&T

AT&T has developed a UNIX-based LAN.

2) Corvus

Corvus has developed the Omninet LAN with the following specifications: twisted pair, baseband, CSMA/CA(avoidance with positive acknowledgement), 1 Mbps and supports IBM PCs.

3) IBM

IBM has developed the PC Net LAN which runs on Microsoft's MS-DOS

3.1 operating system and uses Sytek Inc.'s broadband network as its protocol. Given the widespread use of IBM PCs in todays office environment and their dominant position as a PC supplier, IBM is expected to dominate the LAN market as well

4) Sperry

Sperry has developed the UserNet LAN with the following specification: twisted pair, baseband, CSMA/CA(avoidance with positive acknowledgement, 1 Mbps and supports IBM PCs.

5) Ungermann-Bass

Ungermann-Bass has developed the Net/One LAN with the following specifications: coaxial cable/optical fiber, CSMA/CD, 10 Mbps and supports IBM PCs.

6) Xerox

Xerox is a major hardware supplier in the data processing industry and LAN vendor.

7) Wang

Wang is a major hardware supplier in the data processing industry and LAN vendor.

8) 3 COM

3 COM has developed the EtherSeries LAN with the following specifications: coaxial cable, baseband, CSMA/CD, 10 Mbps and supports IBM PCs.

4.2.5 Summary

The local area network (LAN) is a communication network that facilitates the flow, processing and management of large volumes of data through the interconnection of a variety of communications devices generally within a localized area. Through the sharing of communications and peripheral devices, LAN systems improve the flow of information and reduce the numbers of computing devices and peripherals required and hence, the costs incurred. The most commonly used transmission media used in present LANs is twisted pair or coaxial cable; optical fibre is used in those applications where the need for higher speed data commuincations outweighs the cost.

LANs form the backbone of a much broader technology known as office automation which is presently revolutionizing today's office environment. Thus, the primary market for LAN systems is the office environment. Current trends in LAN technology include the implementation of optical fibre as the backbone of the LAN to meet high speed data communication requirements, the development of fourth generation hybrid PBX/LANs for integrated voice and data communications and finally, the development of multi-user LAN application software.

The North American market for LANs is estimated to be $1.4 billion by 1988. The primary factors responsible for the less than projected implementation of LAN systems, thus far, include delays in licensing agreements for multi-user software, the lack of variety of multi-user application software, and delays in copywrite protection for multi-user software. The North American LAN market is presently dominated by US equipment suppliers and data processing companies. Rather than directly compete in markets traditionally held by US giants, Canadian companies should focus their resources towards less research and cost intensive areas such as the development of value-added multi-user application software. Canadian LAN companies could enter into agreements with equipment suppliers to develop value-added software as a third-party software houses. In order to successfully penetrate and sustain a presence in the US market, Canadian LAN companies look to the federal government to provide financial and marketing assistance as a means to success in a highly competitive market.

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4.3 Electronic Mail

4.3.1 Technical Description

Electronic mail in the broadest sense refers to person-to-person communications of text and graphic information, and includes such services as facsimile, person-to-person computer based messaging (CBM), teleprinter services (i.e. telex, TWX and teletex) and voice mail. As PCs become more prevalent in the office environment, the major trend is towards person-to-person messaging within computer based messaging systems (CBMSs).

Electronic mail offers the following advantages:

- speed of delivery
- replication of text and graphics
- store-and-forward message capability
- rapid turnaround
- cost savings over regular mail and courier services

Facsimile is a method used to transmit and receive documents over the long distance telephone network. Information is transmitted outside peak load times, making more efficient use of the communication network. To achieve compatability between various manufacturers, the CCITT Group XIV, proposed a series of recommendations and standards in 1981. Four groups of standards were developed affecting machine protocol and transmission techniques:

Group 1 - 4 to 6 minute per page analog facsimile devices.
Group 2 - 2 to 3 minute per page analog facsimile devices.
Group 3 - 1 minute or less digital fascimile devices operating over voice-grade lines.
Group 4 - digital facsimile devices operating at subminute speeds.

The standards for Group 4 follow the Open Systems Interconnection reference model but are not yet fully developed. Unresolved areas include the type of modem to be used, a mixed-mode concept which involves merging text and graphics and compatibility with other office equipment such as word processors, CBMSs and intelligent copiers.

CBMS provides the ability to send and receive messages using computers. CBMS generally falls into three categories:

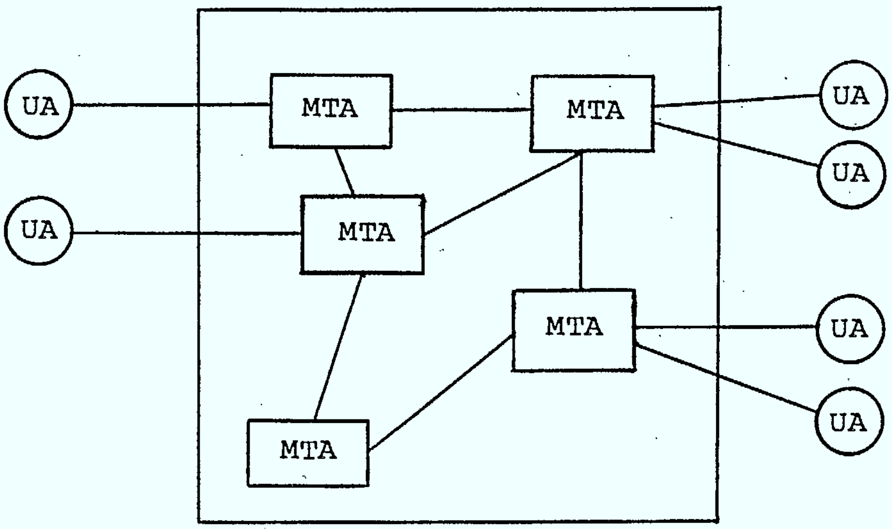
1) in-house software packages that perform electronic mail functions over existing facilities
2) communicating word processors
3) public electronic mail services

In March 1984, the CCITT adopted a series of recommendations, known as X.400, defining the network architecture, protocol structure, implementation options, message transfer and interpersonnal messaging services for a national electronic mail service to include text, facsimile, graphics, voice, binary data structures and various combinations.

The functional model defined in Recommendation X.400 includes a distinction between message preparation and message transfer. Receipt and message preparation are supported by functional units called User Agents (UA's) which allow messages to be transferred between all UA's regardless of the level of sophistication. Message transfer is supported by Message Transfer Agents (MTA's), devices responsible for providing store-and-forward delivery service.(See Figure 4.3.1.1). The evolution of the CBMS has reached a point where the primary terminal is a standard PC, preferable to the dedicated terminal used in telex.

FIGURE 4.3.1.1

Message Transfer System



Source: Telecommunications, July 1985

Teleprinter services include telex, TWX and teletex. These services use teleprinters to access public networks through domestic and international record carriers (IRCs). Telex, a messaging service introduced in Germany in the 1930's, is still widely used for domestic and international message communications. However, due to its slow transmission speed of 50 baud and inflexible format, telex is giving way to higher speed services. TWX, a message service originally owned and operated by AT&T, was acquired by Western Union in 1969 and made compatible within WU's existing telex network. TWX offers a higher transmission speed than telex, typically operating at 110 baud. Finally, teletex, a message service first introduced in Germany in 1981, offers a much high transmission speed than either telex or TWX. Teletex operates at a baud rate of 2400 and as well, offers memory and text-editing capabilities.

Voice mail, introduced in the late 1970's and early 1980's, is an enhancement to electronic mail services with considerable potential for increasing productivity. Voice mail systems allow the user to store a digitized voice message on a hard disk and forward it to another user's voice mailbox for later retrieval. Voice mail can be provided by an outside service bureau, a standalone turnkey system, or an integrated module of a PBX.

Critical to the acceptance of any electronic mail system is its accessibility, compatability and use by the people one wishes to communicate with. Any additional hardware necessary should be incremental to allow its widespread acceptance.

4.3.2 Demand Analysis

Factors of Change

Factors contributing to the growth of the facsimile industry include: reduced prices ($3000 range US)
improved quality
improved reliability
stabilization of basic and enhanced features
a shift from rentals to purchases has occurred with purchases accounting for 80% of the current market

Areas of Major Growth

The CBMS industry growth is largely attributed to standardization as outlined in the CCITT X.400 recommendations making electronic mail more accessible and allowing users with different equipment to communicate with each other. Also electronic mail is no longer a stand alone feature but is considered an essential part of the overall office automation trend.

Telex terminals are also expected to see continued growth primarily because of the already established base of terminals in existence and the ability to interconnect telex with other electronic mail services.

Voice mail technology has never quite achieved the market success as predicted. Early product offerings were expensive (over $500,000 US) and targeted at large organizations with hundreds or even thousands of users. A common perception amongst users was that voice mail was nothing more than an enhanced phone answering machine, and as such led to much user resistance towards voice messaging. However, within the past several months, voice mail has begun to gain wider acceptance, as smaller, less expensive systems become available and more and more service bureaus appear.

Growth Estimates

1) International Market

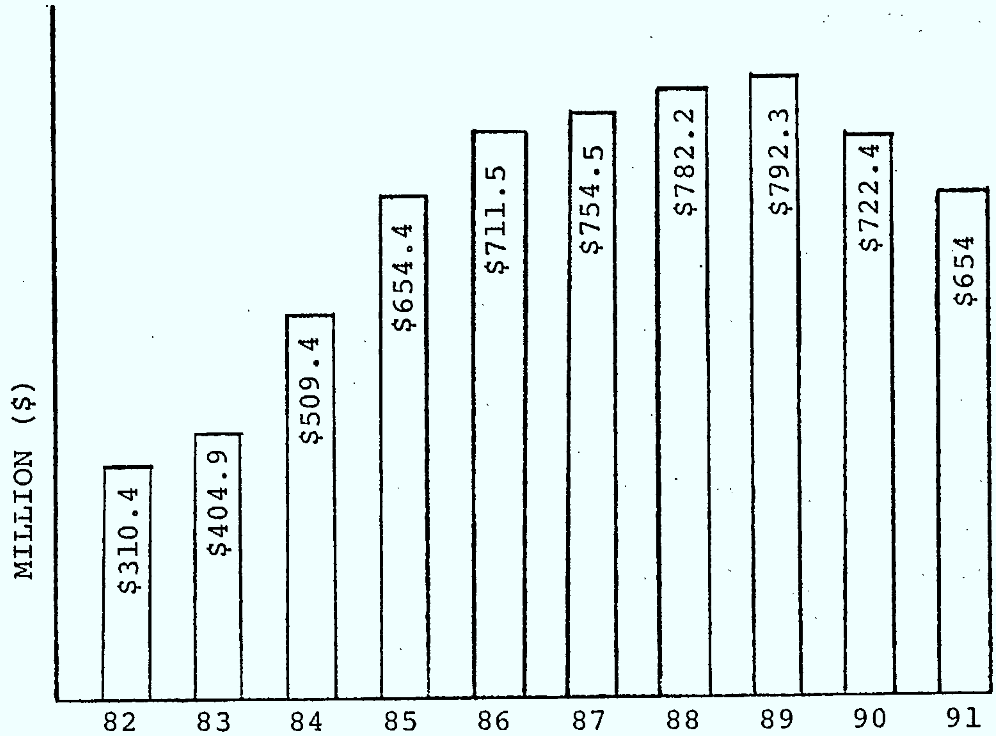
Connecticut based International Resource Development Inc. (IRD) estimates that electronic mail will be a $4.3 billion industry by 1990. (1) This agrees with with predictions by M. Cavanagh, executive director of the US Electronic Mail Association, that the existing $200 million (US) industry will grow to one worth several billions in the 1990s. (2)

The growth in the electronic mail industry is based on growth in all the three areas of facsimile, CBMS and telex. Growth in CBMS is predicted to be largest overall and will see continued growth whereas facsimile and telex growth will begin to taper off in the early 1990's.

According to the New Jersey based Eastern Management Group there will be rapid growth in facsimile tapering off towards the end of the decade. (Refer to Figure 4.3.2.1) Total annual USA facsimile revenues are expected to peak at $792 million in 1989 and taper off to $654 million in 1991, with the primary growth areas being Group 3 and 4 facsimile machines. This is consistent with past US experiences, where for example, between 1982 and 1983, the installed USA facsimile base grew from 164,500 units to 270,290 units, representing an annual growth rate of 26%. (1) By 1988, the US base is expected to reach 504,000 units. (3)

FIGURE 4.3.2.1

Total Annual USA Facsimile Revenues: 1982-1991



Source: Telecommunications, August 1985

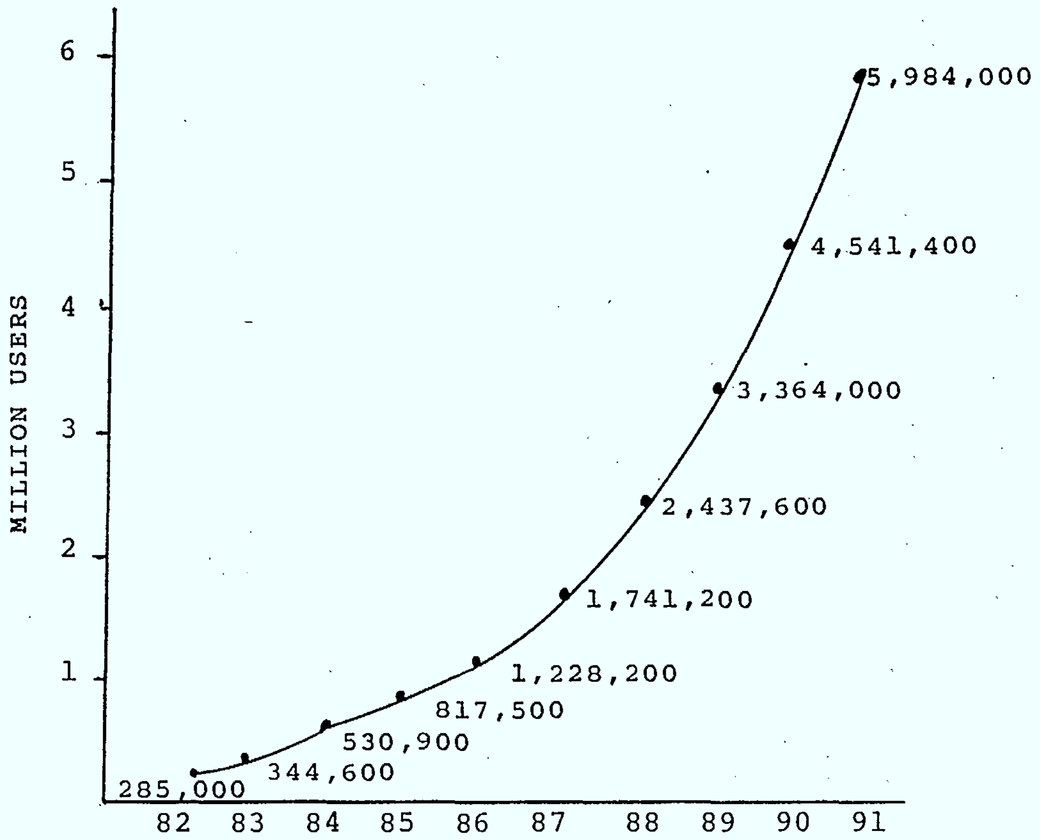
The Japanese have been world leaders in developing facsimile machines for two major reasons. First, with a language composed of over 2,000 characters, high resolution machines were required and secondly, with telephone connect times 40-50% higher in Japan than the US, faster speeds were required. A comparison of facsimile sales in Japan and the US, reveals the great dependence of the Japanese on facsimile; in 1984 in Japan were $648 million (US) compared to $158 million (US) in sales in the US.

Japan will continue to be a major exporter of facsimile machines and expects to export 150,000 to 160,000 facsimile units in 1985 according to figures from Japan's Ministry of Trade and Industry (MITI), representing a 40 to 50 % increase over 1984 and largely as a result of Group 3 technology stabilization. (1)

It is estimated that CBMS will become the most widely used form of electronic mail service in the next 5 years. According to Eastern Management Group, electronic mail traffic is made up the following components: 33% messaging, 21% sales orders, 10% administrative reports, 10% inventory/production control and 26% other. Further, 18% of all US businesses use some form of CBMS and another 19% are planning some form of implementation. It is expected that by 1995, 60% of all US businesses will employ some form of electronic mail service. In terms of users, there are expected to be 817,500 by 1985 reaching 4,541,000 by 1990. This growth is from a base of 285,000 users in 1982, who were linked to inhouse CBMS systems or to public network systems. (See Figure 4.3.2.2) (1)

FIGURE 4.3.2.2

Total Annual USA CBMS users: 1982-1991



Source: Telecommunications, August 1985

Telex terminals in the US were estimated at 142,000 in 1982 and projected to grow at a rate of 6,000 per year according to Eastern Management Group. Thus, by 1990, it is expected that 187,900 installed terminals will exist. On a worldwide basis it is estimated that in excess of 2 million terminals exist. Eastern Management Group has also estimated that 66,400 TWX terminals were in use in 1982 in the US and yearly growth is projected at 2000 terminals reaching 84,000 by 1990. (1) In Canada, there are an estimated 50,000 telex units installed and according to B. Sullivan, a 3M marketing manager, an estimated base was expected to grow by 5% in 1985.(4)

Present market projections and directions for teletex are unclear. Despite the efforts of Telecom Canada and CNCP to popularize teletex, some industry observers doubt the potential success of teletex in North America noting that PC-based electronic mail services offering the same service will erode, if not eliminate, the need for teletex. However, there are those who feel that PC-based electronic mail sources are best suited for short messages, while teletex is designed for longer formal documents.

Although telex is the oldest technology, it appears to be secure because of the increasing trend to offer linking between telex and other electronic mail messaging services. A Telex-IBM interface already exists and CNCP plans to offer Telex connections with its electronic mail and international teletex service. Telecom Canada's Envoy 100 will also be capable of linking with the 2 million telex terminals worlwide.(4)

2) Canadian Market

Envoy 100, an electronic messaging service established by Telecom Canada in 1981, had in excess of 10,000 subscribers comprised mainly of medium and large businesses in 1984. (5) EnvoyPost, introduced commercially in 1984, allows Envoy users to electronically send letters to post offices in Canadian cities, the printouts of which are delivered in the regular mail. The number of Envoy subscribers, listed at 19,000 in the second quarter of 1985, was expected to double by the third quarter. Further, a survey of 224 Canadian companies by Evans Research Inc., projects that by year end 1985, larger sized companies will add 47,500 electronic mailboxes and smaller companies will add 12,500 for a total addition of 60,000. (2) One of the reasons for the rapid growth, is the relative ease in adding a new subscriber to a public electronic mail system. Usually the worksation does not require upgrading except for the addition of a modem with a communications package for a cost of $600 to $700.

Since most larger Canadian companies subscribe to public electronic mail systems, real growth is expected from inhouse systems. By 1988, the Canadian market is expected to approach $500 million (Cdn), according to California based Creative Strategies International market research consultants. (6)

Canada is currently two years behind the U.S. in adopting voice mail. Canadian corporate head offices are smaller and consequently there are fewer organizations large enough to be able to justify the purchase of a system. However, this trend is expected to change as recent developments in voice mail technology make it more affordable and user friendly.

4.3.3 Supply Analysis

Strengths and Weaknesses

A consortium of 29 Canadian colleges and universities have established an electronic messaging system called CDNnet based on X.400 standard. Although the network itself is deliberately restricted to educational institutions and is not intended for commercial applications because of its X.400 technology. The CDNnet software, EAN, was developed at the University of British Columbia and is now in use in the US, UK, West Germany, Switzerland, Spain, Italy, Korea and Australia. (7) Telecom Canada provides Envoy 100 a national store and forward messaging service, for the business community.

International Market Share

Presently it is unclear who the dominant players are in the international electronic mail market, since widespread adoption of the X.400 standard, which will allow the interconnection of various services worldwide, has not yet happened. Currently, US service providers dominate the US market, European PTT's dominate the European market and Canadian service providers dominate the Canadian market. For the present, Telco's have an obvious advantage, however deregulation of terminal equipment in North America is opening up a large market for private installations to provide private electronic mail service over private networks. Once widespread adoption of the X.400 standard is realized, major US-based equipment suppliers and service providers such as IBM/ROLM, Wang, Xerox, Data General, Hewlett-Packard, Texas Instruments, Western Union and GTE may capture substantial shares of this market by offering price reductions and competitive rates. Canadian companies are not expected to become major hardware suppliers for electronic mail systems, but do have the potential to compete as service providers. Presently, Telecom Canada, CNCP and Immedia Telematics dominate the Canadian electronic mail market, and together with Cableshare, I.P. Sharp and Northern Telecom, these companies represent a potentially strong Canadian presence in the international electronic mail market.

Market Constraints

Several factors common to all service providers are responsible for the limited use of electronic mail services. Among these have been user awareness of electronic mail, incompatibility issues and complex pricing structures due to varied service offerings. Many potential subscribers to electronic mail services are unaware of electronic mail technology, its workings and its benefits and therefore never consider adopting this service. Another problem is the inability to communicate with other services internationally due to incompatibility in protocols and equipment; however, incompatibility problems will be resolved with widespread adoption of the X.400 standard. Another major problem is a complex pricing structure. Typically, prices are based on some combination of monthly rates, line charges, and/or character counts with further variations based on the type and when the service is used. Present pricing structures confuse and deter potential subscribers.

4.3.4 Competitive Analysis

Major Supplier Strategies

Supplier strategies include joint development of equipment as specified by the X.400 Recommendations and interconnection of major public electronic mail systems, as outlined below:

1) Northern Telecom, 3 Com, Xerox, Wang, ICL, GTE, and others have an agreement to work towards a joint demonstration of X.400 interworkings in 1986.

2) MCI and GTE have both announced forthcoming X.400 compatability.

3) Announcement that GTE's Telemail and Telecom Canada's Envoy 100 will be interconnected.

4) Most European PTT's will support X.400.

Marketing strategies will be a key factor in selling electronic mail systems. Because it is application oriented, and difficult to quantify potential cost savings, it must be sold with a definite use in mind. This will be particularly challenging to existing sales forces. Further, stand alone systems are not expected to be able to compete with PBX-integrated systems and suppliers who do not have agreements with PBX manufacturers will probably not survive.

Some PBX manufacturers appear to be using integration strategies as an interim solution. Northern Telecom, for example, is marketing the EVX (electronic voice exchange) system from US based ComTerm, as an integrated module, however Northern is also known to be developing its own integrated voice mail system. Mitel, will also be marketing a voice mail system called ASPEN, from Octal Communications Inc. of San Jose, California in 1986 but is seriously considering developing its own.

Rolm appears to be the only manufactuer with its own integrated voice mail systems and unlike other manufacturers whose strategy is to develop systems compatible with as many PBXs as possible, they make no claims to compatibility with other suppliers of PBXs.

Comparison of costs on a per port basis, showed price ranges from a high of \$20,000 (US) per port for the IBM ADIS (audio distribution system) to \$5,000 (US) per port as the low. (8)

<u>Market Niches</u>

Market niches include the provision of specialized and added feature services which have the capability to send word processing documents, graphics, data processing files, spreadsheets and voice-grams. Another market niche which Cableshare has successfully exploited is the provision of private elctronic mail services for companies wanting control over their own systems.

Major Canadian Suppliers

Service Providers - There are three major service providers in Canada:

1) Telecom Canada - Envoy 100, Envoy Post, TWX

Telecom Canada is an association of the nine largest Canadian telephone companies and Telesat Canada, the domestic satellite carrier. Telecom Canada's Envoy 100 is a national store and forward messaging service accessed by standard terminals through the conventional telephone network. Envoy Post, an Envoy 100 option, is an electronic mail service offered jointly by Telecom Canada and Canada Post. Envoy Post allows subscribers to send messages to nonsubscribers through Canada Post's electronic mailprint and delivery service. Telecom Canada's Teletypewriter Exchange (TWX), a switched teleprinter service, provides access to over 1 million teleprinters worldwide.

2) CNCP - Electronic Office Services

CNCP is a partnership of the telecommunications divisions of Canada's two major railways, Canadian National Railways and Canadian Pacific Ltd. CNCP's Infotex service enables users of word processors to communicate with each other both nationally and internationally. Telepost, a joint service between CNCP and Canada Post, provides the electronic transfer of messages received by Telex, telephone or computer tape to a post office near the intended destination, to be printed out and delivered by mail. CNCP's Telex, a switched teleprinter service, provides access to more than 1 million teleprinters worldwide.

3) Immedia Telematics Inc.

Immedia Telematics Inc. offers a bilingual electronic mail service directed at the business market. Immedia's service operates on software they have developed for IBM PC's and compatibles.

4) I.P. Sharp & Assoc.

I.P. Sharp has offered a mailbox service to its subsidiary companies since 1970 through its own international telecommunications network (Ipsanet). Ipsanet is also interconnected to the international Telex network and provides access to more than 600 cities in 46 countries. Sharp's electronic mail service can provide a timesharing service with access to Sharp's central computer or allow companies to purchase or buy mailbox software for use on their computers.

Equipment Manufacturers

1) Northern Telecom

Northern Telecom, a leading designer and manufacturer of telecommunications equipment, is also a major hardware supplier of office automation equipment. Northern Telecom is presently marketing US-based ComTerm's EVX (electronic voice exchange) system as an integrated module for their switching equipment.

2) Cableshare Inc. offers a private electronic mail service called Mercury 2000. As of March 1985, there were 600 subscribers and the company expected to add 200 subscribers per month, allowing it to turn a profit within 12 months. The company believes they have found a niche in private network electronic mail systems.(2)

Non-Canadian International Competitors

Service Providers - major US service providers include:

1) Western Union - Telex I, Telex II (TWX), Infocom, Easylink, Teletex, Mailgram, telegram, E-COM, Computer Letter.

Telex services, Telex I and Telex II, allow subscibers to send Mailgram and domestic and overseas telegram messages from their terminals. The Infocom service provides the interconnection of computer and data terminals of various speeds. Easylink provides a store-and-forward message and an electronic mail service. Teletex, a more recent electronic mail service, combines text typing and processing with directory-based switched communications. Mailgram provides next day delivery with mail of messages transmittted nationwide. E COM (Computer Originated Mail) provides two day delivery of priority mail messages; and Computer Letter, three days or more.

2) IRC's - RCA, ITT, TRT, WUI, FTCC provide international telex services from the USA.

3) GTE Telenet Communications Corp.

GTE is a major supplier of electronic mail services in the US. GTE, a leader in the application of the X.400 protocol, announced the future interconnection of their Telemail service with Telecom Canada's Envoy 100 service.

Equipment Manufacturers

1) Wang - OFFICE

2) DEC - All-In-One

3) Data General - CEO

Wang's OFFICE, DEC's All-In-One and Data General's CEO offer extensive electronic mail features fully integrated with their other office automation offerings. These systems are incompatible with IBMs SNA (Systems Network Architecture) which has emerged as the standard for large area networks and will have to compete directly with IBM in the marketplace.

4) IBM/Rolm - has specified electronic mail standards based on SNA. These standards are called Document Content Architecture (DCA) and Document Interchange Architecture (DIA), however, even IBM has been supportive of the X.400 development as an OSI standard.

5) Texas Instruments

Texas Instruments recently announced its own LAN-integratable voice-mail system.

6) Sperry

Sperry is a supplier of office automation equipment

7) Hewlett Packard

Hewlett-Packard is a major electronic mail hardware vendor.

4.3.5 Summary

Electronic mail in its simplest form is the person-to-person communications of text and graphics information employing facsimile devices, computer-based message systems (CBMSs), teleprinter services (i.e. telex, TWX, teletex) and voice mail.

Electronic mail offers several advantages including speed of delivery, duplication of text and graphics, store-and-forward capabilities, rapid turnaround, and cost savings over conventional mail and courier services.

The electronic mail market is estimated to be $4.3 billion in 1990 and $500 million in 1988 for the Canadian market in particular. It is unclear as to who will emerge as dominant players in the international electronic mail market since widespread adoption of the X.400 standard allowing the interconnection of various service providers internationally has not yet happened. Presently, US service providers, European PTT's and Canadian service providers dominate their respective domestic markets. For obvious reasons, Telco's presently have the advantage, however, continued deregulation will lead to the introduction of private electronic mail services. With consideration given to current trends (ie. widepsread adoption of the X.400 standard, deregulation) Canadian electronic mail service providers may some day experience increased competition in domestic as well as international markets. Present market niches for Canadian companies include the provision of specialized and value-added services with capabilities to send word processing documents, graphics, data processing files, spreadsheets, and voice-grams and the provision of private electronic mail services.

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4.4 CAD/CAM Systems

4.4.1 Technical Description

Computer-aided-design (CAD) and computer-aided-manufacturing (CAM) were originally conceived as design and automation tools for the aircraft and automotive industries in the late 1960's. The early systems were mainframe-based, centralized and offered only two-dimensional graphics capabilities with limited software.

Advances in semiconductor and other computer-related technologies have resulted in more powerful computing capabilities while dramatically reducing the costs and physical size of CAD/CAM system hardware.

As a computer-based technology, CAD/CAM systems are ideally suited for those applications requiring the processing and management of vast amounts of variables and data (ie. CAD systems facilitate the modification of existing drawings) and for those processes requiring duplication and repetitive operations (ie. assembly line-type operations). Since CAD/CAM systems offer great potential for reduced expenses and increased productivity and profits, they are considered by those manufacturers without such systems as a necessary means for survival, especially against competitors who also employ them.

4.4.2 Demand Analysis

Factors of Change

Several factors are responsible for the lack of implementation of CAD/CAM systems in many Canadian industries. Among these are human factors of attitudes and awareness and price. A major factor responsible for the growing trend to implement CAD/CAM systems is the need for manufacturers to increase their competitiveness.

1) Human Factors of Attitude and Awareness

A recent survey involving 623 executives of small, medium and large Ontario manufacturing firms was conducted by Foster Research Services for the Ontario Centre for Advanced Manufacturing (OCAM). The study revealed that 'attitudes' were the major barrier to the implementation of advanced manufacturing techniques such as CAD/CAM and robotics. Although many of these respondents were aware of the advantages of CAD/CAM and robotics, reasons of attitude were cited 3 to 5 times more often than reasons of finances. The survey revealed that 43% believed their company was too small and did not have the volume to justify installing a system; 37% believed CAD/CAM technology did not apply or qualified people were in short supply; and only 8% expressed financing as the reason. (1)

A second major reason for the lack of implementation of CAD/CAM systems by many manufacturers is the lack of awareness of the technology and the benefits to be derived from its application. Due to the large number of suppliers in the market, the wide variety of systems available and the continual introduction of new generations of systems; it becomes extremely difficult for the would-be user to make a purchasing decision. Many executives are not thoroughly convinced of the potential to increase productivity and reduce costs through the application of CAD/CAM technology.

2) Price

The cost of major CAD/CAM systems have deterred many potential users. Executives who are faced with buying decisions show an unwillingness to make substantial investments in CAD/CAM systems; especially for the first-time user when there is no basis for comparison. For example, a mainframe-based CAD system is priced within the $100,000 range, whereas a standalone CAD workstation is approximately $15,000.(2)

3) Need to be Competitive

According to a recent study by the Canadian Manufacturing Association (CMA), only about 14% of manufacturing companies in Canada have installed CAD/CAM systems. (3) As Brian McGourty, president and CEO of Honeywell Ltd., Toronto, stated in a speech at the recent Canadian CAD/CAM and Robotics Conference: "Canada's relatively poor record of adopting manufacturing-automation technologies translates itself directly into higher unit costs, low productivity, a quality disadvantage and slow market responsiveness...the real bottom-line benefit is competitiveness and the long-term viability of the business". (4) Canadian manufacturers are now realizing that in order to remain competitive, they must install CAD/CAM systems to increase productivity and reduce costs. As Haig Saadetian, General Manager of CAD/CAM for Massey-Ferguson, noted with regards to MF's plan to be "totally CAD/CAM dependent by 1986": "We had to do it because our main competitor already has over 80 CAD/CAM terminals in operation." (5)

Areas of Major Growth

1) Trends in CAD/CAM and CAE

Development trends in CAD continue toward more powerful 32-bit colour workstations operating standalone or in multi-station configurations linked to a central database.

Current trends in CAM include software for mechanical numerically controlled (NC) applications, more powerful and widespread use of micro-processor based programmable controllers on the factory floor, and improved size, number and complexity of database management systems (DBMS).

Trends in CAE hardware parallel those in CAD; however as far as functionality is concerned, product and part layout comprise the majority of work for CAD systems while engineering functions such as conceptual design, modelling, simulation and analysis are the domain of CAE systems. CAE systems, originally developed for electronics applications (printed and integrated circuit design), are also performing mechanical analysis and simulating functions in three dimensions which requires more complex software than the two dimensional world of circuitry.

2) Applications Software

The demand for a wider range of more versatile applications software packages, particularly for electronics applications, is continually increasing. Software packages for mechanical, architectural and engineering applications are also in high demand, and as well three dimensional solids and modelling software as they become more affordable.

3) Automation

Numerically controlled tools, operating under the control of computers, perform a variety of specific functions including lathing, milling, metal forming, boring, drilling and flame cutting. The number of NC tools installed in Canadian industries is on the increase, from 500 in 1974 to 3,500 in 1984, but lags far behind its three industrial trading partners with NC tools accounting for only 4.4% of machines in Canadian industries in 1983 compared to 38% in Japan, 13% in the US and 8% in the UK. (6)

Much of the robotic equipment used in industry today is too primitive to respond flexibly to a dynamic environment. Robotics software is currently limited to motion control and the basics such as program, storage and recall. For robotics to gain a wider acceptance in industry more powerful and user-friendly robotics languages must be developed. As with NC tools, the number of robots installed in Canadian industries is on the increase, rising from 20 in 1975 to 1,032 by September 1985, but far behind other industrialized nations. As of January 1984, there were 3.7 robots per 10,000 labourers in Canadian industries, placing Canada ninth behind Japan, Sweden, West Germany, Czechoslovakia, France, Belgium, the US and Italy. (6)

4) Computer-Integrated-Manufacturing (CIM)

CIM is a combination of advanced technologies designed towards the total integration of virtually all business functions, from design and production to marketing and administration, through the sharing of information in a central database. The significant advantages of CIM is improved productivity and profits, improved control over expenses and decreased product design cycles. CIM utilizes a number of technologies including CAD/CAM, numerical control, robotics, artificial intelligence applications, and flexible manufacturing systems (FMS) etc. The key difference between a CIM system and a

CAD/CAM system is the database management system (DBMS). CAD/CAM systems are designed for special applications and have special definitions for their data. DBMS's in a CIM system operate independently of all other functions and act as the system's controller, unifying individual workstations to create an overall automated system.

5) Combining Artificial Intelligence Principles With CAD and CAE

Artificial intelligence principles and applications (expert systems in particular) will be incorporated into and integrated with CAD and CAE systems to extend the horizons of computer-aided-engineering to computer-automated-engineering. The central computer will have the capability to undertake a project from conception to completion with only one input from the project manager (by voice) similar to the way in which design teams work today.

Growth Estimates

1) International Market

According to SRI International, the North American CAD/CAM market (essentially the US market) is estimated to be approximately $4.4 billion in 1988 with 36% of the total accounting for applications software (7) and according to International Data Corp. (IDC), the CAD/CAM market for electrical/electronic design will total $3.2 billion in 1987 of which CAE workstations will account for $1.1 billion. (8)

Although projected estimates for the CAD/CAM/CAE market may not be clear, substantial growth in the next several years is expected to continue. This trend can be attributed to the record-breaking year for revenues CAD/CAM/CAE vendors experienced in 1984. According to Daratech Inc., a US-based research firm specializing in CAD/CAM/CAE market research, US vendors had estimated revenues of $2.7 billion in 1984, which translates into an annual growth of 50%, up from 40% in 1983 and 28% in 1982. (9) This growth is mainly due to the availability of more powerful and cost-effective systems coupled with an increasing willingness by corporations to make substantial investments in design and automation tools.

2) Canadian Market

Given the significantly smaller base of manufacturing facilities in Canada in relation to that of the US and the fact that approximately only 14% of Canada's manufacturers purchased and implemented major CAD/CAM systems as of 1985 (3), the Canadian CAD/CAM market is currently small, but is expected to experience rapid growth in the next several years.

The Canadian CAD/CAM market, which was estimated at $57 million in 1982, is expected to grow at an approximate annual rate of 40% increasing to approximately $294 million in 1987. (10)
Large US-based turnkey vendors such as Intergraph, Computervision, Calma, Auto-trol and Applicon dominated the Canadian market in 1983 with a 75% share while hardware manufacturers such as IBM, Digital Equipment Corp., Prime, Hewlett-Packard and Data General accounted for the remaining 25%. (10) Similar market domination by US-based turnkey vendors is not expected to change in the foreseeable future since turnkey systems are generally the most cost-effective means to quickly apply CAD/CAM technology. Turnkey vendors supply application software, software support, customer training and system installation. The hardware is usually supplied by Original Equipment Manufacturers (OEMs).

4.4.3 Supply Analysis

Strengths

1) Technical Resources and Expertise

Canada's major strength lies in its technical resources. Canadian universities and colleges continually generate an adequate supply of engineering and computer graduates, technologists and technicians, capable of applying CAD/CAM technology. However, in order to develop and implement CAD/CAM technology and remain competitive, Canadian CAD/CAM vendors and Canadian manufacturers must utilize this resource to the fullest.

Although Canada lacks the capability to be a major leader in developing and supplying robotics hardware and computer-related products (particularly in the areas of semiconductor technology and associated computer hardware), the potential for Canada to become a major developer and supplier of CAD/CAM system and applicatons software is real. I.P. Sharp and Assoc. serves as one example of a Canadian firm with a significant portion of the international CAM software market. Among its many services, I.P. Sharp develops CAM software used in the manufacturing processes for semiconductor IC and pharmaceutical industries.

2) Government Support

To promote the awareness and benefits of CAD/CAM technology to industry and foster a better working relationship between industry and government, the Provincial Government of Ontario has allocated $90 million over 5 years to open six CAD/CAM technology centres across the province. (3) Two of the centres, the Ontario CAD/CAM centre in Cambridge and the Ontario Robotics Centre in Peterborough, were established in 1982 under OCAM through the provincial Board of

Industrial Leadership and Development. Thus far, industry reaction towards the centres has been mixed, and it may take some time before the real benefits are realized.

Weaknesses

There are several major weaknesses responsible for the lack of development, implementation and marketing of CAD/CAM techology by Canadian vendors.

1) Lack of Major Computer-Related Industries

The absence of strong Canadian corporate entities (ie. a Canadian equivalent to an IBM) in the development and supply of semiconductor or computer-related technologies (computer hardware, operating systems, processing languages) is a major reason there are no large Canadian CAD/CAM vendors with substantial shares of the international market.

2) Lack of Implementation CAD/CAM Technology

The lack of implementation of CAD/CAM systems by many would-be users in Canadian industries has reduced a potentially substantial market for Canadian CAD/CAM vendors into a significantly smaller one.

3) Weak Marketing Infrastructure

Canadian CAD/CAM vendors have mentioned it is extremely difficult and costly to bring a product to market and to penetrate the international market.

International Market Share

Canadian CAD/CAM vendors never had a substantial portion of the international market share, a trend which will not likely change in the foreseeable future.

The international market is dominated by the following US-based turnkey and hardware vendors: Computervision, IBM, Intergraph, Calma and McAuto. According to Daratech Inc., Computervision had estimated revenues of $542 million for a 20% share of the market in 1984. IBM, with sales which grew at an estimated annual rate of 60% in 1984, increased its market share to 19%. Intergraph, with an annual growth rate of 71% in the first nine months of 1984, had estimated sales of $402 million for 15% share of the market in 1984. (9)

Market Constraints

The major market constraint preventing the penetration of the international CAD/CAM market by Canadian vendors is the lack of a strong and effective marketing infrastructure. Canadian companies have not even been able to capture a significant portion of the Canadian CAD/CAM market, let alone the international one. Canadian vendors are not able to compete head-to-head against US giants like IBM and Computervision and others who control approximately three-quarters of the Canadian market. Canadian vendors cite the high costs of advertising and product demonstration and the lack of an effective product distribution network (ie. sales offices and/or manufacturing plants in the international marketplace) as contributing factors to an almost non-existent market share.

4.4.4 Competitive Anaysis

Major Supplier Strategies

The strategy of Computervision, the most dominant of the turnkey vendors, is to bring to market a wide variety of hardware and software, that when combined, provide specific CAD/CAM, CAE solutions over a broad range of price and performance. In a break with tradition, Computervision will base new generation products on purchased computer and workstation hardware, and focus its hardware R&D and manufacturing resources on optimizing performance using system-level interfaces. In the software area, Computervision will continue to develop in house, key graphics and applications packages, but will depend on outside vendors for specialty applications and operating software.

A current strategy being used by traditional suppliers of systems hardware such as IBM, DEC, Prime, Hewlett-Packard and Data General, is to become involved in third-party software joint ventures to claim a larger portion of the market share presently dominated by turnkey vendors. DEC has been of the more aggressive suppliers to use this approach, having signed over 50 contracts with third party software designers, like Tektronix, and continues to search for other potential co-operative marketing partners (CMPs).

Market Niches

CAD/CAM applications software and hybrid CAD/CAM and expert systems application software are two potentially attractive markets which Canadian companies have the capabilities to successfully exploit

Canadian Capabilities and Potential

Due to the dominant position both American and Japanese companies have as developers and suppliers of semiconductor and other computer-related technologies (ie. computer hardware, operating systems and processing languages), Canadian CAD/CAM vendors should avoid research and cost intensive ventures in an attempt to reduce the large technology gap that lies between them. Rather, Canadian companies should exploit the knowledge derived from the research of others and apply it in the form of applications software drawing from our technical resources and utilizing our capabilities and expertise as developers of applications software.

Secondly, Canada should concentrate its efforts in developing a strong marketing infrastructure. A quality product is not adequate to successfully penetrate the international market and sustain a presence there. A cost-effective product distribution network is also required. One small Canadian CAD/CAM vendor noted their unsuccessful attempts to market against giants in the US, a product of similar quality. As well, the costs required to penetrate the international CAD/CAM market are so prohibitive, a move of operations to the US, for these firms, appears necessary for survival. Realizing the need for R&D funding as a means to remain abreast of technology, Canadian companies have recognized a greater need, and that is, a strong marketing infrastructure. Canadian companies would welcome federal government involvement in the form of marketing programs designed to provide funding and strategic planning.

Major Canadian Suppliers

The following is a list of major Canadian companies involved in some aspect of the development and/or implementation of CAD, CAM and CAE products and services. The majority of Canadian companies currently do not have significant shares of either Canadian or International CAD/CAM markets. As an example of Canadian market share, Systemhouse, Orcatech and Omnitech, three major Canadian CAD/CAM turnkey vendors, had a combined market share of approximately 10% in 1982. (5)

1) Bunt-McRae CAM Services Inc.

Bunt-McRae is manufacturer and distributor of CAM software for manufacturing and cost-estimation applications.

2) I.P. Sharp Assoc. Ltd.

Amongst the several services provided by I.P. Sharp, is the development of software for CAM systems used in the integrated circuit manufacturing process.

3) Omnitech Graphics Systems Ltd.

Omnitech develops and markets CAD/CAM workstations for engineering, architectural and manufacturing applications. Omnitech had revenues of $2.8 million or 4% of the Canadian CAD/CAM market in 1983. (10)

4) Orcatech Inc.

Orcatech markets single and multiple-terminal CAD systems particularly in the educational drafting market. Orcatech had revenues of $3.2 million or 4% of the Canadian CAD/CAM market in 1983. (10)

5) Systemhouse Ltd.

Systemhouse markets CADD systems for cartograhy, architectural, electrical, construction, manufacturing and electronics applications. Systemhouse had revenues of $2.4 million or 3% of the Canadian CAD/CAM market in 1983. (10)

Non-Canadian International Competitors

1) Calma

Calma is a turnkey system vendor and ranks among the top five market leaders.

2) Computervision

Computervision is one of the five major turnkey vendors in the US CAD/CAM market. Computervision develops and markets various hardware and software products. Among these, include CAD/CAE workstations for electronic circuit design and analysis applications.

3) Data General

Data General is a major supplier of turnkey systems hardware.

4) Digital Equipment Corp. (DEC)

DEC is a major supplier of turnkey systems hardware.

5) Hewlett-Packard

Hewlett-Packard is a major supplier of turnkey systems hardware.

6) IBM

IBM is a major supplier of turnkey systems hardware and ranks among the top five leaders in the CAD/CAM market.

7) Intergraph

Intergraph is a turnkey system vendor and among the top five market leaders.

8) McAuto

McAuto is a turnkey system vendor.

9) Prime

Prime is a major supplier of turnkey systems hardware.

4.4.5 Summary

CAD/CAM is a technology struggling to reach maturity as evidenced by its slow adoption by Canadian industry. Although a substantial majority of the manufacturing sector acknowledges the potential benefits of improved productivity and profits, improved control over expenses and decreased product design cycles possible through its implementation, many manufacturers have demonstrated a great reluctance towards adopting CAD/CAM technology. Of the various factors contributing to its lack of implementation, attitudes and the awareness on the part of the manufacturer towards CAD/CAM technology were cited more often than financial reasons. Many manufacturers believe their companies are too small, the technology does not apply to their operations or the lack of qualified people to operate such systems suggests their purchase cannot be justified. Additional factors of price and the fact that numerous vendors and products on the market add confusion and difficulty to the purchase of CAD/CAM systems have deterred potential users.

Given the smaller base of manufacturing facilities in Canada, relative to that in the US, and the small percentage of Canadian manufacturers who have thus far implemented major CAD/CAM systems, the Canadian CAD/CAM market is signifcantly smaller than the US market. Adding to the difficulty faced by Canadian companies competing in a small domestic market is the fact that US hardware manufacturers and turnkey system vendors presently dominate the

Canadian CAD/CAM market. Although various government-backed CAD/CAM centres were designed to promote the awareness and benefits of CAD/CAM technology to Canada's various manufacturers, the benefits to Canadian manufacturers and turnkey vendors of CAD/CAM systems have been questionable. Canadian companies involved in all aspects relating to CAD/CAM products and systems recognize that their survival depends upon primarily their successful penetration and sustained presence in international markets, specifically the large and nearby US market, as well as the development of products and systems directed at niche markets.

Canadian CAD/CAM companies cannot and should not compete head-to-head in markets presently dominated by US and Japanese giants. These markets which are too research and cost intensive for most Canadian companies include the development and manufacture of CAD/CAM system hardware and the development of system software (ie. processing languages and operating systems). Rather, Canadian companies should concentrate their resources towards the development of less research and cost intensive products of application software for which there is a significant lack of and demand for. As well, the CAD/CAM related areas of computer-integrated-manufacturing (CIM) and hybrid AI (specifically expert systems)/CAD/CAE systems, technologies still in their infancy and far from being fully commercialized, are additional areas Canadian companies should pursue.

However, the most pressing issue and one of greatest concern to Canadian CAD/CAM manufacturers and system providers is that of Canada's weak marketing infrastructure. These companies recognize the importance of R&D funding to remain abreast of technology, but recognize an equally important need for an effective product distribution network if successful penetration and sustained presence in international markets are to be achieved. Thus, Canadian CAD/CAM companies recognize the need for federal government assistance through funding and strategic planning to strengthen Canada's marketing infrastrucutre and competitive position in international CAD/CAM markets.

Definitions and Terms

DBMS Database Management System

A central database requiring specific software and a separate set of rules for database definition. The DBMS consists of three parts: 1) the conceptual schema, 2) the internal schema and 3) the external schema. The conceptual schema is a logical definition of the overall database and is used to establish the entity types used to make up this information resource and the way they will relate to each other. The internal schema maps out how the data will be stored and the access paths which will exist to allow users to retrieve the information. The external schema sets out the logical definitions for the section of the database to be used for a specific application.

FMS Flexible Manufacturing Systems

In an FMS system, individual machines or machining lines are replaced with groups of horizontally integrated, programmable machines which are organized into cells and connected by automated materials handling systems. Configurations such as these form 'islands of automation' on the factory floor. Several of these islands are then linked to a master computer system.

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4.5 Expert Systems

4.5.1 Technical Description

Expert Systems is one of five areas that comprise artificial intelligence (AI) technology:

1) expert systems
2) natural-language software
3) computer-aided-instruction
4) visual recognition
5) voice recognition

Expert systems are knowledge-based systems which use rules of inference unique to a specific area of expertise to aid in decision making and problem solving.

The phrase, artificial intelligence, was coined by John McCarthy, then assistant professor of mathematics at Dartmouth College in Hanover, N.H., to describe the work of researchers to automate human cognitive processes. The roots of AI can be traced back to 1956 when McCarthy organized a conference to bring together top researchers in the field and establish channels of communication among them. The Dartmouth conference helped to formally establish AI as a separate entity of computer science.

A milestone in AI was the presentation of Logic Theorist at the Dartmouth conference. Developed by Allen Newell and Herbert A. Simon at the Carnegie Institute of Technology in Pittsburgh (presently the Carnegie-Mellon University), Logic Theorist was the first working AI program and the first program to allow a computer to process concepts rather than numbers. Written in Information Processing Language (IPL), a language created to model simple human problem-solving techniques, Logic Theorist enabled a computer to function as the first symbolic processor.

Another AI pioneer in attendance at the Dartmouth conference was Marvin Minsky of the Massachusetts Institute of Technology (MIT) in Cambridge. Since then, these researchers have led the way in the development of AI technology. McCarthy, creator of the most commmonly used AI language, LISP, is director of the AI lab at Stanford University, Palo Alto, Caifornia. Newell and Simon have turned Carnegie-Mellon into a leading US AI research centre and Minsky has directed AI programs at MIT and written extensively on heuristic programming.

AI milestones in the 1970's included the development of the first expert system under Edward Feigenbaum of Stanford. Feigenbaum's Dendral expert system assisted chemists in the analysis of mass spectrosocopy. At Xerox Corp.'s Research Centre at Palo Alto, California, AI developments included enhancements to LISP and the creation of LISP tools, interactive programming environments and workstations with graphics capabilities. At SRI International in Menlo Park, California, other knowledge-based systems were developed.

Since the Dartmouth conference, AI has relatively been the subject of research by academia with little or no commercial applications until recently. Early AI research focused on general problem-solving solutions. However, this approach suffered from computational explosion as exhaustive searches of a problem domain resulted in numerous possible paths whose branches grew exponentially. To solve a problem in this manner was too complex for conventional computing methods. Realizing that humans have a tendency to use their accumulated knowledge of the world and their unique experiences to solve problems rather than trying all possible alternatives, AI researchers felt computers could be programmed to do the same. Eventually AI research centred on problems of how to conceive of and represent thinking and learning and how to represent knowledge and make inferences from it. AI researchers have now abandoned an earlier approach in trying to create machines to think, settling for those that draw inferences from data. With this approach and the availability of less expensive and more powerful computing capabilities, commercial applications of expert systems and other AI-related technologies can now be realized.

Applications of expert systems are based on the premise that a programmer will work with an expert in a certain area to create an 'expert system' which would then be an electronic equivalent of a specialist or professional. Ultimately the benefit of an expert system will be the duplication of not only a single expert but a group of experts. The remaining technical description deals with the basic functional components of an expert system and provides examples of current expert systems.

<u>Expert System Components</u> (Refer to Figure 4.5.1.1)

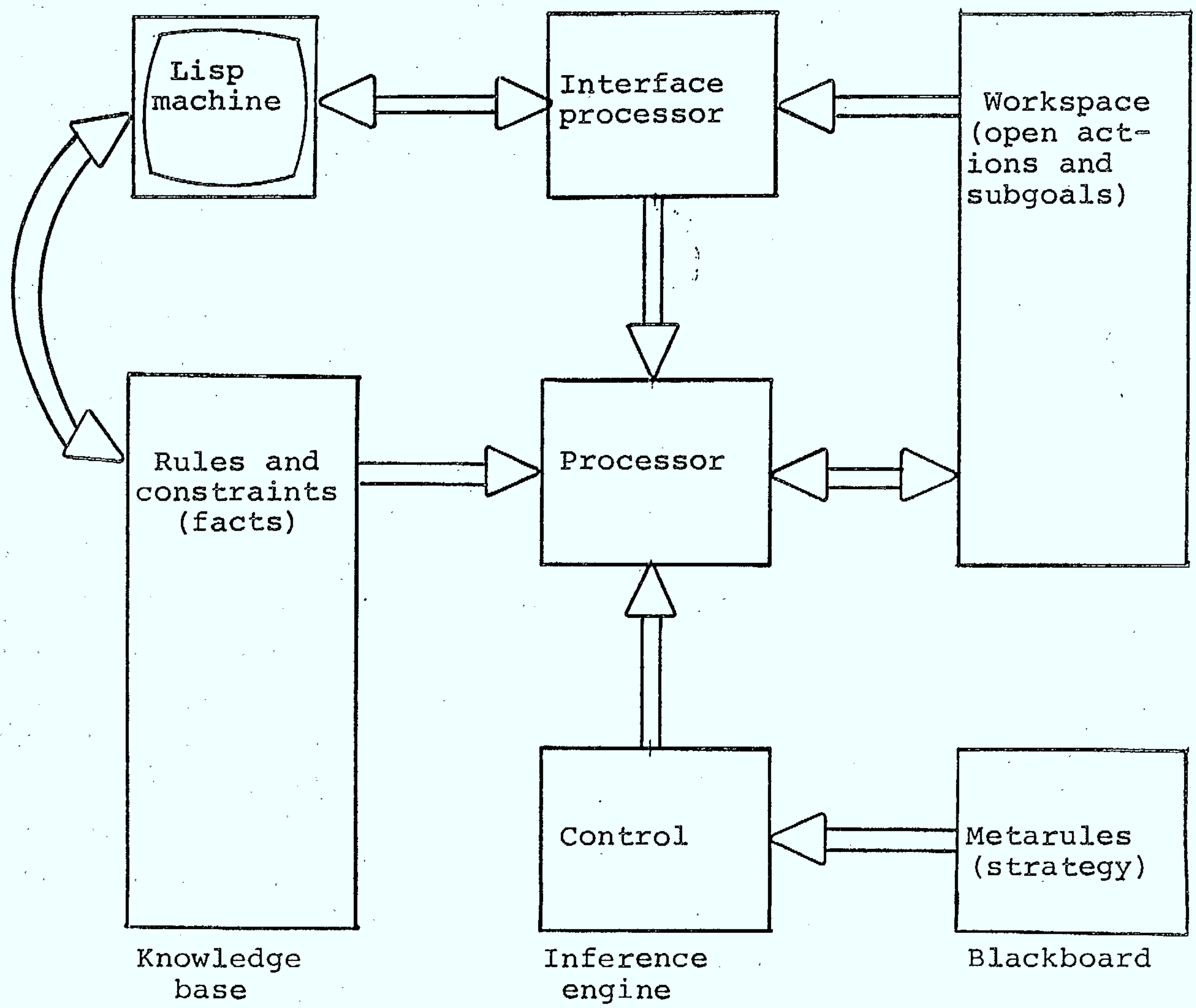
1) Hardware

Currently most expert systems require large and fast mainframe computers (ie. VAX-11/780) with intelligent terminals (Lisp machines) and large memory requirements. However, the requirement for faster processing and larger memories will lead to the use of fifth generation supercomputers (ie. Cray-2, X-MP) and optical storage media. (Refer to Figure 4.5.1.2.) Fifth generation computers incorporate gallium arsenide based IC's allowing these computers to operate in excess of 800 million instructions per second (Mips) compared to a minicomputer with a typical processing rate of 1 Mips.

Currently, personal computers are not suitable for the implementation of extensive expert systems which require large memory capabilities. AI researchers have expressed concern over the potential for the end-users to regard expert systems, configured for PC's, as infallible. Such expert systems may be limited in scope and

FIGURE 4.5.1.1

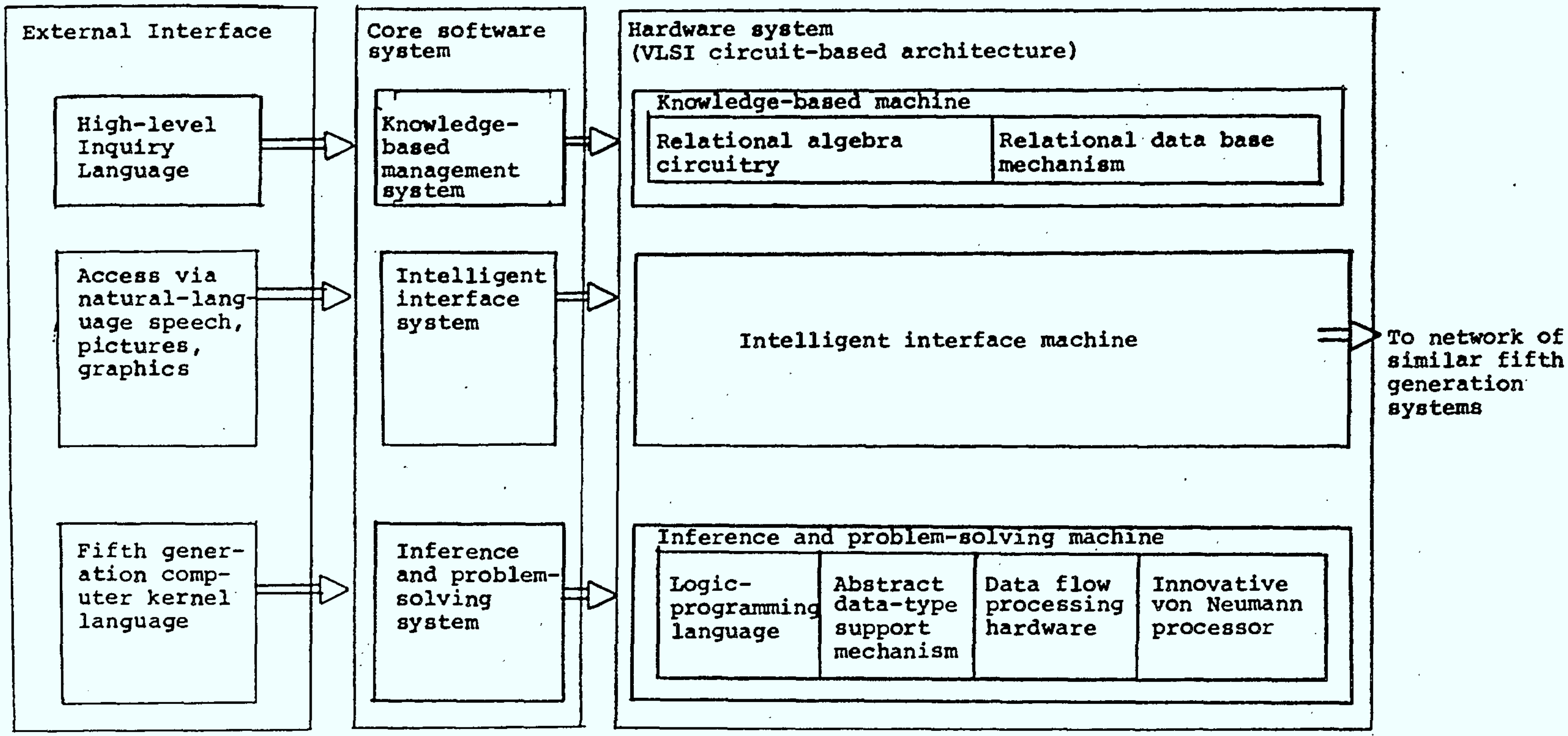
BLOCK DIAGRAM OF AN EXPERT SYSTEM



Source: Electronic Design, August, 1984

FIFTH GENERATION COMPUTER SYSTEM STRUCTURE

FIGURE 4.5.1.2



Source: Fourth Generation Languages Volume 1, James Martin, October 1983 contain too few rules; however, recent developments indicate that workable expert systems employing fewer rules can, depending upon the application, be successfully tailored for PC's.

2) Software

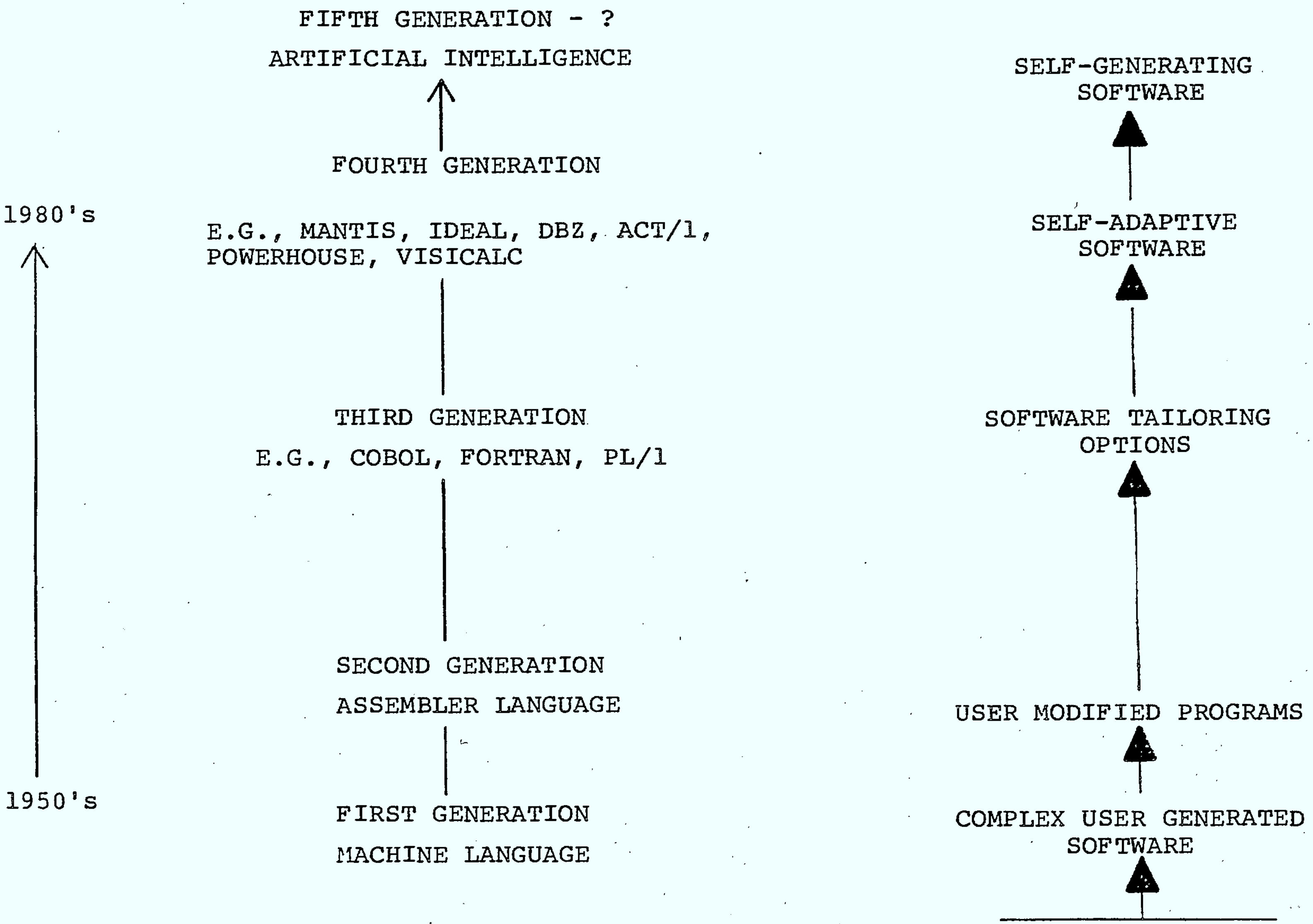
The heart of an expert system lies in its software. An expert system, basically consists of three parts: a knowledge base, an inference engine and a blackboard. The knowledge base is a data base that contains rules and facts from which the inference engine can deduce solutions. An inference engine operates like a 'software CPU' which manipulates rules (equivalent to algorithms) and facts or constraints (equivalent to data). It operates under the control of metarules (equivalent to the operating system) that determines system strategy. The blackboard is also a data base for recording intermediate results during problem solving.

Software requirements for expert systems include intelligent operating systems and compilers and fourth generation languages (4GLs) such as Lisp and Prolog. These are the two most commonly used symbolic processing languages. Trends in software development are illustrated in Figure 4.5.1.3. Fourth generation languages vary greatly in power and capabilities. Some are only query languages, others are report generators or graphics generators and yet others can generate complete applications.

LISP Lisp is a symbolic processing language used mainly in the US in artificial intelligence R&D activities and applications. Lisp, an acronym for List Processing Programming Language, was developed by John McCarthy at MIT in 1958. Lisp processes linked lists of symbols in memory and the symbols are manipulated by separately stored rules in the program.

PROLOG Prolog is a symbolic processing language used mainly in Canada, Japan and Europe in artificial intelligence R&D activities

Figure 4.5.1.3 SOFTWARE TECHNOLOGY TRENDS



Source: Technology Evaluation and Forecast, Robert Nickerson Ltd., March 1985 and applications. Prolog, an acronym for Programming in Logic, was developed by Alain Colmerauer and Phillipe Rousel at the University of Montreal in 1960's and later at the University of Marseilles in France. Prolog is based on objects and their relationships which are stored in a database. Prolog uses the database to make inferences and patterned relationships between the stored objects and rules.

Example Expert Systems

DENDRAL: determines the structures of chemical compounds.

HASP/SIAP: identifies and tracks ships at sea.

MYACIN: recommends a course of treatment for bacterial infections.

PROSPECTOR: determines possible sites of mineral deposits.

TAUMMETEO: translates weather bulletins.

XCON: configures combinations of VAX computer components.

Marketing Analysis

4.5.2 Demand Analysis

Factors of Change

1) Need for Expertise

Many companies have recognized the benefit of implementing expert systems as a means of eliminating the dependence upon highly skilled labour and experts who may be in short supply and in reducing the problems associated with human intervention in complex manufacturing processes. Currently, the Canadian process industry is experiencing deficiencies in quality and performance attributed to operators' mistakes, due in part to aging skills. Expert systems are seen as a means to eliminating these 'operational perturbations'.

2) Benefits of Increased Productivity and Reduced Costs

Expert systems have an enormous potential to reduce development costs, production cycle times and labour costs.

3) Advances in Computer-Related Technologies

With rapid developments in semiconductor technology and other computer related technologies; faster processing machines and larger storage systems become less expensive and more available, making the implementation of expert systems more attractive. Expert systems are no longer confined to a lab environment but are becoming a commmercial reality.

Areas of Major Growth

Major applications of expert systems include programs that diagnose diseases and recommend cures, prospect for mineral deposits, assist in the drilling and analyzing of oil wells, analyze investments, configure computer systems and assist in business decision-making.

With these tools, the potential for increased productivity and cost reductions are enormous. For example, if expert systems were employed in mineral deposit exploration, such that mineral detection was faster and more reliable than by conventional means, the development costs of such a program would be more than offset by the savings.

Although most of the best known and widely-used expert systems developed to date have been for medical and scientific applications, expert systems are expected to have a major impact in three other areas: financial services, equipment maintenance and manufacturing markets. In the financial services area, two sectors having the greatest potential to benefit from the use of expert systems are banking and insurance underwriting, where judgements must be made according to at least partly defined rules. Equipment maintenance experts are skilled in performing diagnostic work and expert systems have considerable potential as diagnostic tools to solve equipment failures. Therefore, in this area, expert systems could have a tremendous impact, especially considering the enormous range of equipment maintenance problems that exist today (ie. computers, automotive engines, aircraft, locomotives etc.). The manufacturing market provides a variety of applications for the use of expert systems from product design, production coordination and the enhancement of robotics systems to the supervision of orders and inventory.

Growth Estimates

1) International Market

Estimates of market growth for expert systems vary due to the fact that expert systems technology is presently in its infancy and any major commercialization of research and development activities in this area has yet to peak.

One source, DM Data Inc., a research firm based in Scottsdale, Arizona, has estimated the expert systems market to rise from $25 million in 1985 to $220 million in 1990 as indicated in Figure 4.5.2.1. (1) A more optimistic projection suggests that todays market of $20 million for expert systems and their development tools will rise to approximately $2.5 billion by 1993. (2)

2) Canadian Market

Projected estimates for the Canadian expert system market are significantly smaller than the US or international market. It is generally agreed that for Canadian AI-related companies to be successful, and to sustain growth will require a world market mandate. As Bill Campbell, president of Unitek, pointed out, international success is the key to survival for Canada's young and small AI-related companies.(3)

4.5.3 Supply Analysis

Strengths

Major strengths in Canadian expert systems technology lie in the ability of Canadian academic institutions to produce the required

Figure 4.5.2.1

THE ARTIFICIAL INTELLIGENCE MARKET

($ Millions)

MARKET AREA	Years									
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Expert Systems	4	6	10	16	25	40	60	90	145	220
Natural-Language Software	5	8	18	32	60	105	190	335	600	1090
Computer-Aided Instruction	3	5	7	11	15	20	30	45	70	100
Visual Recognition	7	15	30	55	100	150	230	360	555	860
Voice Recognition	4	6	10	14	20	30	50	80	130	230
TOTAL:	23	40	75	128	220	345	560	910	1500	2500

Source: The Emerging Artificial Intelligence Industry, DM Data Inc.

technical expertise, current R&D activities within Canada's universities and growing number of AI-related companies, and the financial and directional support provided by various research and government institutions.

Canadian companies involved in the development of expert systems technology feel that Canadian universities are producing sufficient numbers of highly skilled graduates and researchers in expert systems and AI-related areas.

Among the foremost Canadian universities conducting research into AI technology including expert systems are the Universities of Toronto, Western Ontario, Ottawa, Montreal, Saskatchewan, Alberta, British Columbia, and Laval and Simon Fraser University. The areas of research into expert systems are varied, with no one particular area dominant over another.

Areas where expert systems are currently undergoing development include: heart analysis (U of T), analysis of remotely sensed images of forests (U of Ottawa), linguistics and economic decision making (Laval), meterological productions (U of Alberta) and forest management (UBC).

Financial and/or directional support has been provided by the following organizations: the National Science and Engineering Research Council (NSERC), the Canadian Society for Computational Studies of Intelligence (CSCSI) and the Canadian Institute for Advanced Research (CIAR). NSERC currently funds the majority of the salaries of 275 assistant professors and intends to increase research professorship funding to $18 million per year within five years.(4) These grants are designed to support long term research and personnel development and potentially could have a considerable effect on AI work including expert systems in the country.

The CSCSI, established in 1973, promotes AI research and development in Canada. The membership in CSCSI has grown rapidly from 300 to 600 within the last year, reflecting the growing interest in this field. However, of these members, less than 200 are active in AI research and approximately only 20 are internationally known.(5)

Recently the CIAR, a private, nonprofit corporation established to promote Canadian research, has injected funds into AI and robotics. One of the aims of the CIAR program is to create a research environment at McGill, U of T and UBC that would attract top AI researchers worldwide to these institutions.

Weaknesses

The major weaknesses in the development of expert systems technology in Canada are a diminishing base of technical expertise and a lack of sufficient funding for AI-related research.

Canadian academic institutions are continually losing top AI researchers and graduates to the US. American universities, research centres, industries, and the US Department of Defense (DOD) have substantial amounts of money and equipment to attract AI researchers (for example, the DOD is reportedly spending $1 billion over 10 years into its Strategic Computer Initiative project). Although NSERC, the CSCSI and the CIAR currently provide funding for AI-related R&D activities in Canadian universities, it pales in comparison to that in the US. As well, there is a lack of a strong corporate presence devoted to AI research and development in Canada providing employment opportunities for Canada's AI researchers and graduates.

Consequently, it is difficult to keep top researchers or graduates here in Canada. As U of T's AI researcher Tsotsos notes: "You need a concentration of people, research time, and funding to keep people in the country. Even the CIAR program isn't always enough to keep people here, although it's a significant step in the right direction."(5) As long as substantial amounts of money and equipment and job opportunities in the US continue to attract Canada's best and the present state of Canada's AI research environment continues, there is no indication the current migration of technical expertise to the south will decline.

A major weakness in the commercialization of expert system technology in Canada is the lack of penetration into the US and worldwide markets due to a Canada's weak marketing infrastructure. Several companies have indicated the urgent need for marketing funds from the government to help overcome the substantial costs incurred while competing with the larger US firms in the worldwide market.

International Market Share

The international expert systems market, particularly in the areas of medical diagnosis, geological exploration and configuring computer equipment, is presently dominated by American companies who have several successful expert systems products on the market (ie. DENDRAL, MYACIN, PROSPECTOR, XCON etc.). Among the US companies who are expected to have a significant presence in the expert systems market (software and/or development tools) include IBM, AT&T, DEC, Honeywell, and Xerox to name a few. The following Japanese companies: NEC, Fujitsu, Mitsubishi and Sharp are also expected to have a significant international market share.

Canadian companies generally agree that Canada's share of the international market in the areas where American and Japanese presently dominate (ie. processing languages, operating systems, compilers and hardware) will surely be insignificant in comparison. However, they do suggest Canada's international market share could be significant in the application of expert systems to areas of industrial automation, consulting, transportation and in particular, where Canadians have noted expertise, resource industries: mining, oil and gas, hydro-electric power, fishing, forestry and wheat.

Market Constraints

There are currently no major regulatory restrictions or other such barriers restricting Canadian suppliers of expert systems products and services from penetrating the worlwide expert systems market other than the competitive market itself. Canadian companies continually mention the dominance by US giants in similar market areas and the difficulty they have in penetrating the US market due to 'buy American' policies of many US firms and a weak marketing infrastructure most Canadian companies possess. The most frequently mentioned causes for this weak marketing infrastructure are the high costs of advertising and a small, if non-existent, product distribution network.

4.5.4. Competitive Analysis

Major Supplier Strategies

1) Exploiting Canadian-developed Technology and Expertise

One Canadian company involved in the development of applications of expert systems expressed the view that rather than compete head-to-head against giant US and Japanese companies in markets in which they presently dominate, Canadian companies, as this particular firm is planning to do, should develop expert systems application software in those areas Canadians have past and present expertise in, namely hydro-electric power, mining, forestry, marine and fishing industries. Another Canadian company involved in the development of expert systems expressed the view that Canadian companies should not concern themselves with competing against US and Japanese firms in the development of AI-related hardware and software products, an area significantly dominated by both, but rather benefit from the knowledge derived from their development while adding value to them through their adaptation to specific applications.

2) Making a Presence in the Worldwide Market

Several Canadian companies involved in the development and marketing of expert systems have indicated that a physical presence in the US, be it manufacturing plants and/or sales offices, is essential in order to penetrate that market. For example, Unitek Technologies Corp. expects that 99% of their business will be in the US and intends to open up an office in Bellevue, Washington to continue expanding their presence there. As Bill Campbell, president of Unitek, noted: "You really can't sell in the US without having a physical presence there".(6)

3) Joint Effort Between Industry and Academic Institutions

Since the majority of research and development activities in expert systems in Canada are still confined to the laboratories of universities, many companies are taking advantage of the wealth of information derived from such research.

Digital Equipment of Canada Ltd had announced in early 1984 a $65 million joint venture with the University of Waterloo in which DEC would supply 15 VAX minicomputers and 2,000 PC's in return for research into the development of new technology including AI. This agreement was a move that many AI observers have been advocating for some time. Similar joint efforts between industry and academic institutions may be necessary to reduce the high costs of R&D while keeping Canadian companies on the leading edge of this technology.

Market Niches

The market niche for Canadian companies in the development and marketing of expert system products and services is application software. Since the areas of financial services, equipment maintenance and manufacturing have not been fully exploited and are not as R&D intensive as medical diagnosis and geological exploration expert systems are, Canadian companies have the potential to succeed in these markets. According to industry views, Canada's greatest potential to succeed in the expert systems market lie in those areas of Canadian expertise in particular industrial automation (ie. process control etc.) and Canada's resource industries (ie. mining, oil and gas, hydro-electric power, fishing and marine-related areas, forestry and wheat).

Canadian Capabilities and Potential

Approximately 10 Canadian universities are involved in AI-related research including expert systems, and form the backbone of Canada's development into expert systems technology. However, the university community is suffering from a continued 'brain drain' to the south, a situation which cannot be ignored. The flow of AI researchers and graduates to the US is primarily due to the lack of sufficient R&D funding to Canadian universities and the lack of a strong Canadian corporate entity in AI-related work resulting in few employment opportunities. Universities recognize that efforts by NSERC, CSCSI and CIAR to promote R&D activities are helpful, but are not adequate to stem the flow of top researchers and graduates to the US and in turn, are looking to the federal government for increased infusion of R&D funds. Citing a potential solution to this problem, then AI researcher Pylyshyn noted: "..each year, several Canadian AI researchers go to the United States. If a corporate entity in AI emerged in Canada, many of those expatriate researchers have indicated they would return."(7)

Canadian manufacturing industries must undertake massive steps towards modernization in terms of automation through the use of robotics and the application of other AI principles within the next decade in order to remain competitive. Computer-Aided-Design (CAD) and Computer-Aided-Manufacturing (CAM) technologies will interact with expert systems to fully automate process control. The opportunities in Canada to develop a CAD/Expert systems hybrid are many, but are time dependent. Various other industrial countries are facing a similar opportunity. Canada has the capabilities to emerge a leader in these and other emerging hybrid technologies. The next two years are critical in this area if sufficient support and strategic planning is provided by the Government.

Many Canadian companies in AI-related activities are in general agreement that Canada possesses the technical resources to produce competitive products and the need to keep technical resources located here but recognize the need for marketing funds as well as R&D funds. As such they are looking to the federal government for assistance primarily in marketing, as this represents the major barrier to penetration of the international market.

Major Canadian Suppliers

The following is a list of major Canadian companies involved in the development of expert systems and the provision of consulting services; however, the committment by these companies to develop AI including expert systems technology pales in comparison to Japan's Fifth Generation project (\$20 - \$30 million per year)(8), UK's British Program for Advanced Information Technology (\$600 million over 5 years)(9), Europe's Esprit program (\$1.2 billion over 5 years)(8), and US' Defence Dept.'s Strategic Computer Initiative (\$1 billion over 10 years)(8).

1) Bell-Northern Research Ltd.

BNR formed an artificial intelligence research group early in 1984 whose resposibilities have been to handle basic technological issues and to define and support applications throughout the corporation. This BNR group is also responsible for the co-ordination with AI activities in universities and the government. Expert systems research at BNR is focusing on applications of expert systems.

2) Canadian Artificial Intelligence Products Corp. (CAIPC)

Canadian Artificial Intelligence Corp. provides contractual research and development work in artificial intelligence and eventually plans to market artificial intelligence products.

3) Cognicom Inc.

Cognicom is a private consulting company formed in 1983 by a group of leading AI researchers from five Canadian universities, among them is president Zenon Pylyshyn from the University of Western Ontario. One of Cognicom's major commitments is to provide technical assistance and other consulting services to CAIPC for the development of AI products, including expert systems.

4) Cognos Inc.

Cognos provides consulting services to firms and institutions considering developing or purchasing AI-based systems and consulting services to venture capitalists interested in investing in new technologies. Cognos focuses most of its AI effort in the area of expert systems.

5) Cosigma Inc.

Cosigma, a subsidiary of Lavalin Group, Canada's largest consulting firm, is a service organization involved in data processing and industrial automation. Cosigma is currently developing expert system applications for process control industries (ie. hydro-metallurgical plants, aluminum smelters etc.)

6) Interact Research and Development Corp.

Interact manufactures and markets products and provides services in various fields for both telecommunications and information systems industries. Major areas of involvement include expert systems, videotex, LANS and office automation. Interact is presently developing expert system application software for resource industries such as mining and hydro-electric power.

7) Logicware Inc.

Logicware, a susidiary of G&B Automated Equipment Ltd., is well into its second year of operation and employs a working force of over 20 people. Logicware holds the sole marketing rights in North america for MPROLOG, the advanced version of PROLOG. A year ago, Logicware introduced a version of MPROLOG for IBM's XT and AT PC's and Motorola's 68000 microprocessor-based machines. Logicware intends to develop applications (expert systems) of its logic-based programming language for Japan's fifth generation computers.

8) Netron Inc.

Netron Inc. developed the Computer-Aided-Programming (CAP) product, the world's first automated software manufacturing system.

9) Unitek Technologies Corp.

Unitek develops software products which incorporate artificial intelligence concepts for chartered accountants, the hotel and restaurant industry and retail stores.

Non-Canadian International Competitors

The following is a list of major US and Japanese companies, many of which are well recognized in the information industry, who are expected to have a significant presence in the international experts sytems market.

1) AT&T

AT&T is currently developing software tools.

2) Carnegie Group Inc.

Carnegie Group was founded by four AI researchers in 1983 to promote the commercialization of AI technology.

3) Digital Equipment Corp. (DEC)

DEC is a major supplier of hardware, notably the VAX and PDP-11 line of computers. DEC uses the expert system XCON to configure its computer systems.

4) Fujitsu

Fujitsu is a major participant in Japan's Fifth Generation Project.

5) General Research Corp.

General Research developed, TIMM/tuner, an expert system which optimizes the performance of an operating system.

6) IBM (Thomas J. Watson Research Center)

IBM is a major supplier of computer and other information processing hardware and is currently conducting research into various AI-related areas.

7) Lisp Machines Inc.

Lisp Machines is a major supplier of Lisp tools, notably, Lambda, a powerful Lisp processing computer.

8) Mitsubishi

Mitsubishi is a major participant in Japan's Fifth Generation Project.

9) NEC

NEC is a major participant in the Fifth Generation Project.

10) Sharp

Sharp is a major participant in the Fifth Generation Project.

11) Symbolics Inc.

Symbolics is a major supplier of Lisp tools.

12) Xerox Corp.

Xerox is a major hardware supplier of Lisp tools.

The major U.S. academic institutions conducting AI research in expert systems include Stanford University in California, Carnegie-Mellon University in Pennsylvania and MIT in Massachusetts.

4.5.5 Summary

Although artificial intelligence has been primarily the subject of research by academia since the mid 1950's, only recently have government departments, industrial organizations and research centres devoted substantial resources to its development and commercialization. One of the most research intensive technological areas of artificial intelligence is expert systems. With new approaches to modelling cognitive processes and the recent availability of less expensive and more powerful computational capabilities, commercial applications of expert systems are now now being realized. Until recently, all of Canada's R&D activity into artificial intelligence and expert systems was conducted by the universities. The last several years has seen the emergence of several small to medium sized companies involved in the development of products and/or the provision of services relating to various AI-related technologies, most notably expert systems. However, Canada's corporate sector devoted to the development of AI technology is small, young and fragmented. Given that expert systems is a technology still in its infancy and considerable commercialization of R&D activities has yet to be achieved, Canada should take advantage of this situation and potential large markets previously forecasted (ie. projected US market of $2.5 billion for expert systems and development tools by 1993). However, several major problems currently threaten Canada's chances for success in the international expert systems market. Canadian universities are losing top AI researchers and graduates to US universities, companies, research centres and the military all of which have substantial funds, equipment and an extensive research program. The lack of sufficient R&D funding to Canadian universities, the absence of major corporate entities devoted to AI-related technologies translating into a lack of employment opportunities for AI researchers and graduates and the lack of an extensive AI research programs all contribute to the 'brain drain' to the US. Canada must certainly take steps to prevent further errosion to fledgling AI R&D

environment. Canada's best chances for success in international expert systems markets will be realized if Canadian companies concentrate their resources to the application of expert systems technology with added value to areas of major Canadian involvment and expertise (ie. industrial automation, consulting, resource industries), rather than research and cost intensive areas of hardware and development of processing languages and operating systems. However, real success will also depend upon Canada's successful penetration and sustained presence in international markets, currently a major problem experienced by many Canadian companies. Canadian companies are optimistic about Canada's chances for success in the international expert systems market, but recognize the need for federal government involvment possibly in the form of R&D funding, strategic planning and marketing assistance.

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4.6 High Definition Television (HDTV)

4.6.1 Technical Description

There are three major areas of technological development within the worldwide television industry: improved NTSC, enhanced definition TV (EDTV) and high definition TV (HDTV).

Improved NTSC involves improving the currently displayed picture while retaining the existing transmission format. Upgrading existing picture quality can be achieved through the inclusion of digital signal processing in the conventional television receiver coupled with complementary and compatible processing at the transmitter. The picture quality attained by improved NTSC systems is noticeably greater than that of present systems. Digital receivers in existence today are basically conventional sets with some circuitry replaced by digital IC's with no improvement in picture quality. True digital sets, soon to hit the market, will have frame store memory capability and additional signal processing which will eliminate most NTSC picture defects while doubling the perceived picture resolution.

The EDTV television system employs different modulation schemes for luminance and colour difference signals, yet retains compatibility with the existing television system. The EDTV system is derived from the European proposal for 'multiplexed anlogue component' (MAC) systems. An enhanced definition version of the MAC system with suitable transmitter/receiver signal processing will produce pictures with quality approaching that of HDTV on a display with a wider aspect ratio.

HDTV is a new television system requiring new production standards and transmission formats and is therefore incompatible with conventional NTSC receivers. An HDTV system is characterized by high resolution both horizontally and vertically with a wide aspect ratio display. The picture quality in HDTV systems rivals that of 35 mm film by approximately doubling the number of scanning lines.

Marketing Analysis

4.6.2. Demand Analysis

Factors of Change

Technical Developments:

The critical question is which of the new TV technologies: 'improved NTSC', EDTV or HDTV will the worldwide television industry adopt.

a) Consumer interest in 'feature' and 'impairment free' NTSC signals may be sufficient to initiate major development and production by receiver and IC manufacturers to produce 'smart' receivers, the next step in the evolution of conventional sets. If 'smart' receivers become available, it is questionable whether broadcasters and programming suppliers would develop new television systems and display formats as required by EDTV or HDTV, thus improvements in NTSC digital television sets may eliminate the need for EDTV or HDTV.

b) If the trend is toward HDTV, the question remains whether the worldwide television industry can agree on a standard or will adopt several standards as ocurred with colour television. The CCIR meeting, held in Geneva during October 1985 and with representation from over 50 countries, was designed to adopt a proposed HDTV production standard. Most countries, including the US and Japan, favoured the proposed technical specifications based on a 1125 line, 60 Hz standard. However, several European countries chose not to endorse the proposal, reserving their final judgement until the next CCIR meeting in May 1986.

All delegates at the CCIR meeting did agree that definite advantages exist in having a single international HDTV production standard. A common standard would enable easier, less costly and larger program exchanges among broadcasters internationally, as well, provide an opportunity to set studio standards. However, it appears that political and economic factors prevented unaminous agreement. The proposed Japanese 1125 line, 60 Hz HDTV standard was supported by most countries, including US and Canada, and even some 50 Hz countries like New Zealand. However, a number of European and Latin American countries and Australia did not endorse the Japanese proposal. Engineers from 50 Hz countries doubted that programs produced in 1125 line, 60 Hz HDTV format could be converted to a 625 line, 50 Hz PAL/SECAM system, claiming that present conversion techniques produce inadequate pictures. These 50 Hz countries opted for further research and assessment of the 60 Hz system. As well, some European countries are reluctant to endorse the Japanese standard because of their major committment to MAC transmission technology. In particular, France and Germany have made huge investments in using MAC transmission techniques with satellites. Although MAC can be upgraded to HDTV, complete compatibility would still not be achieved because of the refusal by some countries, including the US and Japan, to endorse MAC.

Most countries realize that without a CCIR recommendation on HDTV production standards in May 1986, multiple television formats, standards and systems will likely develop, as is the case today.

Areas of Major Growth

The areas of major growth in HDTV technology include the development of specialized IC's required for various signal processing, transmission and storage applications and the development of HDTV displays and projectors. Many HDTV products in the areas of production, transmission and reception will not be manufactured until various signalling, transmission and display formats and standards have been agreed upon.

Areas of major growth for HDTV technology are not only confined to the television industry and the consumer market. There is considerable interest in HDTV technology for use in flight simulators, avionic information displays, teleconferencing, closed-circuit TV and other video display technologies including VCR's and videodisks. As well, a strong market for HDTV technology is anticipated in the medical research and educational broadcasting fields.

Growth Estimates

International and Canadian Markets

Given that much of the technology required to offer cost-effective HDTV products and services has yet to be developed, projected growth estimates for the International and Canadian HDTV markets must be treated with caution.

Based on market forecasts made by Nordicity Group, HDTV services may be available to the home consumer market in North America by the early 1990's but will not attain substantial mass market penetration until the year 2000. Projected estimates for HDTV services in the year 2000 indicate a market penetration of 25%-65% in the US and 14%-30% in Canada with possible receiver sales of 350,000 to 900,000. (1)

4.6.3 Supply Analysis

Strengths

Canada's major strength is an established transmission systems industry. For example, Canada has a viable satellite communications industry (ie. Spar Aerospace, SED Systems, Microtel) and potential fiber optics industry (ie. Bell-Northern Research, Northern Telecom)

In the government sector, the Communications Research Centre of the DOC has conducted research into new television technologies.

Weaknesses

The major weaknesses in Canada's television industry infrastructure are the lack of R&D and strong corporate entities in semiconductor and consumer products industries.

Canada's committment to R&D into new TV tehnologies, including HDTV, has been negligible both in academic and private sectors. Very few Canadian companies have made recent major contributions to the development of TV technology; the most notable exception being Digital Video (which was recently purchased by US-based Scientific Atlanta) in the area of B-MAC scrambling/reception systems.

Canada does not have a strong semiconductor industry with which to develop and supply components required in signal processing and other television technology-related applications. Hence, Canada does not have any strong coporate entities to develop and market various industry and consumer electronics products including those for television.

As well, most Canadian companies experience difficulty in penetrating international markets, particularly the consumer electronics market which is dominated by Japanese industries. The majority of Canadian companies do not possess an effective product distribution network, and as a result, high cost of sales and stiff competition by Japanese and US giants makes market penetration and a sustained presence there prohibitve.

International Market Share

Canada is not expected to capture substantial portions of the international market in HDTV products and services although potential for Canadian companies to succeed in niche markets for HDTV products is real.

Given the strength of their television industry infrastructures, their dominant position as leaders in the semiconductor and telecommunications industries and their lead in the development of HDTV technology, Japanese and American industries are expected to dominate in the manufacture of production, broadcast and consumer HDTV products and the provision of HDTV services.

Market Constraints

Given that HDTV technology is currently in an evolutionary stage and the commercialization of HDTV technology has yet to be realized, there are many technological as well as marketing constraints facing Canadian television-related industries.

The most critical of constraints are ones related to technolgy. Although most of the technology has been developed, new generations of HDTV products require specialized IC's which have yet to be produced. As well, other HDTV products will not be manufactured until transmission and other standards have been agreed upon.

Whether Canadian companies will develop HDTV products and services for niche markets, they are likely to face stiff competiton from other countries (ie. in particular the UK, France and Germany - provided they adopt similar HDTV standards which is expected to be the case) pursuing a similar strategy. Given this scenario, Canadian companies will require a strong and effective product distribution network if penetration and a sustained presence in the international market is to be achieved.

4.6.4 Competitive Analysis

Major Supplier Strategies

1) NHK (Japanese National Broadcasting Organization)

NHK has made a strong committment towards the implementation of an HDTV broadcast system and service by 1990. Their objective is to launch a new service that will generate new licence fees and to provide Japanese set manufacturers a replacement market for the near-saturated NTSC receiver market. To achieve these aims, NHK has been heavily active in R&D in all facets of the TV industry and has awarded R&D contracts to the Japanese private sector. NHK's HDTV service is scheduled to begin in 1990 using MUSE coding on one transponder of the BS4 satellite with full bandwidth service beginning in mid-1990 using a 22 GHz transponder on the BS5 satellite.

NHK has proposed an 1125 line, 60 Hz field rate, 2:1 interlace HDTV system to become a world standard which will be non-compatible with conventional systems. The proposed HDTV standard is receiving the backing from Japanese industries.

2) SONY

Sony is not overly concerned about compatibility issues but would like to see NHK's proposal become a world standard as they feel the HDTV market will not grow without an accepted signal standard.

3) CBS

CBS has considered a more conservative approach in the transition to HDTV. CBS is planning to provide a two channel system with one channel configured for conventional sets only and with HDTV receivers of using both channels.

Market Niches

Based on impact assessment research obtained through an Industrial Opportunities Workshop and follow-up survey of Canadian corporate resources (1), specific product areas for potential Canadian participation have been identified and are examined under functional system categories:

1) HDTV Studio Products

NHK and other major players presently dominate the research and development of major HDTV studio products, namely: cameras, processing equipment components and recorders. However, there are minor complementary HDTV studio products to which the major players may not devote significant resources to develop. These products, which Canadian manufacturers may consider developing, include: distribution amplifiers, cable equalizers, sync generators and switchers.

2) Network/Broadcast Transmission

Major international broadcast and manufacturing companies have made considerable investments towards the development of various improved television transmission formats. As the present development of any new transmission format would prove too cost-intensive and probably too late, Canadian manufacturers have the capabilities to contribute to further developments of existing transmission systems. An example would be the development of the B-MAC system to a 2 channel bandwidth reduced HDTV system.

3) Reception and Display

The display area is recognized as a major component required to penetrate the HDTV market and presently, little research activity has been devoted to HDTV projectors. Research undertaken by Canadian universities to develop the next generation of projectors could possibly lead to a patent and if granted, manufacturers could be licensed on the condition partial manufacture or assembly of components would take place in Canada.

Canadian Capabilities and Potential

Given that considerable development into HDTV technology is required before commercial applications are realized, the time is present for Canadian television industries to take advantage of Japanese and American R&D activities and at the appropriate time exploit identified niche markets.

To realize these aims, Canada should initiate a forum of broadcast, cable, satellite and supplier industries to develop future strategies for Canada's involvement in HDTV. Without a coordinated effort towards R&D activites, the small Canadian television industry will not be capable of capitalizing on potentially successful market areas. Secondly, incentive programs designed to initiate involvement in the development and application of HDTV technology by the private sector must be created immediately. Since television service has a major influence on many Canadians and the issue of Canadian content in both television products and services is an important concern of federal government policy, it is essential that the Federal Government takes the leading role to initiate and direct Canada's involvement in the development and application of HDTV technology.

Major Canadian Suppliers

Given that Canada has essentially no major players in the consumer electronics receiver markets the focus is on the suppliers of studio equipment, suppliers to the transmission and distribution systems sector and the program production industry.

Canadian companies which have the potential to play an important role in the development, manufacture and marketing of HDTV technology include:

1) Bell-Northern Research Ltd.

Bell-Northern is the research arm of the telecommunications manufacturer Northern Telecom Ltd. BNR has strong managerial, financial and technical and R&D capabilities in digital transmission technology and as a leader in this area is expected to have major involvements in future TV distribution technologies.

2) Electrohome

Electrohome Systems is a manufacturer of consumer, industrial and broadcasting electronics products. Electrohome was the only Canadian company manufacturing television sets in Canada until it ended its consumer electronics product line in 1982. The components used in Electrohome sets are manufactured by Mitsubishi in Japan and assembled in a Mitsubishi plant in Canada.

3) Microtel Ltd.

Microtel, formerly AEL Microtel Ltd., is a wholly-owned subsidiary of B.C. Tel and is affiliated with GTE. Microtel designs and manufactures advanced telecommunications equipment. As a manufacturer of satellite systems, Microtel has the potential to become a major supplier of products related to the distribution and reception of HDTV television signals.

4) Northern Telecom Ltd.

Northern Telecom is a leading designer and manufacturer of telecommunications equipment and the world's largest supplier of fully digital telecommunications systems and a major supplier of integrated office systems. Northern Telecom, like BNR, also has strong managerial, financial and technical capabilities and has the potential to become a dominant supplier of studio and broadcast equipment. In particular, Northern Telecom could be a major supplier to fiber optics-based distribution systems.

5) SED Systems

SED Systems was incorporated by the Space Engineering Division of the University of Saskatchewan and its major products are 4 GHz and 12 GHz satellite receiving systems.

6) SPAR Aerospace Ltd.

SPAR conducts research and develops products for the communications, space and defence sectors.

Non-Canadian International Competitiors

The major players in the development of HDTV systems have been a few Japanese and American organizations and companies. The more dominant ones have been NHK of Japan and Japanese consumer electronics manufacturers who are seeking new television markets to offset a tapering world demand for conventional television receivers.

1) CBS

CBS, a major US television broadcaster, has developed an HDTV system compatible with the existing NTSC system. CBS's system incorporates both the NTSC signal for reception on conventional receivers, as well as the HDTV signal for reception on the new generation of HDTV receivers.

2) NHK

NHK, the Japanese national broadcasting organization, currently operates with a staff of 360 and an annual budget of approximately $50 million. NHK has pioneered the development of HDTV and since 1968, has been the driving force behind its evolution. NHK not only undertook the research required to develop the technology, but conducted studies of the psycho-visual reactions of viewers to a variety of video images. The results of this research led NHK to the proposal of specifications (refer to MUSE in the appendix) for an HDTV standard that would fulfill consumer viewing requirements.

3) Panasonic

Panasonic is a major supplier of HDTV transmission and reception equipment and, hence, endorses NHK's proposal for MUSE as the industry standard for HDTV.

4) Scientific Atlanta

US-based Scientific Atlanta has recently purchased Digital Video Systems which was noted for the development of the B-MAC scrambling/reception system.

5) Sony

In 1975, Sony decided to develop HDTV production equipment in accordance with NHK's proposals for an HDTV standard. Since then, Sony has been a strong supporter of NHK's proposed HDTV standard as well as a major supplier of HDTV equipmnent to NHK.

4.6.5 Summary

High Definition TV (HDTV) is a radically new television system employing new production standards and transmission formats. Although HDTV offers extremely high resolution and quality picture and is expected to revolutionize the television industry, its incompatability with existing television systems and standards makes it a highly controversial issue. For various political and economic reasons, the CCIR meeting, convened in October 1985, failed to result in an unanimous endorsement of a proposed HDTV production. A final recommendation may be made at the next CCIR meeting slated for May 1986.

Given that an HDTV production standard has yet to be agreed upon, much research into HDTV technology remains to be conducted and much HDTV product development is still required, market forecasts should be treated with caution. Penetration of HDTV services into the consumer market is expected to occur in the early 1990's reaching mass markets by the year 2000 at which time market penetration is estimated to be between 25-65% in the US and 14-30% in Canada.

Canada's ability to capture a share of the international HDTV market will be enhanced by the early adoption of an HDTV standard by Canada's television industry (both manufacturers and broadcasters) to keep Canadian industries at the leading edge of technology. Given that Canada lacks strong semiconductor and consumer electronics industries, Canadian companies are not expected to successfully compete in the Japanese dominated market for consumer electronic products. However, Canada could successfully compete in market niche and transmission systems areas, developing various studio products which major players may not consider, improvements in satellite transmission systems, and various reception and display products such as projectors. Canada's ability to successfully penetrate and sustain a major presence in the international HDTV market will largely depend upon a highly effective product distribution network within a strong marketing infrastructure. Canadian companies will likely require federal government assistance to acquire R&D funding and direction as far as strategic planning.

To better address all issues and aspects of HDTV technology and its implications for the Canadian consumer and television industry, Canada should initiate a forum of broadcast, cable, satellite and equipment supplier industries to develop future strategies in preparation for Canada's involvment in HDTV.

Definitions And Terms

Aspect Ratio Aspect ratio is the ratio of the picture width to the picture height. Conventional TV has an aspect ratio of 4:3 (or 1.33) whereas HDTV will have an aspect ratio of 5:3 (or 1.66) or 5:33 (or 1.78) much like that of motion picture film.

MAC 'Multiplexed Analogue Component'
MAC is a video transmission format with the following distinguishing characteristics: 1) the separate transmission of luminance and chrominance information (as opposed to NTSC which combines them into the same signal), and 2) employs time division multiplexing (TDM) techniques to transmit the luminance and chrominance separately. B-MAC is one of three proposed MAC formats.

MUSE 'MUltiple sub-Nyquist Sampling Encoding'
MUSE is a new single-channel, 1125 TV line, 60 field rate and 2:1 interlace HDTV system with luminance and colour information sent by a time-compressed integration (TCI) signal; additional colour information by a time-compressed line-sequential colour component signal and a digital audio signal multiplexed with the video system. MUSE is the bandwidth compression technique used to cram all these signals into a 24/27 MHz bandwidth. The MUSE system is incompatible with existing NTSC broadcast or reception equipment.

NTSC National Television System Committee, a television broadcasting standard used in Canada, USA, Mexico and Japan. NTSC uses 525 TV lines and a 60 Hz field rate.

PAL	Phase Alteration by Line, a television broadcasting standard used in Europe with the exception of France and the Soviet Union. PAL uses 625 lines and a 50 Hz field rate.
SECAM	A television broadcasting standard used in France and the Soviet Union. SECAM, like PAL, uses 625 lines and a 50 Hz field frequency but differs in that the signals are transmitted sequentially rather than simultaneously.
'smart sets'	Enhanced digital television sets offering higher quality pictures and other features.

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4.7 Videotex

4.7.1 Technical Description

Originally, videotex referred to a form of electronic publishing in which graphics and text were transmitted to subscribers with dedicated videotex terminals. Converging developments in computer and communications technologies has broadened the definition of the term videotex to mean an interactive system in which end-users can easily retrieve information or execute transactions through a computer terminal or microcomputer. The videotex system was not only developed to bring digital services to the business world but to the private consumer as well. The videotex system takes advantage of the existing twisted pair conventional telephone network to transmit text and graphics information to inexpensive display devices such as the television set.

The remaining technical description discusses the basic components of a typical videotex system, videotex standards, two major types of videotex services and the major videotex services in existence today.

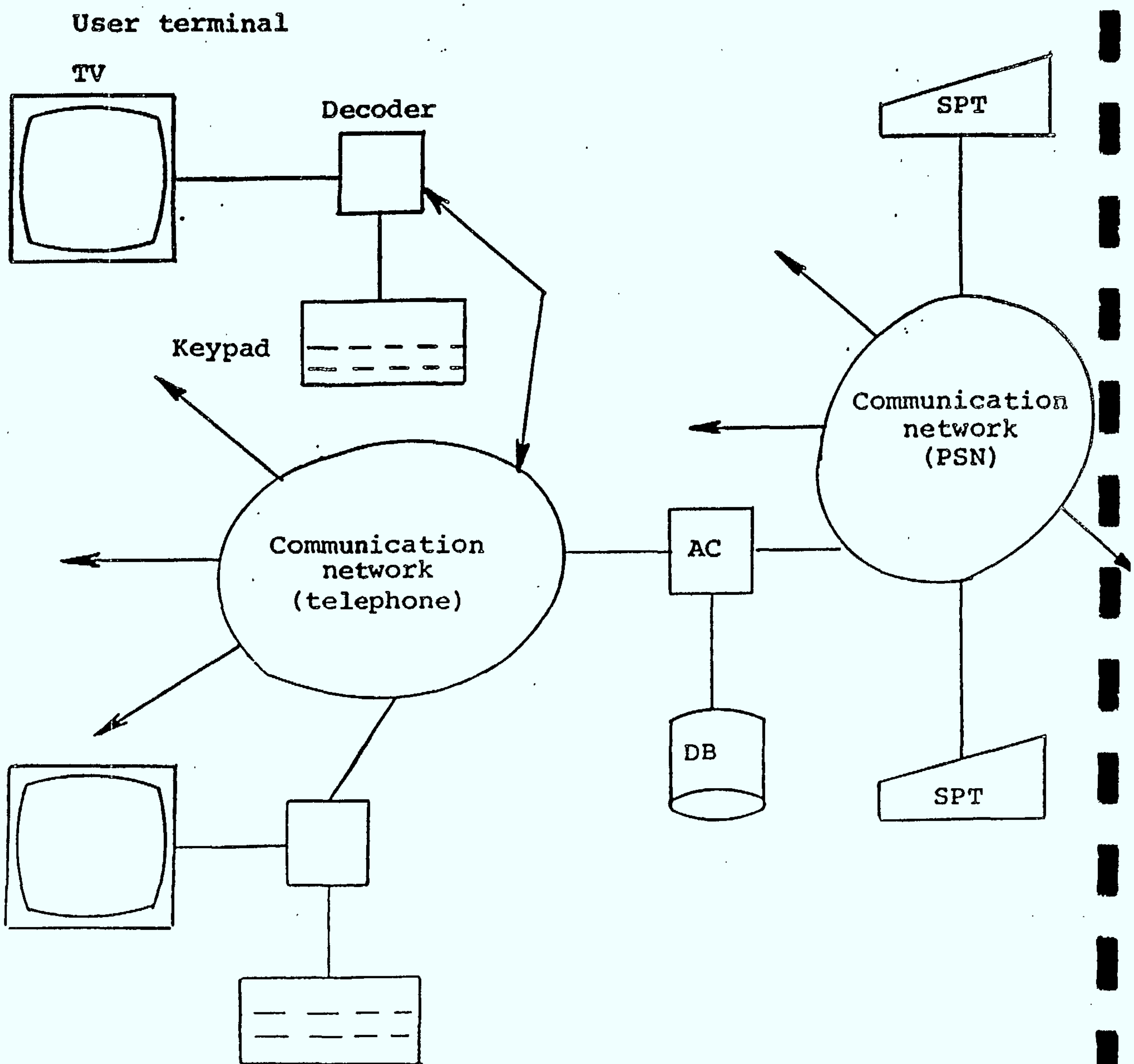
<u>Videotex System</u> (Refer to Figure 4.7.1.1)

Input Hardware:

Page creation terminals (or service provider terminals) are used by graphics designers to create or update pages of information. Pages are then stored in a databank at a videotex service centre for future retrieval. The access controller/database at the videotex service centre may be a mainframe, minicomputer or a microcomputer.

FIGURE 4.7.1.1

TYPICAL VIDEOTEX SYSTEM



AC: Access Controller
DB: Database
SPT: Service-provider Terminal
PSN: Packet Switching Network

Network:

Videotex services are transmitted over telephone or cable networks. Depending on the area of coverage, the network may be circuit switched, packet switched or a hybrid of both.

Output Devices:

1) Decoders:

Videotex decoders may be either hardware or software devices with keypads which translate received data into pages of text or graphics for display.

2) Displays:

Displays may include dedicated videotex terminals with keypads or touch-sensitive screens for use in public-access systems, or any type of monitor: a television set or a PC with a monitor.

<u>Videotex Standards</u>

ASCII

ASCII is the traditional text only service.

Three relatively new videotex standards recognized by the International Telegraph and Telephone Consultive Committee (CCITT) include:

1) Antiope

Antiope is a French developed videotex standard.

2) Prestel

Prestel is an ASCII and mosaic protocol developed in the UK.

3) NAPLPS (North American Presentation Level Protocol Syntax)

The NAPLPS protocol provides higher resolution and more colourful graphics than either Antiope or Prestel and was developed as a result of research conducted by the Communications Research Centre as part of Canada's videotex program, Telidon. The NAPLPS protocol was endorsed by Canadian and American standards bodies in 1983 and is now recognized by the CCITT.

Major Types of Videotex Services

1) Tele-shopping

Using a TV set or terminal, a videotex decoder and a keyboard or keypad, a consumer can access product or service information, compare prices, check product availability and in-store specials, query for additional information, balance accounts and make 'armchair' purchases all from the comfort of the living room. As well, tele-shopping eliminates time, energy and aggravation encountered in conventional shopping. Additionally, videotex can provide 24 hour a day, 7 day a week service. For the retailer, tele-shopping is a means to expand market share, reduce overhead costs, offer lower prices and improve inventory and margin control.

2) Tele-banking

Tele-banking offers banking services, similar to those offered by Automatic Teller Machines (ATM's), to customers in the privacy of their homes. Tele-banking would provide the capability to obtain account balances, transfer funds between accounts and obtain history of account transactions.

Major Canadian Videotex Services

1) Teleguide

Teleguide is a public-access videotex service offered by Infomart and was originally introduced in Toronto in 1982. Teleguide, using Telidon technology (NAPLPS-based), provides information on restaurants, entertainment, tourist attractions, accomodations, sports, weather, time, business, finance and transportation. Currently, 1.4 million people access more than 8 million Teleguide pages per month. Teleguide systems have been installed in nine cities with plans for future installations and the eventual interconnection of all locations.

2) Grassroots

Grassroots is a farm management information service offered by Infomart to prairie farmers and was originally introduced in Winnipeg in 1981. Grassroots provides prairie farmers with information on farm management, market reports, weather, financial news, crops, livestock, government, energy, money management, insurance and offers limited banking services.

3) Marketfax

Marketfax is a stock information service offered by Marketfax Infoservice Ltd. of Toronto.

Major American Videotex Services

1) Dow Jones

The Dow Jones ASCII videotex service, introduced in 1979, is a market retrieval information service offering current stock quotations, market information from Merril Lynch, news, weather, sports and travel information.

2) Source
3) Compuserve

Both the Source and Compuserve ASCII videotex services provide shopping services, entertainment information and games.

4) Grassroots America

Grassroots America, an extension to Canada's Grassroots service, is provided by three US agricultural co-operatives.

5) Viewtron

Viewtron is a videotex service in southern Florida offered by Knight Ridder Newspapers Inc. through its subsidiary Viewdata Corp. of America. The service offers health, food and entertainment information, games, shopping and banking.

Marketing Information

4.7.2 Demand Analysis

<u>Factors of Change</u>

1) Cost of Videotex Hardware and Service

Despite several years of intense promotion in over 20 countries, videotex has failed to gain wide acceptance of home and business users. It is apparent that customers are not willing to pay for access to information which is otherwise available at a fraction of the cost.

The relatively high cost of videotex terminals has been one of the major factors inhibiting the wide acceptance of videotex services in Canada, especially in the home market. In addition to the cost of the terminals, the user must pay a monthly fee and telephone connect charges. Currently, there are approximately 5,000 dedicated videotex terminals installed in Canada and depending upon the manufacturer, are priced at $1,000 - $2,400 and up. (1) For example, the videotex terminals used in Teleguide, a public access videotex service, cost $4,000 - $5,000 each. (1) However, a new generation of videotex terminals incorporating more sophisticated ICs and priced under $350 is due to appear on the market this fall. (1)

Federal Government sources are encouraged by the fact that although the public was initially repelled by the high cost of videotex terminals, less expensive videotex decoders and an interface between the telephone and television set are both promising developments that could open the market for videotex. (2) An alternative to the purchase of expensive videotex terminals, is the purchase of videotex decoder software (the NAPLPS software decoder) which configures the user's PC into a videotex terminal. Given that the installed base of PCs in North America is large and continually on the increase, purchasing NAPLPS software decoders may finally bring videotex service into the home and business.

According to John Madden, president of New Media Technologies, a $50 videotex decoder IC could be incorporated into television sets and PCs in three years time (1988), which would again eliminate the need to purchase expensive terminals to obtain videotex service. (3)

2) The Need for Videotex Services

As stated previously, customers are not willing to pay for access to information which is otherwise available at a fraction of the cost, particularly for news, weather and sports which is easily accessible. Thus, the future of videotex lies in specialized applications (ie. Grassroots - the farm management and information videotex service).

3) Consumer Marketing

Although Telidon technology was developed in 1979, today the public's general awareness of videotex is still very limited, an additional factor contributing to the lower than projected subscribership for videotex services.

4) Technical Issues

Improvements in image processing coupled with a new generation of storage and output devices will contribute to less expensive videotex hardware and a more enhanced and attractive service for the consumer.

The display methods for CRTs and video monitors have changed from original vector graphics methods to bit-mapping methods for increasingly higher resolution images. Also, improvements in encoding and decoding techniques have reduced display times considerably. A long display time for page retrieval was a common complaint among videotex subscribers.

Areas of Major Growth

Videotex Technology:

1) encoding and decoding techniques

Improvements in encoding and decoding technologies will further reduce storage requirements and display times.

2) storage media

Recent developments in optical disk technology that store images using digital compression techniques have reduced the number of bits required to store a page by a factor of 22. (4)

3) future digital services

Telephone bypass networks and the development of integrated digital services network (ISDN) using optical fibre for the transmission of voice, data and video will bring digital services to the home. These trends contribute to a lessening distinction between what is referred to as 'videotex' and what may be considered as information or database retrieval systems, and, in the future, between integrated communication networks.

Videotex Products:

The development and marketing of hardware and software versions of videotex decoders for IBM, Apple and Commodore PC's and compatibles.

Videotex Services:

The areas of major growth in videotex services are banking, shopping and specialized information retrieval services.

1) Tele-Shopping

Presently, large retailers such as Consumers Distributing, Sears, The Bay, and J.C. Penny are planning or operating consumer videotex services, offering electronic catalogues, advertising, product descriptions and evaluations, instant verification of product availability, financial transactions and other services. These and other retailers are not only securing their claim to the electronic shopping systems of the future but are actively working towards providing the consumer with more advanced and convenient shopping services.

2) Tele-banking

Banking institutions in North America are experiencing a similar dilemma with videotex technology as they did with Automatic Teller Machines (ATM's) when they were first introduced: videotex appears much like a technology looking for a market.

In the US, where home banking has evolved more rapidly, major home banking services include Knight-Ridder's Viewtron and Times Mirror's Gateway and Keycom. Although these services have been established for some time, they have only attracted lower than expected numbers of subcribers and at low levels of consumer penetration, there seems little economic justification for home banking. Thus, the banking industry has adopted 'a wait and see attitude' towards home banking. However, ASCII-based home banking services have met with some degree of success in the US, primarily due to the large installed base of PCs. These services which include CompuServe, Bank of America's service and Chemical Bank's Pronto indicate that home banking has the potential to become a commercial reality with the emphasis on PCs rather than dedicated terminals.

Although there is general agreement within the banking industry that home-banking is the next major innovation in consumer banking, the timeframe when videotex will reach a critical mass is much too uncertain. Perhaps with the recent announcement of the formation of Trintex, a new videotex company formed by giants IBM, CBS and Sears with a reported infusion of more than $3 billion, will stimulate rapid growth within the videotex industry and convince the banking community that videotex can offer a more cost efficient and attractive method for delivering financial products and services.

3) Special Services

Special videotex services include those that provide specific information and services to organizations or particular sectors of the general populous (ie. Grassroots videotex service for prairie farmers).

Videotex Market:

Due to a small population and a small installed base of PC's, the Canadian videotex market is not significant; however, the US videotex market provides the greatest opportunity for Canadian videotex industries due to the large population, the large installed base of PC's, the availability of risk capital and a more pioneering attitude towards new technologies.

Growth Estimates

1) International Market

International market forecasts for videotex products and services vary widely. Estimates put videotex revenues at approximately $100 million in 1983, growing at over 100% per year with expectations of reaching $2 billion by 1987. Even more optimistic are other forecasts which estimate $7 billion in revenues in 1987 and up to $10 billion by 1990. However , a more conservative estimate predicts the videotex market will only reach $500 million by 1992. (5) Yet another forecast predicts, based on what is presently known as videotex, the market will be in excess of $2 billion by 1994.4 Such discrepancies in projected estimates are characteristic of an emerging technology whose timeframe to reach critical mass is a major unknown.

2) Canadian Market

The videotex market in Canada is small in comparison to the US market or international market, primarily due to the lack of cost-effective videotex hardware and services, the lack of variety in videotex services, the small Canadian population and the small installed base of PCs in Canada. Presently, the installed base of videotex terminals is approximately 5,000. The fact that France installed approximately 700,000 Minitel videotex terminals to replace telephone directories, emphasizes the lack of implementation of videotex services in Canada.

4.7.3 Supply Analysis

<u>Strengths</u>

The Canadian videotex industry is highly active in the development of videotex terminals and both hardware and software versions of videotex decoders.

Weaknesses

The Canadian videotex industry is lacking in the area of offering commercial videotex services. Presently, there are no highly profitable and widely used videotex services in Canada. Only Infomart's Teleguide and Grassroots services have achieved some degree of success. The high price of dedicated videotex terminals and a smaller population and installed base of PCs (relative to the US) in Canada has contributed to this problem.

International Market Share

Indications from the Videotex '85 conference held in New York last May suggested that IBM, AT&T, DEC and Honeywell dominated the proceedings and are expected to dominate the North American videotex market. (6) IBM's involvement in Trintex, a $3 billion project, is a clear indicator of their goal to claim a large share of the international videotex market. Major Japanese videotex companies include Sony, Panasonic, Mitsui and Fujitsui. The above companies are all recognized hardware suppliers with extensive technical, manufacturing and marketing resources and are expected to be the dominant suppliers of videotex hardware and software in the international market. It is expected that major banking institutions (ie. Bank of Montreal in Canada and Bank of America in the US) and major retail outlets (ie. Sears, J C Pennys etc), as present innovators of home banking and home shopping services, will be among the first commercial suppliers of videotex services. Against such giants, Canadian companies will experience difficulty in penetrating the US market as hardware, software or service providers. As revenue potentials increase, the trend is for the larger players to become involved and take advantage of previously developed technology and their large resources to produce and provide less expensive videotex products and services.

Market Constraints

The most significant reasons for the lack of penetration of the international videotex markets by Canadian videotex manufacturers and service providers were the delay in adopting a worldwide videotex standard and the lack of patent protection for Canadian developed technology. The present lack of variety in videotex services and Canada's weak marketing infrastructure are also contributing factors.

The delay in the adoption of the Canadian-developed NAPLPS protocol. (now an internationally recognized videotex standard) by the US and the absence of patents protecting Canadian developed videotex technology allowed US industry to gain lost ground in videotex technology. As a result, the US videotex industry was in control and was able to capitalize on Canadian-developed videotex technology, providing both vidoetex hardware and services.

Only several NAPLPS videotex services are currently operating with any degree of success. The limited variety of videotex services may be an important factor for the presently small videotex market. Perhaps if Canada provided specialized videotex services (ie. Videolog - an online index and catalogue of electronic parts), its penetration of the international market for videotex hardware, software and services would expand.

The most significant market constraint against Canadian videotex industries is the lack of a strong Canadian marketing infrastructure. Canadian videotex industries lack the necessary funds and the distribution network (ie. international sales offices and/or manufacturing plants) to cost-effectively penetrate the international videotex market and sustain a presence there.

4.7.4 Competitive Anaysis

Major Supplier Strategies

1) Combining Resources

The emergence of new videotex companies created from the combined resources of larger corporations and institutions has contributed to the resurrection of the US videotex market. The combining of technical and business expertise signifies a new approach being taken to win over the home user. For example, IBM, CBS and Sears have formed a new company, Trinitex - a $3 billion project, to offer videotex services later this decade. IBM is well suited to provide the required hardware and software while CBS can provide customized entertainment content and Sears, the retail services.

Another major joint venture amongst AT&T, Time Inc., The Chemical Bank and the Bank of America, has seen the creation of Covidea, a new company which will merge the home banking services presently offered by the two banking partners and will eventually offer videotex services to home and small business users.

2) Marketing Ploys

In France, two-thirds of the estimated 700,000 Minitel videotex terminals were distributed free by the state-run telephone company in an attempt to attract new subscribers to a service which allows customers to gain access to a computerized telephone directory.

In a similar manner, Viewdata Corp. of America has signed a contract with Addison Information Systems to distribute, software decoders, free of charge, in an effort to attract new subscribers to its floundering videotex service. The Addison software decoder allows current or potential subscribers with Commodore PC's to receive NAPLPS-based graphics on their terminals. Viewdata's videotex service, Viewtron, has suffered losses due to a low subscriber base and high operating expenses.

Market Niches

For Canadian videotex companies, market niches appear to be hardware and software versions of videotex decoders (particularly for IBM, Apple and compatibles), system and application software required to set up databases and allow access to services and videotex services, and the development of technology allowing the insertion of a page of videotex information into the vertical blanking interval (VBI) of a television broadcast signal, a development in which CBS is currently undertaking.

Canadian Capabilities and Potential

The Canadian Government, through the DOC and the CRC, has had extensive experience with videotex technology since 1975 resulting in the development of the NAPLPS standard. As well, the Canadian videotex industry has had some degree of success with the marketing of Canadian developed videotex hardware and services (ie. Telidon terminals and Infomart's Teleguide and Grassroots services). Hence, Canada has proven technical resources required to develop innovative videotex products and services. However, as present markets indicate, new products and techinques are not adequate to penetrate and sustain a large share of the international market. As stated by Jean Grenier, director in the French Department of the Director Generale des telecommunications (DGT), at the Videotex '85 conference held last May 1985: "A good graphic capability will not create the market (for videotex)". Many of the videotex industry leaders in attendance agreed with that particular statement. (6).

Thus in order to survive in the international markets, the Canadian videotex industry must concentrate its efforts on marketing strategies and take advantage of the potential markets while videotex, as a technology, is still in its infancy and has yet to mature. What the Canadian videotex industry requires is a significant infusion of funding to penetrate identified international market niches and sustain a presence there. To enable this, the Canadian videotex industry is seeking aid from the Canadian Government in the form of funding and programs developed to enhance Canadian videotex marketing strategies.

Major Canadian Suppliers

1) Addison Information Systems Inc.

Addison Information Systems, formerly Avcor, develops and markets software videotex decoders.

2) Cableshare Inc.

Cableshare Inc. of London develops, markets and implements packet switching data communications networks products, computer information systems using videotex/videodisc technology and interactive electronic mail and messaging systems. The Electronic Marketing Division designs and markets products and business systems using videotex and videodisc technology. Examples include the distribution of the Picture Painter (NAPLPS Page Creation) and the Touch N' Shop videotex/videodisc systems in Japan and the Far East through Ascii-Microsoft and Mitsui & Co. and the installation of Touch N' Shop videotex/videodisc systems for Compucard in the US. A home system using touch-tone phones, television sets and cable access is expected to hit the market by the mid-1986.

3) Dominion Information Services

Dominion Information Services of Vancouver has had four years of experience in videotex publishing and was scheduled to introduce a public access videotex system, called "In Touch", in Vancouver for June '85. (5)

4) Electrohome

Electrohome of Kitchener designs, manufactures and markets decoders, high resolution terminals, colour graphics workstations and videotex hardware and software. Recently, Electrohome has introduced Mac-NAPLPS, a new NAPLPS software decoder for the Apple Macintosh.

5) FBN Software Inc.

FBN of Ottawa markets an NAPLPS software decoder that runs on IBM PCs and compatibles.

6) Formic Videotex Systems Inc.

Formic of Montreal develops and manufactures videotex systems and exports worldwide.

7) Genesys Group Inc.

Genesys of Ottawa is a computer software firm providing turnkey communications systems to both private and government sectors and specializes in the development and packaging of videotex systems. The GENESYSTEM (tm) product line supports page creation, storage and transmission using the NAPLPS standard for videotex systems. Genesys exports to the US and Japan.

8) Infomart

Infomart of Toronto is one of the world's leading suppliers of videotex systems and services and has installed systems on five continents. Infomart owns and operates two videotex services: Teleguide, North America's first public-access information service and Grassroots, a farm management information service for prairie farmers. Infomart exports to the US, Europe, Japan, the Far East and South America.

9) Network Videotex Systems Inc.

Network Video Systems of Toronto is a videotex consulting and software production company.

10) New Media Technologies Ltd.

New Media Technologies Ltd. of Burnaby, B.C. was created from the purchase of AEL Microtel's videotex-related division. New Media has developed the information, graphic and interactive services segment of Packetcable (a system developed by Packet Technologies of Calif. which configures coaxial cables for high-speed two-way data communications links between subscribers, the headend and/or remote databases outside the cable area) and are supplying Telidon terminals for Dominion's 'In Touch' service.

11) Micropixel Inc.

Micropixel of Toronto markets Quikpel, an NAPLPS decoder board, the only product that provides full Service Reference Model (SRM) NAPLPS functionality on a PC.

12) Microstar Software Ltd.

Microstar of Nepean markets both hardware and software versions of NAPLPS videotex decoders. A major product is the Microstar Virtual Device Interface which provides a low cost PC NAPLPS decoder for office systems. Microstar exports worldwide.

13) Microtaure Inc.

Microtaure of Ottawa also markets a NAPLPS software decoder that runs on IBM PCs and compatibles.

14) Norpak Corp.

Norpak of Kanata manufactures a complete line of videotex/teletext terminals, picture creation, delivery and captioning systems and provides custom Engineering Development Services and training and consulting services. Norpak exports to the US, Korea, Japan, the UK and Australia.

15) Le Groupe Videoway Inc.

Videoway of Montreal has introduced the Home Interface Unit (HIU) which combines the functions of a cable television converter, pay TV scrambler and a NAPLPS teletext decoder in a single box and comes with a wireless keypad or optional keyboard.

16) Le Groupe Videotron Ltee

Videotron, Quebec's largest cable television company has announced a new teletext service to be introduced in the fall of 1985. The data base will include news, educational courses, entertainmnet information and video games, public service information and an events calendar.

17) PDI Inc.

PDI of Toronto develops and markets Unix-based Unitasc videotex software for supercomputers.

18) St. Clair Videotex

St. Clair Videotex, affiliated with a publishing company, is a supplier of page design and creation and offers consulting and database services. St. Clair Videotex has been involved in the startup and development of two major commercial systems in Canada.

Non-Canadian International NAPLPS Competitors

1) AT&T

AT&T's involvement in the development of videotex technology dates back to 1980. AT&T has recently announced its Video Transaction Terminal, an integrated keyboard and videotex adaptor for television sets with a price near $100 (US). AT&T has combined efforts with Time Inc., The Chemical Bank and Bank of America to form Covidea, a new company which will merge the home banking services presently offered by its partners and will eventually offer other videotex services to home and business users.

2) Digital Equipment Corp. (DEC)

DEC is a major supplier of videotex hardware.

3) Honeywell

Honeywell is a major supplier of videotex hardware.

4) IBM

IBM has recently announced a new mainframe videotex system, Videotex/370, which allows users of System/370, 43XX and 30XX computers to run videotex appplications. IBM of Armonk, N.Y. has formed a joint venture with Sears, Roebuck and Co. of Chicago and CBS Inc. of New York to provide banking and shopping services to the home. IBM also has a joint venture with Merrill Lynch, Pierce Fenner & Smith Inc. of New York to provide a business information videotex service.

5) Times Mirror

Times Mirror of California launched the Gateway videotex service.

6) Viewdata Corp. of America Inc.

Viewdata, a subsidiary of Knight-Ridder Newspapers Inc. of Miami, operates the Viewtron videotex service in southern Florida.

7) Merchandisers:

Sears, J.C. Penny, Dayton's, The Bank of America, Kodak, Mattel, Black and Decker, Sony, Chevrolet, Coca Cola and Saks Fifth Avenue.

<u>Non-Canadian International Prestel Competitors</u>

British Telelcom (BT)

British Telecom is a developer, manufacturer and service provider of videotex technology. BT has recently introduced a videotex system which can store and transmit digitized photographs and text over cable television networks. BT has been operating the Prestel videotex service since 1979.

Non-Canadian International Antiope Competitors

Poste de Telephone et Telecommunications (PTT)

PTT is France's state owned telecommunications agency who had initiated the installment of an estimated 700,000 Minitel videotex terminals across the country. Approximately two-thirds of the Minitel terminals were distributed at no cost to the customer; a move designed to attract new subscribers and open France's videotex market.

4.7.5 Summary

Videotex, the interactive text and graphics communications medium introduced in the early 1980's, was supposed to revolutionize conventional information retrieval, shopping and banking methods. Howvever, many factors contributed to the less than projected acceptance of videotex technology by business and consumer sectors alike.

Among the factors contributing to the less than widespread acceptance of videotex services include the high costs of service (ie. expensive dedicted videotex terminals and monthly service fees), the fact that consumers could obtain the same information through other less expensive media, the lack of variety in videotex services and the slow display times of pages of information. As a result, videotex was considered a technology in search of a market.

Canada's chances to take advantage of the Canadian-developed videotex technology (in particular, the Canadian-developed NAPLPS protocol), to become a major player in the international videotex market soon vanished. Delays in the acceptance of a worldwide videotex standard, particularly in the US, and absence of patent protection allowed the US videotex industry to make gains and capitalize on Canadian-developed videotex technology.

Videotex is still a technology in evolution and striving to reach maturity. Improvements in videotex technology (ie. the development of more powerful and less expensive terminals, the development of software and hardware vidoetex decoders) and the introduction of more varied and specialized services has made videotex more attractive to both the business and private consumer markets. Videotex has evolved to the stage where its capability to permit the quick retrieval of dynamic information (ie. Videolog), information that would otherwise require the updating, publication and purchase of, represents a tremendous advantage.

Estimates for the projected international videotex market are unclear in light of continuing developments in videotex technology and services; however, one optimistic estimate indicates a $10 billion US market by 1993. For Canada to capture a significant share of this potentially large market, Canadian companies should concentrate their resources towards the development of software and hardware decoders (to bring videotex service to those with existing PCs or television sets), towards improving the relatively recent technology which enables the insertion of a videotex page of information into the vertical blanking interval (VBI) of a televsion broadcast signal and most importantly, towards the introduction of specialized videotex services (ie. Grassroots, Videolog) directed at specific markets.

For Canada to become a major videotex player will require the successful penetration of and a sustained presence in the international videotex market. Canadian videotex manufacturers and service providers are meeting with limited success in the US market, a market expected to be dominated by traditional US giants (ie. IBM, AT&T, Sears, CBS). As the success and survival of the Canadian videotex industry largely depends on this vast market, Canadian companies require financial and marketing assistance from the federal government.

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16. New Information Technologies and Services in Canada: an Overview.

4.8 Wide Area Data Networks

4.8.1 Technical Description

Wide area data networks for the purposes of this study are defined as networks which extend beyond the boundaries of a building or adjacent buildings and may be accessed through Local Area Networks (LANs) or computer workstations such as PCs. As common carrier networks become more complex and continue their evolution towards an Integrated Services Digital Network (ISDN), the role of the private communications supplier in providing the link between LAN's or PCs and common carrier networks becomes more critical.

Increased information flow and a need to effectively manage company resources has led to an ever increasing demand for wide area data networks. Regulatory changes in the area of interconnection to public switched telephone networks for the purpose of providing value added services has also renewed the interest of potential service providers in the area of wide area data network services. These factors are expected to stimulate demand for wide area data network services and components.

Data networks may include several topographies and speeds including switched networks, point-to-point and multipoint applications and distributed networks, ranging from lowspeed to very high megabit plus speeds. All of these networks have in common the same basic building blocks, which consist of central processing unit(s) (CPU), front-end processors, modems, multiple access units, analog and digital transmission facilities (ie. twisted pairs, coaxial cable, fibre optics, microwave, satellite) and remote operator stations. Data networks also have associated Network Control and Management Systems for test, control, restoration and maintenance. The quantity and capabilities of each component will determine the complexity of the overall network. A typical network is illustrated in Figure 4.8.1.1

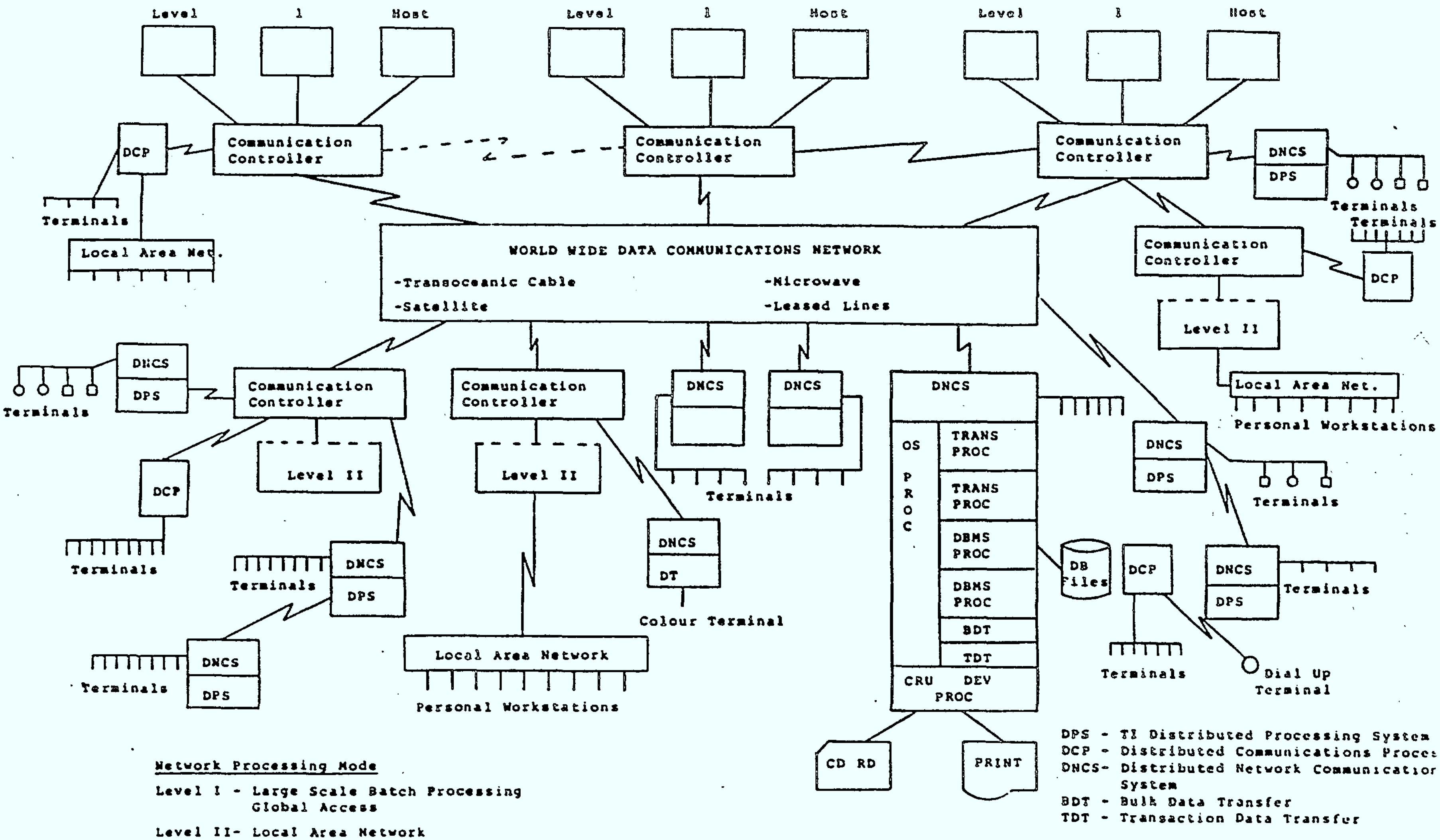

FIGURE 4.8.1.1 Wide Area Data Network Configuration

The most typical topographies include:

Point-to-point - a point-to-point circuit may be half or full duplex and operate in either a dedicated or switched network. Such a link is most often used to connect a CPU to a CPU or a CPU to a dumb terminal.

Mutlipoint - provide connections between host sites and remote stations, requiring that the terminal be addressable and operable within the host controlled protocol.

Distributed network - consists of mutliple processors or hubs, interconnected to one another or to a central host and each supporting an independent network. Point-to-point or multipoint circuits may be used to connect to the hubs or the host.

Mutliplexed Circuits - a multiplexer combines two or more channels for simultaneous transmission over a common medium. A multiplexer may be an integral part of a modem, have an integral modem or provide connection to a modem for digital or analogue transmission facilities. Many forms of mutliplexers are available depending on the network architecture; the data rate (varying from low speed (1200 bps) to high speed (megabits/sec)); and the modulation (synchronous, asynchronous; frequency division multiplexing (FDM), time division mutiplexing (TDM) and variations thereof, etc.).

Local Area Networks - employ either baseband or broadband links to interconnect workstations in either a bus, ring or star topology. LANs are covered in detail in Section 4.2.

The relation between data services and data networks is defined in terms of the Open System Interconnection (OSI) model which includes seven layers of communication protocols, designed to standardize communication systems and network organization. Each layer provides a service to the next higher layer in terms of its own functions and the service provided by the next lower layer.

Layer 7, Application - user application and management functions.
Layer 6, Presentation - data interpretation, format and code transformation.
Layer 5, Session - administration and control of sessions between two entities.
Layer 4, Transport - transparent data transfer, end-to-end control, multiplexing, mapping.
Layer 3, Network - routing, switching, segmenting, blocking, error recovery, flow control.
Layer 2, Link - establish, maintain and release data links, error and flow control.
Layer 1, Physical - electrical, mechanical, functional control of data circuits.

With the use of the model, different categories of telecommunications services can be distinguished, as follows: (1)

Local area network services:
consisting of switched connection services, ie. realized by means of a basic network such as a LAN and corresponding to levels 1 to 3 of the OSI model.

Wide area network services:
including public or regulated data communication services,(ie. includes the data networks provided by regulated carriers such as Telecom Canada or CNCP and corresponds to levels 1 to 7 of the OSI model), and unregulated communication services offering enhanced or value-added services and private networks (ie. Texas Instruments worldwide data communications network and corresponding to levels 1 to 7 of the OSI model).

Marketing Analysis

4.8.2 Demand Analysis

Factors of Change

Three major areas comprise the wide area data networks industry; hardware manufacturing, software, and processing and professional services.

A major factor of change affecting all three areas will be standardization in terms of the OSI model which will maximize compatibility between terminal equipment and which will help to create larger markets for such equipment. Competition between manufacturers can be expected to be stimulated providing benefits to users particularly those requiring international communications.

The reduction in computing costs estimated at 20% per annum is another major factor that will create higher demand for wide area data network products and services.

Areas of Major Growth

The hardware and software sectors will continue to experience growth above the general North American economic growth rates. Although statistics specifically relating to wide area data networks was not available, general trends relating to data networks and information processing services were available. These statistics are presented as an indication of the trends and growth projections that can be expected in the wide area data network segment.

In Canada, annual software revenue growth between 1982 and 1988 is expected to average 28.8% (2), although hardware revenues will continue to dominate industry earnings. Processing and professional services revenues will experience the lowest growth rates, with annual projections of only 5%.

Growth Estimates

1) International Market

The world market for general hardware and software products but excluding processing services is expected to grow to $156-178 billion (1983 US dollars) by 1988 and $233-255 billion (1983 US dollars) by 1993. (3) The US accounts for over half of the world demand; a trend that is expected to continue, and the US, Western Europe and Japan together account for over 90% of the world demand.

2) Canadian Market

In 1982, Evans Research Corp. reported revenues of $5.5 billion for the top 141 computer firms in Canada. Of this total, 81.8% was accounted for by the top 60 hardware suppliers (45 are foreign owned), 12.4% by the top 35 processing and professional services (primarily Canadian owned companies) and 2.6% by the top software companies. Of the leading hardware suppliers, IBM Canada accounted for 40% of the revenues earned by the leading computer firms in Canada. (4)

The three levels of Government in Canada account for a significant percentage (20%) of the institutional demand for services, products and systems. Todate their programs have provided the greatest assistance to equipment manufacturers. Extension of their purchasing power to include software developers could have a substantial impact on this segment of the industry. Further, a more favourable environment, particularly in the taxation area could do much to stimulate the software development sector. Canadian software developers have expressed their concern over tax policies that provide an advantage to import companies and have expressed the opinion that their software products could be distributed and sold for less cost in Canada if they were produced in another country ie. the US.

4.8.3 Supply Analysis

Strengths and Weaknesses

The strength of Canadian companies lies in their innovative ability to find special product and service niches which have allowed some companies to excell internationally. Overall, Canada is relatively self-sufficient in terms of the computer service bureau business and custom software development, but can expect continued trade deficits in off-the-shelf software. Hardware manufacturing which provides the most significant share of industry revenues is highly competitve and dominated by multinationals. However, even in this area, Canadian companies have created a position for themselves within special market segments.

International Market Share

Since the production and sale of equipment in Canada and worldwide is dominated by multinationals, Canada's international market share will not be significant. In software, however, Canadian companies could sustain a larger market share. The major markets of interest would be the US, Western Europe and Japan.

Market Constraints

The wide area data network industry is already dominated by multinationals headquartered in the US, particularly IBM. Of the top 60 Canadian hardware suppliers in 1982, 45 were foreign owned and only one of the top 10 was Canadian owned; AES Data. A similar trend has developed in software whereby most of the systems and applications software used in Canada is provided by foreign companies primarily headquartered in the US. Since the market is already dominated by large multinationals, Canadian companies will be largely constrained to specialized market segments where they will have the greatest chance for export sales.

4.8.4 Competitive Analysis

Major Supplier Strategies

Prior to a few years ago, the wide area data network market consisted primarily of hardware suppliers who provided equipment to the carriers or service providers. Changes in regulatory policies permitting value-added services and increased demand for data services, in general, has created an opportunity for software suppliers and unregulated service providers to enter the wide area data networks market.

In the past, Canadian companies have tended to focus on supplying specialized hardware products such as modems and multiplexers to larger system vendors. GEAC, Gandalf and Develcon are all examples of this strategy. In future, suppliers are also expected to cater to specialized market segments but will include the supply of both software and services.

Market Niches

In the software industries, Canadian companies should concentrate on specific application services and systems, and custom software. Canadian companies have the highest chance of success in the higher-level software application areas, including network management, process control, and specialized user features.

On the hardware side, Canadian companies should concentrate on market niches including turnkey systems (office communication systems, control and monitoring systems, switching and network devices) rather than general purpose hardware dominated by US and Japanese multinationals.

On the services side, on-line information retrieval and transactional services hold the greatest promise for Canadian firms.

Major Canadian Suppliers

Component Suppliers

Gandalf - designs, develops, manufactures and markets data communications and information network equipment. It has operating subsidiaries in Canada, US, UK, the Netherlands and Australia. Fiscal year ending July 31 1985, saw revenue earnings of $85,822,000 of which almost one-half was generated in the US. (5)

Develcon - specializes in the design, manufacture and marketing of data communications equipment used in the transmission of information between terminals, computers and other data processing equipment. Develcon has been in business ten years and has established two US subsidiary companies. Of the $20,267,000 total 1984 sales, approximately $12.5 million was generated in the US and a further $1 million from other international operations.6

AES Data - designs, manufactures and distributes office automation products ranging from standalone integratd workstations to sophisticated shared and distributed systems. AES markets and supports its products in more than 55 countries. Worldwide sales in 1984 totalled almost $150 million of which 13% was sold in the US.

Systems Integration and Software Development

GEAC - designs and manufactures integrated on-line processing systems. Developed an integrated software package called GOAST (GEAC Office Automation Support Tool) that provides a number of office automation software modules.

I.P. Sharp - offers the computer industry's most comprehensive range of APL services. The company has wholly-owned subsidiaries in many European countries, Australia, the Far East and North America.

Other Major Canadian Owned Firms

A partial list of the more frequently cited Canadian companies is included below.

- Ahearn and Soper Inc.
- Canada Systems Group
- Cognos
- Comterm
- Dataline
- Infomart
- Norpak
- Systemhouse

Canadian Imports/Exports

Canada's deficit in both hardware and software continues to rise. In the software area the deficit was estimated at $300 million in 1982 and in hardware, specifically computers and parts, the deficit was estimated at $1.3 billion for the same time period. (4) Development of Canada's system integration and software development sector, which is labor intensive, has the greatest potential to lead to import substitution and export, both of which would have a positive impact on the balance of trade as well as creating employment opportunities.

Development of the software sector will require skilled labour and as indicated by the industry survey, the development of Canada's human resources through the educational process is an area requiring serious review.

Non-Canadian International Competitors

The largest multinational companies involved in wide area data networks are listed below. At the top of the list is IBM whose total market share almost equals that of all other companies combined.

IBM
Digital Equipment
Burroughs
Control Data
NCR
Sperry
Fujitsu
Hewlett-Packard
NEC
Honeywell
Wang

4.8.5 Summary

Although information specific to wide area data networks appears to be in short supply, there is a wealth of information available on data networks and information processing, in general. The trends evidenced in this literature also apply to the more specific segment of wide area data networks.

The greatest opportunity for Canadian companies, both domestically and internationally, is in the software development sector. As noted in the industry survey section, there is a need to review Canadian educational policies with regards to human resource development.

Definitions

Multiplexing - is a technique that allows users to share a common transmission facility. This is achieved by channel bandwidth sharing in which different users are assigned different frequency subchannels or by time bandwidth sharing in which different users must alternate their use of the channel on a time-sharing basis.

Multiplexing allows a channel to be more efficiently ultilized.

Demultiplexing is the inverse process of multiplexing whereby the individual channels are separated from the multiplexed channel.

Frequency Division Multiplexing (FDM) - in frequency division multiplexing, several signals share the same channel band. Each signal modulates a different carrier. The various carriers, known as subcarriers, are adequately separated to avoid interference between the spectra of various modulated signals. All the modulated spectra are then added to create a composite signal, known as the baseband signal, which is further used to modulate a high-frequency (radio frequency or RF) carrier for the purpose of transmission.

Time Division Multiplexing - in TDM the signals to be multiplexed and transmitted over a common facility occupy the same frequency band on a time-sharing basis. TDM uses pulse code modulation or other digitizing techniques to convert an analog signal into a digital signal. The individual samples of a given signal are of sufficiently short duration that the time between samples is used to transmit other signals. The switching process between incoming line occurs so rapidly that each channel appears to be 'on' constantly.

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4.9 Satellite Ground Segment Networks

Satellite systems can be subdivided into their space segment and their ground network segments. Of particular interest to this study is the potential opportunities for Canadian companies in the ground network segments.

With the changes in regulatory policy and advances in technology making earth stations more compact and affordable, many new satellite services are being investigated. Introduction of these services will create a demand for the appropriate ground segment network equipment. The types of services under investigation can be classified as audio, data and image information services. Audio services include FM superstations and radio networking; data services include electronic mail, financial information services and various publications and directories; image information services include education, video conferencing and high definition TV.

The marketing analysis concentrates on ground segment network of space systems. However, to place ground networks in context of the overall system architecture, we include both components in the technical description that follows.

4.9.1 Technical Description

Satellite Systems

Satellite communication systems are microwave relay systems, with typically one intermediate repeater: an orbiting satellite. Communication satellites are typically geostationary, where the orbit is synchronized with the rotation of the earth. It can serve a particular geographical area of the earth (approximately 1/3 of the earth's surface) continuously. As repeaters, satellites are capable of receiving signals from the earth, amplifying and forwarding them. Telecommunication satellites are typically grouped as point-to-point satellites, distribution satellites or direct broadcast satellites.

Point-to-point satellites receive signals from and relay signals to earth stations. The earth station may be connected via microwave or terrestrial cable to the customer location. Large, powerful and expensive earth stations are generally required. A typical application would be long distance telephone service.

Distributional satellites distribute strong signals over a wide area to many earth stations, which can be relatively small. A typical application would include cable and pay TV.

Direct broadcast satellites (DBS) transmit powerful signals to be received by radio and TV sets. They are primarily employed for broadcasting and educational purposes.

The advantage of satellite systems is their extensive coverage of the earth. Because a single orbiting satellite is visible to a large number of widely scattered locations on earth, there is greater flexibilty in application.

Commercial Satellite Frequencies

The microwave frequencies assigned to commercial satellite communications are known as the C-band and the K-band. The K-band is further subdivided into the Ku-band and the Ka-band. The frequencies associated with these bands are listed below:

Frequency Band	Up-Link GHz	Down-link GHz	Bandwidth MHz
6/4 GHz (C)	5.925-6.425	3.7-4.2	500
14/12 GHZ (Ku)	14.0-14.5	11.7-12.2	500
30/20 GHZ (Ka)	27.5-31.0	17.7-21.2	3500

The 6/4 GHZ band is the most widely used today and until late 1970's all commercial satellites utilized this band. Because of congestion and mutual interference with terrestrial microwave systems, the 14/12 GHz band was developed. With the expectation that traffic would outstrip the capacity of both C and Ku-band, experimental work has been carried out to develop satellites that operate at the even higher frequencies of Ka band.

Satellite Space Segment

Transponder Capacity

As indicated above, a typical C-band satellite has 500 MHz of frequency, divided into 12 transponders (repeater channels) of 36 MHz each, with a 4 MHz guard band. A 36 MHz bandwidth is equivalent to one TV channel or approximately 1,000 voice channels. Frequency reuse is often employed to make better use of available bandwidth. One form is to double the available transponder channels by assigning orthogonal polarizations to two transponders having the same (or overlapping) frequency assignments. Research is continuing to provide greater utilization per transponder. Another form of frequency reuse is to assign the same frequencies to different satellite spot beams covering different regions of the earth, which is a key effort in the technology development.

Satellite Ground Segment

Earth Stations

The performance of the earth station plays an important role in the satellite systems, and can have a significant effect on the service area.

Earth stations are now configured with solid-state electronics instead of the earlier used travelling wave tubes (TWT) which had a relatively short life span and required a high level of maintenance. Earth stations include both indoor and outdoor equipment. Outdoor elements include the antenna dish, up and down converters, power amplifiers, receivers and remote monitoring electronics. Indoor elements include the multiplexing equipment, modems, monitoring, and display equipment.

Terminal Equipment

With the advent of mobile satellite services, could come new terminal equipment including mobile radio, mobile paging, mobile telephone and mobile data. The implementation of such a system would also require development of interface equipment to existing systems including base stations for mobile radio, paging and data operations and for access to the public telephone networks.

Marketing Analysis

4.9.2 Demand Analysis

Factors of Change

Changes in the regulatory environment, making private earth station ownership possible, has influenced the demand for satellite services and in turn has increased the demand for ground segment equipment.

Another important factor that has influenced demand is the evolution in earth station technology making it more affordable, and more compact.

Earth station technology developed in several phases, beginning with the large antennas (30 metres) required for international satellite communication systems providing many high quality multiplexed voice channels or wideband television signals. These earth stations interface with telephone and broadcasting systems and cost in the order of 4 to 6 million dollars.

As domestic satellite systems developed, smaller earth stations with 10-metre antennas could be used to handle the lower traffic requirements, with earth station costs in the order of 1/2 million dollars.

The next phase in development saw 3 to 5 metre antennas designed to serve light traffic density areas and receive only TV. Primary uses include private business network communications, teleconferencing and educational television. A small earth station antenna generally utilizes SCPC service and can handle up to 12 voice channels either preassigned or demand assigned.

The utilization of very high power satellites has seen a further reduction in earth station antenna size to 1 metre, thus making it even more affordable to locate earth stations on a customers' premises, particularly in urban centres.

Areas of Major Growth

The growth of satellite services is closely linked to the cost-effectiveness of ground network systems and services. Because of the reductions in cost of earth stations, a major area of growth is expected to emerge in direct broadcast satellite, particularly in privately owned satellite receive only terminals (TVRO's). This market is expected to provide opportunities for small business development in various areas including, retail sales, system assembly and, installation.

Major growth could also result from a proposed mobile satellite system, referred to as MSAT. Since MSAT is not expected to begin commercial operation before 1990, growth projections are for the longer term.

The MSAT system is designed to provide mobile communication services to users over a wide area, using a geostationary satellite system. MSAT would consist of a satellite, ground control facilities and a family of terminals for vehicles, ships, aircraft and fixed installations. System services would include mobile radio, mobile telephone, mobile paging and mobile data and would offer a major alternative to the establishment of private mobile communication facilities, particularly in rural and remote areas.

Growth Estimates

The growth in demand for satellite ground segment networks is dependent on the demand for satellite services. Demand for satellite services are difficult to estimate for several reasons:

Purchasing decisions in the international market place are subject to political interests thereby making the future export market unpredictable for the longer term.

Regulatory and Government policy decisions are key factors in estimating the potential for broadcast applications.

MSAT is still in the proposal stages and many issues remain to be resolved before services are implemented.

Free trade in telecommunication services (as opposed to just goods) could have various effects on the Canadian satellite industry. There is a need for an in-depth analysis of the payoffs and risks. The possibility of arranging a government/industry forum should be considered as a means of obtaining industry feedback on the free trade issue and its consequences.

Despite these difficulties, the demand for satellite services is expected to grow from 40 to 80% within the next five years (excludes MSAT) and could increase by a rate of 100% if plans to launch a Ku-band Direct Broadcast Service are implemented. According to studies conducted by Telesat Canada, the impact of this increased service demand will result in a 1990 cumulative Canadian satellite ground segment market ranging between $1000 M to $2000 M.

In 1982, the total sales by Canadian space-related manufacturers was $180 million dollars (reported to the Canadian Space Information Bank). Ground segment sales accounted for 40% of this and about 80%

of the sales are considered Canadian value-added. Therefore, growth projections for satellite ground segment networks over the next five years are expected to reach record highs.

The most promising services creating the demand for satellite ground segment networks are the following DBS services: FM superstations, radio networks, household data services and financial information services. All of these services are characterized by a fairly large market, modest competition from existing technologies and reasonable hardware/software costs.

4.9.3 Supply Analysis

Strengths and Weaknesses

Canada has been very strong in research and development, particularly as a result of the work of such organizations as Communications Research Council (CRC), Bell Northern Research (BNR), Microtel Pacific (MPR), and SPAR.

Military applications could be a source of innovation, however, the size of the Canadian military budget makes their innovation difficult in comparison to the funding available to the US military.

International Market Share

The limited size of the Canadian market forces Canadian companies to enter the international market in order to sustain growth. However, Canadian companies are relatively small particularly in comparison to their US counterparts. In order to compete effectively on an international basis, Canadian companies will likely pursue specialized market niche strategies. The most likely export items include up-link stations and head-end receivers, which will have low volume requirements. High volume items such as TVRO receivers and decoders will likely be developed domestically, so that the major export potential will be for specialized components rather than finished products. Canada's expected share of the international market will therefore be small but nevertheless important.

Market Constraints

Satellite services have to compete with terrestrial services which will become more difficult on a point-to-point basis with the ever increasing introduction of fibre optics. In order to remain competitive, Canadian suppliers will have to reduce the cost of hardware and develop services to increase the use of satellite systems.

4.9.4 Competitive Analysis

Major Supplier Strategies

Major Canadian companies have traditionally been suppliers of system integration/contract work. Canada's strategy to develop a prime system contractor in SPAR has been largely successful. However, for the most part, Canadian companies will provide products and services for specialized market segments, such as those described above.

Market Niches

Given the limited size and unique infrastructure of the Canadian market, growth is highly dependent on new applications as opposed to the expansion of existing networks. Further, the domestic market alone cannot support the development of a competitive satellite ground system industry and Canadian companies will have to plan for the international market. Companies will probably achieve the most success in special market niche areas.

Market niches with the most potential have two characteristics in common:

a) The existence of a distinctive domestic market for special requirements (ie. far North oil rigs, mobile communications, data collection platforms).

b) The availability of R&D resources at a competitive international level.

Major Canadian Suppliers

The major Canadian suppliers of ground segment network equipment are identified below along with their major product offering.

SED - provides private voice/data networks (Skyswitch) primarily for educational institutions and businesses.

SPAR - prime contractor in spacecraft supply and earth station sales.

Microtel - provide public/private voice/data supervisory networks (Spacetel) and public switched telephone network to remote communities (interconnected by LAN's).

Mitel - primarily provide switches.

Comdev - provide spacecraft subsystems.

Glenayre - development of mobile terminal equipment.

Andrew - supply direct broadcast receivers and earth station dishes.

MDI - development of hand held and in-car mobile terminal equipment.

CAL - processors for remote unattended navigation/communications beacons and the supply of Search and Rescue (SARSAT) ground stations.

Miller - involved in a wide range of communication equipment in areas where voice and data signals are transmitted, detected, processed, measured, jammed or secured.

MDA - leading supplier of Earth Resource Satellite Stations.

Non-Canadian International Competitors

The major international competitors and their home country are listed below.

Company	Country
Comtech	US
Scientific Atlanta	US
Microdyne	US
Vitaline	US
Compression Labs	US
Ma/Comm (Linkabit)	US
Varian	US
Honeywell	US
Federal Electric	US
GTE	US
ITT	US
Alcoa-NEC	US
Comsat Telesystems	US
Harris	US
Aventek	US
LNR Communications	US
Microwave Associates	US
Varian Associates	US
General Instruments	US
Sony	Japan
Panasonic	Japan
Toshiba	Japan
Mitsubishi	Japan

4.9.5 Summary

The satellite ground segment market is expected to experience high growth in the next five years as a result of introduction of new satellite services, primarily direct broadcast services. Beyond 1990, further growth is anticipated as a result of the introduction of mobile satellite (MSAT) services.

Canadian companies that can export their products and services will experience the greatest growth. The greatest export potential will be for specialized products and services. As a result, companies will require assistance in determining the specialized segments that will provide these opportunities internationally and once determined, assistance in penetrating foreign markets through marketing and distribution channel set-up.

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3. Canada Astronautics Ltd., " A Study to Identify Requirements for New Services on A Direct Broadcast Satellite (DBS) System", Sept. 1981.

5.0 Telecommunication and Information Technology Subsystems

5.1 Integrated Switches

Switches are devices capable transferring data arriving over multiple input facilities onto multiple output facilities in accordance with requirements to serve specified connections. A switching network is one in which multiple devices with switching capabilities are interconnected via trunks to enable efficient interconnection of dispersed user workstations (terminals) and resource workstations (computers). There are basically three widely employed switching techniques: 1) circuit switching, 2) packet switching, and 3) hybrid switching. Circuit switching, which is employed by the telephone networks, is essentially an electronic path formed through the switch to connect the input facilities with the output facilities. Packet switching, introduced with the advent of data networks (ARPANET), is the store and forward of small packages of data through computer-based packet switches. Hybrid switching is a combination of circuit switching and packet switching and provides flexibility depending on user requirements.

Major technical trends in integrated switches include improvements in existing digital switches (ie. greater use of distributed processing and lower cost and more powerful components) and the development of hybrid voice/data PBX's and optical switches. Voice/data switches will meet voice/data switching requirements demanded by the office environment as it evolves through office automation. Optical switches, of which prototypes are expected by the early 1990's, will meet the switching needs as fibre optic networks evolve and their widespread implementation is realized.

Telephone networks worldwide have evolved through two distinct stages and are presently evolving through a third. The first stage was analog switching and transmission. The second stage introduced digital switching and transmission. Now the third stage will encompass end-to-end digital connectivity. This third stage is referred to as Integrated Services Digital Network (ISDN).

Basically, ISDN is a switched network providing end-to-end digital transparency where voice and data services are provided over the same switching and transmission facilities.

There are three factors responsible for the evolution towards ISDN. These are 1) the new and expanded services which can be offered, 2) the lower cost of offering services due to the benefits derived in using digital networks, and 3) new technology which enable new services to be offered at reasonable costs. ISDN services are expected to include the following:

1) Digitized Voice
2) Facsimile, Graphics
3) Video
4) Other Services:
- telemetry, videotex, software transfer, electronic mail, data base access for word processors, computers and other terminals.

According to Arthur D. Little Decision Resources, the 1984 market of $175 million (US) for voice/data PBX's is expected to grow at annual rate of 40% and reach $2.2 billion by 1990. As well, Arthur D. Little projects the first generation optical switch market will grow to $125 million (US) in 1995, $500 milion by 2000 and to approximately $1 billion in 2005.(1)

Canada's foremost leading supplier of telecommunications equipment is Northern Telecom Ltd. Northern Telecom is the second largest designer and manufacturer of telecommunications equipment in North America and sixth in the world. Northern Telecom is a world leader in the supply of integrated voice and data communications systems and development and application of digital opto-electronic technologies. Among its many products are switching and transmission systems, cable, subscriber switching systems, telephone apparatus, outside plant, and other equipment for public and private communications networks.

In 1976, Northern announced its Digital Program which committed the company to introduce a complete line of products and systems based on digital technology. As the Digital World program evolved, Northern introduced the DMS (digital multiplexing switch) family of digital switches. Among these include local switchers of different sizes, a toll switcher and a tandem switch designed for the specialized common carrier market. In 1982, Northern Telecom announced a new R&D program entitled Open Protocol Enhanced Networks (OPEN) with a committment of $1.2 billion between 1982 and 1987 for the development of improved information management systems. In the 1971 - 1977 time frame, Northern Telecom spent 6.2% of its sales revenue on R&D; in 1978 - 1981 this ratio increased to 7%. It is partly due to these major commitments in R&D spending, the ability to manage its R&D programs effectively and the excellent research organization of Bell Northern Research that have enabled Northern Telecom to sustain success in the international telecommunications market. Northern Telecom has been an advocate of tax credits as a means of encouraging more commercially oriented R&D. Although Northern Telecom and Bell Northern Research essentially stand alone in their areas of expertise, the federal government should examine current R&D funding policies and programs with the intention to improve and create other means to stimulate development and growth for other Canadian companies involved in telecommunications.

1) Arthur D. Little Decision Resources, Research Letters:L850502 & L850202, July, 1985.

5.2 Software

5.2.1 System Software

System software controls the basic functions of the computer and consists of operating systems, language compilers, language development tools, data base management systems (DBMS) and various utility programs.

Operating systems are continually being upgraded to meet technical and user requirements for real-time applications, file sharing, windowing and multi-user computer systems and local area networks (ie. Microsoft's new operating system for LANs: Microsoft Network). The most common and established operating systems are DEC's CP/M and Microsoft's MS-DOS, both of which have been endorsed by major hardware suppliers such as IBM and Apple. The UNIX operating system, originally developed by AT&T for engineering and scientific applications, is presently 'unfriendly' for business applications. However, with its recent adaptation to IBM and AT&T PCs, the UNIX operating system is increasing in popularity.

The use of software development tools to increase programmer productivity is increasing as current packages are not powerful or flexible enough to meet the specific requirements of many data processing (DP) departments of large organizations. Software development tools include fourth generation languages (ie. Focus and Powerhouse) and other data base management tools such as application generators, screen painters and interactive program editors. The advantages of fourth generation languages include the reduction in development time for applications and improved user 'friendliness' with improved documentation and menus. Although the benefits of these tools have been recognized, their acceptance has been limited, primarily due to the lack of qualified personnel to implement them. Wider acceptance of fourth generation tools is expected in the early 1990's.

Data base management systems (DBMSs) offer the simultaneous handling of several files and can perform multiple interactive tasks. The DBMS market is expected to experience rapid growth, particularly in the microcomputer market, as DBMS products increase in complexity and sophistication.

Revenues for system software in Canada totalled $375 million in 1984 for an annual growth rate of 27%. Although system software revenues are expected to continue at an average growth rate of 27% for the remainder of the decade, the revenues generated by applications software are expected to surpass those of system software, primarily due to the wide range and abundance of applications software. Projected estimates indicate that system software revenues will total $1.050 billion in 1989. (1)

5.2.2 Application Software

Applications software, usually configured as software packages, allow the user to perform various tasks including word processing, accounting and electronic mail.

The most commonly used applications software used in systems with minicomputers and mainframes include payroll inventory, accounting and corporate data base applications in the commercial market and CAD/CAM in the engineering and scientific market. In most microcomputer or PC applications, the most commonly used software packages are for word processing, spreadsheets and data base management applications.

The current trend is toward integrated software packages (ie. Symphony - with spreadsheet, word processing, data base, graphics and communications functions all in one package) and integrated software environments (ie. windowing and split-screen functions) to meet multi-functional and multi-user requirements.

Software vendors are developing software products specifically aimed at industry niches. This trend toward vertical market software is expected to experience rapid growth within the next several years. Major growth areas include CIM, AI applications (expert systems in particular) and hybrid CAD/CAM and AI software.

Applications software revenues in Canada totalled $370 million in 1984 for a 38% share of the total Canadian market. Applications software, with an annual growth rate of 42% in 1984, is expected to experience an average annual growth rate of 39% throughout the remainder of the decade. Projected estimates indicate that revenues for application software in Canada will total $1.25 billion in 1989. (1)

Canadian software vendors and software-related companies have noted several key factors which have made their penetration and success in the international market very difficult. Among these include an ineffective or absent product distribution network in the form of sales offices and/or software development houses in the international market, and the lack of government programs and funds designed to initiate software development and market software products. The major reason for the latter, these companies note, is the failure, by those outside the industry, to recognize systems or applications software as products on a level similar to hardware. Software products, they maintain, require development and marketing funds as do hardware products. Other significant factors include the the dominance in the international and Canadian markets by US-based companies and the lack of venture capital for development work especially in areas where no previous track record for products exist.

Comments from industry have stated Canada's primary involvement in the international software market should be in applications software, noting Canada's financial and technical resources would be best directed towards the development of applications software, as opposed to the development of system software (ie. operating systems, compilers, software tools and processing languages) which is too research and cost intensive and too competitive since this area is dominated by American giants. Several of these companies further noted that the development of applications software by Canadian companies be directed to those areas Canada is known to have expertise in, ie. the resource industries of mining, forestry, fishing and hydro-electric power.

Identified areas for the development of applications software by Canadian companies include: CAD/CAM (given that many Canadian industries have yet to fully implement major CAD/CAM systems and other forms of automation (ie. robotics)), the provision of videotex services (given that the limited number and variety existing today), as third-party software vendors to develop value-added software for LAN and office automation systems, the application of expert systems to resource industries (ie. mining, forestry, fishing and hydro-electric power) and process control and the application of hybrid CAD/CAM and CIM with expert systems.

The federal government can stimulate growth within the Canadian software industry by encouraging and channeling financial resources towards the development of applications software and by the creation of marketing programs designed to provide direction and funding towards opening international markets and improving Canada's competitveness.

1. Evans Research Corp., A Review of the Software Industry in Canada, May 1985.

5.3 Signal Processing

The digital signal processor is a system that accepts digitized signal information, performs some mathematical operations on the information and then delivers the result to the host system or peripheral. A complete digital processing subsystem consists of three major blocks. At the front end is the analog input section that converts the analog data into digital form. The processing block comprises the arithmetic logic unit (ALU), a controller and sequencer, and the data, coefficient and instruction memories. Lastly, an output section converts the digital data back into analog form.

The rising density and speed of VLSI ICs are providing a new generation of digital signal processing systems. Single IC processors are the dominant chips, but new data-flow and systolic architectures will soon be introduced. Scaled technology permits complex functions of multipliers, sequencers and multiple processors to be embedded as part of more complex circuits, so that a near complete signal processing system can reside on a single IC. As a result, system complexity and costs are decreasing rapidly. Processor architectures are changing from the standard Von Neumann structure to the faster Harvard architectures, data-flow machines and systolic arrays. Circuit complexity and speed are critical considerations for digital signal processing. If these two parameters were to increase significantly, ICs could possibly match the computational abilities of mainframes and minicomputers. Real-time applications such as speech recognition, object recognition and image enhancement all depend on fast execution times. The cycle times of digital signal processing ICs are now well under 200 nanoseconds. Circuits that execute full 32-bit floating-point calculations in 100 nanoseconds are being introduced, as are 16-bit parallel devices that can multiply in less than 50 nanoseconds.

Given that the Japanese and the US semiconductor industries dominate overwhelmingly the international semiconductor market, Canadian companies are not expected to and could not capture a significant portion of this market. Canadian companies may be able to succeed in specialized market niches such as providing custom ICs for telecommunications applications, given that telecommunications and telephony are areas of Canadian expertise. However, in light of Canada's small and fragmented semiconductor industry, Canada should concentrate its expertise and technical and financial resources towards the application of semiconductor technologies, rather than research and cost intensive approaches towards the development of new semiconductor technologies. Since digital signal processing techniques are employed in much of the hardware used in the identified high growth technologies (ie. videotex, HDTV, office automation, LANs, wide area data networks, satellite ground networks), Canadian companies could focus their efforts towards market niches in the development of specialized products for these systems. The federal government could assist Canadian industries with direction and funding to identify and exploit these market possibilities.

5.4 Controlled Network Access

In the days when corporations and universities had single computing centres, the problems associated with security were easily resolved. The only requirement was 'physical security', where physical access to computing facilities was controlled via guarded and/or locked rooms to prevent unauthorized removal of cards, tapes, or disks or access to computing equipment. However, with the advent of networking, the proliferation of inexpensive computing devices and peripherals and the resulting 'explosion' of data traffic, network and data security have become a major concern. 'Access security' measures have been developed to overcome this serious problem.

Access security is applied between the data and the user and involves ascertaining a user's identity and associating some level of access privileges with that identity. In its simplest form, known users are permitted access to computing functions while users with unrecognized identities are not. As well, access security can be extended to include levels of privileges allowing users the capability to read but not to update or delete files.

Many computer operating systems and communication support packages provide some form of access security usually based on the concept of user authentication; however, if host facilities do not exist or are inadequate, an external form of access security must be applied. The various forms of access security include the following:

1) authentication systems
2) call-back systems
3) encryption systems

1) Authentication Systems

The two types of authentication systems are:

a) Implicit or Transparent Authentication

Some of the most recent PC communications products have a form of implicit or transparent authentication which requires software support at both ends of the connection, making unauthorized access to the system impossible without this matching component.

b) Explicit Authentication

Explicit authentication systems require the user's identity to be entered via keying data or using an ID card/device to gain access to the system upon initial connection. Some systems require a password as well. Unmatched ID's or passwords will not provide a connection for the user to access the system.

2) Call-Back Systems

Call-back systems maintain lists of phone numbers of valid users. When a user calls for access and is properly validated, the system disconnects the user, and then dials out to the user's number. The user must then correctly receive the call-back to gain access to the system. To gain unauthourized access, an outsider must not only know the number of the system and the ID and password of a valid user, but must be at the phone number on file in order to receive the call-back.

3) Encryption
(Refer to Section 5.5)

Major developments in network access security systems include the application of artificial intelligence principles, pattern matching in particular, to confirm user identity. Among the techniques presently under consideration include voice recognition to match a user's voice input to a pre-recorded voice imprint and eye identification employing a scanner to match the user's retinal blood vessels to a previously known pattern.

The information security market (information security as defined by Frost & Sullivan consists of both computer and communication security) for standalone products is estimated to be $6,108 billion (1984 US) for the time frame between 1985 and 1989. Computer security is expected to account for 95% of the total projected revenue. However, as security features become increasingly incorporated into computer hardware and software this projected market for standalone products will decrease.(1)

With the continued growth of communications networks and increased transmission of all types of confidential and sensitive information, the potential for abuse and the need for network security has become more apparent. Thus, telecommunications industries, corporations and government agencies are taking measures toward the prevention of unauthorized access to networks of all kinds. This trend is expected to continue and the implementation of such measures will be inherent in the systems of many of the identified high growth technologies, particularly, office automation, LANs, electronic mail, videotex, wide area networks and satellite ground networks. As manufacturers or service providers of network technology, Canadian companies will have to incorporate controlled access techniques into their systems to meet network security requirements demanded by users both domestically and internationally. For the federal government, the need and demand for privacy may require the creation and/or enforcment of policies designed to improve and implement network security.

1. Frost & Sullivan, Information Security Products Market (US), 1984.

5.5 Data Encryption

Since their inception, networks have been vulnerable to access by unauthorized personnel. The information transmitted, can be intercepted, altered, and retransmitted without the knowledge of the sender or receiver and the risk of detection of the interceptor is mininal, sometimes non-existent. Telephone lines or data circuits are extremely vulnerable as they can be tapped inexpensively and with little technical knowledge required by the eavesdropper. Although the interception of wirelines is risky to install and leaves physical evidence of a tap, the chance of detecting the interceptor is minimal. Microwave communications, via satellite or terrestrial links, can easily be tapped, but usually at a greater expense. All that is required is to position a parabolic antenna in the right direction. Detection of interception is often difficult or impossible to prove. In the case of microwave communications, the eavesdropper has much to gain at minimal risk as the vast majority of all toll calls are transmitted via microwave and typical traffic includes voice, computer data, facsimile, TWX/Telex, teleconferencing, and videoconferencing. The need for data security has led to the development of 'communications security'.

Communications security refers to the protection, from interception and compromise, of information in transit from one destination to another, generally using techniques known as cryptography or data encryption. The purpose of cryptography is to render transmitted information unintelligible to all except the intended receiver. While the sender encrypts the transmitted information into an unintelligible form (ciphertext), the receiver decrypts the ciphertext into an intelligible form (plaintext). The majority of present day cryptographic devices create ciphertext using a technique known as the conventional cryptographic method. This method involves two mathematical components: first, a Data Encryption Standard (DES) algorithm, a published set of rules for encryption; and second, a crypto variable or key known only to the sender and the receiver. The DES algorithm, which could be described as a large set of mathematical rules, or permutations and substitutions, encrypts each input block of data under the control of a 56-bit key. Only a similar DES device, under the control of the same 56-bit key, of which there are 72 quadrillion key combinations, can properly decrypt the scrambled data.

Given the vulnerabilities of communications systems and the adoption of the DES standard by the National Bureau of Standards in 1977, the data encryption market was expected to flourish. However, the market for encryption devices did not meet predicted expectations for several reasons. Among the factors responsible for the lack of implementation of data encryption into communications systems were price, limited product mix, lack of awareness of system vulnerabilities and distribution of the cryptographic keys. It was difficult to convince users to purchase cryptographic equipment which was several times more expensive than the equipment it was designed to protect. Secondly, most domestic vendors of cryptographic equipment had a limited product mix and could only offer a single product type (ie. a data encryption device or analog scrambler) rather than a mix of products for a wide range of applications. Thirdly, there was a significant lack of awareness to the problems of electronic interception and the vulnerabilities of communications systems and lastly, the operational difficulty to manage the distribution of the cryptographic key imposed a burden perceived as greater than the value of the added security.

More recently, certain markets, in particular the financial industry, have awakened to the need for network security and cryptographic protection. The catalyst for this renewed interest in cryptography has been the explosive growth of electronic funds transfer (EFT) and office automation systems. EFT systems include a wide range of applications, from automated teller machines (ATMs), bill paying by phone, to daily transfers of billions of dollars by corporations, banks and governments. The successful 'theft' of data in many applications actually represents theft of dollars. Concern of theft of data extends beyond the theft of funds. The major concern on the national level is the disruption of important business transactions, the destruction of computer data files and the conceivable economic chaos created by the disruption of the entire monetary system by hostile governments, terrorist groups or special interest groups. As ordered by the US Treasury Department, all electronic funds transfers to the government are to be encrypted using the DES algorithm by 1988.

The announcement issued by the Treasury Department will definitely contribute to the growth of the information security market, as approximatley 5,000 financial institutions alone will be required to incorporate DES encryption techniques into their operations. The estimated market for information security (includes both computer and communication security as defined by Frost and Sullivan) standalone products is projected to be $6,108 billion (1984 US) between 1985 and 1989, with computer security products accounting for 95% of this total.1

IBM, who developed the DES algorithm in 1977, is considered as the current leader in the DES encryption market. However, the recent directive issued by the Treasury Department has spawned numerous vendors offering less expensive software encryption products. Among the encryption software products offered for mainframes and minis are Decrypt by Prime Factors Inc. and Dyl-Security (Dylan Corp.) and for micros are Datasafe by Trigram Systems and Vault by Management Analytic Support. Among the various hardware encryption products are the Techland Systems Encryption option for the IBM 3270 emulation line, Technical Communications Cypher X5000 and the Transcryptor by Cryptext Corp. It is apparent that Canada's involvment in the development of information security products (either hardware or software) and share of the international information security market is presently not significant; however, various Canadian companies manufacturing products for communications networks often incorporate various levels of information security into their product lines and systems.

The commercial applications of cryptography and data encryption techniques are finally being realized as the need for data security becomes more apparent. The present trend is the development of new and more sophisticated data encryption techniques, the manufacture of an extensive product mix of devices for a wider range of applications and the increased implementation of devices into communications systems. This trend is expected to generate a large market for cryptographic equipment in the near future and its implementation into many types of networks and applications, including several indentified high growth technologies (ie. office automation, LANs, electronic mail, wide area networks and satellite ground networks). For Canadian companies involved as manufacturers of products for and/or as service providers of network systems, data encryption or similar techniques will have to be incorporated into future network products and systems in order to meet the increasing need and demand by network users for network security. With an available standard (ie. DES) to conform to, Canadian manufacturers are able to develop, manufacture and market cryptographic equipment for the growing domestic and international information security markets. Given an increasing use of communications networks both domestically and internationally and an increasing need and demand for network security, the federal government must foster the development of data encryption and other similar techniques to encourage Canadian companies to incorporate these into future network products and systems.

1. Frost and Sullivan, Information Security Products Market (US), 1984.

5.6 Fibre Optics

Fibre optics as a lightwave transmission technology evolved from the experimental use of lasers and lightwaves for telecommunication transmission in the early 1960's. Continued work in the studies of lightwave propagation and optical fibre fabrication led to the development, in the early 1970's, of optical fibre of sufficient quality to make lightwave communications realizable.

Common to any fibre optics transmission link are the following components: the light source (a LED or a laser), the transmission medium (optical fibre constructed of a high purity glass or plastic dielectric), and the light detector (an avalanche or pin photodiode).

There are basically three types of optical fibre as characterized by their physical properties:

1) Step-Index Multimode Fibre

This fibre consists of a homogeneous core surrounded by a cladding of slightly lower refractive index. Lightwaves are guided by total reflection within the core, and propagate at different angles resulting in different transit times, therefore limiting the bandwith.

2) Step-Index Singlemode Fibre

In this fibre, the core diameter is so small that multipath transmission is significantly reduced allowing only one mode to propagate. For this reason, singlemode fibre has an extremely large bandwidth.

3) Graded-Index Multimode Fibre

In this fibre, the gradual change in the refractive index from the core to the cladding results in a reduction in the difference of transit time between partial rays. Thus, all modes can propagate at nearly the same velocity.

Fibre optics technology employs the use of optical fibres to transmit information in the form of lightwaves and offers the following advantages which make it an attractive alternative to traditional media of copper and coaxial cable:

1) Large Bandwith - the bandwidth of fibre, the information carrying capacity, is measured as a function of distance. Typical bandwidth-distance products in multi-mode fibres range from 400 MHz-km to 1200 MHz-km. Recent developments have demonstrated the operation of single-mode fibre at data rates in excess of 1 GHz over a distance of 50 km.

2) Low Loss/Large Repeater Spacing - signal attenuation for single-mode fibres have been demonstrated to be as low as 0.2 dB/km.

3) Small Size/Low Weight Cable - the core diameter of single mode optical fibres range from 250 micrometers to 5 micrometers and when fully cabled weighs less than 25 kg/km.

4) Noise Immunity - optical fibres are immune from electro- magnetic interference (EMI), radio frequency interference (RFI) and electromagnetic pulse (EMP).

Present research into fibre optics technology is quite intensive in the fabrication processes of the optical fibres where the following parameters are of most concern: losses, bandwidth, strength and reproducibility. It is expected that operation of fibre optics at higher wavelengths will result in significantly reduced losses. Although it is still a relatively new technology, multi-mode fibre technology is rapidly being replaced by single-mode technology, especially so in long distance transmission, due mainly to the larger bandwidth that single-mode fibre offers.

Improved vapour deposition processes for the manufacture of optical sources and detectors are being developed to produce monolithic optical integrated circuits. Unless suitable mass production processes are developed to produce these optical integrated circuits, fibre optic systems will remain hybrid or continue to be expensive.

On the system level, wavelength division multiplexing (WDM) can be used to multiplex several signals of different wavelengths over a single fibre to increase the transmission capability of the system. It is expected that WDM and higher bit rates will bring forth a realm of existing and new services into homes and businesses that will include telephone, community access television (CATV), picturephone, teleconferencing, and electronic shopping and banking.

With regards to the residential segment, the existing paired copper network will continue to provide voice and voiceband data services and the existing coaxial cable network will continue to provide cable and pay TV services for several years to come. Towards the end of this decade, as the use of data services and digital switching increases in networks, integrated voice and digital systems are expected to be introduced as the concept of Integrated Services Digital Network (ISDN) becomes realized. Fibre optics will likely be used in the digital feeder link to interconnect the distributed switching units with the switching centres. Paired copper will still be adequate for distribution purposes. Coaxial cable is expected to continue to provide video services towards the end of the decade. In the early 1990's as new video services (ie. HDTV) are introduced, a fibre optic-based integrated services centrally switched star system is a logical configuration in the evolution of networks. Given the large installed base of copper in the field today, dramatic cost reductions in fibre optic components (particularly the fibre optic switch and distribution links) are required before fibre optic systems will replace paired copper and coaxial systems.

In the business segment, the use of communications services requiring high speed data transmission systems are expected to increase within the next several years. Demands by medium and large sized companies may accelerate the introduction of fibre optic-based integrated voice/data digital systems. Increased use of fibre optics as the backbone in LANs, the interconnection of peripherals and exchanges to the public switched network and for private network applications is expected to increase in the next several years as data speed requirements increase and fibre optic hardware costs decrease.

Due to its large bandwidth, single-mode is presently the dominant mode in fibre optics technology. It will take some time before the large bandwidth offered by single-mode technology is fully exploited. By this time, LAN systems are expected to be well developed and in widespread use. Future developments will include the simplification of circuit designs and transmission capacities.

The US is presently the dominant leader in the development and implementation of fibre optics technology. Major US companies in the development of fibre optics technology include Corning Glass Works and AT&T. Japan, presently second to the US in fibre optics technology, is very strong in the production of optical fibres and will soon be expected to dominate in the area of optical integrated circuits. Japan's achievements in fibre optics technology can be attributed to the support and leadership provided by the Japanese government to initiate and stimulate development of fibre optics technology in private industry. Major Japanese companies involved in fibre optics technology include Nippon Telegraph and Telephone (NTT), Hitachi, Mitsubishi and Fujitsu.

The amount of research and development and implementation of fibre optics technology in Canada has been considerable given the small size of the Canadian fibre optics industry. Canada's major players in the development and implementation of fibre optics technology have been Bell Northern Research (BNR) and Northern Telecom, Canstar, Foundation Electronic Instruments Inc. and Phillips Cables.

Northern Telecom is the second largest designer and manufacturer of telecommunications equipment in North America and sixth in the world. It is also a world leader in the development and application of digital and optoelectronic (ie. fibre optic) telecommunications technologies. Northern Telecom's headquarters and main manufacturing facilities of the Optical Systems Division is located in Sakatoon, Saskatchewan. Other Optical Systems Division facilities are located in Ottawa, Kanata and Atlanta. Northern Telecom's fibre optics products include optical fibre cable, light sources (ie. lasers and LEDs), detectors, wavelength division multiplexers, optical attenuators, complete fibre optic systems and as well, associated tools and test equipment.

Canstar is a major manufacturer of optical communications products and second only to Northern Telecom in Canada. Canstar supplies complete fibre optic systems for telecommunications, industrial control, computer and CATV applications. Canstar also produces optical cables, fibre optic couplers, optical line terminating equipment, electrooptic modems, attenuation measurement systems, cable termination and fibre distribution panels. One of Canstar's major developments has been Hubnet, a 50 Mb/s local area network.

Foundation Electronic Instruments Inc. supplies fibre optic data systems, fibre optic video-audio transmission systems, fusion splicers for glass fibres and optical power meters. As well, Foundation provides consulting services, custom system design, field installation services and tutuorial courses in the use and maintenance of its products.

Phillips Cables is a major producer of optical cables and provides system design, complete system and field suppport, on-site installation supervision and testing and training courses dealing with equipment maintenance, cable splicing and testing.

Other Canadian companies involved in fibre optics-related technologies include ASW Controls and Instruments Ltd., Barringer Research Ltd., Canadian Instrumentation and Research Ltd., Focal Marine Ltd., JDS Optics Inc., Ph.D. Associates Inc., and RCA Inc. Canadian government laboratories conducting research into fibre optics technology include the Fibre Optics and Broadband System R&D division of the Department of Communications (DOC) and the National Research Council (NRC).

During 1982, Canada was considered second in the world in fibre optic-related activities; however since then, Canada has not been able to sustain that leading position as a manufacturer or a user. Projected estimates indicate Canada will fall to sixth place in worldwide fibre optics activities within the next few years. Bell Northern Research, through its excellent research and development facilities, has enabled Northern Telecom to become one of the largest and most successful designers and suppliers of telecommunications equipment and opto-electronic products in the world. Together, BNR and Northern Telecom could provide direction and leadership for Canada's small fibre optics industry. BNR and Northern could assist other companies in areas of research which they (BNR and NT) could not or would not consider doing, and as well, contribute to the development and growth of smaller companies through the purchase of their products wherever possible. Northern Telecom has been known to take the latter course. Although Canada has a Bell Northern and Northern Telecom, the Canadian fibre optics industry lacks depth and scope. Perhaps one role for the federal government would be to take steps towards the formation of new companies in the area of fibre optics technology; preferably in market niche areas so as to avoid head on competition with well known and established US and Japanese giants. Canadian companies already have a proven track record in the development and implementation of fibre optics technologies. As well, the federal government must take advantage of the well recognized and valuable resources within Canadian universities. Very limited research and development into fibre optics technologies is presently being conducted in most Canadian universities. The federal government could increase its R&D funding to those institutions best suited for research into fibre optics technologies thereby maintaining Canada's position near the leading edge of technology.

6.0 Conclusions and Recommendations

Conclusions

Through this study, we have assessed the characterisitics of telecommunications and information systems companies to determine which of these have contributed most to company success; we have assimilated the major concerns of industry representatives particularly regarding government incentives and policies; and finally, we have determined the specific technology areas that hold the greatest promise for Canadian economic growth.

Clearly, government support must be directed at those companies and those areas that will provide the greatest economic benefit to Canada.

In terms of the companies surveyed, the characteristics of telecommunications and information systems companies that can be expected to contribute the most to their future success and their implications are summarized as follows:

Size - a disproportionately higher response of larger firms was obtained (17%), and was attributed to their greater interest in the outcome of the survey as a result of their ability to make the greatest contribution to Canada's position in the international markets.

Revenues - those companies in excess of 25 million dollars revenues, are positioned to make the most significant direct contribution to Canada's international position. Contributions by smaller companies can best be made indirectly through their subcontracting relationships to larger firms.

These findings suggest that government incentives be directed at larger firms or at least, be administered as two parallel programs.

Products and Services - it is becoming more difficult to distinguish telecommunications from information systems markets. One-quarter of the companies surveyed consider themselves in both. Of the companies classified in information systems, the most significant number provide software products and services. This suggests that government incentives directed at developing Canada's human resources may enhance her ultimate success in the export market.

National Ownership - one-third of the largest companies surveyed are wholly foreign owned, and have parent companies based primarily in the US. This large representation of foreign companies within the domestic market, suggests that Government incentives should encourage capital investment in Canada and development and expansion of Canadian R&D facilities by foreign owned companies.

Characteristics of Market Segments - there is a diversity of market segments ranging from those that approximate free competition to those that are very administered markets. This suggests that government incentives must be able to accomodate varying market segments. Incentives directed at free markets could focus on R&D and marketing, whereas those directed at the more administered markets could focus on financial incentives.

Foreign Markets - the largest foreign market for Canadian companies is and will continue to be the US. The small size of Canadian market requires entry into foreign markets as indicated by the fact that medium sized firms do as much foreign trade as large firms. This suggests that government incentives be directed at assisting companies in penetrating foreign markets, particularly the US.

Government Procurement - federal government procurement, in general, is larger than that of the provincial/local governments. However, commercial and consumer markets are considerably larger and it is in these markets that companies must succeed. Governments do, however, comprise the most important class of customer for R&D Service companies and as such should be encouraged to use outside R&D service companies as a means of stimulating R&D.

R&D Investment - the primary source of R&D funds lies with the private sector, the government is not considered a major source of funds.

The results indicate a need to encourage higher R&D investment by larger firms, particularly those in the Manufacturing sector. There is also a need to subsidize smaller firms to sustain their high R&D levels.

Further, the involvement of Canadian companies in basic research may be far less critical than their involvement in other areas and suggests that the focus of R&D should centre on product innovation and marketing.

Marketing Investment - marketing investment is considered a major factor to the success of export companies. Government incentives directed at enhancing export capabilities are required.

Competitiveness - only five percent of the respondents felt Canadian companies have an advantage in foreign markets. Canada's major advantages centre on product innovation, quality, service and support. Major disadvantages stem from a lack of wide distribution, the size of the sales force, and insufficient promotion/advertising and financing. Stimulation of export marketing should address the areas considered as a disadvantage.

Growth - many telecommunications and information systems companies anticipate high annual growth rates over the next five years and have experienced high growth rates over the past five years. Past company growth would be an appropriate criteria for direct government incentives.

Companies consider the most important factors to growth to be quality and service, which suggests that government incentives include quality assurance and quality control. Next in importance are marketing and R&D. Marketing appears to have a greater impact on growth than R&D investment, however, further analysis would be required to establish the explicit conditions that promote growth.

Although, government incentives and programs have not been considered key in the past in stimulating growth, they are considered important to stimulating future growth.

In terms of the major concerns of the companies surveyed that must be addressed by government, these concerns are summarized as follows:

Financial - provide capital for small businesses in their start-up stages and support R&D through tax incentives.

Human Resources - increase government support in vocation and training of qualified professional resources. Increase R&D funding so that Canada can retain its professionals.

Strategy for Industrial Development - improve government program availability (ie. one-stop shopping). Focus on enhancing foreign market penetration through market assesment subsidies and grants, market research and market development money, and continued industry tracking.

Procurement - increase government purchasing of Canadian products and services.

Information Exchange - improve exchange between industry and government.

With regard to the specific technology areas assessed in this survey, they have the following commonalities:

- Canadian exporters are most likely to succeed in the niche market segments
- assistance in foreign market penetration is required
- R&D funding assistance will improve competitiveness and allow Canadian researchers and graduates to remain in the country
- development of Canadian human resources through the educational process particularly for the software development sector
- assistance in assessing viable market segments.

In conclusion, the enthusiastic interest expressed by the majority of the companies interviewed during this study, the constructive commentary received from survey respondents and the magnitude of relevant testimony in print, all point to the fact that Canada's Telecommunications and Information Systems industries are reaching out for improved national leadership and direction. As a country rapidly moving from natural resources production to greater industrialization, Canada **must carefully plan** a strategy to guide its free enterprise into **international market niches** - the place where Canadian telecommunications and information systems products and services could most successfully compete.

The rapid evolution of telecommunications and information systems technologies is the decisive factor dictating to Canada the **urgency of establishing national policies, goals and industrial direction.** If we are to be ready to meet the demand of the international market, the time to act is **now.** Serious concern has been expressed throughout the study that Canada is already missing major opportunities by not having a firm national strategy in place; a strategy that would foster Canadian capabilities in specific technologies based on well defined markets. Other western countries such as Japan, W. Germany, and Switzerland, have been very successful in approaching world markets as a nation, rather than as fragmented individual industry segments.

Canada is producing some of the best technical minds and has some of the world's most qualified engineering teams in the telecommunications and information systems technologies. In particular, Canadians have developed world class expertise in **system integration and network development.** There is no real impediment to our national capabilities that should prevent Canadians from **world leadership** in these areas.

Recommendations

The following sections address telecommunications and information systems industries' concerns which fall into three basic categories:

- access to government information on the performance of industry sectors
- an economic environment conducive to planning expansion
- input towards government's leadership in the long term development of industry sectors.

As a fundamental goal, **Canada needs a strategic 5-year plan.**

The development of this strategic plan should be the prime resposibility of one authority. In reviewing the most likely Federal Government Departments that are presently involved in various aspects of monitoring, regulating, evaluating and supporting of Canadian hi-tech industry in general and telecommunications and information systems technologies, in particular, we note quite a long list (see Table 6.1). Each operates with different departmental goals, and responsibilities, such that the possibility of duplication and lack of common direction is quite possible.

Table 6.1

Federal Departments Possibly Associated with Telecommunications & Information Systems Technologies

(in alphabetic order)

- Anti-Dumping Tribunal Canada
- Canada Institute for Scientific and Technical Information
- Canadian Industrial Renewal Board
- Canadian International Development Agency
- Canadian Patents & Development Ltd.
- Canadian Radio, Television and Telecommunications Commission.
- Communications, Department of
- Consumer & Corporate Affairs Canada
- Counselling Assistance to Small Enterprises
- Economic Council of Canada
- Employment and Immigration Canada
- Export Development Corporation
- External Affairs Canada
- Federal Business Development Bank
- Finance Canada, Department of
- Foreign Investment Review Agency (FIRA)
- International Development Research Centre
- International Joint Commission

- Machinery and Equipment Advisory Board
- National Research Council
- Regional Economic Expansion/Industry Trade & Commerce
- Regional Industrial Expansion
- Revenue Canada, Customs and Excise
- Royal Commission on the Economic Union & Development Prospects
- Science Council Canada
- Science and Technology Canada
- Small Business, Ministry of State for
- Small Business Loans Act
- Standards Council of Canada
- Supply and Services Canada
- Tariff Board
- Tax Court of Canada
- Treasury Board of Canada

Source - Government of Canada, January 1985, Telephone Directory

The concerns and interests of companies included in this study (see Table 3.8.4.2), combined with the desire of the Department of Communications to identify **high impact technologies** and recommend ways to improve Canada's market share, leads us to **conclude that there is no clearly defined single organization within the government that has the mandate and full responsibility to provide the required leadership necessary to develop policies that could be implemented as a strategic 5-year plan.** We further conclude that this task could only be expediently accomplished through close collaboration and joint responsibility between **industry, Government** and **user groups.**

The options for strategic government support to address these concerns has been reviewed in this study from the singular point of view of the Department of Communications. However, the nature of the industries concerns goes beyond the mandate of the DOC. We therefore strongly recommend that the findings of this report be forwarded to other government ministries and departments (see Table 6.1) in particular, Ministry of Science and Technology and External Affairs.

The Department of Communications could play a major role in providing the needed leadership to prepare a Canadian strategic plan that would result in increased domestic and international market shares by Canadian companies.

We also recommend that the Department of Communications responsibilities in the area of information systems technologies be better defined. The ever increasing overlap of information technologies and telecommunications technologies dictates by its technical and business nature, that information and telecommunciations technology assessment, market evaluation, industry support and regulatory control should be amalgamated under one authority.

In some areas of the high impact telecommunications and information systems technologies, as identified in this study, undue delay in establishing national strategies, from both marketing and financing points of views, would reduce Canada's chances in becoming a serious international competitor. Already, the limited funding of R&D work on 5th generation computers, expert systems, some areas of office automation and voice/data networks, is allowing international competitors to rapidly surpass Canadian expertise.

In addition, the pending trade discussions between Canada and the U.S., makes it imperative, in our opinion, to establish Canada's position vis a vis open trade with the U.S. in this field. We realize that Canadian industries on one hand depend, by and large, upon the imports of electronic components from the U.S., Japan and Europe while on the other , are trying to find international market segments in which to compete. Will an open border with the U.S. hurt Canadian industries? This is not a simple issue and was not addressed in this study, but we believe it must be addressed now so that Canadian direction in this regard is firmly established.

We therefore further recommend:

1. Under the leadership of DOC, in consultation with MOST, that a Gazette Notice be prepared to inform Canadians (Canadian Industry in particular) of the recommendations of this study, and to solicit comments, as additional inputs to DOC, in its activities towards developing a national strategic 5-year plan.

2. To obtain further industry comment, the Department of Communications, in collaboration with MOST, could establish a special display and consultation area within the Expo 86 grounds. This will provide a first hand opportunity for interaction with Canadian and International industry representatives.

3. To inform industry of the progress made in all areas of concerns expressed by them, a conference should be scheduled for September 1986 where an open forum would allow for the discussion of the national strategic 5-year plan and the governments longer term plans.

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ATTACHMENTS

ATTACHMENT I

SURVEY QUESTIONNAIRE

KVA Communications and Electronics Co.

VERSION C May 21, 1985

GOVERNMENT ASSESSMENT OF TELECOMMUNICATIONS AND INFORMATION SYSTEMS TECHNOLOGIES

		FIELD LENGTH
I.D. NO. ________ (reserved field)		4
COMPANY NAME	________________________________	30
CONTACT PERSON	________________________________	
TITLE	________________________________	30
ADDRESS		
P.O. Box/Street	________________________________	28
City	____________________	30
Province	____________________	4
Postal Code	______________	7
Area Code/Telephone Number	______________	12
Two Primary Standard Industrial Classification Codes (SIC Codes) if known	______________ , ______________	9

INSTRUCTIONS

Please circle or write in the answer to each question.

In some cases, you may have no opinion or the question may be irrelevant to your company. **In these cases, leave the answer blank.**

If your company does **not** engage in telecommunications, information systems, or related activities, please indicate in Question A-1 and return the questionnaire.

For clarification, definitions have been included in this package. Should you have any questions while completing the questionnaire, please call Sheila Flynn, (416) 661-6644.

DEFINITIONS

TELECOMMUNICATION/INFORMATION SYSTEM

- enables a message (voice, data or video) to be input at one point and output to a distant point. Inputs are those devices related to the creation of messages while outputs are those devices located at end user points. Between creation of the message and the end user are all the components necessary to local or long haul transmission including: transmission facilities, switches, processing and storage facilities.

VOICE

- signals which represent speech or audio messages.

DATA

- signals which represent text graphics, or information type messages.

VIDEO

- signals which represent moving optical images.

ANALOGUE SIGNAL

- continuously varying in time.

DIGITAL SIGNAL

- discrete, taking on fixed levels or values. Systems that perform conversion between the continuous variables and their digitized representations (or the reverse process) are classified as digital systems.

COMPANY BACKGROUND

A-1 In which of the following telecommunications, information activities or related areas does your company engage? (PLEASE CIRCLE ALL WHICH APPLY)

1 - Manufacturing
2 - Distribution and Sales
3 - Common Carrier
4 - Service Organization
5 - Research and Development
9 - Other (please specify)

0 - None 6

IF "NONE", PLEASE DISCONTINUE AND RETURN QUESTIONNAIRE

________________________________ 30

A-2 Does your company primarily engage in:

1 - Telecommunications 2 - Information Systems 3 - Both 4 - Other 1

If other, please specify ________________________________ 30

A-3 Is your company:

1 - Canadian Owned 2 - Foreign Owned 3 - Both 1

If both, what percentage is Canadian owned? __/__/__/% 3

A-4 How many full time equivalent employees does your company have for its Canadian operations?

1 - 1 to 5	5 - 50 to 99
2 - 6 to 10	6 - 100 to 249
3 - 11 to 19	7 - 250 to 499
4 - 20 to 49	8 - 500 or more

1

A-5 For your last fiscal year, what were your total company revenues in Canadian Dollars from its Canadian operations?

1 - Under $1.0 million	5 - $25.0 to $49.9 million
2 - $1.0 to $4.9 million	6 - $50.0 to $99.9 million
3 - $5.0 to $9.9 million	7 - $100.0 to $249.9 million
4 - $10.0 to $24.9 million	8 - $250.0 million or more

1

A-6 What are the major products and/or services that your company provides? Please mark in order of revenue contribution, with (1) as the most significant.

(1)____ 30

(2)____ 30

(3)____ 30

(4)____ 30

(5)____ 30

3 - C

A-7 What is the percentage of Canadian content of your major product based on the dollar cost?

1 - 0 to 20% 3 - 41 to 60%

2 - 21 to 40% 4 - > 60% 1

CONTINUED ON NEXT PAGE

MARKETS AND COMPETITION

FOR YOUR MAJOR PRODUCT OR SERVICE AS IDENTIFIED IN A-6:

B-1 What percentage of your revenue is generated in the following major markets?

1 - Canada __/__/__/% If other, please specify: 3

2 - U.S. __/__/__/% ______________________________ 3

3 - Other __/__/__/% 3

100% 30

B-2 How many clients provide 70% of your revenues?

1 - 1 to 4
2 - 5 to 9
3 - 10 to 14
4 - 20 to 49
5 - 50 to 99
6 - 100 or more 1

B-3 What percentage of your total sales does your largest customer provide?

1 - < 1 to 4%
2 - 5 to 9%
3 - 10 to 19%
4 - 20 to 39%
5 - 40 to 59%
6 - 60% or more 1

B-4 What percent of your revenue is provided by customers belonging to each of the following categories?

Federal Government __/__/__/% 3

Local and Provincial Govt. __/__/__/% 3

Transportation __/__/__/% 3

Service Industries __/__/__/% 3

Manufacturing Industries __/__/__/% 3

Consumers __/__/__/% 3

Other (PLEASE SPECIFY) __/__/__/% 3

100%

______________________ 30

B-5 Are your major competitors:

1 - Canadian | 4 - European 1
2 - United States | 5 - Other (PLEASE SPECIFY)
3 - Japanese/Far Eastern | ________________ 30

B-6 Including **both your Canadian and foreign markets, if any,** with how many companies do you compete?

1 - none to 4 | 3 - 20 to 49
2 - 5 to 9 | 4 - 50 to 99
3 - 10 to 19 | 5 - 100 or more 1

B-7 List the names of your four major overall competitors.

1 - ____ 30
2 - ____ 30
3 - ____ 30
4 - ____ 30

B-8 If you know your share of the **Canadian** market, is it?

1 - nil to 4% | 4 - 20 to 39%
2 - 5 to 9% | 5 - 40 to 59%
3 - 10 to 19% | 6 - 60% or more 1

THE REMAINING QUESTIONS RELATE TO YOUR ENTIRE OPERATION

B-9 What has been your company's <u>average annual growth rate</u> over the past five years?

1 - none | 5 - 16 to 20%
2 - 1 to 5% | 6 - 21 to 25%
3 - 6 to 10% | 7 - 25 to 30%
4 - 11 to 15% | 8 - more than 30% 1

B-10 Considering your resources, your domestic competition, and your foreign competition, what realistic average annual growth rate, if any, do you anticipate for your company annually over each of the next five years?

1 - none
2 - 1 to 5%
3 - 6 to 10%
4 - 11 to 15%
5 - 16 to 20%
6 - 21 to 25%
7 - 26 to 30%
8 - more than 30% 1

B-11 Listed below are a number of factors which might or might not affect your company's revenue growth. Please indicate the relative importance of each to your company's revenues over the next five years.

	Extremely Important	Very Important	Somewhat Important	Not at All Important	
Price	1	2	3	4	1
Quality	1	2	3	4	1
Marketing	1	2	3	4	1
Service	1	2	3	4	1
Research and Development	1	2	3	4	1
Competition	1	2	3	4	1
Government Incentives	1	2	3	4	1
Government Tax Policy	1	2	3	4	1
Capital Investment	1	2	3	4	1
Other	1	2	3	4	

Please Specify ________________________________ 30

CONTINUED ON NEXT PAGE

MARKETING AND THE COMPETITIVE ENVIRONMENT

C-1 For your last fiscal year, what percent, if any, of its total revenues did your company devote to marketing and sales?

1 - Less than 5% 4 - 15 to 19%

2 - 5 to 9% 5 - 20 to 24%

3 - 10 to 14% 6 - 25% or more 1

C-2 Does your company sell it's products and/or services in other countries or just in Canada?

1. Just in Canada

IF "JUST IN CANADA" GO TO QUESTION D-1 1

2. U.S.

3. Other
Please Specify ______________________ 30

C-3 Within foreign markets, do your non-Canadian competitors have the general advantage, do Canadian companies have the general advantage, or do they compete equally?

1 - Non-Canadian Companies have advantage 2 - Compete equally 3 - Canadian companies have advantage 1

C-4 Listed below are a number of factors which may influence the success of companies in your major foreign markets. Please indicate the extent to which each factor is an advantage or disadvantage for your own Canadian Company.

Specify your major foreign market: ____________________________ 30

	Major Canadian Advantage	Minor Canadian Advantage	Even	Minor Canadian Disadvantage	Major Canadian Disadvantage	
Product Innovation	1	2	3	4	5	1
Product Quality	1	2	3	4	5	1

	Major Canadian Advantage	Minor Canadian Advantage	Even	Minor Canadian Disadvantage	Major Canadian Disadvantage	
Product Service and Support	1	2	3	4	5	1
Pricing	1	2	3	4	5	1
Financing	1	2	3	4	5	1
Wide Distribution	1	2	3	4	5	1
Promotion/ Advertising	1	2	3	4	5	1
Marketing Expertise	1	2	3	4	5	1
Corporate/ Brand Image	1	2	3	4	5	1
Management Capability	1	2	3	4	5	1
Government Financial Support	1	2	3	4	5	1
Government Regulatory Support	1	2	3	4	5	
Compatability with Existing Standards	1	2	3	4	5	1
Compatability with Future Standards	1	2	3	4	5	1

	Major Canadian Advantage	Minor Canadian Advantage	Even	Minor Canadian disadvantage	Major Canadian disadvantage	
Discriminatory Foreign Regulations	1	2	3	4	5	1
Restrictive Canadian Regulations	1	2	3	4	5	1
Foreign Duty Barriers	1	2	3	4	5	1
Size of Sales Force	1	2	3	4	5	1
Ability of Sales Force	1	2	3	4	5	1
Other	1	2	3	4	5	1

Please specify ______________________________ 30

CONTINUED ON NEXT PAGE

RESEARCH AND DEVELOPMENT

D-1 For your last fiscal year, what percentage of the total revenues of Canadian operations were devoted to research and development?

1 - less than 3%	4 - 9 to 11%	
2 - 3 to 5%	5 - 12 to 14%	
3 - 6 to 8%	6 - 15% or more	1

D-2 Overall, how important do you consider research and development in contributing to your company's growth?

1 - Extremely important	3 - Somewhat important	
2 - Very important	4 - Not at all important	1

D-3 For your last fiscal year, what percent of the above research and development funds did you allocate to each of the following functions?

Basic Research	__/__/__/%	3
New Product Development	__/__/__/%	3
Improving Existing Products	__/__/__/%	3
Quality Assurance and Control	__/__/__/%	3
Market Research and Development	__/__/__/%	3
Other (Please specify).........................	__/__/__/%	3
______________________________	100%	30

D-4 For your last fiscal year, what percent of your research and development was:

Company Financed	__/__/__/%	3
Government Financed	__/__/__/%	3
Customer/Client Financed	__/__/__/%	3
Parent/Affiliate Financed	__/__/__/%	3
Other (Please Specify).........................	__/__/__/%	3
______________________________	100%	30

D-5 Listed below are a number of telecommunication, information systems and related areas. Please indicate how much, if any, research and development effort your company devotes to each.

	Much	Some	None At All	
Voice Recognition	1	2	3	1
Language Translation	1	2	3	1
CAD/CAE/CAM	1	2	3	1
Expert Systems	1	2	3	1
Robotics	1	2	3	1
Videotex	1	2	3	1
Teletext	1	2	3	1
Teletex	1	2	3	1
High Resolution TV	1	2	3	1
Slow Scan TV	1	2	3	1
Image Processing	1	2	3	1
Visual Recognition	1	2	3	1
Narrow Band Modulation	1	2	3	1
Signal Processing	1	2	3	1
Encryption	1	2	3	1
Error Correction	1	2	3	1
Networks				
- Controlled Access	1	2	3	1
- Fibre Optic	1	2	3	1
- Laser Beam/Optical	1	2	3	1
- Local Area	1	2	3	1
- Satellite (space segment)	1	2	3	1
- Satellite (ground segment)	1	2	3	1
Systems				
- Automatic Location	1	2	3	1
- Electronic Mail	1	2	3	1
- Office Automation	1	2	3	1
- Intelligent Buildings	1	2	3	1
Switches				
- Digital	1	2	3	1
- Optical	1	2	3	1
- Integrated Voice/Data	1	2	3	1
- Integrated Voice/Data/Video	1	2	3	1
Other (please specify)				
__________________	1	2	3	30

ATTACHMENT II

SURVEY RESULTS

D-6 Over the next five years, what is the most important product or service, if any, that you expect to market as a result of your company's research and development activites?

____

PRODUCT __________________________________ 30

SERVICE __________________________________ 30

CONTINUED ON NEXT PAGE

TECHNOLOGY TRENDS

E-1 In which telecommunications, information systems and related areas do you foresee the **greatest growth** over the next five years?

NATIONALLY ______________________________ 30

______________________________ 30

INTERNATIONALLY ______________________________ 30

______________________________ 30

3 - C

E-2 Listed below are a number of telecommunications, information systems, and related areas. Please indicate the annual international growth you anticipate over the next five years in each one. Also, indicate your primary areas of expertise with an "X".

		nil to 9%	10% to 19%	20% to 29%	30% or more	Area of Expertise	
(a)	Voice Audio Input	1	2	3	4	____	2
(b)	Voice Audio Transmission	1	2	3	4	____	2
(c)	Voice Audio Switching	1	2	3	4	____	2
(d)	Voice Audio Processing	1	2	3	4	____	2
(e)	Voice Audio Storage	1	2	3	4	____	2
(f)	Voice Audio Output	1	2	3	4	____	2
(g)	Data Input	1	2	3	4	____	2
(h)	Data Transmission	1	2	3	4	____	2
(i)	Data Switching	1	2	3	4	____	2

		nil to 9%	10% to 19%	20% to 29%	30% or more		
(j)	Data Processing	1	2	3	4	____	2
(k)	Data Storage	1	2	3	4	____	2
(l)	Data Output	1	2	3	4	____	2
(m)	Video Input	1	2	3	4	____	2
(n)	Video Transmission	1	2	3	4	____	2
(o)	Video Switching	1	2	3	4	____	2
(p)	Video Processing	1	2	3	4	____	2
(q)	Video Storage	1	2	3	4	____	2
(r)	Video Output	1	2	3	4	____	2
(s)	System Software	1	2	3	4	____	2
(t)	Application Software	1	2	3	4	____	2

E-2 (u) From the above list, please select the one item you believe will have the highest growth and specify the applicable product or service on which your selection has been based.

1 - Item ______________________________________ 1

2 - Technology product or service ____________________ 30

3 - C

3 - List your related patents ________________________ 30

E-3 Listed below are a number of **transmission media.** Please indicate the annual growth within your markets that you anticipate over the next ten years for each media, **for the total market,** Canada **and export combined.** Also, indicate your primary area of expertise with an "X".

	nil to 9%	10% to 19%	20% to 29%	30% or more	Area of Expertise	
INTEGRATED VOICE/ DATA SWITCHES						
Central Office/Toll						
- Digital	1	2	3	4	____	2

	nil to 9%	10% to 19%	20% to 29%	30% or more	Area of Expertise	
- Analogue	1	2	3	4	____	2
- Fibre Optic	1	2	3	4	____	2
PBX						
- Digital	1	2	3	4	____	2
- Analogue	1	2	3	4	____	2
- Fibre Optic	1	2	3	4	____	2
Integrated Voice/ Data Video Switch	1	2	3	4	____	2
Remote Sensors/ Alarms	1	2	3	4	____	2
Optical Character Reader	1	2	3	4	____	2
Digital Monitors/ Displays	1	2	3	4	____	2
Videodiscs	1	2	3	4	____	2
Picturephone	1	2	3	4	____	2
Photocopiers	1	2	3	4	____	2
Signal Processing	1	2	3	4	____	2
Data Integrity	1	2	3	4	____	2
Data Security	1	2	3	4	____	2
Other	1	2	3	4	____	2

Please Specify ____ 30

CONTINUED ON NEXT PAGE

GOVERNMENT INCENTIVES

F-1 Overall, how important do you consider current government assistance, programs, and policies in contributing to your company's present ability to compete in foreign markets?

1 - Extremely important 3 - Somewhat important

2 - Very important 4 - Not at all important 1

F-2 How important do you believe revised and expanded government assistance, programs and policies could be in contributing to your company's future ability to compete in foreign markets?

1 - Extremely important 3 - Somewhat important

2 - Very important 4 - Not at all important 1

F-3 What government initiatives, programs, or policies could you see aiding your company's export sales?

____ 30

____ 30

____ 30

F-4 Listed below are several possible incentives which government could consider for stimulating Canadian exports. How important would each be for your own company's ability to become more competitive in foreign markets?

	Extremely Important	Very Important	Somewhat Important	Not at All Important	
Tax credits for pure Research	1	2	3	4	1
Tax credits for product R&D	1	2	3	4	1
Tax credits for capital investment	1	2	3	4	1

	Extremely Important	Very Important	Somewhat Important	Not at All Important	
Tax credits for venture capital investment	1	2	3	4	1
Tax credits for foreign market development	1	2	3	4	1
Tax credits for foreign advertising	1	2	3	4	1
Assisting finance of export Inventories	1	2	3	4	1
Patent protection of product innovations	1	2	3	4	1
Supporting Canadian interests regarding U.S./International standards	1	2	3	4	1
Coordinating flow of university/government R&D with Canadian Co's.	1	2	3	4	1
Facilitating formation of export consortia	1	2	3	4	1
Providing seminars on export markets	1	2	3	4	1
Promoting compatible standards with export markets	1	2	3	4	1
Creating an ongoing industry/government forum for improved cooperation	1	2	3	4	1
Skilled Work Force	1	2	3	4	1
Manufacturing Automation	1	2	3	4	1
Low Interest Loans For:	1	2	3	4	1

(Please Specify) ______________________________ 30

G-1 Please indicate specific problems and their possible solutions that may be usefully addressed through government policy and regulation.

______________________________ 30

______________________________ 30

______________________________ 30

______________________________ 30

G-2 Please provide any additional comments or information that you feel will add to the clarity or completeness of the data provided.

______________________________ 30

______________________________ 30

______________________________ 30

______________________________ 30

______________________________ 30

Finally, do you wish to receive a summary of this study when it becomes available in approximately four to six months?

1 - Yes 2 - No 1

THANK YOU SO MUCH FOR YOUR HELP. PLEASE RETURN IN THE ENVELOPE PROVIDED TO:

MR. MICHAEL KEDAR
KVA COMMUNICATIONS AND ELECTRONICS CO.
364 SUPERTEST ROAD
DOWNSVIEW, ONTARIO
M3J 2M2

We would also appreciate if you could include a copy of your latest annual report.

FOR OFFICE USE ONLY

DATE OF RETURN ______________________________ 20

RESPONSE WEEK 1 2 3 4 1

08/21/85

KVA Communications and Electronics Co.

TELECOMMUNICATIONS AND INFORMATION
SYSTEM TECHNOLOGIES ASSESSMENT
****

THE TOTAL NUMBER OF RESPONDENTS WISHING TO RECEIVE A COPY IS 327 .

THE TOTAL NUMBER OF QUESTIONNAIRES MAILED IS 2033.
THE TOTAL NUMBER OF QUESTIONNAIRES RETURNED IS 925 .
THE TOTAL NUMBER OF QUESTIONNAIRES RETURNED WITH WRONG ADDRESSES 187 .
THE TOTAL NUMBER OF NONRELEVANT QUESTIONNAIRES RETURNED IS 338 .
THE TOTAL NUMBER OF RELEVANT QUESTIONNAIRES RETURNED IS 400 .

THE RESPONSE RATE IS 45.50 %

SECTION A -- COMPANY BACKGROUND

A - 1 COMPANY ACTIVITIES

#0	338	OF	738
#1	158	OF	738
#2	202	OF	738
#3	25	OF	738
#4	191	OF	738
#5	188	OF	738
#9	50	OF	738

492 ANSWERED IN ONLY 1 AREA
121 ANSWERED IN 2 AREAS
86 ANSWERED IN 3 AREAS
39 ANSWERED IN MORE THAN 3 AREAS

A - 2 ACITIVITY CLASSIFICATION

7 OF 400 DID NOT ANSWER 2%

# 1	101	OF	400	25%
# 2	166	OF	400	42%
# 3	86	OF	400	22%
# 4	40	OF	400	10%

TOTAL: 100%

A - 3 OWNERSHIP

3 OF 400 DID NOT ANSWER 1%

# 1	358	OF	400	90%
# 2	25	OF	400	6%
# 3	14	OF	400	4%

TOTAL: 100%

CANADIAN % IF BOTH
3 ANSWERED IN THE RANGE OF 1 - 25%
3 ANSWERED IN THE RANGE OF 25 - 50%
4 ANSWERED IN THE RANGE OF 51 - 75%
7 ANSWERED IN THE RANGE OF 76 - 100%

A - 4 SIZE (EMPLOYEES)

1 OF	400	DID	NOT	ANSWER	0%
# 1	105	OF	400	26%	
# 2	69	OF	400	17%	
# 3	55	OF	400	14%	
# 4	67	OF	400	17%	
# 5	33	OF	400	8%	
# 6	33	OF	400	8%	
# 7	8	OF	400	2%	
# 8	29	OF	400	7%	
TOTAL: 100%					

A - 5 SIZE ($)

7 OF	400	DID	NOT	ANSWER	2%
# 1	203	OF	400	51%	
# 2	103	OF	400	26%	
# 3	25	OF	400	6%	
# 4	25	OF	400	6%	
# 5	11	OF	400	3%	
# 6	7	OF	400	2%	
# 7	8	OF	400	2%	
# 8	11	OF	400	3%	
TOTAL: 100%					

A - 7 CANADIAN CONTENT

22 OF	400	DID	NOT	ANSWER	6%
# 1	34	OF	400	8%	
# 2	34	OF	400	8%	
# 3	53	OF	400	13%	
# 4	257	OF	400	64%	
TOTAL: 100%					

SECTION B - MARKETS AND COMPETITION

B - 1 MARKETS

1 CANADA
- 8 DID NOT ANSWER THE QUESTION.
- 42 ANSWERED IN THE RANGE OF 1 - 25%
- 32 ANSWERED IN THE RANGE OF 26 - 50%
- 29 ANSWERED IN THE RANGE OF 51 - 75%
- 289 ANSWERED IN THE RANGE OF 76 - 100%

2 U.S.
- 243 DID NOT ANSWER THE QUESTION.
- 81 ANSWERED IN THE RANGE OF 1 - 25%
- 36 ANSWERED IN THE RANGE OF 26 - 50%
- 21 ANSWERED IN THE RANGE OF 51 - 75%
- 19 ANSWERED IN THE RANGE OF 76 - 100%

3 OTHER
- 284 DID NOT ANSWER THE QUESTION.
- 86 ANSWERED IN THE RANGE OF 1 - 25%
- 17 ANSWERED IN THE RANGE OF 26 - 50%
- 7 ANSWERED IN THE RANGE OF 51 - 75%
- 6 ANSWERED IN THE RANGE OF 76 - 100%

B - 2 MARKET(# OF CUSTOMERS)

19 OF 400 DID NOT ANSWER 5%

# 1	66	OF	400	16%
# 2	82	OF	400	20%
# 3	56	OF	400	14%
# 4	70	OF	400	18%
# 5	33	OF	400	8%
# 6	74	OF	400	18%

TOTAL: 100%

B - 3 MAJOR CUSTOMERS

22 OF 400 DID NOT ANSWER 6%

# 1	63	OF	400	16%
# 2	63	OF	400	16%
# 3	91	OF	400	23%
# 4	99	OF	400	25%
# 5	36	OF	400	9%
# 6	26	OF	400	6%

TOTAL: 100%

B - 4 MARKET SECTORS

FEDERAL GOVERNMENT
241 DID NOT ANSWER THE QUESTION.
115 ANSWERED IN THE RANGE OF 1 - 25%
25 ANSWERED IN THE RANGE OF 26 - 50%
12 ANSWERED IN THE RANGE OF 51 - 75%
7 ANSWERED IN THE RANGE OF 76 - 100%

LOCAL/PROV GOVT
238 DID NOT ANSWER THE QUESTION.
128 ANSWERED IN THE RANGE OF 1 - 25%
25 ANSWERED IN THE RANGE OF 26 - 50%
4 ANSWERED IN THE RANGE OF 51 - 75%
5 ANSWERED IN THE RANGE OF 76 - 100%

TRANSPORTATION
293 DID NOT ANSWER THE QUESTION.
89 ANSWERED IN THE RANGE OF 1 - 25%
15 ANSWERED IN THE RANGE OF 26 - 50%
0 ANSWERED IN THE RANGE OF 51 - 75%
3 ANSWERED IN THE RANGE OF 76 - 100%

SERVICE INDUSTRIES
169 DID NOT ANSWER THE QUESTION.
102 ANSWERED IN THE RANGE OF 1 - 25%
60 ANSWERED IN THE RANGE OF 26 - 50%
28 ANSWERED IN THE RANGE OF 51 - 75%
41 ANSWERED IN THE RANGE OF 76 - 100%

MANUFACTURING INDUSTRIES
180 DID NOT ANSWER THE QUESTION.
110 ANSWERED IN THE RANGE OF 1 - 25%
63 ANSWERED IN THE RANGE OF 26 - 50%
13 ANSWERED IN THE RANGE OF 51 - 75%
34 ANSWERED IN THE RANGE OF 76 - 100%

CONSUMERS
249 DID NOT ANSWER THE QUESTION.
73 ANSWERED IN THE RANGE OF 1 - 25%
23 ANSWERED IN THE RANGE OF 26 - 50%
11 ANSWERED IN THE RANGE OF 51 - 75%
44 ANSWERED IN THE RANGE OF 76 - 100%

OTHER
266 DID NOT ANSWER THE QUESTION.
54 ANSWERED IN THE RANGE OF 1 - 25%
22 ANSWERED IN THE RANGE OF 26 - 50%
21 ANSWERED IN THE RANGE OF 51 - 75%
37 ANSWERED IN THE RANGE OF 76 - 100%

B - 5 COMPETITION (COUNTRY)

22 OF 400 DID NOT ANSWER 6%

# 1	235 OF 400	59%
# 2	122 OF 400	30%
# 3	12 OF 400	3%
# 4	2 OF 400	0%
# 5	7 OF 400	2%

TOTAL: 100%

B - 11 GROWTH FACTORS

PRICE

11 OF 400 DID NOT ANSWER 3%

# 1	110	OF	400	28%
# 2	160	OF	400	40%
# 3	114	OF	400	28%
# 4	5	OF	400	1%

TOTAL: 100%

QUALITY

10 OF 400 DID NOT ANSWER 2%

# 1	242	OF	400	60%
# 2	137	OF	400	34%
# 3	11	OF	400	3%
# 4	0	OF	400	0%

TOTAL: 100%

MARKETING

13 OF 400 DID NOT ANSWER 3%

# 1	170	OF	400	42%
# 2	162	OF	400	40%
# 3	52	OF	400	13%
# 4	3	OF	400	1%

TOTAL: 100%

SERVICE

11 OF 400 DID NOT ANSWER 3%

# 1	209	OF	400	52%
# 2	138	OF	400	34%
# 3	36	OF	400	9%
# 4	6	OF	400	2%

TOTAL: 100%

R & D

15 OF 400 DID NOT ANSWER 4%

# 1	135	OF	400	34%
# 2	114	OF	400	28%
# 3	99	OF	400	25%
# 4	37	OF	400	9%

TOTAL: 100%

COMPETITION

12 OF 400 DID NOT ANSWER 3%

# 1	82	OF	400	20%
# 2	155	OF	400	39%
# 3	133	OF	400	33%
# 4	18	OF	400	4%

TOTAL: 100%

GOVT INCENTIVES

20 OF 400 DID NOT ANSWER 5%

# 1	62	OF	400	16%
# 2	87	OF	400	22%
# 3	136	OF	400	34%
# 4	95	OF	400	24%

TOTAL: 100%

GOVT TAX POLICY

19 OF 400 DID NOT ANSWER 5%

# 1	84	OF	400	21%
# 2	113	OF	400	28%
# 3	123	OF	400	31%
# 4	61	OF	400	15%

TOTAL: 100%

B - 6 NUMBER OF COMPETITORS

35 OF	400 DID NOT ANSWER			9%
# 1	89	OF	400	22%
# 2	107	OF	400	27%
# 3	124	OF	400	31%
# 4	15	OF	400	4%
# 5	30	OF	400	8%

TOTAL: 100%

B - 8 CANADIAN MARKET SHARES

143 OF	400 DID NOT ANSWER			36%
# 1	144	OF	400	36%
# 2	26	OF	400	6%
# 3	23	OF	400	6%
# 4	18	OF	400	4%
# 5	13	OF	400	3%
# 6	33	OF	400	8%

TOTAL: 100%

B - 9 ANNUAL GROWTH (PAST)

36 OF	400 DID NOT ANSWER			9%
# 1	27	OF	400	7%
# 2	45	OF	400	11%
# 3	51	OF	400	13%
# 4	35	OF	400	9%
# 5	37	OF	400	9%
# 6	21	OF	400	5%
# 7	24	OF	400	6%
# 8	124	OF	400	31%

TOTAL: 100%

B - 10 ANNUAL GROWTH (FUTURE)

18 OF	400 DID NOT ANSWER			4%
# 1	10	OF	400	2%
# 2	34	OF	400	8%
# 3	62	OF	400	16%
# 4	46	OF	400	12%
# 5	63	OF	400	16%
# 6	52	OF	400	13%
# 7	31	OF	400	8%
# 8	84	OF	400	21%

TOTAL: 100%

B - 11 (CONTINUED)

CAPITAL INVESTMENT

21 OF 400 DID NOT ANSWER 5%

# 1	101	OF	400	25%
# 2	138	OF	400	34%
# 3	109	OF	400	27%
# 4	31	OF	400	8%

TOTAL: 100%

OTHER

336 OF 400 DID NOT ANSWER 84%

# 1	33	OF	400	8%
# 2	13	OF	400	3%
# 3	5	OF	400	1%
# 4	13	OF	400	3%

TOTAL: 100%

SECTION C – MARKETING AND THE COMPETITIVE ENVIRONMENT

C – 1 MARKETING BUDGET

18 OF 400 DID NOT ANSWER 4%

# 1	127	OF	400	32%
# 2	82	OF	400	20%
# 3	74	OF	400	18%
# 4	37	OF	400	9%
# 5	27	OF	400	7%
# 6	35	OF	400	9%

TOTAL: 100%

C – 2 MARKETS (COUNTRIES)

6 OF 400 DID NOT ANSWER 2%

# 1	205	OF	400	51%
# 2	118	OF	400	30%
# 3	71	OF	400	18%

TOTAL: 100%

C – 3 FOREIGN MARKET COMPETITION

12 OF 189 DID NOT ANSWER 6%

# 1	89	OF	189	47%
# 2	79	OF	189	42%
# 3	10	OF	189	5%

TOTAL: 101%

C – 4 COMPETITIVE FACTORS

PRODUCT INNOVATION

10 OF 189 DID NOT ANSWER 5%

# 1	86	OF	189	46%
# 2	32	OF	189	17%
# 3	49	OF	189	26%
# 4	10	OF	189	5%
# 5	2	OF	189	1%

TOTAL: 100%

PRODUCT QUALITY

9 OF 189 DID NOT ANSWER 5%

# 1	73	OF	189	39%
# 2	38	OF	189	20%
# 3	66	OF	189	35%
# 4	3	OF	189	2%
# 5	0	OF	189	0%

TOTAL: 100%

PRODUCT SERVICE & SUPPORT

10 OF 189 DID NOT ANSWER 5%

# 1	33	OF	189	17%
# 2	27	OF	189	14%
# 3	56	OF	189	30%
# 4	48	OF	189	25%
# 5	16	OF	189	8%

TOTAL: 101%

C - 4 (CONTINUED)

PRICING

11 OF 189 DID NOT ANSWER 6%

# 1	25	OF	189	13%
# 2	54	OF	189	29%
# 3	49	OF	189	26%
# 4	33	OF	189	17%
# 5	18	OF	189	10%

TOTAL: 101%

FINANCING

20 OF 189 DID NOT ANSWER 11%

# 1	6	OF	189	3%
# 2	7	OF	189	4%
# 3	59	OF	189	31%
# 4	51	OF	189	27%
# 5	47	OF	189	25%

TOTAL: 101%

DISTRIBUTION

13 OF 189 DID NOT ANSWER 7%

# 1	5	OF	189	3%
# 2	8	OF	189	4%
# 3	38	OF	189	20%
# 4	74	OF	189	39%
# 5	52	OF	189	28%

TOTAL: 101%

PROMOTION/ADVERTISING

13 OF 189 DID NOT ANSWER 7%

# 1	3	OF	189	2%
# 2	8	OF	189	4%
# 3	58	OF	189	31%
# 4	60	OF	189	32%
# 5	48	OF	189	25%

TOTAL: 101%

MARKETING EXPERTISE

12 OF 189 DID NOT ANSWER 6%

# 1	6	OF	189	3%
# 2	24	OF	189	13%
# 3	70	OF	189	37%
# 4	56	OF	189	30%
# 5	22	OF	189	12%

TOTAL: 101%

CORPORATE/BRAND IMAGE

13 OF 189 DID NOT ANSWER 7%

# 1	9	OF	189	5%
# 2	18	OF	189	10%
# 3	53	OF	189	28%
# 4	61	OF	189	32%
# 5	36	OF	189	19%

TOTAL: 101%

MANAGEMENT CAPABILITY

15 OF 189 DID NOT ANSWER 8%

# 1	12	OF	189	6%
# 2	46	OF	189	24%
# 3	89	OF	189	47%
# 4	24	OF	189	13%
# 5	4	OF	189	2%

TOTAL: 101%

C - 4 (CONTINUED)

GOVT FINANCIAL SUPPORT

23 OF 189 DID NOT ANSWER 12%

# 1	4	OF	189	2%
# 2	23	OF	189	12%
# 3	57	OF	189	30%
# 4	45	OF	189	24%
# 5	38	OF	189	20%

TOTAL: 101%

GOVT REGULATORY SUPPORT

30 OF 189 DID NOT ANSWER 16%

# 1	3	OF	189	2%
# 2	8	OF	189	4%
# 3	71	OF	189	38%
# 4	43	OF	189	23%
# 5	35	OF	189	19%

TOTAL: 101%

EXISTING STANDARDS

18 OF 189 DID NOT ANSWER 10%

# 1	11	OF	189	6%
# 2	26	OF	189	14%
# 3	117	OF	189	62%
# 4	14	OF	189	7%
# 5	4	OF	189	2%

TOTAL: 101%

FUTURE STANDARDS

21 OF 189 DID NOT ANSWER 11%

# 1	13	OF	189	7%
# 2	26	OF	189	14%
# 3	111	OF	189	59%
# 4	16	OF	189	8%
# 5	3	OF	189	2%

TOTAL: 101%

FOREIGN REGULATIONS

23 OF 189 DID NOT ANSWER 12%

# 1	2	OF	189	1%
# 2	5	OF	189	3%
# 3	75	OF	189	40%
# 4	63	OF	189	33%
# 5	22	OF	189	12%

TOTAL: 101%

CANADIAN REGULATIONS

27 OF 189 DID NOT ANSWER 14%

# 1	2	OF	189	1%
# 2	8	OF	189	4%
# 3	94	OF	189	50%
# 4	43	OF	189	23%
# 5	16	OF	189	8%

TOTAL: 101%

FOREIGN DUTY BARRIERS

24 OF 189 DID NOT ANSWER 13%

# 1	1	OF	189	1%
# 2	6	OF	189	3%
# 3	77	OF	189	41%
# 4	57	OF	189	30%
# 5	25	OF	189	13%

TOTAL: 101%

C - 4 (CONTINUED)

SIZE OF SALES FORCE

14 OF 189 DID NOT ANSWER 7%

# 1	4	OF	189	2%
# 2	6	OF	189	3%
# 3	47	OF	189	25%
# 4	67	OF	189	35%
# 5	52	OF	189	28%

TOTAL: 101%

ABILITY OF SALES FORCE

18 OF 189 DID NOT ANSWER 10%

# 1	11	OF	189	6%
# 2	22	OF	189	12%
# 3	89	OF	189	47%
# 4	37	OF	189	20%
# 5	13	OF	189	7%

TOTAL: 101%

OTHER

174 OF 189 DID NOT ANSWER 92%

# 1	3	OF	189	2%
# 2	0	OF	189	0%
# 3	4	OF	189	2%
# 4	0	OF	189	0%
# 5	8	OF	189	4%

TOTAL: 100%

```
. SET TALK OFF
. DO REPORTD1
SECTION D   -   RESEARCH AND DEVELOPMENT
======================================

D - 1    R & D BUDGETS

     19 OF  400 DID NOT ANSWER    5%
   # 1       129 OF  400     32%
   # 2        36 OF  400      9%
   # 3        32 OF  400      8%
   # 4        31 OF  400      8%
   # 5        24 OF  400      6%
   # 6       129 OF  400     32%
   TOTAL: 100%

D - 2    R & D IMPORTANCE

     11 OF  400 DID NOT ANSWER    3%
   # 1       186 OF  400     46%
   # 2        88 OF  400     22%
   # 3        90 OF  400     22%
   # 4        25 OF  400      6%
   TOTAL: 100%

D - 3    R & D MAKE UP

BASIC RESEARCH
        276 DID NOT ANSWER THE QUESTION.
         95 ANSWERED IN THE RANGE OF  1 -  25%
         20 ANSWERED IN THE RANGE OF 26 -  50%
          4 ANSWERED IN THE RANGE OF 51 -  75%
          5 ANSWERED IN THE RANGE OF 76 - 100%
NEW PRODUCT DEVELOPMENT
        115 DID NOT ANSWER THE QUESTION.
         50 ANSWERED IN THE RANGE OF  1 -  25%
        104 ANSWERED IN THE RANGE OF 26 -  50%
         67 ANSWERED IN THE RANGE OF 51 -  75%
         64 ANSWERED IN THE RANGE OF 76 - 100%
IMPROVING EXISTING PRODUCTS
        154 DID NOT ANSWER THE QUESTION.
        118 ANSWERED IN THE RANGE OF  1 -  25%
         99 ANSWERED IN THE RANGE OF 26 -  50%
         17 ANSWERED IN THE RANGE OF 51 -  75%
         12 ANSWERED IN THE RANGE OF 76 - 100%
QUALITY ASSURANCE AND CONTROL
        247 DID NOT ANSWER THE QUESTION.
        134 ANSWERED IN THE RANGE OF  1 -  25%
         14 ANSWERED IN THE RANGE OF 26 -  50%
          2 ANSWERED IN THE RANGE OF 51 -  75%
          3 ANSWERED IN THE RANGE OF 76 - 100%
```

D - 3 (CONTINUED)

MARKET RESEARCH AND DEVELOPMENT
220 DID NOT ANSWER THE QUESTION.
132 ANSWERED IN THE RANGE OF 1 - 25%
31 ANSWERED IN THE RANGE OF 26 - 50%
4 ANSWERED IN THE RANGE OF 51 - 75%
13 ANSWERED IN THE RANGE OF 76 - 100%

OTHER
375 DID NOT ANSWER THE QUESTION.
12 ANSWERED IN THE RANGE OF 1 - 25%
5 ANSWERED IN THE RANGE OF 26 - 50%
1 ANSWERED IN THE RANGE OF 51 - 75%
7 ANSWERED IN THE RANGE OF 76 - 100%

D - 4 R & D FINANCING

COMPANY FINANCED
79 DID NOT ANSWER THE QUESTION.
27 ANSWERED IN THE RANGE OF 1 - 25%
37 ANSWERED IN THE RANGE OF 26 - 50%
34 ANSWERED IN THE RANGE OF 51 - 75%
223 ANSWERED IN THE RANGE OF 76 - 100%

GOVERNMENT FINANCED
313 DID NOT ANSWER THE QUESTION.
46 ANSWERED IN THE RANGE OF 1 - 25%
32 ANSWERED IN THE RANGE OF 26 - 50%
5 ANSWERED IN THE RANGE OF 51 - 75%
4 ANSWERED IN THE RANGE OF 76 - 100%

CUSTOMER/CLIENT FINANCED
300 DID NOT ANSWER THE QUESTION.
51 ANSWERED IN THE RANGE OF 1 - 25%
30 ANSWERED IN THE RANGE OF 26 - 50%
4 ANSWERED IN THE RANGE OF 51 - 75%
15 ANSWERED IN THE RANGE OF 76 - 100%

PARENT/AFFILIATE FINANCED
374 DID NOT ANSWER THE QUESTION.
9 ANSWERED IN THE RANGE OF 1 - 25%
6 ANSWERED IN THE RANGE OF 26 - 50%
0 ANSWERED IN THE RANGE OF 51 - 75%
11 ANSWERED IN THE RANGE OF 76 - 100%

OTHER
390 DID NOT ANSWER THE QUESTION.
5 ANSWERED IN THE RANGE OF 1 - 25%
2 ANSWERED IN THE RANGE OF 26 - 50%
0 ANSWERED IN THE RANGE OF 51 - 75%
3 ANSWERED IN THE RANGE OF 76 - 100%

VOICE RECOGNITION

168 OF 400 DID NOT ANSWER				42%
# 1	6	OF	400	2%
# 2	38	OF	400	10%
# 3	188	OF	400	47%
TOTAL: 100%				

LANGUAGE TRANSLATION

174 OF 400 DID NOT ANSWER				44%
# 1	5	OF	400	1%
# 2	24	OF	400	6%
# 3	197	OF	400	49%
TOTAL: 100%				

CAD/CAE/CAM

161 OF 400 DID NOT ANSWER				40%
# 1	24	OF	400	6%
# 2	55	OF	400	14%
# 3	160	OF	400	40%
TOTAL: 100%				

EXPERT SYSTEMS

160 OF 400 DID NOT ANSWER				40%
# 1	19	OF	400	5%
# 2	57	OF	400	14%
# 3	164	OF	400	41%
TOTAL: 100%				

ROBOTICS

169 OF 400 DID NOT ANSWER				42%
# 1	9	OF	400	2%
# 2	28	OF	400	7%
# 3	194	OF	400	48%
TOTAL: 100%				

VIDEOTEX

174 OF 400 DID NOT ANSWER				44%
# 1	16	OF	400	4%
# 2	31	OF	400	8%
# 3	179	OF	400	45%
TOTAL: 100%				

TELETEXT

181 OF 400 DID NOT ANSWER				45%
# 1	8	OF	400	2%
# 2	26	OF	400	6%
# 3	185	OF	400	46%
TOTAL: 100%				

TELETEX

185 OF 400 DID NOT ANSWER				46%
# 1	5	OF	400	1%
# 2	18	OF	400	4%
# 3	192	OF	400	48%
TOTAL: 100%				

HIGH RESOLUTION TV

181 OF 400 DID NOT ANSWER				45%
# 1	6	OF	400	2%
# 2	13	OF	400	3%
# 3	200	OF	400	50%
TOTAL: 100%				

SLOW SCAN TV

180 OF 400 DID NOT ANSWER				45%
# 1	1	OF	400	0%
# 2	13	OF	400	3%
# 3	206	OF	400	52%
TOTAL: 100%				

D - 5 (CONTINUED)

LOCAL AREA
156 OF 400 DID NOT ANSWER 39%

# 1	40	OF	400	10%
# 2	70	OF	400	18%
# 3	134	OF	400	34%

TOTAL: 100%

SATELLITE (SPACE)
181 OF 400 DID NOT ANSWER 45%

# 1	9	OF	400	2%
# 2	13	OF	400	3%
# 3	197	OF	400	49%

TOTAL: 100%

SATELLITE (GROUND)
170 OF 400 DID NOT ANSWER 42%

# 1	20	OF	400	5%
# 2	24	OF	400	6%
# 3	186	OF	400	46%

TOTAL: 100%

SYSTEMS

AUTOMATIC LOCATION
185 OF 400 DID NOT ANSWER 46%

# 1	16	OF	400	4%
# 2	23	OF	400	6%
# 3	176	OF	400	44%

TOTAL: 100%

ELECTRONIC MAIL
171 OF 400 DID NOT ANSWER 43%

# 1	24	OF	400	6%
# 2	76	OF	400	19%
# 3	129	OF	400	32%

TOTAL: 100%

OFFICE AUTOMATION
148 OF 400 DID NOT ANSWER 37%

# 1	79	OF	400	20%
# 2	74	OF	400	18%
# 3	99	OF	400	25%

TOTAL: 100%

INTELLIGENT BUILDINGS
190 OF 400 DID NOT ANSWER 48%

# 1	10	OF	400	2%
# 2	27	OF	400	7%
# 3	173	OF	400	43%

TOTAL: 100%

SWITCHES

DIGITAL
175 OF 400 DID NOT ANSWER 44%

# 1	29	OF	400	7%
# 2	34	OF	400	8%
# 3	162	OF	400	40%

TOTAL: 100%

OPTICAL
193 OF 400 DID NOT ANSWER 48%

# 1	5	OF	400	1%
# 2	14	OF	400	4%
# 3	188	OF	400	47%

TOTAL: 100%

. DO REPORTE
SECTION E - TECHNOLOGY TRENDS
==================================

E - 2 ANTICIPATED GROWTH (SYSTEMS)

ITEM A VOICE IN

234 OF 400 DID NOT ANSWER	58%	373 OF 400 NO EXPERTISE	93%
# 1 68 OF 400 ANSWERED	17%	7 OF 400 EXPERTISE	2%
# 2 54 OF 400 ANSWERED	14%	8 OF 400 EXPERTISE	2%
# 3 23 OF 400 ANSWERED	6%	6 OF 400 EXPERTISE	2%
# 4 21 OF 400 ANSWERED	5%	3 OF 400 EXPERTISE	1%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	99%

ITEM B VOICE TR

229 OF 400 DID NOT ANSWER	57%	350 OF 400 NO EXPERTISE	88%
# 1 65 OF 400 ANSWERED	16%	7 OF 400 EXPERTISE	2%
# 2 61 OF 400 ANSWERED	15%	19 OF 400 EXPERTISE	5%
# 3 24 OF 400 ANSWERED	6%	8 OF 400 EXPERTISE	2%
# 4 21 OF 400 ANSWERED	5%	11 OF 400 EXPERTISE	3%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	99%

ITEM C VOICE SW

234 OF 400 DID NOT ANSWER	58%	369 OF 400 NO EXPERTISE	92%
# 1 66 OF 400 ANSWERED	16%	6 OF 400 EXPERTISE	2%
# 2 59 OF 400 ANSWERED	15%	11 OF 400 EXPERTISE	3%
# 3 19 OF 400 ANSWERED	5%	3 OF 400 EXPERTISE	1%
# 4 22 OF 400 ANSWERED	6%	8 OF 400 EXPERTISE	2%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	99%

ITEM D VOICE PR

244 OF 400 DID NOT ANSWER	61%	377 OF 400 NO EXPERTISE	94%
# 1 52 OF 400 ANSWERED	13%	2 OF 400 EXPERTISE	0%
# 2 48 OF 400 ANSWERED	12%	7 OF 400 EXPERTISE	2%
# 3 34 OF 400 ANSWERED	8%	6 OF 400 EXPERTISE	2%
# 4 22 OF 400 ANSWERED	6%	6 OF 400 EXPERTISE	2%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	100%

ITEM E VOICE ST

242 OF 400 DID NOT ANSWER	60%	384 OF 400 NO EXPERTISE	96%
# 1 58 OF 400 ANSWERED	14%	1 OF 400 EXPERTISE	0%
# 2 47 OF 400 ANSWERED	12%	2 OF 400 EXPERTISE	0%
# 3 30 OF 400 ANSWERED	8%	4 OF 400 EXPERTISE	1%
# 4 23 OF 400 ANSWERED	6%	7 OF 400 EXPERTISE	2%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	100%

ITEM F VOICE OP

240 OF 400 DID NOT ANSWER	60%	376 OF 400 NO EXPERTISE	94%
# 1 60 OF 400 ANSWERED	15%	1 OF 400 EXPERTISE	0%
# 2 54 OF 400 ANSWERED	14%	8 OF 400 EXPERTISE	2%
# 3 28 OF 400 ANSWERED	7%	6 OF 400 EXPERTISE	2%
# 4 18 OF 400 ANSWERED	4%	5 OF 400 EXPERTISE	1%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	99%

ITEM G DATA IN

204 OF 400 DID NOT ANSWER	51%	324 OF 400 NO EXPERTISE	81%
# 1 29 OF 400 ANSWERED	7%	6 OF 400 EXPERTISE	2%
# 2 63 OF 400 ANSWERED	16%	16 OF 400 EXPERTISE	4%
# 3 55 OF 400 ANSWERED	14%	23 OF 400 EXPERTISE	6%
# 4 49 OF 400 ANSWERED	12%	22 OF 400 EXPERTISE	6%
TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	98%

E - 2 (CONTINUED)

ITEM H DATA TR

185 OF 400 DID NOT ANSWER	46%		291 OF 400 NO EXPERTISE	73%
# 1	19 OF 400 ANSWERED	5%	2 OF 400 EXPERTISE	0%
# 2	51 OF 400 ANSWERED	13%	21 OF 400 EXPERTISE	5%
# 3	67 OF 400 ANSWERED	17%	30 OF 400 EXPERTISE	8%
# 4	78 OF 400 ANSWERED	20%	50 OF 400 EXPERTISE	12%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	98%

ITEM I DATA SW

213 OF 400 DID NOT ANSWER	53%		343 OF 400 NO EXPERTISE	86%
# 1	29 OF 400 ANSWERED	7%	2 OF 400 EXPERTISE	0%
# 2	45 OF 400 ANSWERED	11%	13 OF 400 EXPERTISE	3%
# 3	53 OF 400 ANSWERED	13%	15 OF 400 EXPERTISE	4%
# 4	60 OF 400 ANSWERED	15%	24 OF 400 EXPERTISE	6%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	99%

ITEM J DATA PR

187 OF 400 DID NOT ANSWER	47%		296 OF 400 NO EXPERTISE	74%
# 1	22 OF 400 ANSWERED	6%	5 OF 400 EXPERTISE	1%
# 2	70 OF 400 ANSWERED	18%	26 OF 400 EXPERTISE	6%
# 3	66 OF 400 ANSWERED	16%	30 OF 400 EXPERTISE	8%
# 4	55 OF 400 ANSWERED	14%	33 OF 400 EXPERTISE	8%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	98%

ITEM K DATA ST

202 OF 400 DID NOT ANSWER	50%		325 OF 400 NO EXPERTISE	81%
# 1	24 OF 400 ANSWERED	6%	1 OF 400 EXPERTISE	0%
# 2	52 OF 400 ANSWERED	13%	16 OF 400 EXPERTISE	4%
# 3	57 OF 400 ANSWERED	14%	18 OF 400 EXPERTISE	4%
# 4	65 OF 400 ANSWERED	16%	31 OF 400 EXPERTISE	8%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	98%

ITEM L DATA OUT

213 OF 400 DID NOT ANSWER	53%		337 OF 400 NO EXPERTISE	84%
# 1	31 OF 400 ANSWERED	8%	3 OF 400 EXPERTISE	1%
# 2	64 OF 400 ANSWERED	16%	19 OF 400 EXPERTISE	5%
# 3	49 OF 400 ANSWERED	12%	14 OF 400 EXPERTISE	4%
# 4	43 OF 400 ANSWERED	11%	20 OF 400 EXPERTISE	5%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	98%

ITEM M VIDEO IN

243 OF 400 DID NOT ANSWER	61%		383 OF 400 NO EXPERTISE	96%
# 1	46 OF 400 ANSWERED	12%	0 OF 400 EXPERTISE	0%
# 2	61 OF 400 ANSWERED	15%	4 OF 400 EXPERTISE	1%
# 3	34 OF 400 ANSWERED	8%	5 OF 400 EXPERTISE	1%
# 4	16 OF 400 ANSWERED	4%	6 OF 400 EXPERTISE	2%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

ITEM N VIDEO TR

230 OF 400 DID NOT ANSWER	58%		366 OF 400 NO EXPERTISE	92%
# 1	43 OF 400 ANSWERED	11%	4 OF 400 EXPERTISE	1%
# 2	67 OF 400 ANSWERED	17%	6 OF 400 EXPERTISE	2%
# 3	34 OF 400 ANSWERED	8%	10 OF 400 EXPERTISE	2%
# 4	26 OF 400 ANSWERED	6%	11 OF 400 EXPERTISE	3%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	99%

E - 2 (CONTINUED)

ITEM O	VIDEO SW			
	248 OF 400 DID NOT ANSWER	62%	387 OF 400 NO EXPERTISE	97%
# 1	51 OF 400 ANSWERED	13%	3 OF 400 EXPERTISE	1%
# 2	65 OF 400 ANSWERED	16%	4 OF 400 EXPERTISE	1%
# 3	22 OF 400 ANSWERED	6%	1 OF 400 EXPERTISE	0%
# 4	14 OF 400 ANSWERED	4%	3 OF 400 EXPERTISE	1%
	TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	100%
ITEM P	VIDEO PR			
	241 OF 400 DID NOT ANSWER	60%	379 OF 400 NO EXPERTISE	95%
# 1	49 OF 400 ANSWERED	12%	3 OF 400 EXPERTISE	1%
# 2	53 OF 400 ANSWERED	13%	4 OF 400 EXPERTISE	1%
# 3	35 OF 400 ANSWERED	9%	5 OF 400 EXPERTISE	1%
# 4	22 OF 400 ANSWERED	6%	7 OF 400 EXPERTISE	2%
	TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	100%
ITEM Q	VIDEO ST			
	247 OF 400 DID NOT ANSWER	62%	388 OF 400 NO EXPERTISE	97%
# 1	50 OF 400 ANSWERED	12%	0 OF 400 EXPERTISE	0%
# 2	39 OF 400 ANSWERED	10%	1 OF 400 EXPERTISE	0%
# 3	34 OF 400 ANSWERED	8%	1 OF 400 EXPERTISE	0%
# 4	30 OF 400 ANSWERED	8%	8 OF 400 EXPERTISE	2%
	TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	100%
ITEM R	VIDEO OP			
	246 OF 400 DID NOT ANSWER	62%	383 OF 400 NO EXPERTISE	96%
# 1	46 OF 400 ANSWERED	12%	1 OF 400 EXPERTISE	0%
# 2	48 OF 400 ANSWERED	12%	3 OF 400 EXPERTISE	1%
# 3	42 OF 400 ANSWERED	10%	4 OF 400 EXPERTISE	1%
# 4	18 OF 400 ANSWERED	4%	5 OF 400 EXPERTISE	1%
	TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	99%
ITEM S	SYS SOFT			
	183 OF 400 DID NOT ANSWER	46%	302 OF 400 NO EXPERTISE	76%
# 1	20 OF 400 ANSWERED	5%	2 OF 400 EXPERTISE	0%
# 2	39 OF 400 ANSWERED	10%	19 OF 400 EXPERTISE	5%
# 3	76 OF 400 ANSWERED	19%	28 OF 400 EXPERTISE	7%
# 4	82 OF 400 ANSWERED	20%	39 OF 400 EXPERTISE	10%
	TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	98%
ITEM T	APP SOFT			
	163 OF 400 DID NOT ANSWER	41%	248 OF 400 NO EXPERTISE	62%
# 1	14 OF 400 ANSWERED	4%	3 OF 400 EXPERTISE	1%
# 2	35 OF 400 ANSWERED	9%	19 OF 400 EXPERTISE	5%
# 3	60 OF 400 ANSWERED	15%	33 OF 400 EXPERTISE	8%
# 4	128 OF 400 ANSWERED	32%	82 OF 400 EXPERTISE	20%
	TOTAL ANSWERED:	100%	TOTAL EXPERTISE:	96%

E - 3 GROWTH ANTICIPATION (TRANSMISSION MEDIA)

DIGITAL

	249 OF 400 DID NOT ANSWER	62%	367 OF 400 NO EXPERTISE		92%
# 1	38 OF 400 ANSWERED	10%	4 OF 400 EXPERTISE		1%
# 2	47 OF 400 ANSWERED	12%	8 OF 400 EXPERTISE		2%
# 3	32 OF 400 ANSWERED	8%	6 OF 400 EXPERTISE		2%
# 4	34 OF 400 ANSWERED	8%	12 OF 400 EXPERTISE		3%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		99%

ANALOGUE

	256 OF 400 DID NOT ANSWER	64%	381 OF 400 NO EXPERTISE		95%
# 1	96 OF 400 ANSWERED	24%	10 OF 400 EXPERTISE		2%
# 2	31 OF 400 ANSWERED	8%	4 OF 400 EXPERTISE		1%
# 3	11 OF 400 ANSWERED	3%	1 OF 400 EXPERTISE		0%
# 4	6 OF 400 ANSWERED	2%	2 OF 400 EXPERTISE		0%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		100%

FIBRE OPTIC

	250 OF 400 DID NOT ANSWER	62%	386 OF 400 NO EXPERTISE		96%
# 1	40 OF 400 ANSWERED	10%	1 OF 400 EXPERTISE		0%
# 2	28 OF 400 ANSWERED	7%	1 OF 400 EXPERTISE		0%
# 3	42 OF 400 ANSWERED	10%	4 OF 400 EXPERTISE		1%
# 4	40 OF 400 ANSWERED	10%	6 OF 400 EXPERTISE		2%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		100%

PBX DIGITAL

	256 OF 400 DID NOT ANSWER	64%	365 OF 400 NO EXPERTISE		91%
# 1	37 OF 400 ANSWERED	9%	2 OF 400 EXPERTISE		0%
# 2	43 OF 400 ANSWERED	11%	10 OF 400 EXPERTISE		2%
# 3	35 OF 400 ANSWERED	9%	7 OF 400 EXPERTISE		2%
# 4	29 OF 400 ANSWERED	7%	12 OF 400 EXPERTISE		3%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		99%

PBX ANALOG

	268 OF 400 DID NOT ANSWER	67%	379 OF 400 NO EXPERTISE		95%
# 1	83 OF 400 ANSWERED	21%	10 OF 400 EXPERTISE		2%
# 2	35 OF 400 ANSWERED	9%	6 OF 400 EXPERTISE		2%
# 3	12 OF 400 ANSWERED	3%	1 OF 400 EXPERTISE		0%
# 4	2 OF 400 ANSWERED	0%	1 OF 400 EXPERTISE		0%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		99%

PBX FIBRE OPTIC

	272 OF 400 DID NOT ANSWER	68%	392 OF 400 NO EXPERTISE		98%
# 1	48 OF 400 ANSWERED	12%	1 OF 400 EXPERTISE		0%
# 2	27 OF 400 ANSWERED	7%	2 OF 400 EXPERTISE		0%
# 3	25 OF 400 ANSWERED	6%	0 OF 400 EXPERTISE		0%
# 4	28 OF 400 ANSWERED	7%	3 OF 400 EXPERTISE		1%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		100%

INTEG VOICE/DATA VIDEO SWITCH

	260 OF 400 DID NOT ANSWER	65%	378 OF 400 NO EXPERTISE		94%
# 1	40 OF 400 ANSWERED	10%	1 OF 400 EXPERTISE		0%
# 2	42 OF 400 ANSWERED	10%	3 OF 400 EXPERTISE		1%
# 3	33 OF 400 ANSWERED	8%	8 OF 400 EXPERTISE		2%
# 4	25 OF 400 ANSWERED	6%	7 OF 400 EXPERTISE		2%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		99%

E - 3 (CONTINUED)

REMOTE SENSORS/ALARMS

254 OF 400 DID NOT ANSWER	64%	368 OF 400 NO EXPERTISE	92%
# 1	44 OF 400 ANSWERED	11%	2 OF 400 EXPERTISE	0%
# 2	43 OF 400 ANSWERED	11%	8 OF 400 EXPERTISE	2%
# 3	34 OF 400 ANSWERED	8%	9 OF 400 EXPERTISE	2%
# 4	25 OF 400 ANSWERED	6%	10 OF 400 EXPERTISE	2%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	99%

OPTICAL CHARACTER READER

263 OF 400 DID NOT ANSWER		66%	391 OF 400 NO EXPERTISE	98%
# 1	53 OF 400 ANSWERED	13%	2 OF 400 EXPERTISE	0%
# 2	46 OF 400 ANSWERED	12%	0 OF 400 EXPERTISE	0%
# 3	21 OF 400 ANSWERED	5%	2 OF 400 EXPERTISE	0%
# 4	17 OF 400 ANSWERED	4%	4 OF 400 EXPERTISE	1%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

DIGITAL MONITORS/DISPLAYS

262 OF 400 DID NOT ANSWER		66%	383 OF 400 NO EXPERTISE	96%
# 1	40 OF 400 ANSWERED	10%	1 OF 400 EXPERTISE	0%
# 2	52 OF 400 ANSWERED	13%	6 OF 400 EXPERTISE	2%
# 3	31 OF 400 ANSWERED	8%	4 OF 400 EXPERTISE	1%
# 4	15 OF 400 ANSWERED	4%	5 OF 400 EXPERTISE	1%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

VIDEODISCS

259 OF 400 DID NOT ANSWER		65%	393 OF 400 NO EXPERTISE	98%
# 1	52 OF 400 ANSWERED	13%	0 OF 400 EXPERTISE	0%
# 2	35 OF 400 ANSWERED	9%	1 OF 400 EXPERTISE	0%
# 3	25 OF 400 ANSWERED	6%	1 OF 400 EXPERTISE	0%
# 4	29 OF 400 ANSWERED	7%	4 OF 400 EXPERTISE	1%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

PICTUREPHONE

271 OF 400 DID NOT ANSWER		68%	397 OF 400 NO EXPERTISE	99%
# 1	82 OF 400 ANSWERED	20%	1 OF 400 EXPERTISE	0%
# 2	32 OF 400 ANSWERED	8%	1 OF 400 EXPERTISE	0%
# 3	7 OF 400 ANSWERED	2%	0 OF 400 EXPERTISE	0%
# 4	8 OF 400 ANSWERED	2%	1 OF 400 EXPERTISE	0%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

PHOTOCOPIERS

270 OF 400 DID NOT ANSWER		68%	395 OF 400 NO EXPERTISE	99%
# 1	69 OF 400 ANSWERED	17%	1 OF 400 EXPERTISE	0%
# 2	38 OF 400 ANSWERED	10%	2 OF 400 EXPERTISE	0%
# 3	14 OF 400 ANSWERED	4%	1 OF 400 EXPERTISE	0%
# 4	9 OF 400 ANSWERED	2%	1 OF 400 EXPERTISE	0%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

SIGNAL PROCESSING

273 OF 400 DID NOT ANSWER		68%	378 OF 400 NO EXPERTISE	94%
# 1	38 OF 400 ANSWERED	10%	0 OF 400 EXPERTISE	0%
# 2	44 OF 400 ANSWERED	11%	6 OF 400 EXPERTISE	2%
# 3	24 OF 400 ANSWERED	6%	8 OF 400 EXPERTISE	2%
# 4	21 OF 400 ANSWERED	5%	6 OF 400 EXPERTISE	2%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:	100%

E - 3 (CONTINUED)

DATA INTEGRITY

	251 OF 400 DID NOT ANSWER	63%		364 OF 400 NO EXPERTISE	91%
# 1	33 OF 400 ANSWERED	8%		0 OF 400 EXPERTISE	0%
# 2	25 OF 400 ANSWERED	6%		2 OF 400 EXPERTISE	0%
# 3	49 OF 400 ANSWERED	12%		17 OF 400 EXPERTISE	4%
# 4	42 OF 400 ANSWERED	10%		15 OF 400 EXPERTISE	4%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		100%

DATA SECURITY

	264 OF 400 DID NOT ANSWER	66%		376 OF 400 NO EXPERTISE	94%
# 1	36 OF 400 ANSWERED	9%		0 OF 400 EXPERTISE	0%
# 2	42 OF 400 ANSWERED	10%		3 OF 400 EXPERTISE	1%
# 3	31 OF 400 ANSWERED	8%		9 OF 400 EXPERTISE	2%
# 4	27 OF 400 ANSWERED	7%		11 OF 400 EXPERTISE	3%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		100%

OTHER

	366 OF 400 DID NOT ANSWER	92%		390 OF 400 NO EXPERTISE	98%
# 1	21 OF 400 ANSWERED	5%		0 OF 400 EXPERTISE	0%
# 2	1 OF 400 ANSWERED	0%		1 OF 400 EXPERTISE	0%
# 3	6 OF 400 ANSWERED	2%		2 OF 400 EXPERTISE	0%
# 4	6 OF 400 ANSWERED	2%		4 OF 400 EXPERTISE	1%
TOTAL ANSWERED:		100%	TOTAL EXPERTISE:		99%

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DO REPORTF
 SECTION F   -  GOVERNMENT INCENTIVES
 ====================================

 F - 1    INCENTIVES IMPORTANCE (PRESENT)

      51 OF   400 DID NOT ANSWER   13%
    # 1         87 OF  400      22%
    # 2         73 OF  400      18%
    # 3         87 OF  400      22%
    # 4        102 OF  400      26%
    TOTAL: 100%

 F - 2    INCENTIVES IMPORTANCE (FUTURE)

      57 OF   400 DID NOT ANSWER   14%
    # 1        124 OF  400      31%
    # 2        102 OF  400      26%
    # 3         67 OF  400      17%
    # 4         50 OF  400      12%
    TOTAL: 100%

 F - 4    NEW INCENTIVES

 PURE RESEARCH
     113 OF   400 DID NOT ANSWER   28%
    # 1         87 OF  400      22%
    # 2         56 OF  400      14%
    # 3         74 OF  400      18%
    # 4         70 OF  400      18%
    TOTAL: 100%
 PRODUCT R & D
      94 OF   400 DID NOT ANSWER   21%
    # 1        173 OF  400      43%
    # 2         87 OF  400      22%
    # 3         26 OF  400       6%
    # 4         30 OF  400       8%
    TOTAL: 100%
 CAPITAL INVESTMENT
      80 OF   400 DID NOT ANSWER   20%
    # 1        143 OF  400      36%
    # 2         86 OF  400      22%
    # 3         64 OF  400      16%
    # 4         27 OF  400       7%
    TOTAL: 100%
 VENTURE CAPITAL
     107 OF   400 DID NOT ANSWER   27%
    # 1         93 OF  400      23%
    # 2         75 OF  400      19%
    # 3         75 OF  400      19%
    # 4         50 OF  400      12%
    TOTAL: 100%
 FOREIGN MARKETS
      99 OF   400 DID NOT ANSWER   25%
    # 1        108 OF  400      27%
    # 2        100 OF  400      25%
    # 3         61 OF  400      15%
    # 4         32 OF  400       8%
    TOTAL: 100%
```

F - 4 (CONTINUED)

FOREIGN ADVERTISING

107 OF 400 DID NOT ANSWER			27%
# 1	79 OF 400	20%	
# 2	77 OF 400	19%	
# 3	81 OF 400	20%	
# 4	56 OF 400	14%	
TOTAL: 100%			

FINANCE OF EXPORT INVENTORIES

117 OF 400 DID NOT ANSWER			29%
# 1	69 OF 400	17%	
# 2	69 OF 400	17%	
# 3	71 OF 400	18%	
# 4	74 OF 400	18%	
TOTAL: 100%			

PATENT PROTECTION

114 OF 400 DID NOT ANSWER			28%
# 1	73 OF 400	18%	
# 2	68 OF 400	17%	
# 3	76 OF 400	19%	
# 4	69 OF 400	17%	
TOTAL: 100%			

U.S./INTERNATIONAL STANDARDS

117 OF 400 DID NOT ANSWER			29%
# 1	54 OF 400	14%	
# 2	89 OF 400	22%	
# 3	87 OF 400	22%	
# 4	53 OF 400	13%	
TOTAL: 100%			

UNIVERSITY/GOVT R & D

115 OF 400 DID NOT ANSWER			29%
# 1	48 OF 400	12%	
# 2	67 OF 400	17%	
# 3	107 OF 400	27%	
# 4	63 OF 400	16%	
TOTAL: 100%			

EXPORT CONSORTIA

122 OF 400 DID NOT ANSWER			30%
# 1	37 OF 400	9%	
# 2	49 OF 400	12%	
# 3	108 OF 400	27%	
# 4	84 OF 400	21%	
TOTAL: 100%			

SEMINARS ON EXPORT MARKETS

112 OF 400 DID NOT ANSWER			28%
# 1	26 OF 400	6%	
# 2	69 OF 400	17%	
# 3	115 OF 400	29%	
# 4	78 OF 400	20%	
TOTAL: 100%			

STANDARDS WITH EXPORT MARKETS

113 OF 400 DID NOT ANSWER			28%
# 1	42 OF 400	10%	
# 2	85 OF 400	21%	
# 3	101 OF 400	25%	
# 4	59 OF 400	15%	
TOTAL: 100%			

```
IMAGE PROCESSING
     164 OF  400 DID NOT ANSWER  41%
   # 1        18 OF  400       4%
   # 2        30 OF  400       8%
   # 3       188 OF  400      47%
   TOTAL: 100%
VISUAL RECOGNITION
     178 OF  400 DID NOT ANSWER  44%
   # 1         5 OF  400       1%
   # 2        19 OF  400       5%
   # 3       198 OF  400      50%
   TOTAL: 100%
. DO REPORTD2
NARROW BAND MODULATION
     178 OF  400 DID NOT ANSWER  44%
   # 1        11 OF  400       3%
   # 2        32 OF  400       8%
   # 3       179 OF  400      45%
   TOTAL: 100%
SIGNAL PROCESSING
     172 OF  400 DID NOT ANSWER  43%
   # 1        29 OF  400       7%
   # 2        40 OF  400      10%
   # 3       159 OF  400      40%
   TOTAL: 100%
ENCRYPTION
     176 OF  400 DID NOT ANSWER  44%
   # 1         8 OF  400       2%
   # 2        42 OF  400      10%
   # 3       174 OF  400      44%
   TOTAL: 100%
ERROR CORRECTION
     176 OF  400 DID NOT ANSWER  44%
   # 1        15 OF  400       4%
   # 2        41 OF  400      10%
   # 3       168 OF  400      42%
   TOTAL: 100%
NETWORKS
--------
CONTROLLED ACCESS
     177 OF  400 DID NOT ANSWER  44%
   # 1        25 OF  400       6%
   # 2        34 OF  400       8%
   # 3       164 OF  400      41%
   TOTAL: 100%
FIBRE OPTIC
     185 OF  400 DID NOT ANSWER  46%
   # 1        10 OF  400       2%
   # 2        28 OF  400       7%
   # 3       177 OF  400      44%
   TOTAL: 100%
LASER BEAM / OPTICAL
     191 OF  400 DID NOT ANSWER  48%
   # 1         4 OF  400       1%
   # 2        17 OF  400       4%
   # 3       188 OF  400      47%
   TOTAL: 100%
```

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D - 5 (CONTINUED)

INTEGRATED VOICE/DATA
     181 OF  400 DID NOT ANSWER  45%
   # 1        15 OF  400      4%
   # 2        34 OF  400      8%
   # 3       170 OF  400     42%
   TOTAL: 100%
INTEGRATED VOICE/DATA/VIDEO
     188 OF  400 DID NOT ANSWER  47%
   # 1         9 OF  400      2%
   # 2        23 OF  400      6%
   # 3       180 OF  400     45%
   TOTAL: 100%
OTHER
-----
     293 OF  400 DID NOT ANSWER  73%
   # 1        77 OF  400     19%
   # 2        16 OF  400      4%
   # 3        14 OF  400      4%
   TOTAL: 100%
```

F - 4 (CONTINUED)

```
FORUM FOR COOPERATION
     121 OF  400 DID NOT ANSWER  30%
    # 1        25 OF  400      6%
    # 2        89 OF  400     22%
    # 3       106 OF  400     26%
    # 4        59 OF  400     15%
    TOTAL: 100%
SKILLED WORK FORCE
     116 OF  400 DID NOT ANSWER  29%
    # 1        90 OF  400     22%
    # 2       110 OF  400     28%
    # 3        48 OF  400     12%
    # 4        36 OF  400      9%
    TOTAL: 100%
MANUFACTURING AUTOMATION
     134 OF  400 DID NOT ANSWER  34%
    # 1        45 OF  400     11%
    # 2        81 OF  400     20%
    # 3        79 OF  400     20%
    # 4        61 OF  400     15%
    TOTAL: 100%
LOW INTEREST LOANS
     174 OF  400 DID NOT ANSWER  44%
    # 1       101 OF  400     25%
    # 2        54 OF  400     14%
    # 3        34 OF  400      8%
    # 4        37 OF  400      9%
    TOTAL: 100%
```

* * * * * * END OF REPORT * * * * * *

- International market possibilities

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Supply Analysis

o **strengths and weaknesses**

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O **market share - International**

- the international market share for Canadian videotex industries will be small as US-based IBM, AT & T, DEC and Honeywell presently dominate the North American industry.

o **market constraints**

- a small Canadian market due to the high cost of videotex terminals and limited videotex services in Canada.
- the U.S. market, although larger than the Canadian market, is presently relatively small and dominated by U.S.-based companies.

Competitive Analysis

- Strategies of major suppliers in areas of major growth

1) continue to incorporate the NAPLPS protocol in videotex products and systems
2) create videotex services for specialized applications. (i.e. Grassroots etc.)

- Identification of market niches

1) for Canadian industries financially viable markets appear to be developing for specialized applications (i.e. Infomart's most successful product: Grassroots - an agricultural information service for farmers)
2) NAPLPS software decoders

- Assessment of Canada's capabilities and potential to exploit identified market niches

Canadian videotex industries can compete effectively in specialized applications of videotex services (i.e. Grassroots) and software packages (i.e. NAPLPS software decoders)

Continued on Next Page

ATTACHMENT III

PERSONAL INTERVIEW

GUIDELINE SAMPLE

KVA Communications and Electronics Co.

HIGH IMPACT SYSTEM TECHNOLOGIES
SECOND ROUND DATA COLLECTION

INTERVIEW GUIDELINES

VIDEOTEX

COMPANY NAME ______________________________

CONTACT PERSON ______________________________

TITLE ______________________________

ADDRESS:

P.O. Box/Street ______________________________

City ______________ Province ______________

Postal Code ______________________________

Area code/Telephone Number ______________________________

MARKET AND COMPETITION

Introduction

The following questions will address the Videotex system technology as an entity comprising the following elements:

- Networks
- Transmission Techniques
- Computers
- Terminals
- Picture-Coding Techniques

The market assessment includes all aspects of the technology:

- R&D
- Manufacturing
- Service

General Discussion

The following discussion will be in reference to the items listed above.

Demand Analysis

o recent experience

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o **factors of change**

1) price of videotex hardware and services
2) improvements in videotex technology resulting in much improved and less expensive videotex services.
3) identifying market niches (i.e. banking, teleshopping, specialized applications etc.)

o **projected requirements - growth estimate**

According to Cable Communications Magazine, the videotex market, as videotex is known today (since advances in technology continually erase the barriers between videotex and database retrieval systems and what may be known in the future as integrated communication networks), is expected to exceed $2 billion by 1994.1

1. Source: Videotex - a technology on the wane? Cable Communications Magazine, July/August, 1985, pg.68.

o **potential role for Videotex systems and services - areas of major growth**

1) public access information
2) home use: banking, teleshopping, providing financial information: commodities' prices, news, weather and sports, specialized information databases (i.e. Grassroots)

- The Canadian dimension

Overall, the Canadian videotex industry has been a disappointment, but a few companies are doing well, having taken advantage of Telidon, the Canadian-developed videotex technology.

A1 List the major Canadian companies involved in Videotex systems development and implementation, and who, in your opinion, will emerge as major suppliers of Videotex technologies.

Company Name	% of Canadian Market, 1985
1. Infomart Corp of Toronto	
2. Network Videotex Systems Inc. of Toronto	
3. Cableshare Inc. of London	
4. Genesys Group Inc. of Ottawa	
5. Groupe Videotron of Montreal	
6. Groupe Videoway Inc. of Montreal	
7. New Media Technologies of Burnaby, B.C.	
8. Dominion Information Services of Burnaby, B.C.	
9. Medio Videotex Services of Vancouver, B.C.	

10.AEL Microtel of Burnaby, B.C.

11.Norpak of Kanata

12.Electrohome of Kitchener

13.Tayson Information Technology Inc. of Toronto

14.St. Clair Videotex Designs of Toronto

15.PDI Inc. of Toronto

16.Addison Information Systems of Toronto

A2 Could you estimate the total Canadian and international market, in terms of 1985 sales dollars, for Videotex technology products and services.

	1985	1986	1987	1988	1989	1990	1994
Canadian Market							
Canadian Imports							
Canadian Exports							
World Market							$2 billion

A3 Could you name major Canadian suppliers to world markets?

Company Name

1. Infomart
2. Norpak
3. New Media Technologies
4.
5.
6.
7.
8.
9.
10.

A4 Could you name technical, entrepreneurial and management resources in Canada in terms of the number of jobs existing and the potential growth over the next 5 years.

	1985	1990
TECHNICAL		
MANAGEMENT		
ENTREPRENEURIAL		

Are any of these three areas a source of weakness for Canadian industry? If so, what measures could be taken to ensure Canadian resources will be available?

TECHNICAL: The technical workforce in Canadian videotex industries is a source of strength as evidenced by the development of the NAPLPS graphics protocol.

MANAGEMENT: Represents a source of weakness. International markets were not aggressively and effectively pursued, and as a result, were lost to the U.S. giants. Specialized applications markets must be tapped.

ENTREPRENEURIAL: Although entrepreneurial resources are few, the potential for success is promising: as evidenced by the recent appearance of a number of Canadian videotex industries continuing to develop videotex products and services based on the Telidon technology and the tapping of specialized applications market niches.

A5 Could you name major international non-Canadian competitors in Videotex technologies.

Company Name	Country	Canadian Market Share	World Market Share
1. IBM	U.S.		
2. AT & T	U.S.		
3. DEC	U.S.		
4. Honeywell	U.S.		
5. CBS	U.S.		
6. Sears	U.S.		
7. Viewdata Corp.	U.S.		
8. British Telecom	U.K.		
9. PTT	France		
10.			

CANADIAN CAPABILITIES

B1. In the following areas of Videotex technology, please indicate Canadian strengths and weaknesses in relation to both the Canadian and International markets.
(insert S for strength or W for weakness.)

	NETWORKS				TRANSMISSION TECHNIQUES	COMPUTERS		TERMINALS		PICTURE-CODING TECHNIQUES
	CABLE	TELEPHONE	PACKET SWITCHED	ISDN		ACCESS MACHINES	EXTERNAL COMPUTERS	USER	SERVICE-PROVIDER	
PRODUCTION STATE-OF-THE-ART EQUIPMENT										
PRODUCTION R&D										
APPLIED R&D										
PURE R&D										
MARKETING -- DOMESTIC										
MARKETING -- INTERNATIONAL										
PRICE										
STANDARDS										
REGULATORY INNOVATIONS/ LIMITATIONS										
SYSTEM INTEGRATION/ CONTRACT WORK										
OTHER PLEASE SPECIFY										

B2 (cont'd)

W1

W2

W3

B2 Discussion of Canadian strengths and weaknesses as identified in B1.
(Potential Government support role, Canadian technical innovations, special applications)

S1 ____

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S2 ____

____

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S3 ____

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ATTACHMENT IV

MAJOR PRODUCTS AND SERVICES BASED ON SURVEY

KVA Communications and Electronics Co.

MAJOR PRODUCTS AND SERVICES

Code	Classification	Major Product or Service Percent
001	AI	1%
002	- Voice Recognition	
003	- Language Translation	
004	- Expert Systems	
005	- Robotics	
010	CAD/CAE/CAM	1%
020	Videotex	1%
021	Teletext	1%
022	Teletex	
030	Image Processing	2%
040	Narrow Band Modulation	
041	Signal Processing	1%
042	Encryption	1%
043	Error Correction	
050	Networks	
051	- Controlled Access	
052	- Fibre Optic	2%
053	- Laser Beam/Optical	
054	- Satellite	2%
055	- LAN	1%
056	- ISDN	
070	Systems	
071	- Automatic Location	
072	- Electronic Mail	
073	- Office Automation	2%
074	- Intelligent Buildings	
075	- Alarm and Control	4%
076	- Data	
077	- Voice	1%
078	- Voice/Data	4%
079	- Data	1%
080	- Video	
081	- Voice/Data/Video	
090	Switches	1%
091	- Digital	
092	- Optical	
093	- Integrated Voice/Data	
094	- Integrated Voice/Data/Video	
095	- Video	
100	Radio	
110	Components	6%
120	Data Processing	1%
130	Computer Software	15%

Code	Classification	Major Product or Service Percent
131	Computer Hardware	5%
132	Computer System	7%
140	CATV	2%
200	Consulting	9%
201	Sales/Service	25%
202	Service Bureau	
203	University	1%
	TOTAL:	100%

A REVIEW OF TELECOMMUNICATIONS
AND INFORMATION SYSTEMS TECHNOLOGIES

KVA

KVA Communications
and Electronics Co.
364 Supertest Rd.
Downsview, Ontario
M3J 2M2