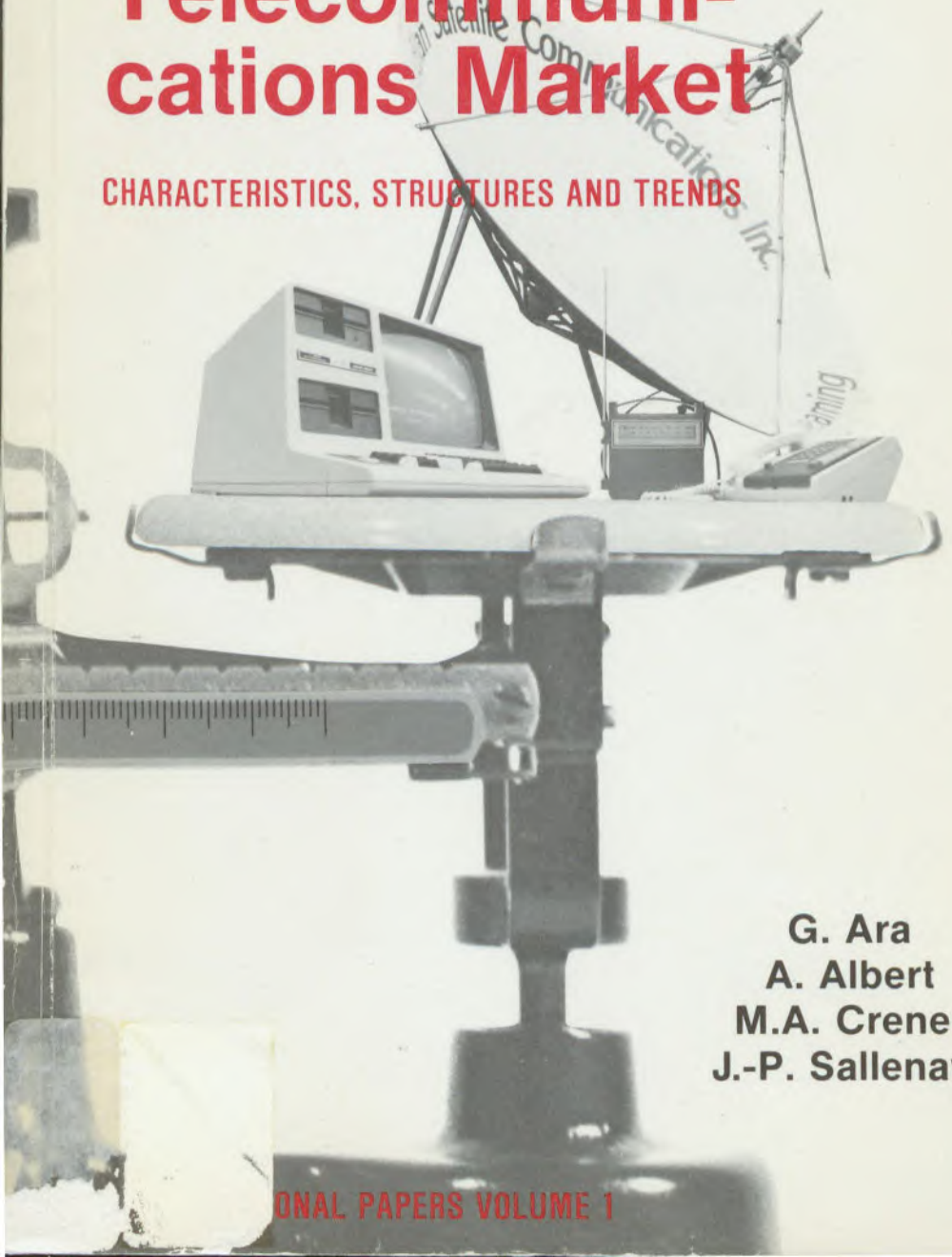
Faculty of Administration • University of Ottawa
In collaboration with the Department of Communications

The World Telecommunications Market

CHARACTERISTICS, STRUCTURES AND TRENDS



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Occasional Papers
Volume 1

The World Telecommunications Market

CHARACTERISTICS, STRUCTURES AND TRENDS

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IN COLLABORATION WITH THE DEPARTMENT OF COMMUNICATIONS

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Foreword

The *Occasional Papers* of the Faculty of Administration of the University of Ottawa are a series of studies published to tackle some important issues.

The professional or technical paper is often too short to allow an adequate treatment of an important issue; the definitive treatise is on the other hand likely to take quite some time to materialize. In the meantime, it has appeared to us that, when the occasion arises, it would be important to help throw some light on those burning issues deserving to be put at the top of the agenda for public debates, by publishing works by colleagues from Ottawa or elsewhere.

These *Occasional Papers* are meant to stimulate discussions and to help foster a fruitful debate.

Gilles Paquet
Dean

About the Authors

In January 1982 a group of business administration professors from several Canadian universities organized a nucleus of expertise in the field of telecommunications marketing. They incorporated INTERESEARCH Inc.

In cooperation with industry, universities, and the public sector, INTERESEARCH promotes the development of Canadian management technology geared to the evolution and challenges of the telecommunications industry.

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* The technical terminology is explained in the glossary. The sign [g] will refer to the glossary when the term first appears in the text.

INTRODUCTION

A) The Project

The world market for telecommunications equipment is currently experiencing a number of significant changes that in the long term cannot fail to affect the future of Canadian industry. On the world scene, where overall demand for this type of equipment is growing, some foreign manufacturers have increased their share of the market while Canadian manufacturers have seen their share decline. With forecast growth in the order of 8% per year in constant dollars for the period 1980-1990, avenues for the sale of telecommunications equipment are the subject of increasingly strong competition. The competition is rarely of the classic type, tending instead to operate in a compartmentalized marketplace under the protective wing of governments favouring their domestic producers.

These "preserves" represent approximately seven-tenths of the world market, in effect the overwhelming majority of wealthy nations. Since 1974, new customers have appeared for companies seeking orders outside their usual sphere of influence. The countries of the Middle East and Third World are discovering the need to create telephone communication infrastructures in order to further their economic and social development. Some client countries insist that technical expertise and manufacturing be transferred to them, while others are seeking to increase the percentage of local production. To take the example of analog transmission[x], it is estimated that local industry becomes economically viable for production exceeding 12,000 telephone lines per year — Indonesia, Mexico and Singapore being cases in point. Beyond 30,000 lines (such as in Brazil), economies of scale are sufficient to make products competitive on the export market. South Korea, for example, sells network cables even to Europe. Thus, Western producers are often forced to adopt new strategies. Behind the United States, where the major names are Western Electric, ITT, G.T.E., and Europe, with Siemens, Ericsson and CIT-Alcatel, a third pole in the telecommunications universe has emerged: Japan, the living illustration of an information-based economy invaded by electronics.

In this context, market changes go beyond the negotiation of sales contracts and are far more fundamental in nature. For manufacturers, the

issue is not simply the need to improve their capacity as negotiators or to conduct better market studies. In addition, they must quickly recognize changes in the market structure and assess the strategic levers most suited to changing the very nature of their product offerings. Such a perspective changes the very vocation of producers' activities and leads them to develop plans based on product diversification and on the integration of complementary technologies and new types of relationships with public authorities. The "development chain strategy", defined later, is a fundamental concept in this study; it is exemplified in an exciting manner in Japan.

For government, at issue is not only the matter of competitiveness and the cost of the assistance it gives to industry. The challenge lies in investment in a high technology sector that generates jobs and capital, in the degree to which it should directly intervene or stimulate the manufacturing sector and in the type of measures and actions it should take to assist Canadian industry in getting a solid foothold in a promising market. The importance of the international performance of the Canadian telecommunications industry is therefore obvious.

The increased foreign penetration of various domestic markets, including North America, indicates that some parts of the world market are still open and others may be penetrated still further. Given this situation, Canada's Department of Communications has undertaken a study of the international marketing strategies used by certain major world competitors in the field of telecommunications equipment manufacturing, to help Canadian industry develop better strategies for penetrating the most promising markets and thereby increase its share of the world telecommunications market.

The governments of Ontario, British Columbia and Quebec, federal departments such as External Affairs and Industry, Trade and Commerce & Regional Economic Expansion, and private firms such as Bell Canada International, Mitel Corporation and Northern Telecom Ltd. demonstrated their interest in this research by providing funding and information.

The fact that all these organizations participated shows how important this issue is for the Canadian economy. Some hypotheses have been formulated to explain the erosion of Canadian manufacturers' share of the world market:

Hypothesis I: Foreign manufacturers have superior products and/or strategies and/or benefit from more advantageous conditions for penetrating international markets.

Hypothesis II: Canadian manufacturers are poorly positioned in terms of products/markets, or are not competitive in one or more of the marketing mix variables (product, price, promotion, distribution).

These two hypotheses have been tested in case studies of major competing firms in the Federal Republic of Germany, France, Japan and the United States. The international marketing strategies they use for certain products have been studied in terms of their successes in Latin American, African, U.S. and Canadian markets.

Technological developments and the growth in world needs in telecommunications equipment require a retrospective and prospective analysis of the strategies of foreign competitors and of the support they receive from their governments. Owing to the scope of this study, the research is divided into three major phases:

Phase I : The world telecommunications market, its characteristics, structures and trends.

Phase II* : Case studies of the international marketing strategies of major competitors for certain selected products and markets.

Firms studied	Country of Origin	Products	Markets/Countries Studied
Siemens	Federal Republic of Germany	Turnkey	Latin America
		PABX[g]	North America
L.M. Ericsson	Sweden	Entire range	Latin America
CIT-Alcatel	France	Switching[g]	North Africa
Fujitsu	Japan	Terminals	North America
Rolm	United States	PABX	North America

Phase III*: A typology of the strategies of major governments, and an evaluation of the forms of development assistance for telecommunications equipment manufacturers. General synthesis.

*We hope to publish shortly, out of these two phases, a study on the strategic moves of governments, and the form of their support to firms in the global battle of telecommunications equipment.

B) The Sponsors

A number of persons in government and industry have participated in this research project by providing financial assistance, offering primary and secondary data and by conducting research.

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C) Synopsis

The world market for telecommunications equipment, a market whose salient features are:

A GROWING TREND TOWARDS THE INTERNATIONALIZATION OF MARKETS

- enhanced by converging industries and complementary technologies (telecommunications, computers...);
- but facing certain protectionist attitudes that result in the closing of certain markets;

IN A CONTEXT
—of growth

- the world market should double between 1980 and 1990, from over 1979 U.S. dollars 40 billion to close to 90 billion;
- telephone and data transmission , consistently the major por-

tions of this market, with respective shares of 80% and 10%, should grow less rapidly than satellite communications and radio paging ;

—of stable overall sales pattern by regions and systems

- see recent estimates in tables 1 and 2 below;

—but with far reaching changes within each world area and product class

- some countries still will have to catch up or to establish telecommunications infrastructures throughout the eighties;
- other countries will mainly appear as replacement and/or new service creation markets;
- product generations and concepts emerge in the fields of transmission (fiber optics[s]), switching (digital exchanges) and terminal equipment (integrated systems);

BEARING THE STAMP OF TECHNOLOGICAL CHANGE

—as evidenced by

- the obsolescence of certain classes of products, gradually replaced by new product generations and concepts;
- increasing shifts from analog[s] to digital[s] techniques;
- the increasing use of computers in the various product classes;
- the advent and development of new markets as a consequence of converging technologies;
- the importance of R & D efforts in the telecommunications industry and as a component of industrial strategies in certain countries (particularly Japan and France);

IN WHICH FOUR KEY FACTORS SHAPE THE MARKET SCENE

- recognition of the importance of R & D, both by government and telecommunications common carriers and equipment manufacturers;
- the various forms of market entry used by telecommunications equipment manufacturers, among which investment abroad and industrial cooperation appear as modes to be favoured;
- foreign contract financing under the various forms of international credit (supplier credit, buyer credit, bilateral aid...);
- the all-pervading political factor on the industrial scene of telecommunications.

Overview of Certain Factors Affecting the Telecommunications Equipment Market

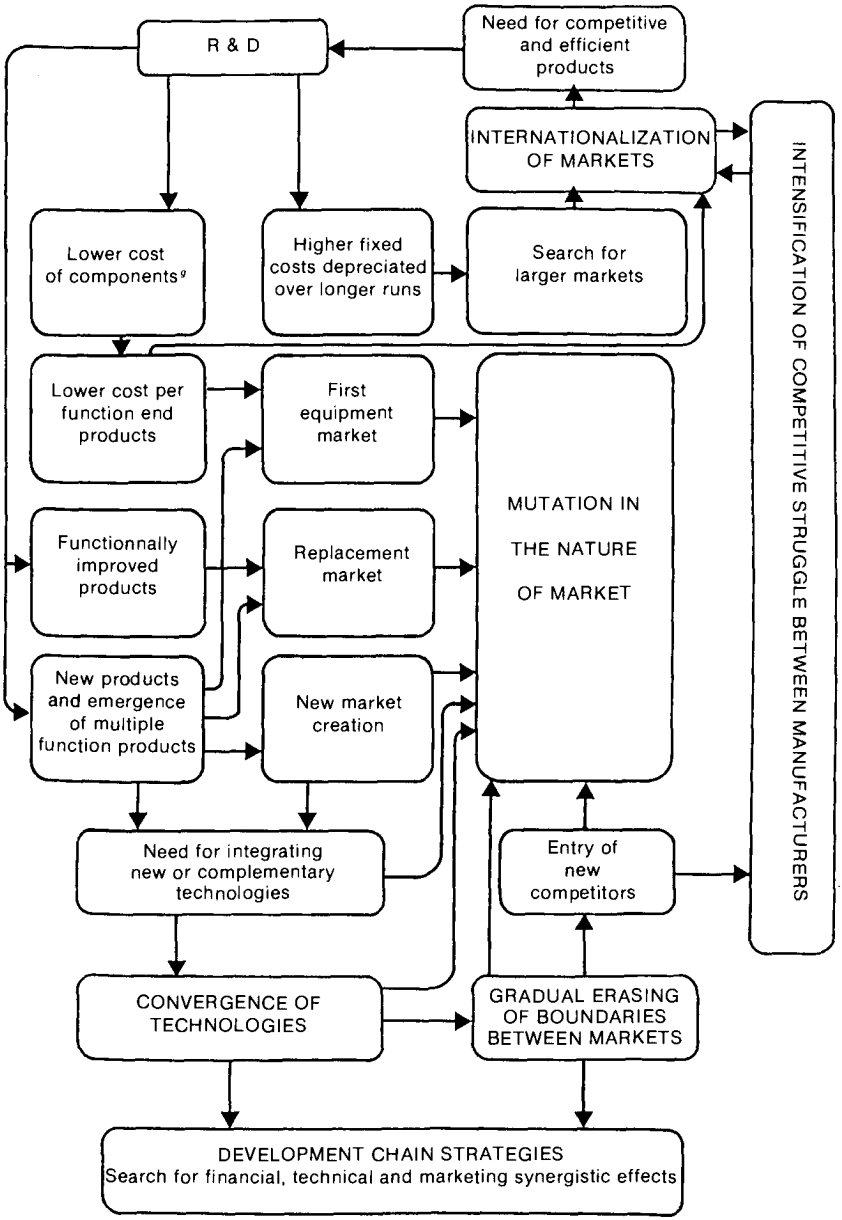


TABLE 1

Regional Markets for Telecommunications Equipment (Shipments in billions of U.S. dollars)

	1982	1987	Growth Rate (%/Year)
North America	19.9	29.1	7.8
Europe	12.5	17.2	6.7
Asia	11.8	19.1	10.1
Latin America	1.4	2.0	7.7
Oceania	0.9	1.2	6.6
Africa	0.4	0.7	8.2
World	**46.9**	**69.3**	**8.1**

TABLE 2

System Markets for Telecommunications Equipment (Shipments in billions of 1979 U.S. dollars)

	1982	1987	Growth Rate (%/Year)
Telephone	38.1	55.7	7.9
Record and Data Communications	4.8	7.6	9.6
Mobile Radio	3.1	4.4	7.3
Satellite Communications	0.5	0.9	12.8
Cable TV	0.3	0.4	5.7
Radio Paging	0.1	0.3	12.2
World	**46.9**	**69.3**	**8.1**

Source: Arthur D. Little, Inc., *World Telecommunications Information Program;* Data from *The Changing Basis of Competition in the '80s*, p.21, The Fifth Arthur D. Little Executive Forum in International Telecommunications, Boston, October 17-20, 1982

CHAPTER I

The Electronics Industry and Its Development Chain: World Challenges

I.1 Challenges for the Electronics Industry

Canada and the world in general have entered the 1980s with some pessimism about the international economic future, an attitude that contrasts with the optimism of the early 1970s. Profound structural changes in the world economy began over a decade ago and have upset the former seemingly unshakeable balance. These changes not only affect the international scene, but herald the advent of a major new phase of the industrial revolution. The crisis the West is experiencing has led to somewhat more liberal and flexible government intervention in the economy, and has produced new types of involvement designed more to promote *structural change* rather than to protect existing structures. These problems once again bring the entire *industrial question* to the fore. In the midst of international economic adjustments, with electronics industry at the crossroads, this study encompasses Canada's industrial strategy in a sectoral perspective. It may help gain some insights into the competitive position of certain Canadian firms on the world market and, indirectly, provide the basis for an understanding of Canada's part in the *third industrial revolution*[1].

With growing international integration, new trends are taking form in the *world industrial challenge*. The partial redistribution of the balance of power between industrialized and developing countries, a more pronounced hierarchy of the relative competitive capacities of large industrialized nations (competitiveness and restructuring of production) and the importance of electronics (birth of the third industrial revolution) are thus essential and striking indicators of what some people are already calling industrial warfare. The emergence of new nations changes the international picture of both supply and demand, with large markets opening up to industries of the Western world. Major and fundamental changes are likely to occur between now and the year 2000: in 25 years, the income of the Third World will probably have more than quadrupled

in size. Never before has such an extensive industrial market existed for consumer products, semi-finished goods, and equipment. Technical progress, changing patterns of demand, the transformation of comparative advantages and the industrial policies of governments will all be factors in the world industrial challenge, but each will play a different role depending on the product categories involved.

In this context, the strategic importance of the electronics industry far surpasses the relatively small part it currently plays in the industrial production and employment sectors of developed countries. In the future, the industry will have a major impact on the production process and on the organization of work as well as on the evolution of economic relationships between nations. It is essential, for any good understanding of the telecommunications industrial sub-sector, to see that its spreading effect is upsetting the conditions of international competition: for example, electronics today represent 70% of the manufacturing cost of an Airbus aircraft! Electronics not only account for an increasingly large portion of a product's cost, but intervene, inescapably and decisively, in production processes. In Japan in particular, the automobile has helped create a complete electronics chain [2], and the use of robotics in production operations is accelerating this development process.

Over the next 20 years, the electronics industry may grow twice as quickly as the whole of the industrial sector [3]. This dynamism will be maintained largely by the speed with which technical innovation in *basic components* [6] *and related software* [8] moves from the laboratory to the production process.

In this sector, the rules of competition will be determined by technological changes that will require the growing involvement of governments. Techniques that have produced the incredibly rapid development of increasingly integrated circuits will reach their limits in the next decade and basic research will become ever more costly. As reported by J. Lesourne in his latest work [4], the outcome to be expected is twofold:

- a more pronounced dual integration movement, in which component producers will seek to manufacture assembled equipment, and producers of mechanical and electrical equipment will attempt to manufacture their own components; and
- the on-going dominance of the five major manufacturing countries (the USA, Japan, the Federal Republic of Germany, France and Great Britain), which together account for 80% of world production.

The major battle will thus take place in the West, in the electronics industry. The third industrial revolution is creating enormous technological opportunities that help newcomers fit into the major oligopolies. Through Northern Telecom, Canada has a place in the telecommunications sub-sector, but it must understand the rules of the international oligopoly. Recent Japanese strategy [5] is a good illustration of the opportunities available to

countries with great financial leverage for large capital investments in high technology.

It is important to stress from the outset that to conceive of tomorrow's industry in terms of yesterday's *driving forces* is to forget that, slowly but surely, its major branches (the automobile, chemical and textile industries) have reached or are approaching maturity and are no longer bringing growth and development. The future will focus on *electronics*, on sources of renewable energy and on biology in a broad sense of the term. For Canada, the consequences of political choices favouring industrial sectors on the wane, such as textiles, and an under-estimation of the role of science and research and development in the industrial sector of developed countries would clearly raise bleak prospects for future technologies. Now, and even more so in the future, a country's economy essentially draws its vitality from *the efficiency of its research system and from the quality of the interface between this and its production system*[6].

I.2 Major Traits and Trends in the Electronics Industry: the "Development Chain" Concept

Through its links with data processing and telecommunications, through the introduction of automation throughout the entire industrial sector, through changes that the office-of-the-future concept introduces into service activities, and through the very services it engenders, the electronics sector will become the major industrial challenge in the international marketing field by the end of the century. On a world scale, electronics grew faster than any other industrial sector between 1965 and 1975: close to 10% annually[7]. According to OECD forecasts for the period from 1980 to 1990, the world electronics industry may grow by 8% per annum, a growth rate far superior to that of the manufacturing industry which, overall, cannot hope to exceed 5%.

However, the importance of the electronics industry is not to be measured simply in terms of growth or of its share of production and employment. In order to understand it and to try to evaluate some of its consequences for the future, we must examine the industrial logic of which it is part: the various stages in the development and manufacturing process of products from raw materials and basic components, their technological and marketing links, the resulting complementarity and synergy, and their effects on the marketplace. This overall perspective corresponds to what we shall henceforth call the *development chain*. To illustrate this concept in concrete terms, let us first examine the definition proposed by J. Parent[8]:

> *"The sum of all production and marketing operations required to pass from one or several basic raw materials to a product in its final stage (i.e. into the hands of its user), occurs in successive and/or simultaneous stages, and involves various mutually interdependent technologies." (trans.)*

Thus, various basic components have to be used and assembled in order to manufacture a tape recorder or a calculator. The manufacturer of the end product is able to manufacture some or all of these basic components. However, some of these components may be used to manufacture other end products such as electronic office equipment. If the tape recorder manufacturer only meets his own component requirements and passes his surplus over, for example to manufacturers of electronic office equipment, he is following a development process of vertical integration and client diversification[9]. If, on the other hand, on the basis of his control of the components, he moves into the manufacture of other finished products, built with these components but meant for other end users (e.g. word processing equipment for industry instead of the general public), he will have diversified according to the development chain concept, drawing benefits from his advantage in one sector for increasing his technological, commercial and financial penetration of other sectors. In Japan, this massive specialization in consumer products has helped firms master the production of classical components, gain leadership first in the domestic market, then abroad, and at the same time build up large cash inflows.

> *"...Hence the opportunity to enter the computer market, with government encouragement, first through calculators. The 1970 computer market plan was thus partly financed by audio-visual profits and partly by the government. Furthermore, the fact of belonging to giant groups that are also involved in industrial equipment has largely resolved the marketing problem. Because of the delay in computer components, in 1974 major firms participated in a government plan to accelerate research in, and production of, advanced integrated circuits designed particularly for this sector. Independent research activities, a massive injection of funds and the existence of a captive market (depending on the firm, the internal component consumption rate varies between 20% and 50%) were complementary to the experience firms had acquired in manufacturing components for consumer products.* The result has

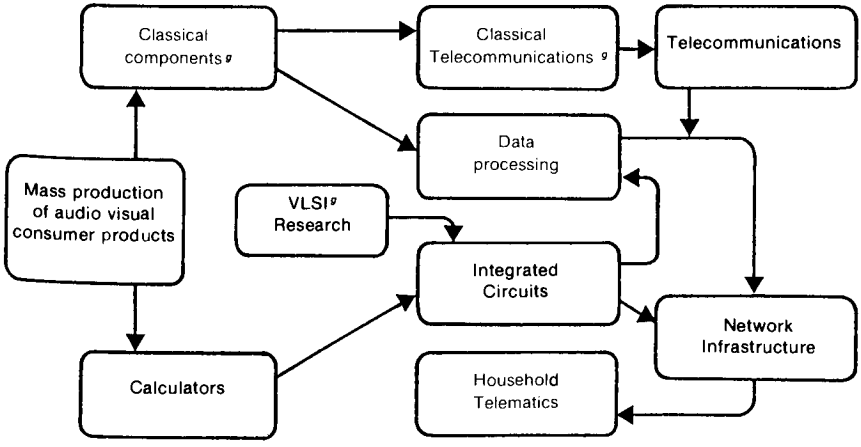
been an involvement in integrated circuits[8] that helps Japanese firms to compete with Americans on their own ground and to capture 40% of the US market for advanced memory devices . *The Japanese component industry has therefore become mature and independent of others. Currently, by using their strength in the computer and telecommunications industries they are making similar efforts in the software field and in the establishment of telematics networks* .[10]"

In a similar fashion, the Japanese automobile chain, a great user of microprocessors and electronic machine-tools and robots, has become the major chain for micro-electronic sales along a pattern of industrial chain strategy that may be compared to the one visualized in Fig. I.1 in the case of audio visual products.

In order to simplify matters and enable us to describe recent OECD work[11], the electronics sector will be divided into three major sub-sectors:

a) electronic equipment;
b) consumer products;
c) electronic components (supplying parts for *a)* and *b)* systems and sub-systems).

FIG. I.I Japanese Chain Strategy[10].



Source: Lorenzi, J.H. and Truel, J.L. "*Se diversifier par les stratégies de filières*", in Harvard-L'Expansion, Winter 1980-81, p. 98-107.

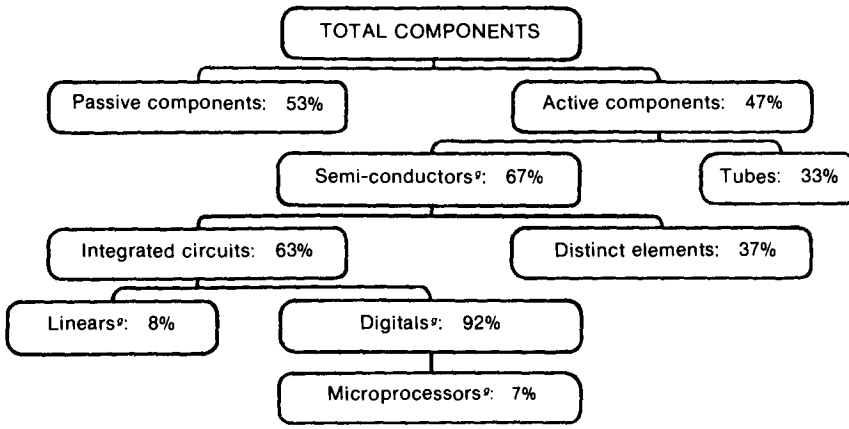
The electronic equipment sub-sector produces computers or peripherals, telecommunications and office equipment, measuring and testing devices and control equipment for industry.

The electronic components sub-sector (in this study, we are not directly concerned with consumer products), which supplies the equipment market, has two segments: one producing *"passives"* and electro-mechanical *devices*, the other *"actives"* devices (electron tubes and especially transistors, forming the basis of integrated circuits). Figure I.2 shows the market structure according to the respective values for various categories of electronic components in OECD countries in 1977.

Although the market value of the integrated circuits segment does not appear to represent a large portion of the electronics sector or even of the components industry, it is of unparalleled importance when one considers its rapid technical evolution and phenomenal growth rate. While per capita Gross National Product in the United States increased by 70% between 1963 and 1973, the electronics market grew by 202%, semiconductor sales by 331% and sales of integrated circuits by 5406%, or 77 times more quickly than the GNP [12]. It should be noted that the sub-sector's growth is marked statistically by a phenomenon which should also increase in importance: the integration of integrated circuits activities in firms producing finished products. The advent of microprocessors should accelerate the speed of change in this field.

The world demand structure will show a noticeable shift in the next ten years away from household products and toward industrial equipment, as illustrated in Table I.1.

FIG. I.2 Electronic Components Market Structure in OECD Countries



Source: **Electronics,** May 1, 1978.

TABLE I.I

Evolution of the Demand Structure for the World Electronics Industry

	1970	1975	1985
Total Demand			
(In billions of current U.S $)	**56.8**	**91.3**	**204.8**
Consumers	20.7%	19.0%	17.4%
Private Industry and Services	30.5%	39.2%	45.4%
Administration (including military demand and communications systems)	48.5%	41.7%	37.2%

Source: *Interfuturs*, OECD, Paris 1979, p. 363.

This introduction to the electronics sector, which is all too brief and necessarily over-simplified, is presented solely with a view to providing a framework for the material hereafter.

In sum, the major traits and trends of the electronics development chain are as follows:

- on the one hand, forecasts show that its growth will surpass the growth of other industrial sectors;
- on the other, a change in industrial logic, based on the convergence of complementary industries and technologies, will give birth to the era of chain strategies.

In other respects, one cannot but observe two additional features of the electronics development chain:

- a trend toward the internationalization of markets;
- the predominant role played by the technological factor and by research and development.

The trend toward the internationalization of markets is evidenced by:

- *the trade deficit of several countries in some areas of the electronics industry* (Canada is a flagrant example of this, as witnessed by the statistical data on pages 79 and following: in the case of electronic components, while apparent consumption was estimated to be Can. $1.18 billion in 1981, domestic production in Canada represented only Can. $565 million; in the case of computers, out of Can. $1.7 billion apparent consumption, domestic production represented only Can. $176 million). *Only imports can counterbalance these domestic production deficits;*
- *the observation of electronics firms strategic behavior.* Either because competition and a relatively narrow or squeezing domestic market force them to do so (such may be the case of French, Swedish or Dutch firms for

instance), or because of government incentives (French and Japanese firms for example), or for structural reasons (cost structures, existing organizational structures in the case of large multinational companies), or as a result of well thought out strategic choices (as witnessed by the Canadian examples of Mitel and Northern Telecom, by the Japanese firms or giants like IBM or Siemens), *these firms launch out more and more into foreign markets*. This has been patent for more than ten years in the case of electronic consumer goods (particularly audio visual products), in the last twenty years in the case of data processing, and since the mid-seventies in the case of new generations of telecommunications equipment (digital equipment);

- *the desire in several countries to gain access to the most advanced technologies,* even when domestic production fails to come up to these requirements, in order not to have to catch up or to modernize too late telecommunications plant in accordance with the needs of their domestic economies. Among industrialized countries, such was the case of France in the mid-seventies (with a first and foremost domestic effort through restructuring of the telecommunications industry); this also prevails in countries like Argentina, South Africa or Australia and even in growing numbers of developing countries.

Chapter IV substantiates the above observations by giving complementary data on countries and regions.

With respect to the predominant role to be played by the technological factor and by research and development in the electronics development chain[13]:

- *this is inherent in the very concept of development chain strategy,* as witness the Japanese example. After gaining complete mastery of electronic consumer goods, Japan was the first country to produce MOS[s] 64K[s] (RAM[s]) memories on an industrial scale in 1977 (Fujitsu), then to undertake important R & D for 256 K memories and fifth generation computers. As a result, nippon firms today extend themselves over the entire electronic spectrum and are geared towards a leadership position in the world market. In Canada, Northern Telecom's effort in R & D (with 7.1% of consolidated sales in 1981, that is $181.6 million; $230 million in 1982; $375 million in 1983) confirms the importance granted to this factor by industry. Finally, in the field of components, it is not unusual to see manufacturers devote between 25% and 35% of sales to R & D (this is the case of Thomson-CSF and Siemens);
- *R & D is used as a strategic tool of the firm in order to acquire competitive advantage.* This is evidenced by such cases as CIT-Alcatel with the early introduction of E10 digital time division switches[s] which now account for 2.5 million lines in service and give this firm a 35% world market share in the

installed base of this type of equipment in 1981[14], Northern Telecom with the introduction of SL and DMS series and of Displayphone®, Mitel with the introduction of the PABX® SX-20 and SX-200 . All these products appeared on the market as genuine technological innovation which at the time induced competition to launch other pieces of innovation in their turn;

- *R & D is a continuous process to be considered in a framework of dynamic analytical perspectives and not just static analysis.* A must of competitive struggle between electronics firms, R & D is a means to establish and undo market shares. Through it, firms like Northern Telecom or CIT-Alcatel on the public switching® market, Mitel or Rolm on the PABX market, just to name a few, may hope to gain leadership positions;
- *the need for continuous R & D efforts involves considerable costs and investments.* This will obviously promote the search for solutions allowing both economic returns and the market safety necessary to recover the enormous amounts of R & D investments at stake. Solutions can differ as the case may be. They may be permanent solutions (a strategic constant in the firm) as in the case of vertical integration (Bell Canada - Northern Telecom) or *de facto* if not *de jure* vertical integration (PTT-CIT-Alcatel, PTT-Thomson-CSF in France). The built-in captive markets thus created are a real asset for these firms[15]. Solution may be niche seeking strategies, that is to say when only certain product lines, by choice or out of necessity, will be developed (for instance electronic components in the case of Intel or Mostek, PABX's in the case of Mitel or Rolm). But with ensuing success these strategies may lead the firms using them to spill over from their original niche into other markets (this is the case of Mitel with the SX-2000).

Whatever the situation may be, the latter characteristics of the electronics development chain, as just brought forward above, i.e. the internationalization of markets and the predominant role of R & D, seem to be indissolubly linked. The internationalization of markets leads to intensified efforts in R & D, a result of the strategic behavior of the firms and of industrial choices of nations in the context of international competition. On the other hand, R & D leads firms to seek foreign markets in order to spread the depreciation of investments over larger production runs. Since this process occurs in a continuous way, between two technological breakthroughs[16], R & D also plays a major part in the development and improvement of product lines (CIT-Alcatel goes as far as presenting an E10 development chain with E10B, E10S and E12 systems. Similar findings might be stated with respect to Northern Telecom's SL and DMS families or Mitel's SX lines).

Finally, let's note that the above observations are corroborated by three studies from the Science Council of Canada[17] and by Louise Séguin-Dulude's study on interindustry technological flows[18] measured on the basis of data on patents from the PATDAT data base of Consumers and Corporations

Canada, where it is estimated that the telecommunications equipment industry had a rate of technological self sufficiency of 83% in 1978, as compared with 74% for office equipment industries and 57% for industrial electrical equipment.

As far as the relationship between R & D and the international performance of manufacturing industries is concerned, Petr Hanel has shown in various studies[19] the importance of the link between these two variables in vanguard industrial sectors as compared with others. His findings confirm the conclusions brought forth above.

The question still at stake, to which only case studies might bring an answer, is as follows: insofar as the several international competitors use, to varying degrees, either development chain strategies or niche specialization strategies, will their growth on the international market rely mainly on R & D efforts (hence a product strategy) or on other variables such as price, buyer financing, maintenance and service or distribution?

I.3 The Canadian Challenge: Towards an Industrial Policy Based on High Technology

In an international context where competition is increasingly stiff and where the need to remain competitive requires increasingly substantial research and development efforts, Canada cannot hope to benefit from the economic fall-out of the third industrial revolution unless it manages to secure a dominant position in a limited number of well-defined segments of the international high technology market. Canada's economic, technological and political autonomy depends on this strategy of international specialization.

At the dawn of the computer era, is Canada committed to this process of specialization?

Balance of trade statistics would indicate that it is not. The trade deficit for products of the high technology industry was assessed at 2 billion dollars in 1970, 2.6 billion in 1975 and 7.5 billion in 1977[20]. The situation has remained virtually unchanged in the past five years because of the lack of any noticeable change in the major factors that explain this decline: structural factors such as a narrow domestic market and the high proportion of foreign-controlled Canadian high technology industries (70% in 1978), economic

factors such as the decline in productivity, and limited research and development activity.

In the context of a broadening of global market opportunities the problem of Canada's narrow domestic market cannot fully explain the deficit, and although it is true that foreign control of Canadian subsidiaries does not necessarily translate into a lack of research and development efforts in Canada or into the lack of enthusiasm of Canadian subsidiaries for export markets, the fact remains that Canada's weaknesses in the R & D field are a matter of on-going discussion. The graph on page 12 is revealing.

There have certainly been increased efforts in recent years (according to recent estimates, Canadian R & D expenditures represented 1.1% of the GNP in 1981 [21] compared to 1% in 1978), but this progression is inadequate when compared to efforts of countries such as France (where R & D expenditures already represent 2% of the GNP and will account for 2.5% in 1985) and Japan (over 2% today, and 3% by the end of the 1980s [22]).

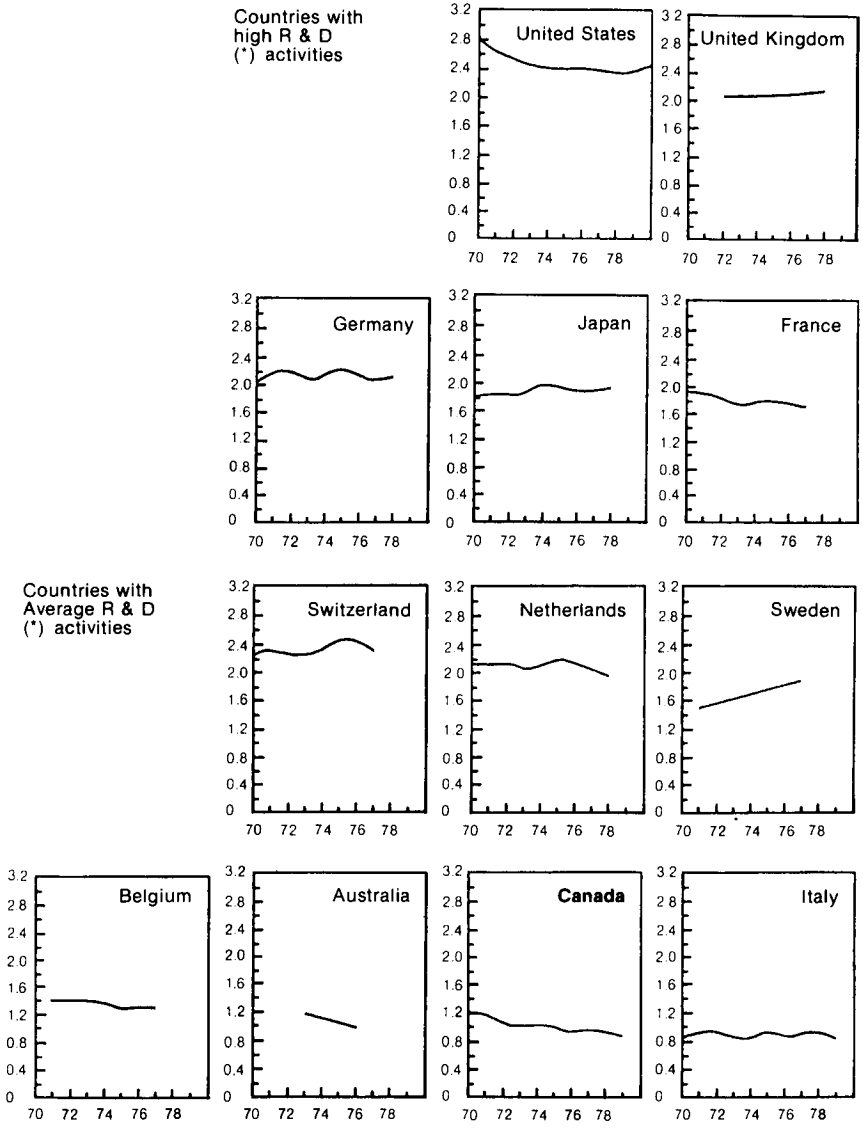
Canada's delay, when compared to its immediate competitors in high technology fields, has obvious consequences: *technological and economic dependence on innovative countries* (80% of the technology used in Canada is currently imported; this figure stands at 56% for the electrical and electronics industries [23]), a *growing deficit in the balance of high technology products* and a *decline in Canada's share of the international market* for high technology products.

The telecommunications sector has nevertheless revealed that sustained R & D efforts are not only profitable but may also lead to impressive penetration of international markets: proof of this lies in the successful records of Northern Telecom and Mitel on world markets and the development potential of Telidon [24]. Northern Telecom is now in a leading position in the world market for digital telecommunications (switching and transmission) and Mitel has made an exceptional entry into the export market, particularly in the United States (61% of its sales in 1979). These successes are not accidental.

Not only is R & D the essential condition for success in fields where the rate of technical progress is extremely rapid; it also helps make full use of innovative strategies as a lever against competition and enables specialization in large-scale products and advanced technologies. These are necessary conditions for penetrating international markets where increasing competition from the "newly industrialized countries" (e.g South Korea, Mexico, Brazil, Taiwan) may readily be observed. In this context of unequal exchange, innovation might well be a means to overcome the price strategies that the new international competitors can afford on the basis of certain lower production costs.

A glimpse at the seventies provided by the figures below shows that only Japan was able to maintain prices within narrow annual variation brackets.

Evolution of Gross Domestic R & D Expenditures as a Percentage of the Gross Domestic Product in Certain OECD Countries from 1970 to 1978 [25]



(*) In absolute terms

Source: OECD (1981)

Price Variations in Telecommunications Equipment (Average annual rate of increase)

	Period	Telecommunications Equipment	Manufacturing Industries
United States (1)	1972-76	5.0	11.7
	1971-79	5.3	9.7
F.R.G. (2)	1971-80	3.4	5.0
Sweden (2)	1971-80	6.6	10.7
Belgium (2)	1971-80	4.8	5.4
Italy (2)	1971-80	16.7	15.5
Netherlands (2)	1971-80	4.0	6.0
France (3)	1971-80	6.6	9.4
Japan (4)	1970-78	0.6	6.0
	1975-81	-0.3	4.5 (5)

Sources: (1) AT & T
(2) INTECS
(3) DGT
(4) Bank of Japan
(5) Until 1980

(As shown in the table, the average annual rate of increase for telecommunications equipment made in Japan was close to 0% between 1970 and 1981). Italy was characterized by high increases owing to its weak currency and high domestic inflation rates in the last ten years.

In other respects, price increases for telecommunications equipment were generally much less pronounced than in other manufacturing industries. Technological change, particularly in the field of microelectronics, is likely to account for a large part of this phenomenon.

With respect to compensation disparities among industrialized countries, the following table shows that, in opposition to a frequently held opinion, Canada compares unfavorably only with the United Kingdom and Japan.

Despite the fact that these data concern all manufacturing industries, and not specifically the electronics sector, it is reasonable to assume that the variations from country to country in the above table also apply to this sector. Consequently, Japan, the United Kingdom and France might appear as the most serious contenders in price competition. However, in the winning of foreign contracts for telecommunications equipment, besides pricing in a narrow sense, another dimension seems to be all the more important: the concept of a "package deal" that includes a financing package, service and technology transfer. This is particularly true in Third World countries. With respect to financing, the ability to grant long term buyer credit terms at competitive rates appears to be a decisive factor. In fact, this raises the issue of the competitiveness of the Canadian system of financing support to exports.

Average Hourly Rate of Compensation in Manufacturing Industries in Ten Industrialized Countries Between 1960 and 1980 (in U.S. Dollars)

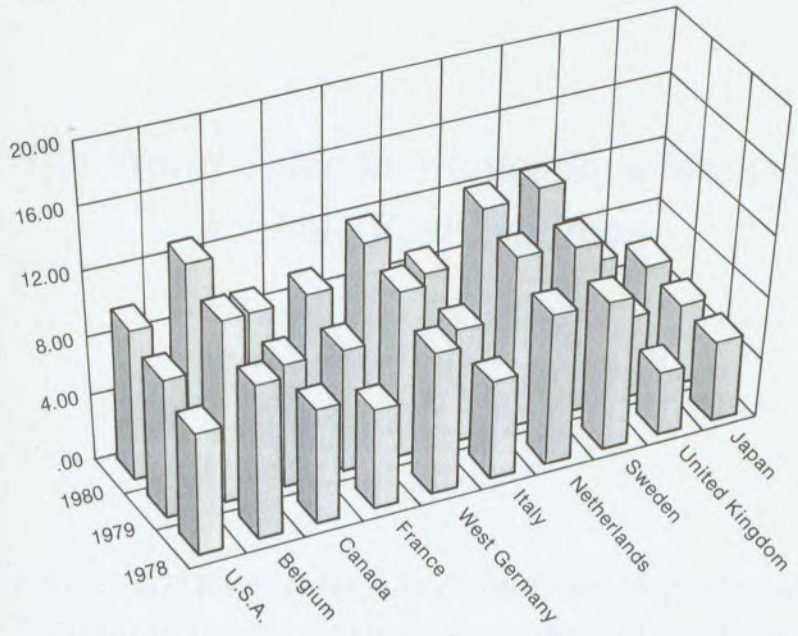
Countries	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*	1980**
United States	2.66	3.14	4.18	4.49	4.84	5.26	5.75	6.35	6.92	7.59	8.31	9.06	9.92
Belgium	.82	1.30	2.07	2.45	3.18	4.22	5.17	6.60	7.02	8.38	10.18	11.91	13.18
Canada	2.13	2.28	3.46	3.91	4.31	4.66	5.45	6.11	7.20	7.55	7.68	8.21	9.06
France	.83	1.24	1.74	1.95	2.37	3.11	3.45	4.63	4.83	5.42	6.70	8.11	9.46
F.R.G.	.85	1.41	2.35	2.78	3.37	4.60	5.41	6.24	6.57	7.70	9.43	10.99	11.94
Italy	.62	1.12	1.76	2.12	2.57	3.20	3.66	4.65	4.42	5.13	6.18	7.54	9.01
Netherlands	.68	1.24	2.14	2.58	3.16	4.33	5.40	6.60	6.99	8.11	9.84	11.30	12.18
Sweden	1.20	1.87	2.93	3.23	4.03	4.93	5.63	7.18	8.21	8.85	9.65	11.33	12.60
United Kingdom	.83	1.15	1.48	1.73	2.03	2.27	2.60	3.27	3.12	3.35	4.26	5.44	7.07
Japan	.26	.48	.99	1.18	1.58	2.19	2.67	3.05	3.30	4.03	5.54	5.59	5.88

*Preliminary
**Provisional

Source: Based on Commerce Canada data, June 1981, and on unpublished material from US Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, March 1981.

Note: The hourly rate of compensation is a global one and includes any payment made to worker (salary and wages for time worked, holidays and other paid vacation, all bonuses and payments in nature made before any deduction). It also includes fringe benefits and "welfare" payments from the employer such as social security, insurance premiums, etc. This informationn is drawn from periodical surveys on the cost of labor weighted in proportion to years spent. Slight variations between global compensation rates should be ignored. Global compensation rates are based upon effective work hours.

Average Hourly Rate of Compensation in the Manufacturing Industry (1978-1980)



Canada's objective of increasing R & D expenditures to 1.5% of the GNP by 1985 cannot be attained without increased participation on the part of the Canadian government, whose meager record to date is in sharp contrast with the efforts of other countries. The Canadian government provides an estimated 11% of the R & D support in key sectors of Canadian industry, while Japan provides 90%, France and the United States 60%, Great Britain 50% and Sweden 45%[26].

Such participation does not necessarily require direct government intervention in R & D: financial incentives, government procurement policies and grants all contribute to attaining the objective. In addition, R & D assistance is only one of the possible approaches to developing a Canadian industrial policy based on high technology. Reorganization assistance and a supportive trade policy (export assistance, investment policies abroad) are also important instruments of an industrial policy. The place that Canada carves out for itself on the international market for high technology products in general and on the telecommunications equipment market in particular, will depend on the careful and coordinated use of these various instruments.

CHAPTER II

The World Telecommunications Market: Technological Evolution

II.1 Share and Relative Growth of the Telecommunications Sector in the World Market for Finished Products

The most characteristic feature of the telecommunications sector is its growth rate over the past decade, rather than its share of the international market for finished products.

Despite the protectionist policies adopted by many countries in the field of telecommunications equipment, there has been a growing internationalization in this sector. Internally, however, the sector still represents only a small percentage of the GNP of most Western countries[27]. Although the figures in Table II.1 date from 1975, they reveal the relative importance of the international market for many countries manufacturing telecommunications equipment, particularly Sweden, the Netherlands and Belgium. However, they also reveal the "closed" nature of this market, as shown by the low penetration rate of the Japanese, American, French and West German markets. This is undoubtedly the result of protectionist policies and/or privileged trade relations between the common carriers in a given country and its domestic manufacturers. This may also be the result of a strong and dynamic domestic sector as in the United States.

TABLE II.I

Export and Penetration Rates of the Telecommunications Equipment Sector in Certain OECD Countries in 1975

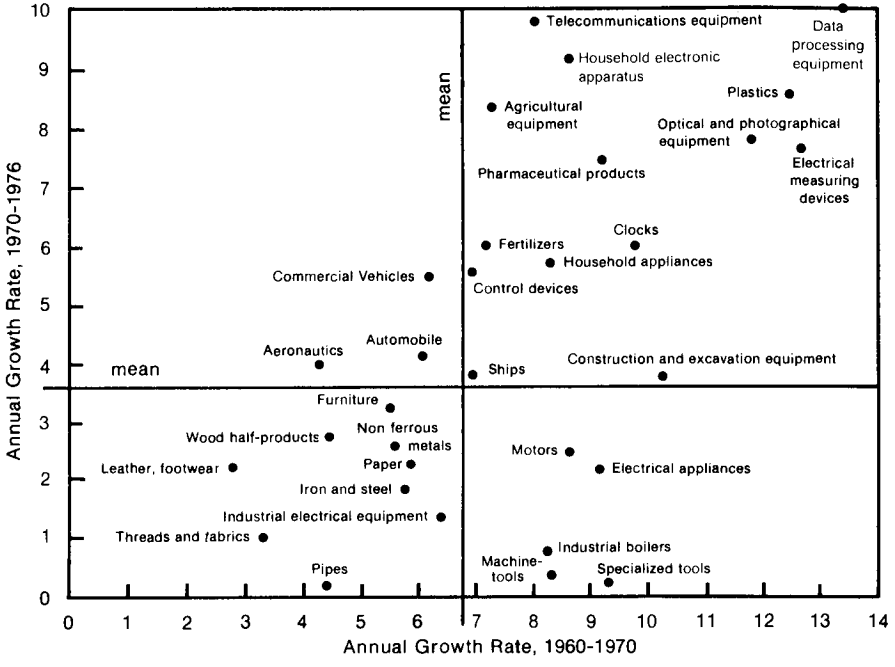
Country	Penetration Rate (1)	Export Rate (2)
Austria	40	30.8
Belgium	32.8	49.2
Canada	33.8 (3)	23.5 (3)
France	4.6	12.1
West Germany	3.5	13.7
Italy	8.9	9.3
Japan	1.4	23.7
Netherlands	49	46.9
Portugal	31.5	14.1
Sweden	24.8	83.4
United Kingdom	8.5	13.9
United States	1.7	3.6

(1) Ratio of imports on domestic consumption
(2) Ratio of exports on domestic production
(3) Estimates of the Department of Industry, Trade and Commerce (Ottawa).

Source: OECD, *Telecommunications Equipment Industry Study*, DSTI/IND/81.28, Paris, 1981, p. 115 (except for Canada. See note [3]).

Graph II.1

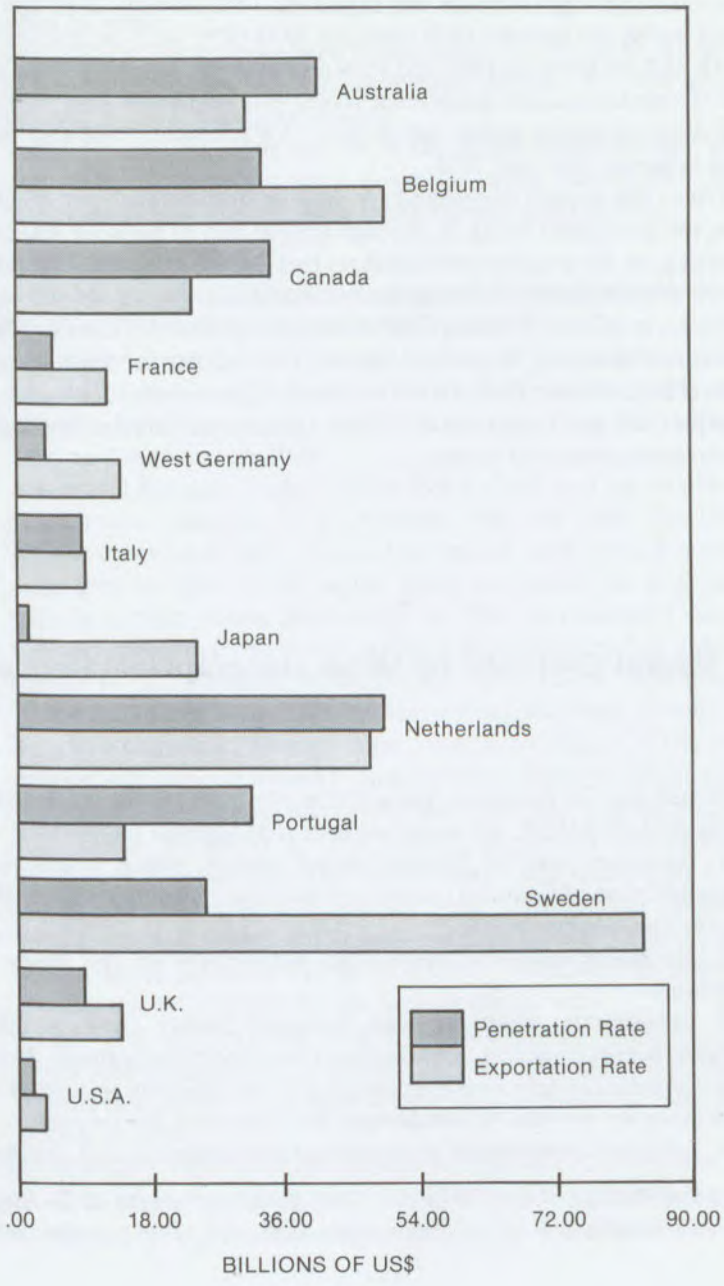
Evolution of World Demand for Finished Products, 1960-1976



Source: OCDE, DSTI/IND/FIS/80.22/Appendix

Note: The central vertical axis of graph II.1 establishes the average annual growth of world demand for all finished products considered at between 6% and 7% for 1960-1969; the horizontal central axis sets the rate at between 3% and 4% for 1970-1976.

Export and Penetration Rates of the Telecommunications Equipment Sector in certain OECD Countries in 1975



In terms of the relative growth of the telecommunications sector on the world of market for finished products, graph II.1 (p. 18) clearly illustrates the favourable position of telecommunications equipment. Quadrant I contains the sectors whose growth rate was higher than the average of all the sectors studied during the periods 1960-1969 and 1970-1976. With an average annual growth of 7.6% between 1960 and 1969 and of 9.8% between 1970 and 1976, the telecommunications equipment sector was surpassed only by the data processing equipment sector, which grew 13.4% between 1960 and 1969 and 10.1% between 1970 and 1976.

Given the growth of demand for telecommunications equipment in the 1980s, the prediction being an average annual rate of between 8% and 11% depending on the products and markets (see Tables II.2 and II.3), it is clear that the telecommunications equipment manufacturing sector will continue to occupy, in relative terms, an increasingly large share of the world market for finished products in general and of the market for high technology products in particular. Only a fresh outbreak of protectionist attitudes among the major trade partners could slow down the growing internationalization of the telecommunications sector.

II.2 Market Evolution by Major Geographical Region

World market forecasts contained in the most recent market studies, notably that of ADL[28], are based on four fundamental hypotheses:

1. No armed conflict between major powers, which would result in reallocation of financial resources from telecommunications to defence activities or armaments.
2. No major economic depression, particularly for the major world powers.
3. Inflationary pressures from increased energy costs, resulting in possible cuts or delays in investments in telecommunications. However, investments in telecommunications will be relatively protected if they provide for services to compensate for increased energy costs.
4. Selective loosening of international trade barriers and restrictions.

In the absence of more complete studies on the impact of the economic and political situation on the telecommunications market between 1980 and

1990, we shall use these estimates as the basis for our discussion of the world market.

From a statistical point of view, the reader will wish to keep the following observations in mind:

- most of our figures have been drawn from the Arthur D. Little Inc. study entitled *World Telecommunications Survey II*, 1980 and are expressed in 1979 American dollars;
- they are reproduced as shown in the above study, except where comparable, more recent data using the same classification were available and thus allowed us to make certain adjustments[29].

Table II.2 reveals:

- a doubling of the world market value, which is predicted to increase from $40 billion to $88 billion between 1980 and 1990;
- a stable structure in the six major regions of the world:
  - *North America* will remain stable in relative terms (40% of the world market) but double in absolute value, from $17 billion in 1980 to $36 billion in 1990;
  - *Asia* will increase its share from 25% to 30% and see its absolute market value multiply by 2.7 between 1980 and 1990. The USSR, which represented only 35% of this zone in 1980, should represent over 45% by 1990, while Japan, which accounted for 42% of this market in 1980 should drop to 21% by 1990. In absolute value, this forecast shows that the Soviet market will multiply by 3.5, from $3.5 billion to $12.3 billion, while the Japanese market will progress moderately from $4.2 to $5.7 billion during the same period;
  - *Europe* will see its relative share drop from 27% to 23.7%, but its market will increase from $11 to $21 billion. France and the United Kingdom will follow an identical growth scenario, France preceding the United Kingdom by five years regardless of the technical differences in equipment. The French market will multiply by 1.5 and the British market by 3. While the French market was assessed in 1980 at an absolute value of $2.1 billion and the British market at $1.1 billion, these positions will be reversed by 1990, with $3 billion for France and $3.5 billion for the United Kingdom;
  - *Latin America, Oceania* and *Africa* will remain stable in relative terms with respectively 3%, 2% and 1% of the world market, but will double in absolute value from a total of $2.3 billion in 1980 to $4.7 billion in 1990;
- an average overall increase of between 8% and 8.5% between 1980 and 1990, more rapid during the first half of the decade than in the second.

TABLE II.2

Telecommunications Equipment Expenditures by Geographical Region (in US $ million)

	1980		1985		1990		Average Annual Growth Rate	
	$	%	$	%	$	%	1980-1985	1986-1990
North America	**17,000.8**	42.31	**24,971.1**	41.11	**35,715.5**	40.55	8 %	7%
Canada	1,554.1	3.86	2,306.1	3.80	3,377.2	3.83		
United States	15,446.7	38.44	22,665.0	37.31	32,338.3	36.72		
Asia	**10,022.3**	24.94	**16,739.3**	27.56	**26,836.8**	30.72	10.8%	10%
Japan	4,224.9	10.51	5,152.7	8.48	5,696.4	6.47		
USSR	3,473.9	8.64	7,273.2	11.97	12,314.9	13.98		
Europe	**10,848.0**	27.0	**15,625.7**	25.73	**20,849.6**	23.67	7.4%	6%
France	2,152.1	5.35	3,072.5	5.06	3,029.3	3.44		
United Kingdom	1,130.5	2.81	1,999.5	3.29	3,473.9	3.94		
Other West European Countries	6,250.2	15.55	7,859.7	12.94	10,133.2	11.50		
East European Countries	1,315.2	3.27	2,694.0	4.44	4,213.2	4.78		
Latin America	**1,172.7**	2.91	**1,804.3**	2.97	**2,390.7**	2.71	9 %	6%
Oceania	**753.7**	1.87	**1,040.9**	1.71	**1,445.6**	1.64	6.7%	7%
Africa	**385**	**0.96**	**555.5**	**0.91**	**839.6**	**0.95**	**7.6%**	**9%**
TOTAL	40,182.5	100	60,736.8	100	88,077.8	100	8.5%	8%

Source: Arthur D. Little Inc., *World Telecommunications Survey II, 1980.*

II.3 Market Evolution by Major Categories of Equipment

Table II.3 shows the relative stability of the major categories of equipment in relation to the whole. Telephone systems are maintaining their share of the market at around 80%, telex[s] shows a slight increase from 10% to 12%, mobile radio[s] and radio-telephone[s] equipment will decline from 6.7% to under 6% of the total and other categories will remain generally stable. In terms of average annual growth, satellite communications systems will have the strongest growth rate, followed by telex and radio paging systems. But these changes cannot be completely understood simply in terms of the value of the equipment sold on the market. At most, all they do is serve as an indicator of the relative size of markets. Trends can be better understood through analysis of the technological evolution presented in section 2.2,

Relative Size of Markets by Geographical Zones

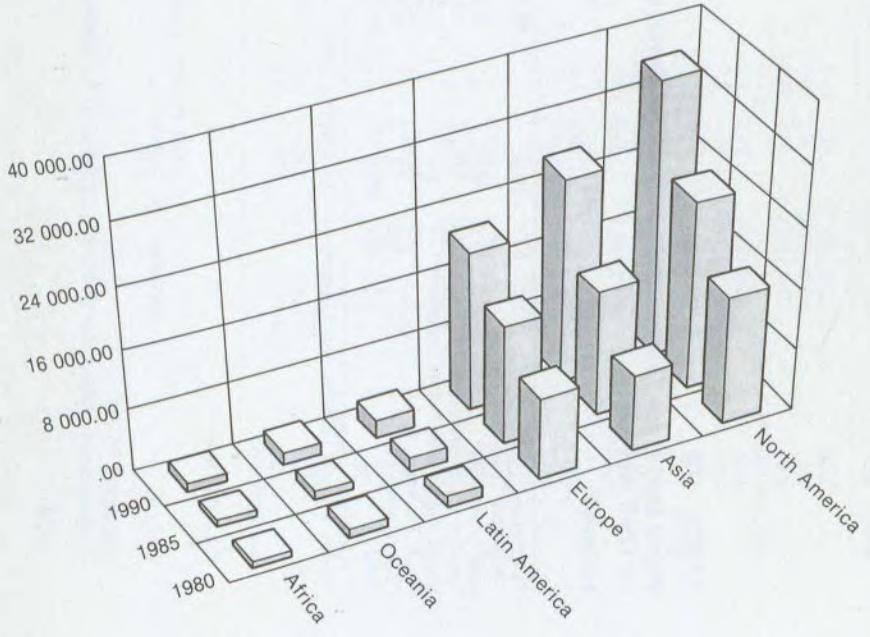


TABLE II.3

World Market for Telecommunications Equipment, by Equipment Category (in US $ million)

Categories	1980		1985		1990		Average Annual Growth Rate	
	$	%	$	%	$	%	1980-1985	1986-1990
Telephone	32.7	81.3	49.2	81.0	70.6	80.3	8.4%	8%
Telegraph, Telex and data processing	4.0	10.0	6.6	10.9	10.3	11.7	10.0%	9%
Satellite Communications	0.4	1.0	0.7	1.1	1.1	1.2	14.2%	10%
Mobile Radio and Radio-Telephone	2.7	6.7	3.8	6.3	5.2	5.9	7.1%	6%
Radio Paging	0.1	0.2	0.1	0.2	0.2	0.2	11.0%	8%
Cable Television	0.3	0.7	0.3	0.5	0.5	0.6	7.7%	8%
Total	**40.2**	**100.0**	**60.7**	**100.0**	**87.9**	**100.0**	**8.5%**	**8%**

Source: Arthur D. Little Inc., *World Telecommunications Survey II, 1980.*

TABLE II.4

Telecommunications Systems Market Forecasts by Major Geographical Region (in US $ million)

Region	Telephone		Telegraph Telex & Data		Satellite communications		Mobile-radio & Radio-telephone		Radio Paging		Cable Television		Total	
US $ (000,000)	$	%	$	%	$	%	$	%	$	%	$	%	$	%
North America														
1980	12,638.2	74.3	2,481.4	14.6	122.9	0.7	1,496.2	8.8	33.4	0.2	228.7	1.3	17,000.8	100%
1985	18,714.3	74.9	3,823.9	15.3	290.4	1.1	1,779.2	7.1	44.4	0.2	318.9	1.3	24,971.1	100%
1990	26,504.6	74.2	6,000.5	16.8	463.7	1.3	2,299.4	6.4	55.8	0.2	391.5	1.1	35,715.5	100%
Asia (incl. USSR)														
1980	8,687.5	86.7	636.5	6.3	122.5	1.2	560.8	5.6	14.5	0.1	0.5	-	10,022.3	100%
1985	14,338.4	85.7	1,157.0	6.9	237.6	1.4	985.7	5.9	19.5	0.1	1.1	-	16,739.3	100%
1990	23,069.1	85.9	1,934.2	7.2	374.2	1.4	1,434.6	5.3	23.1	-	1.6	-	26,836.8	100%
Europe														
1980	9,465.7	87.3	739.9	6.8	59.0	0.5	539.5	5.0	28.7	0.2	15.2	0.1	10,848.0	100%
1985	13,243.9	84.7	1,322.3	8.5	111.4	0.7	854.7	5.5	63.9	0.4	29.5	0.2	15,626.7	100%
1990	17,117.1	82.1	2,015.6	9.7	189.4	0.9	1,297.9	6.2	106.5	0.5	123.1	0.6	20,849.6	100%
Latin America														
1980	978.0	83.4	104.9	9.0	14.2	1.2	70.4	6.0	3.5	0.3	1.7	0.1	1,172.7	100%
1985	1,524.1	84.5	144.3	8.0	14.6	0.8	111.9	6.2	6.8	0.4	2.6	0.1	1,804.3	100%
1990	2,010.4	84.1	186.4	7.8	34.0	1.4	145.3	6.1	10.6	0.4	4.0	0.2	2,390.7	100%
Oceania														
1980	654.2	86.8	33.3	4.4	43.1	5.7	23.0	3.0	0.1	-	-	-	753.7	100%
1985	913.6	87.8	46.6	5.6	48.1	4.6	32.4	3.1	0.1	-	-	-	1,040.9	100%
1990	1,270.3	87.9	79.2	5.5	51.5	8.5	44.4	3.0	0.2	-	-	-	1,445.6	100%
Africa														
1980	313.5	81.4	48.3	12.6	3.2	0.8	20.0	5.2	-	-	-	-	385.0	100%
1985	457.4	82.3	66.7	12.0	5.6	1.0	25.7	4.6	0.1	-	-	-	555.5	100%
1990	689.6	82.1	97.0	11.6	10.5	1.3	42.3	5.0	0.2	-	-	-	839.6	100%
World ($ Billion)														
1980	32.7	81.7	4.0	10.0	0.4	1.0	2.7	6.7	0.1	0.2	0.3	0.7	40.2	100%
1985	49.2	81.0	6.6	10.9	0.7	1.1	3.8	6.3	0.1	0.2	0.3	0.5	60.7	100%
1990	70.6	80.3	10.3	11.7	1.1	1.2	5.2	5.9	0.2	0.2	0.5	0.6	87.9	100%

Source: Arthur D. Little Inc., *World Telecommunications Survey II*, 1980.

Major Characteristics of the Technological Evolution, and through construction of a country/systems matrix.

OECD forecasts confirm, on the world scene, the same stable pattern by major product lines between 1980 and 1985:

Total sales	**1980** **100%**	**1985** **100%**
Switching Equipment	31.1%	31.7%
Transmission Equipment	30.2%	30.0%
Terminal Equipment	14.3%	13.8%
Private Plant	10.6%	11.0%
Mobile Radio Transmission Apparatus	9.4%	8.5%
Miscellaneous	1.8%	5.0%

Source: OECD, *Telecommunications Equipment Industry Study*, DSTI/IND/81.28, p.27.

Table II.4 shows the trends for equipment that should be purchased in the major geographical regions between 1980 and 1990. It enables us to draw the following conclusions:

- except in North America, where they account for only 75% of the total, traditional telephone systems represent over 80% of the market;
- telegraph and telex markets are in second place throughout the world, with a higher than world average share (about 15% to 17%, and 12%, respectively) in North America and Africa, two regions where Siemens, the world leader, is very active;
- North America is the leader for all systems;
- radio paging and cable television systems have significant markets in only three regions: North America, Europe and Latin America.

Section 4.1 of Chapter 4, *National Strategic Perspectives*, provides data on the major countries of various regions of the world.

II.4 Major Trends in the Technological Evolution of Telecommunications

The speed and number of technological changes in the telecommunications field make it difficult to classify its products and clarify its boundaries. On the one hand, new technologies and products are applied in areas other

than telecommunications *per se*, while on the other, the era of development chain strategies[30] leads manufacturers to develop products in related fields and to think in terms of integrated systems in previously unrelated markets.

The classic distinction made between the three major telecommunications equipment categories — transmission equipment, switching equipment and terminals — tends to blur, as one can see from new switching systems and modern terminals. Today, using the Stored Program Control (SPC[g]) technology, new switching systems incorporate computers to control their functions. Switching elements in new word processing equipment give it the capacity to communicate with computers or other terminals through public or private data communications networks, as in the case of electronic mail[g]. It is therefore useful to examine new technological trends in the three major categories, keeping in mind the fact that they are related more closely to the electronics industry as a whole than to the telecommunications industry in particular.

Another way to examine this industry is to examine various telecommunications systems, as summarized in Table II.5 below.

TABLE II.5

Telecommunications Systems	Equipment and Functions
Telephone	- Station apparatus - Local transmission and switching - Long-distance transmission and switching
Telegraph, Telex and Data Communications	- Telegraph station apparatus - Telex station apparatus - Data communications - Telecopy station apparatus - Electronic mail system station apparatus - Transmission and switching
Mobile Radio and Radio Telephone	- Base stations - Mobile units
Satellite Communications	- Satellite and control facilities - Earth stations
Radio Paging Systems	- Base stations - Paging receivers
Cable Television	- Terminals - Transmission - Head-end

Source: Arthur D. Little, Inc., *World Telecommunications Study II*, 1980. Volume I, p.4.

Here again, the technological evolution tends to make such classification outdated. For example, the new private branch exchange (PBX[s]) systems can combine voice and data switching using the same general-purpose processor . Northern Telecom's launching of various SL series products (SL-1, SL-100, ESN) and of the Displayphone (an integrated telephone and data/graphics display terminal[s 31]), in February 1981, illustrates how boundaries between various telecommunications systems are being removed.

This removal of boundaries is not occurring in the telecommunications field alone, but also in various, sometimes unrelated, fields of applied electronics. Firms that began as computing equipment manufacturers are now entering the telecommunications field; conversely, telecommunications equipment firms are becoming involved in electronic office equipment markets. One example is Fujitsu, the Japanese firm[32], and another is Northern Telecom, with its shared data processing systems[s] (models 585, 503, 445) and word processing systems (Omniword, IRIS). These activities flow from the development chain strategies explained earlier. The evolution toward integrated systems is leading telecommunications equipment manufacturers to deal with forms of competition bound to extend well beyond their traditional sphere of activity. The most obvious sign of this phenomenon is in the office-of-the-future market, in which the "natural" suppliers, such as computer, photocopying, word processing and general office equipment manufacturers, but also telecommunications equipment and photographic equipment firms are all in competition with one another. It is therefore not surprising that, to give only a few examples, Mitel, Northern Telecom, Rolm, Philips, Olivetti, IBM, Wang, Xerox, Canon and probably Kodak, are vying for control of the office-of-the-future market. The consequences of this broader based competition on extended markets once again raise the issue of traditional marketing strategies. In the future, the choice of products and markets will be increasingly determined by the ability of firms to absorb new technologies and adapt their commercial structures and strategies to the needs of new markets.

The "market" concept itself is at issue here. Henceforth, solutions to the problem of long-term expansion must obviously be sought in the strategic orientation of research and development activities toward growing markets. Certain firms or countries will find short-term solutions in the maintenance or construction of solid foundations for their development. Because of the enormous R & D costs and the pervasiveness of international competition, an "internationalist" perspective is clearly required.

The impact of technological changes on the telecommunications industry in the 1980s can be observed mainly in:

- the convergence of technologies (of which the office-of-the-future is the first sign);
- the semiconductor and integrated circuit revolution;

- the move from analog to digital techniques;
- the advent of fibre optics[8].

Satellite telecommunications technology will experience the strongest relative growth in the 1980s (see Table II.3), but its role in the overall telecommunications market will remain modest (around 1% of the total market value). For this reason, no further consideration will be given here to this particular sector of telecommunications.

Convergence of Technologies

As previously mentioned, the office-of-the-future field is an example of this convergence. It is examined in greater detail in the appendix.

Underlying current developments in the office-of-the-future market, the concept of development chain strategies is analyzed further in Chapter III. In this respect, Fujitsu, IBM or AT&T are certainly cases in point. The industrial logic which supports this concept is not unique to the telecommunications industry. Examination of its impact on telecommunications can therefore not be dissociated from an overall economic analysis of sectors related to telecommunications, such as data processing, and less similar sectors which nevertheless use technologies and products developed by firms in the telecommunications sector, examples being manufacturers of photographic equipment, T.V. sets, tape recorders, other audio-visual equipment, etc. for the general public. These considerations are beyond the scope of this study, but are mentioned here to serve as a point of reference for the strategic reflection we hope to encourage through this research. A more detailed analysis of these elements is contained in Chapter III.

Semiconductors and Integrated Circuits

Over the past 20 years, semiconductor technology, especially the large-scale integrated (LSI[8]) circuit, has revolutionized the electronics industry. Consequently, the price per circuit function has decreased steadily, while the number of functions in a single chip[8] has increased, thus reducing circuit size, power consumption and interconnection requirements. According to current industry projections, LSI circuits and memories will cost about 1% of their present cost per function by the end of the century.

Microprocessors will follow the same trends. As a result, digital techniques will dominate all telecommunications equipment switching and transmission functions[33].

From Analog to Digital Techniques

Digital technology pervades all classes of telecommunications and electronics equipment.

In transmission equipment, digitally-transmitted voice signals can be regenerated by eliminating distortions usually caused by distance. Transmission equipment is increasingly using electronic elements. The electronic telephone of the future will have a speech network, dual tone multi-frequency (DTMF) dialing generator and loop supervision circuits, all using integrated circuit chips. It will result in lower costs and improvements such as repertory dialing with automatic re-dial of last number, telephone answering, message recording, recorded announcements, call timing, security alarm and key functions such as pick up, hold, intercom and exclusion.

The impact of digital technology on data processing and transmission equipment is already being felt in the potential demand for new services such as electronic mail, electronic funds transfers, cathode ray tubes* and access to data banks and public computer services.

Custom LSI devices are now present in all modern transmission equipment, such as pulse-code modulation systems*, analog/digital code converters*, modems*, codecs* and multiplexers*.

Switching

In this field, where digital technology is expanding rapidly in developed countries, wired logic, as found in the earlier electronic switching systems, is now being gradually replaced by stored program control switching systems. Although initially only large exchanges used SPC, the growth of minicomputers and microprocessors caused a rapid decline in the size of switches, thus making SPC systems competitive with other non-computerized control systems.

In digital switching systems, connections are set up between ports of the switch by switching elements that handle the voice (or data, facsimile, etc.) signal in digital form only. The combined advances of PCM and SPC technologies have given rise to integrated digital networks* using both digital transmission and digital switching. This new concept of integrated systems is receiving considerable attention because of the theoretically lower installation and operation costs that are expected through this for large telephone networks.

Terminals

A terminal is the human user's physical point of interface with the data communications system. Digital technology affects all types of terminals used in public data communications: keyboard/printer terminals*, cathode ray tube display terminals*, bank teller terminals*, remote batch terminals*, word processors, graphics terminals*, etc.

For example, keyboards were originally electromechanical. Today, they are primarily electronic, with microprocessors that give them new capabili-

ties. The "intelligent" terminal era (terminals with the capacity to carry out increasingly complex functions thanks to the incorporation of microprocessors, memories and computer power) has arrived with the appearance on the market of sophisticated equipment first intended for business users, for example Northern Telecom's Displayphone or AES's Alphaplus®. However, they might become an everyday fixture for consumers in the late 1980s, thanks to the development of videotex systems® or kindred products like Telidon®, Teletel®, Prestel® or Vista®, for example.

Fibre Optics

Although investment and experiments in the use of fibre optics as a transmission medium increased in the early 1980s, we will be unable to measure the full scope of their effect before the end of the decade, and they will not be in general use until the end of the century[34].

Fibre optic cables certainly present enormous potential in terms of transmission capabilities[35], immunity to electromagnetic interference and crosstalk. They also need less repeaters. With the opportunities that digital transmission offers in routing voice signals®, video signals® and computer data® on the same network, fibre optic systems, because of their versatility and great capacity also appear to be the best mode of transmission for the growing needs of integrated telecommunications networks. However, the second generation of optic systems, which would directly help double the transmission capabilities of current optics systems and lower the fibre cost to around 15¢ or less per metre, will not be marketed before 1985.

CHAPTER III

Structural Aspects: The World Telecommunications Organization

Demand for telecommunications equipment derives only from demand for telecommunications services. As a result, the structural characteristics the latter industry as well as the institutional form that regulates it, cannot fail to exert a major influence upon those of the equipment manufacturing sector.

It is difficult to find a unique pattern that would apply to all situations in the way the telecommunications industry is organized. Nor can we find, strictly speaking, an international industrial order for telecommunications that would apply all over the world. On the other hand, it may be of interest to highlight those structural features that appear to be identical in most countries, if one wishes to determine to what extent they have influenced—sometimes in very different ways—the institutional organization of the telecommunications sector in various countries.

III.1 Structural Characteristics of the Telecommunications Industry

III.1.1 Public Service Common Carriers

Whatever the institutional form in effect, the situation in the telecommunications services market is characterized by the awarding of geographical monopolies to common carriers of public services, whether regulated private businesses or government monopolies. In Canada, as in the United States, the first type of institutional organization generally prevails. Except for Alberta, Manitoba and Saskatchewan, which have preferred the government solution to the regulation of private businesses, most telecommunica-

tions services are provided by more than 300 private telephone companies, the largest of which, Bell Canada, controls over 60% of Canadian telephones.

Except for Bell Canada, B.C. Tel[36], Manitoba Telephone System (MTS) and CNCP, each of which has a federal charter and is under the jurisdiction of the Canadian Radio-Television and Telecommunications Commission (CRTC), most of these private companies are incorporated provincially and are usually regulated by the public utilities board or commission, or public service regulatory body of their province.

In most other Western countries, telecommunications services are provided either directly by a government agency (British Post Office Corporation in the United Kingdom, Administration des Postes, Télécommunications et Télédiffusion in France, Deutsche Bundespost in West Germany) or by public corporations under government control (Italy's state-owned SIP).

Whether the public services concession is held by a private corporation or a state-owned monopoly, the operating institution exerts a major influence on the characteristics of the production sector, both in terms of the technical specifications of the equipment provided by national producers and in terms of the direction given to research and development efforts. There is often close cooperation, as in Japan or France, or integration, as in the case of Bell-Northern Research laboratories. Thirdly, there is industrial concentration or redeployment of the telecommunications manufacturing industry, as exemplified in France by groups such as Thompson-CSF or CGE-CIT-Alcatel.

III.1.2 The Telecommunications Manufacturing Sector

The major characteristic of this sector is a high degree of corporate concentration. Already visible internationally, where four firms (Western Electric, ITT, Siemens and Ericsson) represent more than half the world

TABLE III.1

Concentration Ratios in the Telecommunications Equipment Production Sector

	Concentration Ratio (*)	Year
Germany	90	1976
Italy	90	1976
Sweden	90	1976
United States	90	1978
Canada	85	1978
United Kingdom	85	1976
France	76	1977

(*) Percentage of domestic demand met by the four largest firms.

Source: OECD, *Telecommunications Equipment Industry Study*, DSTI/IND/81.28, p.27.

market, this concentration is also to be found nationally, where, generally speaking, the four largest firms share over 70% of the market (see Table III.1).

A logical result of this situation should be a fairly high cost of entry into these markets. However, the three principal barriers to entry — economies of scale, the monopsonistic position [37] of the equipment purchaser and the high cost of research and development — tend to diminish over time under the influence of upheavals or changes affecting the electronics industry. The speed of technological change enables newcomers with aggressive marketing techniques to find a place in very specific segments of the market. Such is the case for Mitel and Micom for certain products. By developing their efforts in private telephone markets, such companies could one day conceivably become major suppliers of equipment for public systems.

It is not surprising, then, that the monopsonistic position generally occupied by the chosen common carrier or by the government agency responsible for telecommunications services is the cause of the concentration among equipment manufacturers. Both for technical reasons of system specificity and, in the case of a regulated monopoly [38], for economic reasons, procurement policies tend to shelter these privileged manufacturers from both domestic and foreign competition.

As a result of the private nature of demand for telecommunications equipment, concentration in the United States and Canada shows a trend toward vertical integration for the dominant carriers (AT & T in the United States and Bell Canada in Canada), which thus provide their equipment-manufacturing subsidiaries with the opportunity to sell a substantial proportion of their output without having to face any real competition from domestic firms [39]. On the other hand, the governments of most European countries and Japan have, through a policy of more or less explicit quotas, reserved their purchases for a small group of national manufacturers that are assured of their share of the market in their respective segment.

The Canadian experience of vertical integration between Bell Canada and Northern Telecom demonstrates that there are some not inconsiderable benefits to be had as well. Even if this may be argued, by guaranteeing a market for products resulting from the research conducted by Bell-Northern Research, Bell Canada has given Northern Telecom the opportunity to gain a prominent position in the international telecommunications computer hardware market. This reasoning clearly applies to the case of Siemens in Germany and to that of the major Japanese suppliers. However, the entry barrier represented by a major supplier or by dominant oligopolies in national markets tends to break down under the double influence of deregulation (and political pressures) and technical change. AT & T's restructuring following the 1980 FCC decision [40] in the United States to free the terminal equipment market, the hopes and prospects of a gradual, yet very slow in effect, opening of the Japanese market to foreign suppliers [41], the decision of certain countries

to speed up construction of modern systems and gain access to the most advanced technologies (for example, the French program to modernize and extend the national telephone system since 1979[42]) are all events that could profoundly change the competitive climate by theoretically enabling newcomers to enter traditionally protected markets.

An essential determinant of competitiveness in international markets, is research and development. Costs and the need for on-going efforts make R & D an imposing barrier for firms wishing to penetrate the market and remain competitive. Here again, chosen instruments (common carriers) generally play a major role, whether it be Bell Laboratories and Western Electric in the United States, Bell-Northern in Canada, the Centre National d'Étude des Télécommunications (CNET) in France or the sixteen research centres of the Nippon Telegraph and Telephone Public Corporation (Electrical Communications Laboratory[43]).

Three major reasons account for the role awarded to such entities: the desire to strengthen the country's technological capacity in the case of state-owned public services, the monopsonistic position of the public service common carriers[44], and major financing needs resulting from the need to invest in basic research. The Canadian example of Mitel shows, however, that having a privileged link is not an indispensable condition to success in national or international markets. Such success of course requires a high degree of specialization (private exchanges [PBX], such as SX-200, SX-100, SX-20, and SX-10 for Mitel) and also government support, but it indicates that vertical integration in the telecommunications sector is not an absolutely indispensable factor for profitable R & D activities.

III.1.3 Prospects for Structural Changes in the Telecommunications Market

The progressive lowering of entry barriers in the telecommunications sector is the major characteristic of this sector from the point of view of industrial analysis. This lowering is essentially due to the acceleration of technical progress that has produced the spontaneous emergence of new markets, decompartmentalized old markets and forced public authorities to take steps to encourage competition in the telecommunications equipment market.

The impact of technical progress on the level of entry barriers is to be found in each of the three components of telecommunications systems. Thus, in switching, where the technology (which requires a thorough knowledge of the system peculiar to a particular network) has been a major barrier to entry, the computerization of control centres and the move to digital technology

have considerably increased the flexibility of switching systems. The modular character of stored program control systems (SPC) helps adapt the systems developed for a particular network to the technical characteristics of other networks. Thus, the protection enjoyed by domestic producers, who alone possess intimate knowledge of their network, tends to fade from the moment that technology helps introduce a certain degree of interchangeability between separate networks, and thus a degree of equipment compatibility. Moreover, the move to electronic switching tends more and more to involve manufacturers of computer hardware in the telecommunications sector. Thus, not only must firms in this sector face foreign competition, they must also expect to see computer firms begin to penetrate a market hitherto reserved for them. Finally, given the increasing importance of semiconductors for switching hardware, we may also expect the entry of semiconductor producers into the telecommunications equipment market.

All these factors, in addition to the high costs of R & D (which oblige firms to spread their fixed R & D costs over larger markets and thus to implement aggressive export policies), can only work in favour of increasingly broad liberalization of the switching equipment field. In the transmission field, emergence of new technologies has encouraged the entry of producers who have not traditionally operated in this segment of the market: short-wave radio transmission has gradually supplanted transmission by coaxial cables over long distances and encouraged radio equipment manufacturers (Rockwell International in the United States, Philips in Europe) to compete against traditional transmissions equipment manufacturers (copper wire producers); the rapid development of satellite transmissions — which still represent only four percent of expenditures for long-distance transmissions — has caused manufacturers from the aeronautics industry to enter the market; and finally, transmission by fibre optics, which is bound to develop very rapidly in the next decade (from $50 million in 1980, production will increase to $1,000 million in the United States by 1990), will encourage glass producers (Corning Glass, Saint Gobain) and firms specializing in the laser market (lasers with light-emitting diodes — LED — one of the two types of materials used to transmit signals through fibre optics) to penetrate the transmission equipment market.

Finally, in the terminals field, one of the major characteristics of the market in recent years has been the rapid growth of private demand as compared to demand from telecommunications carriers both private and public. This growth reflects increased demand for information by both private firms and individuals.

Progress in electronics is also the basis of the rapid extension of private exchanges (PBX), which today can automatically provide many services to private business (surveillance and control of calls, thus minimizing a firm's

communications costs, rerouting or automatic hold of incoming calls, optimal routing of calls, automatic call distribution, rapid dialing, etc.). Lastly, electronics has also fostered the rapid development of terminals used to transmit images and texts: codification and digital transmission have greatly improved the quality and reduced the time required for reproduction, whereas digital technology is about to revolutionize the field of text transmission (Telidon, Teletel, Prestel).

Through the almost universal application of electronics to terminals, technological progress has enabled private users (firms and individuals) to benefit from a broader range of services. Under this pressure on the part of private demand, the trend is toward liberalizing the terminals market: while the United States, Canada and Japan have released a great deal of terminal equipment, other countries (Great Britain, Sweden) are at present only exploring the problem. It is clear, however, that the existence of increasingly varied private demand can only accentuate competitive pressure in the market for terminals and encourage governments to move toward progressive deregulation.

The technological progress achieved in terminal equipment tends to modify the structure of this market considerably. In a first phase, only small, highly specialized firms meeting a very specific demand entered the terminal equipment market; however, we are today witnessing the entry of large firms operating in industries that, in the medium or long term, will be affected by technological developments in terminals. Thus, computer manufacturers (IBM, for example) are getting into the private automatic exchange[s] market (PABX[s]) while penetrating the office-of-the-future field; office equipment manufacturers are jumping into the minicomputer market; and telecommunications equipment manufacturers are also becoming increasingly interested.

In conclusion, accelerated progress has, by various means, lowered entry barriers to each of the three major markets (switching, transmission and terminal equipment) in the telecommunications sector. The effect of this has been to encourage competition, particularly in the private equipment market (firms and individuals), and to bring into the market telecommunications equipment from non-traditional producers whose fields are or will be affected by technological progress in the telecommunications sector. The trend for companies like IBM or Xerox to develop integrated digital systems for multipurpose transmission (voice, data, text, image), mainly with large private buyers in mind, is the most recent manifestation of this phenomenon. With the rapid development of the telecommunications sector, the need to formulate a strategy of specialization becomes a pressing necessity, both for individual firms and on the national level. Therefore, we shall now consider the problem of strategies, first in international terms (problems associated with the dynamics of international specialization), and then in sectoral terms (development chain strategy), both being viewed in a dynamic perspective.

III.2 Strategic Behavior: The Dynamics of International Specialization and the Development Chain Strategy

III.2.1 The Dynamics of International Specialization

The progressive disappearance of traditional trade barriers has created a need to redefine the nature and scope of markets.

The emergence of the office automation market demonstrates the value of studying the evolution of markets. The question is not whether this evolution is caused by changes in the content of equipment supplied by producers or, in the opposite, by changes in the requirements expressed by buyers. This distinction is of theoretical interest to the extent that the telecommunications market in developed countries is characterized by a close symbiosis between the production sector and companies operating in the field. In these countries, the market must be seen as a complete system in which it is more important to unveil the nature of relationships between the various economic agents and the relevant factors of change than to dwell on the convenient, but today increasingly artificial, classification between the supply and demand sectors. Deregulation in the United States has today made AT & T a flagrant example in which the buyer (Bell System) is no longer confined to its traditional role but has prospects that through the action of subsidiaries[45], will make it an active supply agent in the traditional sense of the term. Studies conducted by the firm of Solomon Brothers and researchers of Harvard University on the convergence of strategies in the information field[46] confirm this analysis. We shall return to this subject in the section on development chain strategies.

However, the distinction between supply and demand in telecommunications equipment is still of interest in the case of Third World countries that do not have local manufacture, even though structural changes take place in a certain number of these cases (Brazil and Mexico, for example, which are attempting to develop domestic production). For this reason, analysis of these countries may be conducted in a more conventional manner and focus on the direct competitors-products-markets triptych, as may be found in the first part of Chapter IV.

The need to redefine the scope of markets is merely the consequence of the global market phenomenon already discussed in Chapter I and above. Market growth resulting from the disappearance of traditional trade barriers

leads to specialization. Competitiveness develops more and more through the conquest of critical portions of the market, a major effect of which is a higher degree of *accumulated experience* permitting lower costs and, invariably, additional shares of the market. Ensuing profits allow higher technical and business investment and maintain technological innovation, modernization of the manufacturing base and its productivity. This "virtuous circle" of competitiveness, well known in business quarters, spreads throughout the country: thus, it is no longer only firms but entire nations that acquire a *dominant world position* in certain sectors. The case of Japan in the electronics field is an edifying example of cooperation by government, universities, banks and business at the international level[47]. The worldwide growth of markets has beyond any doubt also increased the number of opportunities for concentration: the search for size and technical optima, position or power play a larger role than in domestic markets[48]. Large world industrial sectors are thus becoming dominated by oligopolies. Scarcely ten firms control the world computer market, a market all the more interesting and promising because of its links with the future of the communications society. It is certainly not strange to see a growing interdependence of computers and telecommunications in this sector. IBM is investing in satellites and AT & T and ITT are interested in data processing. The multinationalization and specialization of industry is the result of a series of converging causes typical of the current world economy. In the dynamic perspective of this new international order, the manner in which firms react to world competition must be noted: to protect their market share against inroads from international competition, purely domestic firms may have to go the route of offshore production.

Germany has seized the largest share of export markets in the mechanical and electrical equipment sectors, and the United States has concentrated on high technology (computer, aeronautics, space, the nuclear field, telecommunications, armaments) and in the agro-industrial sector. Japan has oriented its industrial strategy toward market specialization in the iron and steel industry, primary steel processing, ship-building and the mass production of durable consumer goods (automobile, electronic products for the general public). But Canada also appears to have its own assets in high technology with firms such as Northern Telecom and Mitel in telecommunications, and achievements such as Candu reactors and Canadair aircraft. Nevertheless, Canada does not seem to have the mechanisms for international specialization that have helped these other countries in certain sectors. Is Canada truly engaged in this specialization process which has proven its value in the case of other large industrialized countries?

Examination of the changing trends in a number of the analytical specialization indicators for selected Canadian industries helps in answering this question.

III.2.2. Analysis of the Evolution of International Specialization in Selected Canadian High Technology Industries

From a determinist viewpoint, a country's specialization principally reflects that country's production resources and is to be seen in the difference between its production structure and the structure of its domestic demand. This concept, which is used to explain the international division of labour, and is based on the theory of comparative costs, is not adapted to the rapidly developing world in which we have been living since the end of the Second World War. Furthermore, this theory makes sense only in the case of free markets. The world telecommunications market, however, is very far from being what we might call free. Government influence through regulation and the direct involvement of public authorities in telecommunications make this theory impracticable in Canada. On the other hand, certain telecommunications equipment products are also sold on private markets and are thus less influenced by government intervention. This is also the case for the six related industrial branches selected for this analysis of the Canadian situation: manufacturing of electrical products, small electrical appliances, telecommunications equipment, industrial electrical equipment, electrical wiring and cables and miscellaneous electrical products.

a) Conceptual Framework

The need for a dynamic analysis allowing for both technical progress and changes in world demand is to be reminded here. However, as Gérard Lafay has pointed it out[49], adoption of a dynamic viewpoint does not imply absolute rejection of the role played by production factors in any explanation of the international division of labour. The dynamic approach only makes the limitative role of certain factors relative by placing them in a time frame in which the decision-maker (public or private) has some freedom of action in formulating his strategy (industrial or corporate). This freedom of action may of course vary greatly from one firm or industry to the next: thus, physical constraints certainly play a greater role in decisions relating to the location of extraction industries than in those concerning the electronics industry, for example.

Not every dynamic process of specialization is necessarily the result of a strategic decision; it may at times be the product of a series of fortuitous events. However, a number of indicators may be used to assess this process. These indicators help us follow the evolution of the specialization process and, in the absence of information on the strategy adopted, to infer the type of implicit strategy followed by the firm or industry analysed.

b) Choosing Analytical Specialization Indicators

Of the indicators used to understand, in quantitative terms, the evolution of a country's international specialization, those that take into account the

country's internal variables (domestic production and consumption, etc) and international trade flows (exports and imports) are the most reliable. We shall retain the rates of *self-sufficiency*, of *penetration*, and of *export*.

The *rate of self-sufficiency* (or absolute rate of commitment) defined as the ratio of domestic production to apparent domestic market[50] can be used to measure the proportion of domestic needs met by domestic production. As noted by the authors of the Statement of the Industrial Policy Committee to the Science Council of Canada (1981), the market self-sufficiency rate is a major indicator of an industry's success. Any insufficiency of domestic production vis-à-vis domestic demand opens the door to foreign exporters who, according to the dynamics of international specialization, will not hesitate to implement strategies for penetrating the domestic market.

The *rate of penetration* (ratio of imports to apparent domestic market) indicates the extent to which foreign competitors effectively exploit these opportunities to penetrate the domestic market. A growth trend in this rate for a product or family of products may result from a number of factors: a deliberate withdrawal policy, a lowering of customs barriers, loss of competitiveness, etc.

Finally, the *export rate* (ratio of exports to domestic production in a sector) measures the degree to which an industry is open to foreign markets. This may also vary from one sector or product to the next for a number of reasons: privileged dealings between a company and its subsidiary, a narrow domestic market insufficient for the economies of scale needed to lower production costs.

These three analytical indicators will help us follow the evolution of the specialization process and determine the specialization strategy it implicitly reflects. Although the following analysis is of a fairly high agregate level (Statistics Canada's four-figure classification code for economic activities), it helps provide an overview of the dynamic specialization process in which certain high technology industries are engaged, including the telecommunications equipment manufacturing industry.

c) Choosing Branches for Analysis

In general, the research and development efforts serve as a criterion for differentiating high technology industries from other industries.

The indicator for measuring the concentration of R & D efforts in a given industrial branch may be expressed as a percentage of the sales figure that the branch devotes to R & D activities. Thus we generally have the following figures:

- high technology industries: greater than 7%;
- intermediate technology industries: between 2% and 7%;
- low technology industries: less than 2%.

According to the data gathered, the six branches under study belong to the first category. They were studied over a 15-year period (1966-1980).

TABLE III.2

Evolution of Canada's Three International Specialization Indicators (Self-Sufficiency, Export, and Penetration Rates) for the Six Industrial Branches Analyzed (1966-1980).

- Industrial branches according to Statistics Canada's Economic Activity Code -

Years	Electrical products =5160000 Self-sufficiency	Export	Penetration	Small Electrical Appliances =5163310 Self-sufficiency	Export	Penetration
1966	86.0	9.2	21.9	72.9	4.0	30.0
1967	86.7	10.3	22.3	74.0	4.9	29.6
1968	88.8	13.3	23.0	74.0	3.6	28.7
1969	85.5	13.3	25.9	71.3	4.7	32.1
1970	88.7	15.8	25.3	71.6	3.9	31.2
1971	83.9	13.3	27.3	68.5	2.9	33.5
1972	79.9	13.0	30.5	66.1	3.4	36.1
1973	78.9	15.1	32.2	66.2	5.3	37.3
1974	78.7	15.4	32.5	64.8	8.2	40.5
1975	80.4	13.5	30.4	62.2	7.8	42.6
1976	76.4	14.3	34.5	53.8	5.4	49.1
1977	74.1	14.7	36.8	52.4	5.1	50.3
1978	74.0	17.9	39.3	47.7	4.6	54.5
1979	75.3	20.5	40.2	48.7	6.7	54.6
1980	77.3	22.2	39.8	43.4	7.6	59.9

Years	Telecommunications Equipment =5163350 Self-sufficiency	Export	Penetration	Industrial Electrical Equipment =5163360 Self-sufficiency	Export	Penetration
1966	80.1	16.3	33.0	83.1	7.5	23.1
1967	85.2	17.1	29.3	83.7	10.1	24.3
1968	93.3	24.1	29.2	85.1	10.6	24.0
1969	88.9	23.6	32.1	80.2	9.5	27.5
1970	94.5	27.9	31.8	82.3	9.1	25.2
1971	86.9	28.0	37.4	77.4	8.8	29.4
1972	79.8	25.0	40.1	77.1	9.4	30.1
1973	78.8	29.9	44.7	75.5	8.5	30.9
1974	81.6	25.9	39.5	77.9	11.4	31.0
1975	86.5	23.5	33.8	77.0	10.8	31.3
1976	82.8	26.1	38.8	78.4	10.6	29.9
1977	77.2	24.0	41.2	76.6	9.3	30.5
1978	76.2	29.9	46.6	74.0	10.8	34.0
1979	74.8	33.6	50.3	75.7	15.6	36.1
1980	78.6	40.1	52.9	80.1	14.1	31.2

Years	Electrical Wires and Cables =5163380 Self-sufficiency	Export	Penetration	Miscellaneous Electrical Products=5163390 Self-sufficiency	Export	Penetration
1966	103.1	6.9	4.0	87.8	5.0	16.6
1967	102.4	7.0	4.8	87.5	5.5	17.4
1968	104.3	8.1	4.2	87.8	5.9	17.5
1969	103.8	9.0	5.5	85.7	6.5	19.9
1970	114.6	16.1	3.9	81.2	10.9	27.6
1971	104.1	8.1	4.3	85.0	9.7	23.2
1972	104.3	9.2	5.2	82.9	10.2	25.5
1973	99.5	5.3	5.8	81.1	11.3	28.1
1974	98.5	5.0	6.4	78.7	11.4	30.3
1975	97.4	5.0	7.5	79.2	11.4	29.8
1976	97.0	3.8	6.7	75.9	13.2	34.1
1977	96.9	5.8	8.7	73.9	15.0	37.2
1978	99.5	7.0	7.5	77.8	17.0	35.4
1979	98.6	7.6	8.9	78.3	17.3	35.3
1980	99.9	9.2	9.3	78.4	15.6	33.9

Source: *Manufacturing Trade and Measures, 1966-1980*, Economic Intelligence Branch, Department of Industry, Trade and Commerce, Ottawa, July, 1981.

d) Results of the Analysis for Canada

For the entire electrical products manufacturing sector, analysis of the three indicators conducted on the basis of data contained in *Manufacturing Trade and Measures: 1966-1980* (Economic Intelligence Branch, Department of Industry, Trade and Commerce, Ottawa, July 1981) appears to indicate a recent reversal of the trend reported in the Clyne Report[51]. While the trend until 1977 was that of stagnation in the rate of exports, this rate has suddenly risen in the last few years to over 22% in 1980. With regard to penetration and self-sufficiency rates, the Canadian situation appears to have improved in the past two years, the former having stabilized at around 40% after constantly rising since 1968, the second standing at over 85% between 1966 and 1970, then dropping until 1979, when it slowly started again to progress, reaching today around 77%.

Of course, this overall situation tends to hide the marked differences between the various sub-sectors of the electrical products manufacturing sector. The small electrical appliance manufacturing sub-sector witnessed a continuous and marked decline in its self-sufficiency rate between 1966 and 1980 (from 72.9% in 1966 to 43.4% in 1980) and sustained growth in its rate of penetration (from 30% in 1966 to 59.9% in 1980). The change in these two rates suggests the existence of an implicit withdrawal policy for this sub-sector. The export rate is characterized by erratic variations indicating no definite trend other than the fact that the rate remains low (less than 8% over the period).

We should note two interesting facts with regard to the sub-sector in which we have a particular interest, the telecommunications equipment manufacturing sub-sector: first, *the rapid growth of the export rate since 1977* (on average, 26% from 1968 to 1976, an increase beginning in 1977, then over 40% in 1980) and, secondly, *the equally rapid increase in the rate of penetration* from 1975 to 1980 (nearly 53% in 1980 as compared to less than 36% five years earlier). *The separate evolutions of these two rates very certainly reflect the progressive opening-up of a market previously characterized by the existence of protectionist policies and by a degree of vertical integration that had harmful effects on the volume of international trade.*

The broad nature of this analysis does not enable us to present the differences in trends that appear at a more specific level (families of products, products). Only very detailed data could enable us to perform such an analysis of specialization strategies by product. This last remark also holds for the evolution of the self-sufficiency rate which, despite its erratic behavior, shows a declining trend in terms of the entire sector, a trend characteristic of a dynamic process of withdrawal. *A withdrawal strategy in a sector where, depending on markets, demand is bound to grow to an average annual rate of between 8% and 11% over the next decade (1980-1990), is probably not a desirable strategic direction for Canada to take.*

There is no need to go into further detail concerning this trend analysis (illustrated by the data in Table III.2) to confirm the diagnosis given in Chapter I of the decline in Canada's competitiveness in the international high technology industry market. This sectoral approach to the dynamics of international specialization fails to reveal major disparities between firms operating in the high technology field (Northern Telecom and Mitel being fortunate exceptions to the phenomenon of declining competitiveness). At this point, a strategic analysis of the earlier introduced development chain concept has to be considered more in depth.

III.2.3 Strategic Analysis of the Development Chain Concept in the Telecommunications Field

For industry:

This strategy uses both direct industrial links and indirect effects. At the heart of this economic process is the use of common skills, as practised in Japan in the components field, and in particular, joint action with the activities of new sectors requiring large amounts of liquid financing (which may be derived from these activities). Here we find a well-known procedure for the strategic analysis of firms: composition of a portfolio of activities or business units. But there is a major difference: *the logic is more industrial and technological than financial.*

For government:

The approach may be the same. Once the driving development chain (telecommunications) has been chosen, there is a need to reconquer those domestic markets — if this is still feasible — that will spark the dynamics of the "industrializing industry"[52] and help create pivots of competitiveness which, in turn, will lead to the full conquest of a profitable segment in the development chain. Evolving profits will then make it possible to move up and down the development chain. *"A national economy is not constituted solely of over-competitive sectors destined to expand and sub-competitive sectors bound to disappear: in a given area, increased competitiveness helps create a pole that can distribute stimulative effects throughout the development chain in which it is located"*[53].

The profitability of a portion of a development chain also enables government to change from one chain to another: the above-mentioned case of Japan and the most recent global economic indicators concerning international specialization show that Japan is putting a new electronics development chain into place as a result of its strong position in the automobile industry, which has become a major consumer of microprocessors and user of machine tools and robotics. The Japanese government encourages application of a broad industrial policy. This acknowledges the impact of economic policy on the fundamental conditions of long-term prosperity (i.e. invest-

ment, productivity, innovation and international competitiveness). This industrial policy concept is an attempt at adequately combining market forces and interventionism as a non-ideological pragmatic step toward meeting the constraints and objectives of today's industrialized society. Through extensive cooperation among industrial leaders, under the aegis of MITI[54], and with the injection of massive government financing (US $300 million over five years), Japan, after putting its "integrated circuits plan" into place, has caught up with the United States by exploiting existing captive markets. This strategy for *conquering the domestic market* has paid off: Japan is now self-sufficient and can export. All of which brings us back to the idea of specialization, which involves *the deliberate decision of a nation to develop certain industrial sectors and to abandon others.* When international competition increases and industry is a privileged flexible link between economies, the problem of specialization requires that a nation answer a number of basic strategic questions. In so doing, it must take the following points into account[55]:

- the need for specialization (a country cannot do everything with the same degree of effectiveness);
- the size of world demand, its continuum and growth;
- specialization, an essentially dynamic phenomenon (problem of the long term and intrasectoriality);
- the role of poles of competitiveness and the development chain concept.

It goes without saying that the stakes involved in international specialization require difficult arbitration between the various components of national independence, such as the international technology hierarchy, for example, and areas such as jobs. Like every other industrialized country, Canada must make a number of clear decisions: can telecommunications be one of these development chains with a future?

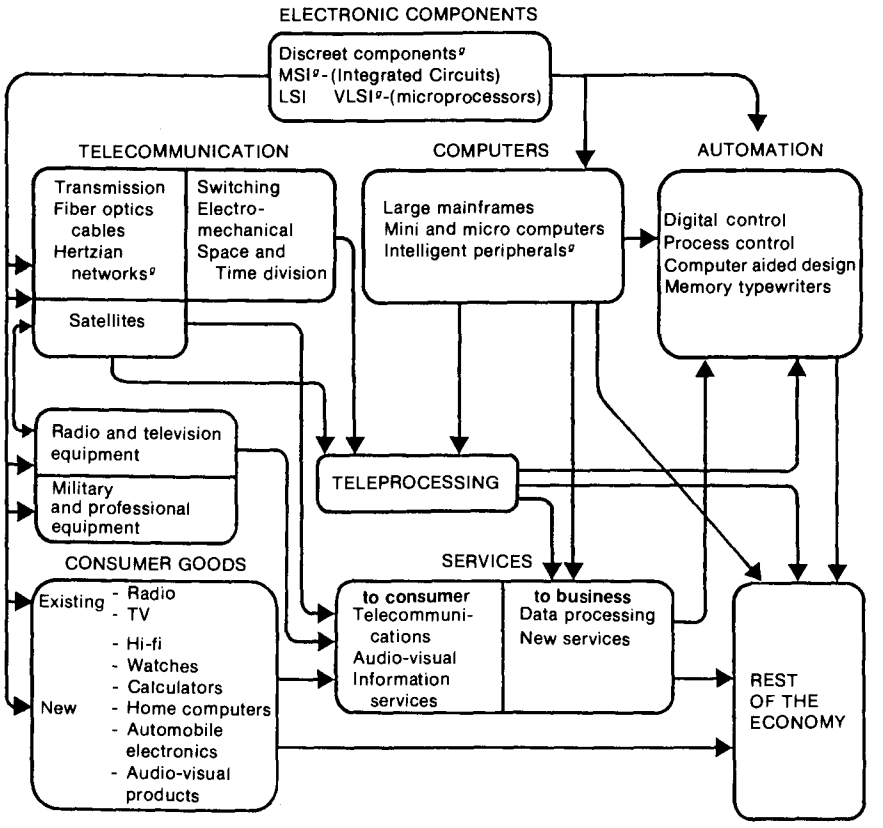
Table III.3 contains a concrete illustration of the links between telecommunications and the other sub-chains of the electronics chain.

Without conducting an exhaustive study of Canada's place in chain systems, and as seen in the introduction to this study, we must be very realistic and repeat that Canada's strong international specialization position is to be found in telecommunications, particularly in digital switching as a result of Northern Telecom's presence, and in videotex with Telidon (the technological battle appears to be going in Canada's favour, but the marketing war has hardly begun).

III.2.4 Positioning and Specialization in the Telecommunications Development Chain

Since the end of the 1970s, exports have become more essential than ever before for the manufacturers of telecommunications hardware, because

TABLE III.3



domestic markets are no longer expanding or will expand less in the future (see the decline of public sector orders in industrialized countries).

Overall, the exports of OECD countries rose by 79.7% between 1974 and 1978, from $2,085,452,000 to $3,747,254,000[56]. In the same period, EEC exports rose from $1,049,113,000 to $1,904,125,000 (an increase of 81.5%), an amount roughly equal to half of all OECD exports.

In terms of exports growth performance these countries may be divided into four categories:

- *the Netherlands and the United States had an exceptional growth rate of 200% and 150% between 1974 and 1978*, while American exports rose by more than 50% between 1977 and 1978;

TABLE III.4

Evolution of Foreign Trade in Major OECD Countries (US $ 000)

	1974	1975	1976	1977	1978	Parts (%)
West Germany						
X	446 473	535 535	583 586	549 380	695 592	35.7
M	81 376	78 310	85 838	102 018	114 779	39.7
trade balance	+ 365 097	+ 457 225	+ 497 748	+ 447 362	+ 580 813	
tc %	449	684	680	538	606	
Canada						
X	90 549	74 199	91 420	91 898	111 370	
M	88 146	88 668	96 675	105 669	100 134	
trade balance	+ 2 403	- 14 469	- 5 255	- 13 771	+ 11 236	
tc %	103	84	94	87	111	
Spain						
X	24 950	41 585	48 544	49 647	40 971	
M	52 994	58 474	45 931	34 205	28 120	
trade balance	- 28 044	- 16 889	+ 2 613	+ 15 442	+ 12 851	
tc %	47	71	106	145	146	
United States						
X	158 794	196 726	225 614	256 176	388 240	
M	162 670	95 246	101 683	127 992	239 088	
trade balance	- 3 876	+ 101 480	+ 123 931	+ 128 184	+ 149 152	
tc %	98	205	222	200	167	
France						
X	129 022	192 305	196 331	186 491	222 913	44.2
M	44 260	43 438	55 945	62 473	74 290	48.6
trade balance	+ 84 762	+ 148 867	+ 140 386	+ 124 018	+ 148 623	
tc %	291	443	351	298	300	
Italy						
X	63 060	82 038	106 320	124 578	121 936	53.6
M	71 363	79 165	81 142	64 456	69 555	67.8
trade balance	- 8 303	+ 2 873	+ 25,178	+ 60 122	+ 52 381	
tc %	88	104	131	193	175	
Japan						
X	226 707	243 418	279 600	296 344	491 669	27.1
M	15 457	15 241	14 656	19 866	23 212	23.4
trade balance	+ 211 250	+ 228 177	+ 264 944	+ 276 478	+ 486 357	
tc %	1 467	1 597	1 908	1 492	2 109	
Netherlands						
X	99 828	123 269	162 984	231 679	294 807	23.1
M	90 589	123 722	109 839	128 034	154 212	58.0
trade balance	+ 9 319	- 453	+ 53 145	+ 103 645	+ 140 595	
tc %	110	100	148	181	191	
United Kingdom						
X	132 925	154 827	209 728	214 314	188 052	37.3
M	72 599	87 586	121 139	78 108	102 226	37.8
trade balance	+ 60 326	+ 67 241	+ 88 589	+ 136 206	+ 85 826	
tc %	183	177	173	274	184	
Sweden						
X	418 894	578 271	583 468	516 384	629 616	39.4
M	25 355	37 596	33 100	40 280	39 817	49.4
trade balance	+ 393 539	+ 540 675	+ 550 368	+ 476 104	+ 589 799	
tc %	1 652	1 538	1 763	1 282	1 581	

Source: OECD, *Telecommunications Equipment Industry Study*, DSTI/IND/81.28

X = **Exports**
M = **Imports**
trade balance = **X-M**
tc = **exports to imports ratio X/M in percentage terms**

- *Japan and Italy recorded major advances* (around 100%). After a regular progression until 1977, Japan's exports jumped in 1978 by 66%, mainly as a result of purchases by Middle East countries. On the other hand, Italian exports dropped by 2% in 1978;
- *Spain and France form part of a third group of countries which may be called "intermediate"* and whose foreign sales grew by more than 60% in this period. Although not all that impressive, this growth was regular, despite a slowdown in Spain in the final year;
- *the United Kingdom has had difficulties with its exports since 1976;* this situation may be due to this country's accumulated lag in time division technology, which explains why few of its firms have established themselves in international markets.

Although the OECD data presented in Table III.4 cover only the five years from 1974 to 1978, they reveal certain significant facts: the increased strength of Japan in world terms, with a highly positive trade balance and an exports to imports ratio by far exceeding that of any other country (with the exception of Sweden, homeland of L.M. Ericsson, one of the main multinational corporations in telecommunications equipment), the ability of the other major manufacturing countries to maintain progression in relative terms, the emergence of less important exporting countries (Spain and Italy, where, however, subsidiaries of majors like Siemens, ITT and Philips are located). In addition to these, the introduction of new technologically advanced products, especially in telephone communications (digital switching equipment) may be considered as another explanatory factor of foreign trade flows to and from these countries.

These countries may be classified as follows in terms of their 1978 telecommunications equipment exports and percentage variations of exports and imports between 1974 and 1978:

TABLE III.5

	Exports ($000 US)	1978/1974 (%)	Imports ($000 US)	1978/1974 (%)
Fed. Rep. of Germany	695 592	+ 55.8	114 779	+ 41.0
Sweden	629 616	+ 50.3	39 817	+ 57.0
Japan	491 669	+ 116.9	23 312	+ 50.8
United States	388 240	+ 145.0	239 088	+ 47.0
Netherlands	294 807	+ 195.3	154 212	+ 70.4
France	222 913	+ 72.8	74 290	+ 67.8
United Kingdom	188 052	+ 41.5	102 226	+ 40.8
Italy	121 936	+ 93.4	69 559	- 2.5
Canada	111 370	+ 23.0	100 134	+ 13.6
Spain	40 971	+ 64.2	28 120	- 46.9

Source: OECD, *Telecommunications Equipment Industry Study*, DSTI/IND/81.28

The impact of foreign trade on domestic industries and markets can also be measured by considering two additional ratios:

Exports/Production (X/P)
Imports/Apparent Domestic Market (M/ADM).

This is shown in Table III.6 following.

The situation varies significantly from one country to another. The Federal Republic of Germany exports more than a quarter of its production and imports enough to cover 6% of its domestic market. In France, the export rate has been dropping since 1976 under the influence of slower demand and international competition.

Great Britain has also registered a decline in its relatively high (16%) export rate. Since 1976, Italy has maintained its share of international trade at approximately 7% of its domestic production. The United States increases its presence in international markets each year, but its export rate remains low (less than 5%). Japan exports approximately one-fifth of its production, and its domestic market appears to be very well protected (import rate of less than 1.5%). In the cases of Belgium and Sweden, foreign trade ratios stand at very high levels, especially in Sweden. The existence of a large company (L.M. Ericsson) with limited opportunities in the Swedish market is likely to account for such an export rate (close to 65%).

TABLE III.6

Impact of foreign trade in telecommunications on production and markets (In %)

		1974	1975	1976	1977	1978
RFG	**X/P**	24.47	27.7	32.32	25.49	26.21
	M/ADM	5.57	5.3	6.56	5.97	5.54
France	**X/P**	10.05	10.62	10.86	9.11	8.79
	M/ADM	3.69	2.61	3.35	3.25	2.96
United Kingdom	**X/P**	13.6	14.1	21.41	22.89	16.1
	M/ADM	7.92	8.5	13.6	9.76	9.45
Italy	**X/P**	4.65	3.74	7.34	8.43	7.38
	M/ADM	5.23	3.62	5.7	4.55	4.34
Sweden	**X/P**	80.63	79.67	84.06	64.2	-
	M/ADM	20.1	20.31	23.03	12.27	-
Spain	**X/P**	8.04	10.71	11.8	-	-
	M/ADM	15.69	14.43	8.4	-	-
Belgium	**X/P**	-	46.38	57.92	45.52	-
	M/ADM	-	26.27	24.54	20.58	-
United States	**X/P**	3.7	4.12	4.44	4.41	4.46
	M/ADM	3.31	1.97	2	2.27	3
Japan	**X/P**	15.09	16.08	18.42	18.37	-
	M/ADM	1.2	1.18	1.16	1.48	-

Source: OECD, *Telecommunications equipment industry study*, DSTI/IND/81.28

CHAPTER IV

National Strategic Perspectives

As an introduction to this chapter, we shall discuss the principal markets and their trends in terms of telecommunications equipment purchases and current practices. International marketing strategies are determined on the basis of market knowledge and understanding, both of which help identify the most adequate ways of penetrating those markets.

Market knowledge is not limited, however, to assessments of current and future demand. One also needs to know the nature of the markets: are they open or closed to foreign competition, and which government agencies dictate what role they shall play? What is the country's policy on foreign investment? What is the foreign companies' experience in the markets under consideration? Only after answering these questions will the foreign telecommunications equipment manufacturer understand the competitive dynamics he faces. He may then make informed decisions about the best way to penetrate a given market for a particular range of products.

IV.1 Equipment Distribution and Market Share in the Most Important Target Zones

Table IV.1 presents an overview of the telecommunications equipment situation in 1979 in the most important target countries and zones. Forecast changes from 1980 to 1990, by major zone and by system, have already been supplied in Chapter III.

It is important, however, to show the telecommunications characteristics by major geographical zone not only in terms of their structural evolution (see Tables II.2, II.3 and II.4) but also in terms of their relative degree of equipment (Table IV.1.). The distinctive features of equipment according to each zone and major country, the special constraints of a political, regulatory or economic nature and, lastly, the competition in a given zone also deserve consideration.

TABLE IV.1.1

TELECOMMUNICATIONS MARKET BY GEOGRAPHICAL ZONES (1979)
Equipment Distribution and Market Share in the Most Important Target Zones

	North America		Asia		Europe	
Number of telephone main stations	102 600 000		76 750 000		90 000 000	
	USA	92 800 000	Japan	37 820 000	Eastern Europe	9 000 000
	Canada	9 800 000	USSR	20 600 000		
			China	4 110 000		
Telex Subscribers	167 300		166 020		506 000	
	USA	124 000	Japan	67 000	Eastern	
	Canada	43 300	India	16 180	Europe (1978)	54 000
			Saoudi Arabia	15 000		
Earth Stations	2 600		353		n.a.	
	USA	2 500	USSR	180		
	Canada	100	Indonesia	51		
	Latin America		**Oceania**		**Africa**	
Number of telephone main stations	12 830 000		8 863 980	21	3 430 000	
	Brazil	4 000 000	Australia	6 910 000	South Africa	1 520 000
	Mexico	2 520 000	New Zealand	1 760 000	Egypt	390 000
	Argentina	1 850 000			Algeria	250 000
Telex Subscribers	68 800		38 535		43 610	
	Brazil	28 000	Australia	32 250	South Africa	19 470
	Mexico	8 700	New Zealand	4 300	Nigeria	4 500
	Venezuela	8 000			Morocco	4 000
Earth Stations	40				92	
	Brazil	6			Nigeria	21
	Peru	5			Algeria	17

Source: Arthur D. Little Inc., *World Telecommunications Survey II*, 1980.

Number of Telephones in Service in the 20 Major Countries in 1980 (millions of telephones)

1. United States	175.5	11. Netherlands	6.8
2. Japan	55.4	12. Brazil	6.5
3. United Kingdom	26.6	13. Sweden	6.4
4. West Germany	26.6	14. Mexico	4.5
5. USSR	22.5	15. Switzerland	4.4
6. France	22.2	16. Belgium	3.4
7. Italy	18.0	17. Poland	3.2
8. Canada	15.5	18. Denmark	3.1
9. Spain	11.1	19. Czechoslovakia	3.0
10. Australia	7.4	20. East Germany	3.0

Source: *Communications News*, January 1982.

The six major world zones are presented below with these points in mind. Since many foreign markets are closed to imports as a result of non-tariff barriers or political decisions, a trial evaluation of what might be called a "free" market — i.e., one that is open to imports — immediately follows our examination of major geographical zones. Following that is a study of the major characteristics of the markets of eight major countries supplying telecommunications equipment on the world scene. Reference may be made here again to the remarks on forecasting hypotheses and sources of data (see p. 20-21).

North America

This market is remarkably uniform, not only in terms of the most advanced equipment and service of very high quality but in terms of its operating structures as well (federal and local regulations, private sector operations more competitive in the United States than in Canada, telephone exchange design, standards, etc.). The obstacle presented by the Canadian-U.S. border is circumvented by investment in American subsidiaries in Canada and vice versa, as in the case of Northern Telecom's acquisition of a number of firms in the United States.

Cracks, however, are appearing in the uniformity of this market. Canada intends to adopt a new long-distance signalling system in accordance with international, not American, standards, and the United States appears to be opening up to foreign competition. To eliminate the obstacle of the *Buy American Act*, the latter are investing in manufacturing subsidiaries in the United States.

While telephone and cable distribution are identical in the United States and Canada, telex is proportionately in more widespread use in the latter. New technologies such as fibre optics, satellite communication earth stations

NORTH AMERICA: 1980-1990 PROJECTIONS
(in U.S. $ millions)

	1980 amount	%	1985 amount	%	1990 amount	%
Country						
Canada	1554.1	9	2306.1	9	3377.2	9
USA	15446.7	91	22665.0	91	32338.3	91
Total	**17000.8**	**100**	**24971.1**	**100**	**35715.5**	**100**
Systems/Markets						
Telephone	12638.2	74	18714.3	75	26504.6	74
Telegraph, Telex and Data	2481.4	15	3823.9	15	6000.5	17
Other	1888.2	11	2432.9	10	3210.4	9
Total	**17000.8**	**100**	**24971.1**	**100**	**35715.5**	**100**

Source: Arthur D. Little, *World Telecommunications Survey II*, 1980.

owned by users and the integrated services terminal equipment using digital technology will all be in widespread use by 1990.

One of the major characteristics of the North American market is the high level of vertical integration in the three major operating companies (Bell Canada, G.T.E., and AT & T) which account for 90% of telephones in use. Despite domination by these three firms, the market is so huge that many suppliers are interested in a share of it.

Asia

Eighteen countries represent 97% of telecommunications investment in this zone, where telecommunications organization is often under the authority of a national department of communications.

Of particular note are organizations such as the Economic and Social Commission for Asia and the Pacific (ESCAP), the Asian Development Bank and the Association of South-east Asian Nations, which at times help finance the development of telecommunications projects. Japan and Australia are particularly interested in these developments. Despite these efforts, however, major projects will be relatively few in number and more should be expected from the association of the private sector with various governments.

In general, Asian countries now have microwave radio stations and other long-distance transmission systems for their domestic needs, the exception being China which still lags very far behind.

Except for Japan, which has the most modern system in the world, Hong Kong, Kuwait, Singapore, Taiwan and the United Arab Emirates, demand greatly exceeds supply. In the absence of modern telephone facilities, telegraph and telex systems are expanding.

Telephone switching is expanding in more than half of the countries with crossbar[8] technology or by replacing step-by-step technology with electronic switching. Some, however, have decided to change to digital and PCM (pulse code modulation) transmission. In terms of distribution, we may expect a renewed market given current deficiencies, particularly in rural areas. The telegraph will be automated and telex services will continue to expand, but data transmission facilities and services will not be given high priority except in a few countries or territories such as Hong Kong and Japan.

The generalized use of satellite communications will tend to double the size of this market between 1980 and 1990, while mobile radio, already developed for private use, will further develop into the public sector, as Japan's experience tends to suggest.

Countries that in the past neglected telecommunications will give them high priority. Five countries, (the USSR, Japan, the Republic of Korea, China and Turkey) alone represent 86%-87% of all expenditures planned between now and 1990.

The financing of equipment purchases is the most critical factor in the markets of this zone, where competition has always been highly diversified because of low local supply (except in Japan). Usual financing agreements in this area will include examples like the USSR paying in kind, petroleum producers drawing on their capital, and others operating on bilateral loan agreements or credits from equipment-exporting countries.

Regarding key elements, particularly in the case of switching equipment, joint-venture agreements for local manufacturing tend to be the major ingredient for success. For this reason, a number of manufacturers such as Siemens, Ericsson, ITT, Thomson-CSF, Fujitsu, NEC and Western Electric

ASIA: 1980-1990 PROJECTIONS
(in U.S. $ millions)

	1980		1985		1990	
	amount	%	amount	%	amount	%
Country						
China	292.4	3	562.6	3	1356.8	5
Japan	4224.9	42.3	5152.7	31	5696.4	21
Rep. of Korea	354.0	3.5	1031.4	6	2670.9	10
USRR	3473.9	34.6	7273.2	43	12314.9	46
Other	1677.0		2719.0	16	4797.6	18
Total	**10022.0**	**100**	**16739.0**	**100**	**26836.8**	**100**
Systems/Markets						
Telephone	8687.5	87	14338.4	86	23069.1	87
Telegraph, Telex	636.5	6	1157.0	7	1934.2	7
Other	698.3	7	1243.9	7	1833.5	6
Total	**10022.3**	**100**	**16739.3**	**100**	**26836.8**	**100**

Source: ADL, *World Telecommunications Survey II*, 1980.

have established assembly or equipment manufacturing plants. The Japanese are taking over positions formerly held by European and American suppliers. The Korean electronics industry is now penetrating Asian markets. While China and India seem to need to open up to foreign suppliers in order to catch up technologically, the two larger markets of the USSR and Japan are likely to remain closed.

Europe

Telecommunications responsibilities in the European market vary from one country to the next, but are always under government control. In general, marketing firms do not possess manufacturing units. On the other hand, relations between government agencies and the private manufacturing sector have been solidly based on models in which the marketing firm (services) cooperate very closely with local manufacturers, often by taking an active part in R & D (as in France, Switzerland and the United Kingdom), or by testing and approving products (as in West Germany). In Eastern Europe, telecommunications equipment is supplied by State-owned plants or government services responsible for imports, exports, and the negotiation of licencing agreements with foreign countries. European countries cooperate through such agencies as the CEPT (Conférence Européenne des Postes et Télécommunications), the EEC, CCITT/CCIR, Eutelsat, etc.[57].

Telecommunications has developed very unevenly in the various European countries in terms of both services and technology. At the end of the 1970s, the dominant technologies in Europe included crossbar or electromechanical switching, the dial telephone, digital exchanges , long-distance connections by FDM[s] coaxial cable (frequency division multiplexing) and by microwave, electromechanical teleprinters . However, the new technologies are now being used for many applications in a number of countries.

Digital PBXs are being introduced at a rate that varies according to PTT approval procedures and the position of established suppliers in the market. Eastern Europe is lagging well behind, but there is a move toward developing licencing agreements for advanced hardware.

In 1979, the PTTs in Western Europe began developing standards for digital integrated service systems, but the shift to digital technology will widely differ from one country to the next.

Eastern Europe's share of the European market will rise from 12% in 1980 to 20% in 1990, while that of France, West Germany, Italy, the United Kingdom and Spain will drop from 66% to 59% ($10.8 billion in 1980 and $20.8 in 1985).

Telephone expenditures will drop from 87% to 82% of all telecommunications expenditures over the same period, while those for the telegraph, telex and digital transmission segment will rise from 6.8% to 9.7% and those for

EUROPE: 1980-1990 PROJECTIONS
(in U.S. $ millions)

	1980 amount	%	1985 amount	%	1990 amount	%
Country						
France	2152.1	20	3072.5	20	3029.3	14
FRG	1792.2	17	1750.5	11	1715.0	8
Italy	1324.3	12	1753.7	11	2313.2	11
United Kingdom	1130.5	10	1999.5	13	3473.9	17
Other Western Eur.	3133.7	29	4355.5	28	6105.0	29
Sub-total	**9532.8**		**12931.7**		**16636.4**	
Rumania	210.5	2	392.0	2.5	559.4	3
Yugoslavia	260.4	2	539.2	3.2	702.4	3
Other Eastern Eur.	844.3	8	1762.8	11.3	2951.4	14
Sub-total	**1315.2**		**2694.0**		**4213.2**	
TOTAL	**10848.0**	**100**	**15625.7**	**100**	**20849.6**	**100**
Systems/Markets						
Telephone	9465.7	87	13243.9	85	17117.1	82
Telegraph	739.9	7	1322.3	8	2015.6	10
Other	642.4	6	1059.5	7	1716.9	8
TOTAL	**10848.0**	**100**	**15625.7**	**100**	**20849.6**	**100**

Source: Arthur D. Little, *World Telecommunications Survey II*, 1980.

mobile communications will increase from 4.9% to 6.2% – growth rates higher than those of North America. The other categories of hardware (radio paging services, cable television, satellite communications) will grow more rapidly but from smaller bases.

European suppliers' market for network equipment is above all a domestic one. ITT and Siemens, followed by Thomson and Ericsson, have the largest share of the European market. Because of the critical size of firms and R & D costs (where government efforts are reaching their limits), we may expect a new restructuring to follow the changes made in the 1970s. In the Eastern European countries, organization is designed to suit the needs of the USSR, and opportunities for Western countries to penetrate these markets are essentially in the form of agreements for technology transfers under licence.

The Japanese are making major efforts to penetrate the terminal equipment market directly, and are offering products ahead of the Europeans. However, it is in markets outside of governmental spheres of influence that non-European suppliers have the greatest chance of success, either through direct sales or through distribution or licencing agreements with local firms.

Latin America

In the Latin American market, almost all equipment is sold according to CCITT/CCIR standards. The market is concentrated in major urban areas where both old and new electromechanical switching equipment are used and are generally overloaded and poorly maintained. There is a critical need for all countries in this zone to update their switching facilities and cables.

Although local switching is based essentially on electromechanical crossbar technology, Latin American telecommunications agencies all expect to convert to SPC switching. Some of these agencies plan to use analog switches[g] at intersection points in order to skip this technological stage (except perhaps for tandem switching[g] centres), and to install PCM digital technology directly in urban areas. More remote zones would continue to use crossbar technology.

New subscriber equipment (push-button telephones or touch-dialing sets, stored program-controlled switches, intelligent video terminal electronic teleprinters, facsimile equipment) has recently been introduced and will continue to spread through direct sales to the end user. Import restrictions are the only means available to telecommunications distributors for controlling subscriber equipment linked to the system.

Brazil dominates this market with 30% of the lines and 40% of telex subscriptions in Latin America. Mexico and Argentina lag far behind. The transition from electromechanical switching to digital and analog technology (SPC, stored program-controlled) varies a great deal from country to country. Brazil will work toward SPC crosspoint[g] technology until 1985, whereas Mexico, Colombia, Argentina, Chile and Peru will install SPC digital equipment well before.

Latin America's most important development will be to link up the microwave networks of Andean countries. Satellite earth stations will grow rapidly in the Amazon Basin. Brazil and Colombia are very interested in satellite communications technology and it is highly probable that one or two satellites will meet both the individual needs of Latin American countries and the requirements for communications between different countries, particularly in the Andean zone.

Typically, the development of telecommunications infrastructures in Latin America will have the following characteristics:

- installation of new local SPC exchanges in urban areas, first with analog technology, and later with digital equipment;
- progressive replacement of old rotary[g] or step-by-step switches;
- replacement of underground paper-insulated cables with plastic-insulated cables filled with water-resistant gel;
- greater use of pressurized cables;

LATIN AMERICA: 1980-1990 PROJECTIONS
(in U.S. $ million)

	1980		1985		1990	
	amount	%	amount	%	amount	%
Country						
Argentina	116.0	10	162.3	9	226.1	9
Brazil	474.6	40	713.3	40	868.3	36
Mexico	175.6	15	285.5	16	430.9	18
Other	406.5	35	643.2	35	865.4	35
Total	**1172.7**	**100**	**1804.3**	**100**	**2390.7**	**100**
Systems/Markets						
Telephone	978.0	83	1524.1	84	2010.4	84
Telegraph, Telex	104.9	9	144.3	8	185.4	8
Other	89.8	8	135.9	8	193.9	8
Total	**1172.7**	**100**	**1804.3**	**100**	**2390.7**	**100**

Source: Arthur D. Little Inc., *World Telecommunications Survey II*, 1980

- introduction of PCM fibre optic systems in urban networks;
  growth of long-distance link-ups by digital modulation of SPC radio microwaves and digital tandem exchanges, and decline of electromechanical equipment;
- new exchanges enabling subscribers to use push-button telephones;
  more complete standards for subscriber terminal equipment;
- improvement of tandem switching facilities;
  computerized timing mechanism, accounting, and call billing;
- long-distance analog networks using frequency division multiplexers;
- development of rural telecommunications;
- development of telex networks;
  larger markets for electronic data and facsimile terminals;
  mobile telephones in large cities;
- slower development of telecommunications in the lates 1980s because of increased energy costs (except in Argentina, Mexico and Venezuela).

The equipment market in Latin America was developed by L.M. Ericsson and ITT, owners of marketing companies that were major clients for equipment manufactured in Europe. Since the takeover of certain marketing companies by host countries, ITT and Ericsson have been losing ground to Japanese competitors (NEC, Hitachi and OKI) and to Siemens, which dominates the telex switching market.

Ericsson, ITT and Pirelli are the major suppliers of multipair[s] telephone cables, which they manufacture locally. In mobile radio and radio paging services, Motorola, GE and NEC are the major competitors.

OCEANIA: 1980-1990 PROJECTIONS
(in U.S. $ million)

	1980 amount	%	1985 amount	%	1990 amount	%
Country						
Australia	689.8	91	942.1	91	1302.8	90
New Zealand	44.1	6	64.6	6	83.2	6
Other	19.8	3	34.2	3	59.5	4
Total	**753.7**	**100**	**1040.9**	**100**	**1445.6**	**100**
Systems/Markets						
Telephone	654.2	87	913.6	88	1270.3	89
Telegraph, Telex	33.0	4	46.6	4	79.2	5
Other	66.5	9	80.7	8	96.1	6
Total	**753.7**	**100**	**1040.9**	**100**	**1445.6**	**100**

Source: Arthur D. Little, *World Telecommunications Survey II*, 1980

Oceania

With the exception of Australia and New Zealand, local telecommunications services are hardly developed in this zone. Satellite communications are essential for this region. Australia and New Zealand are converting from crossbar technology to electronic telephone switching technology. Elsewhere, major disparities exist.

In the years to come, major developments in these regions will include earth stations, to provide international links, and microwave radio systems. Australia and New Zealand will gradually modernize and enlarge their public networks.

Telephones, recording systems, satellite communications and mobile radio are four significant markets in this zone, where major world manufacturers still compete and old colonial links with England and France are still present to some degree.

Africa

With the exception of North Africa (Algeria, Libya, Morocco), Nigeria and South Africa, the markets in this zone are relatively small. Crossbar switching will continue to dominate in the 1980s but analog and digital electronic switching technology is appearing in North Africa, from Egypt to Morocco, as well as in South Africa.

South Africa, by far the largest market today, expects to develop an integrated digital system for telex, telegraphy and data transmission from its digital telex exchanges.

AFRICA: 1980-1990 PROJECTIONS
(in U.S. $ million)

	1980		1985		1990	
	amount	%	amount	%	amount	%
Country						
South Africa	90.1	23.5	124.2	22.4	171.3	20
Algeria	76.4	20	129.6	23.3	232.5	28
Egypt	44.3	11.5	65.7	12	98.3	12
Other	174.2	45	236.0	42.5	377.4	40
Total	**385.0**	**100**	**555.5**	**100**	**839.5**	**100**
Systems/Markets						
Telephone	313.5	81	457.4	82	689.6	82
Telegraph, Telex	48.3	13	66.7	12	97.0	12
Other	23.2	6	31.4	6	53.0	6
Total	**385.0**	**100**	**555.5**	**100**	**839.6**	**100**

Source: ADL, *World Telecommunications Survey II*, 1980

By 1985, Algeria could overtake South Africa as the largest market for individual equipment. Nigeria should increase its purchases toward the end of the 1980s, once it has overcome the effects of the disorganization of its projects in the 1975-1979 period.

Competition in this zone is marked by the presence of all the major world suppliers in a context that encourages local integration. South Africa has made the creation of local suppliers its first priority. The South African subsidiaries of Siemens, Plessey, NEC, ITT and CGE supply basic telecommunications equipment through long-term contracts. It is expected that South Africa's needs for digital switching equipment, which the country obtains through imports, will be met almost entirely by local manufacturers as early as the mid-1980s.

The same trends are appearing in Algeria (telephone exchange equipment, electromechanical switching) and in Morocco (crossbar equipment), where plants are being established to manufacture this equipment.

The key to African markets (with the exception of the oil-rich countries of Libya, Algeria and Nigeria) lies in supplier credit or bilateral loans mechanisms, as witnessed by the French and Japanese successes. The Japanese (NEC, Fujitsu, Hitachi) have made impressive progress in penetrating market areas held by European companies (in Kenya, Algeria, Libya) both in switching (particularly crossbar) and transmission technology.

Siemens, already the telex market leader, is increasing its share in telephone exchange equipment (Egypt, South Africa) and is reaping the benefits of aggressive marketing and investments in Nigeria.

IV.2 Markets of the Eight Major Countries Manufacturing Telecommunications Equipment

Eight countries are currently competing as the main suppliers of the world telecommunications market: the United States, Canada, France, West Germany, the United Kingdom, the Netherlands, Sweden and Japan. As shown in Chapter III, this type of competition does not obey the rules of classic economic theory. With the exception of Canada and the United States, these countries have a high level of State involvement in the competitive climate. It may take several forms: action by the government public service monopoly, a purchasing policy that favours national producers (a clear example is Sweden), protection of the domestic market through regulations and establishment of technical standards (particularly in West Germany and Japan), government intervention in industrial restructuring or redeployment (France, in particular), and state financing and implementing of research and development.

Given the size of the market of these countries in relation to world demand for telecommunications products and the level of development of their telecommunications infrastructures in relation to the population, particularly with regard to telephone density (see Tables IV.2 and IV.3), two basic questions arise concerning the strategic decisions facing producing firms:

- what share of the world market can be considered as an "open market", where are these markets, and what are their growth prospects?
- to what extent will the following factors (to name only a few) broaden the so-called open market: the lowering of entry barriers, the deregulation that has occurred in the United States, the progressive opening up of the Japanese market and the more widespread use of international competitive bidding to supply equipment in certain countries (France, for example)?

Tables IV.2.1 and IV.2.2 provide the background for a comparative analysis of these countries. Examination of the major characteristics of the corresponding domestic markets may provide some sort of answer to these questions. Even though the figures given and the development forecasts are for 1980 (year in which the *World Telecommunications Survey II* by Arthur D. Little was published), analysis of Table II.2 reveals that the structure of the world market, by major geographical zones, should remain relatively stable until 1990, but that major variations should be expected for certain countries.

TABLE IV.2.1

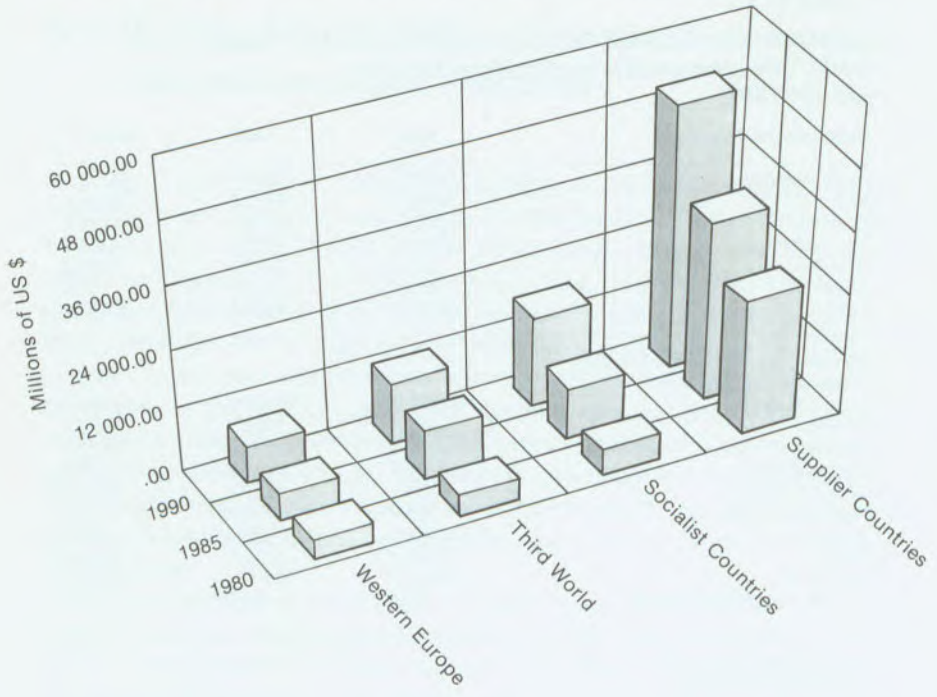
Relative Size of the Markets of Certain Countries in Relation to the World Telecommunications Equipment Market (US $000,000)

Geographical Zones	1980	1985	1990
North America	17000.8	24971.1	35715.5
Asia	10022.3	16739.3	26836.8
Europe	10848.7	15625.7	20849.6
Latin America	1172.7	1804.3	2390.7
Oceania	753.7	1040.9	1445.6
Africa	385.0	555.5	839.6
Total	**40182.5**	**60726.8**	**88077.8**
Domestic Markets of the 8 Major Supplier Countries			
United States	15446.7	22665.0	32338.3
Canada	1554.0	2306.1	3377.2
France	2152.1	3072.5	3029.3
West Germany	1792.2	1750.5	1715.0
United Kingdom	1130.5	1999.5	3473.9
The Netherlands	386.6	506.8	682.3
Sweden	166.1	202.2	253.7
Japan	4224.9	5152.7	5696.4
Total in $	**26853.1**	**35349.2**	**50566.1**
in % of world market	**66.8%**	**58.2%**	**57.4%**
Markets of other Western European Countries			
in $	3905.3	5400.2	7482.2
in % of world market	9.7%	8.9%	8.5%
Third World Markets			
in $	4342.6	9457.6	12144.6
in % of world market	10.8%	15.6%	13.8%
Markets of Socialist Countries			
USSR	3473.9	7273.2	12314.9
Eastern Europe	1315.2	2694.0	4213.2
China	292.4	562.6	1356.8
Total in $	**5081.5**	**10529.8**	**17884.9**
in % of world market	**12.6%**	**17.3%**	**20.3%**

Westen European Countries (other than France, West Germany, the United Kingdom, the Netherlands, and Sweden)	1980 $	1980 %	1985 $	1985 %	1990 $	1990 %
	3905.3	9.7	5400.2	8.9	7482.2	8.5
Third World Countries	**4342.6**	**10.8**	**9457.6**	**15.6**	**12144.6**	**13.8**
Total	**8247.9**	**20.5**	**14857.8**	**23.5**	**19626.8**	**22.3**

Source: Arthur D. Little, *World Telecommunications Survey II*, 1980.

Relative Size of the Global Market for Telecommunications Equipment



If we eliminate from the world market all closed markets formed by the eight above-mentioned supplier countries and the socialist countries, the producing companies can only hope to develop internationally in the markets of other Western European and Third World countries. The relative size of these markets in relation to the world market appears in Table IV.2.1

It is difficult to estimate exactly the size of the so-called open market on the basis of the data on the next page. In light of the observations made above (political decisions, deregulation, the relaxation of certain entry barriers, the effects of technological developments, etc), two factors must be taken into account: first, exchanges between the eight major supplying countries — exchanges which may take the form of the reciprocal opening of domestic markets (very minor, it should be added) — and second, the fact that certain Third World countries are developing their own local production and becoming potential exporters. In this context, we must add to the above figures those imports resulting from the opening of the closed markets of the eight major producing countries and decrease the share of Third World countries

TABLE IV.2.2

Sales of the Major Telecommunications Equipment Manufacturers (billions of U.S. dollars)

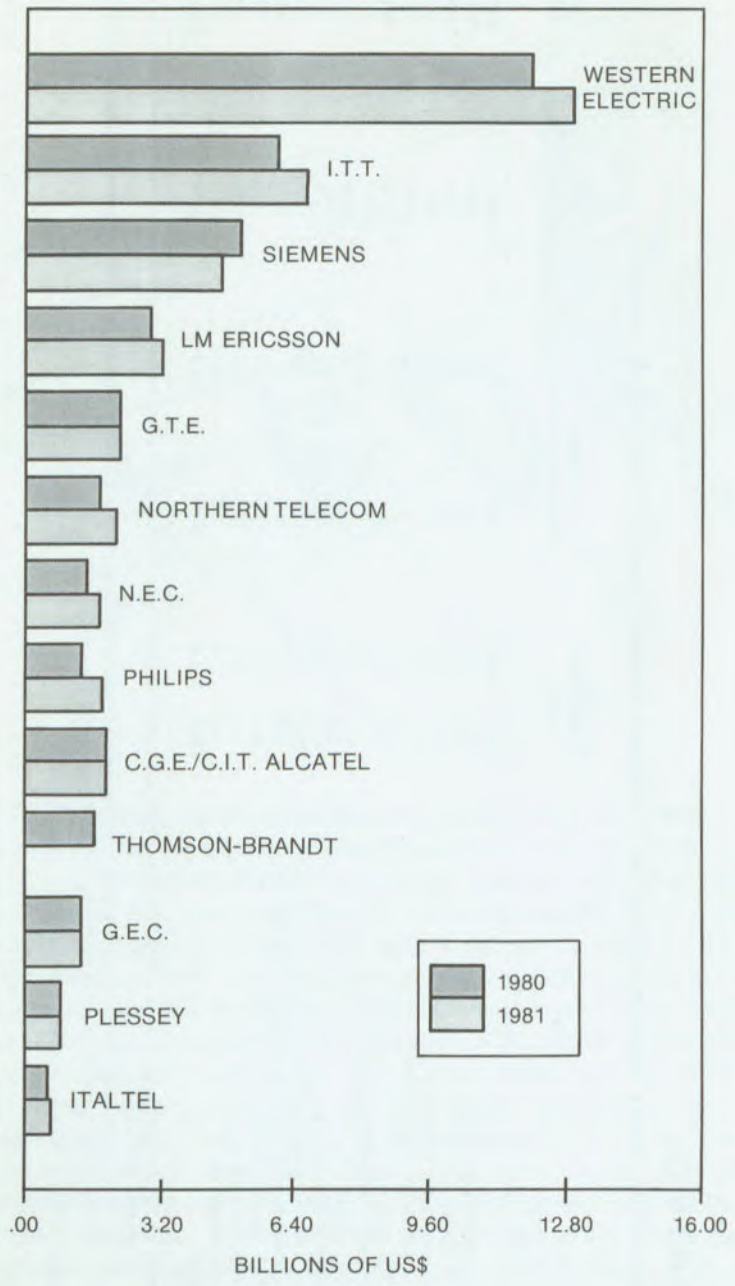
	A Consolidated sales		B Total sales of telecommunications equipment		C x 100 B/A Total	D x 100 B/B Total
	1980	**1983**	**1980**	**1981**	**1980**	**1980**
Western Electric (U.S.A.)	12.0	13.0	12.0	13.0	100%	31%
I.T.T. (U.S.A.)	18.5	17.3	6.0	6.7	33%	16%
Siemens (West Germany)	17.6	15.3	5.0	4.6	29%	13%
L.M. Ericsson (Sweden)	2.9	3.2	2.9	3.2	100%	7%
G.T.E. (U.S.A.)	10.0	11.1	2.2	2.2	22%	6%
Northern Telecom (Canada)	1.7	2.1	1.7	2.1	100%	5%
N.E.C. (Japan)	3.9	4.8	1.4	1.7	37%	4%
Philips (Netherlands)	18.4	17.0	1.3*	1.8	7%	3%
C.G.E./C.I.T.—Alcatel (France)	10.8	9.9	1.9	1.9	18%	5%
Thomson-Brandt/Thomson—C.S.F. (France)	8.6	7.2	1.6	-	19%	4%
G.E.C. (United Kingdom)	8.3	8.4	1.3*	1.3	16%	3%
Plessey (United Kingdom)	1.9	1.9	0.8	0.8	40%	2%
Italtel (Italy)	0.6	0.6	0.5	0.6	100%	2%
Total	**115.2**	**111.8**	**38.7**	**39.9**	**34%**	**100%**

Notes: 1) Figures followed by a star * are estimates based on the hypothesis of a constant share of telecommunications equipment with respect to total sales of the firm over the 1976 to 1980 period.

2) There may be some discrepancies between these figures and other rankings from other sources due to exchange rates for dollar conversion and different fiscal years among the firms considered in this table. Differences may also be due to rounding.

Source: Northern Telecom, and various annual reports and publications.

Total Sales of Telecommunications Equipment by Major Manufacturers

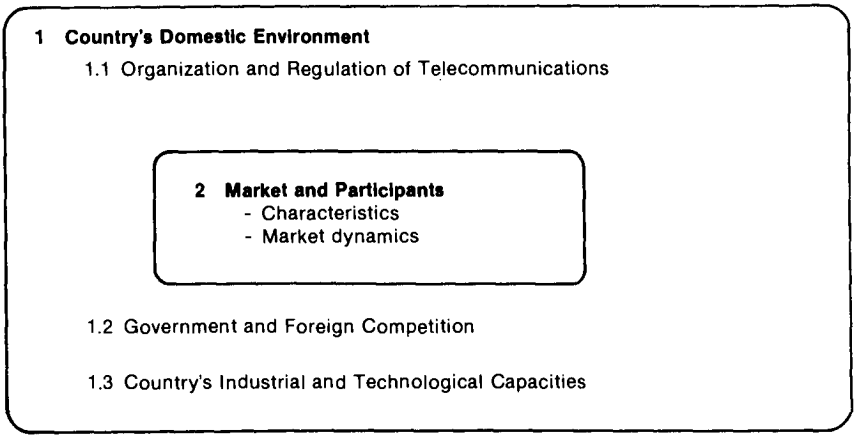


that are developing their own local production as well as that of other Western European countries with local manufacturing.

From information currently available, it may be estimated that the open market is probably less than 20% of the world market and could even be as low as 15%. Its growth depends mainly on the political factor in its various manifestations. This topic will be examined in Phases II and III of this study.

In order to better define the competitive context in which the eight major supplier countries operate, Table IV.2.2 presents comparative data on their amount of equipment, their manufacturing firms, and the other major characteristics of their markets.

The eight major countries manufacturing telecommunications equipment can be studied according to the following outline:



Only the elements judged essential to a sound understanding of the competitive and institutional context of these markets will be described in this section. Given the fact that the economic mechanisms introduced in the first part of this study (development chain, vertical integration, concentration) will interact at varying degrees in these eight markets, they will not be repeated here but rather discussed in the cases studied in Phase II.

It may be observed in Table IV.2.3 that the average annual growth rate of telecommunications equipment sales in all cases exceeded that of net manufacturing output with the exception of the United Kingdom, the United States and Japan. France, Germany and the Netherlands show the most significant differences between both rates, thereby reflecting vigorous investments both public and private in the last ten years.

TABLE IV.2.3

Average annual growth rate (1) of telecommunications equipment sales and net manufacturing output in other industries (current prices)

	Period	Telecommunications equipment sales	Net manufacturing output in other industries
Austria	1970-75	18.8	8.3
Belgium	1970-75	16.6	9.1
Canada	1970-75	15.8	12.7
France	1971-80	21.2	12.4
West Germany	1971-80	15.8	7.1
Italy	1971-80	16.7	21.9
Sweden	1971-80	13.9	12.1
Netherlands	1971-80	22.2	8.8
Portugal	1970-75	17.5	21.9
United Kingdom	1971-80	15.2	16.0
United States	1970-79	10.0	11.5(1)
Japan	1969-78	7.7	10.7

(1) Shipments

Source: OECD survey and INTECS.

TABLE IV.2.4

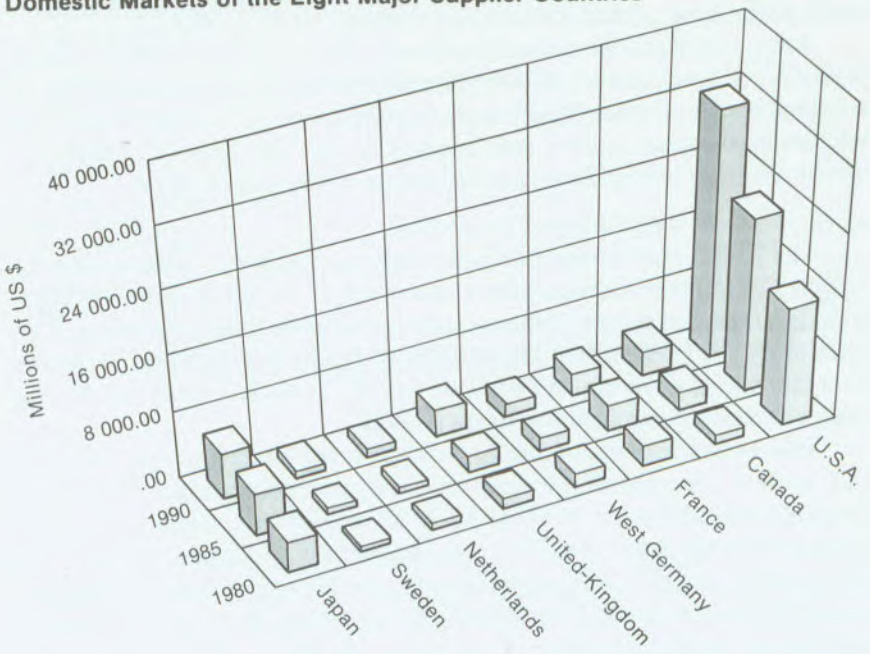
Investments in telecommunications equipment as a percentage of GNP GNP (%)

	1971	1975	1979
Australia	11.67	12.15	10.37
Austria	6.83	9.99	7.82
Belgium	6.33	7.69	5.12
Canada	-	-	-
Denmark	7.74	6.54	6.43
Finland	6.7	9.8	6.9
France (2)	-	7.3	9.2
West Germany	7.84	5.85	5.86
Greece	17.34	7.17	6.10
Iceland	5.88	5.04	4.84
Ireland	6.16	13.48	11.08(2)
Italy	7.15	9.91	8.13
Japan (1)	11.56	9.95	8.11
Luxemburg	-	-	-
Netherlands	5.62	4.95	4.77(3)
New Zealand	-	-	-
Norway	7.36	8.90	11.23
Portugal	7.13	8.70	8.42
Spain	11.28	11.35	7.33
Sweden	4.19	3.48	3,57
Switzerland	9.72	9.18	6.72
Turkey	2.66	11.64	2.69
United Kingdom (1)	10.55	9.27	7.07
United States	9.15	7.89	8.34

(1) Year ending on March 31st the following year
(2) Estimate
(3) 1978

Source: *Statistical Yearbook of Telecommunications in the Public Sector*, 9th edition, UIT.

Domestic Markets of the Eight Major Supplier Countries



Yet, the share of telecommunications investments with respect to GNP varied widely from country to country, depending on the year examined. (See Table IV.2.4). In 1975 and 1979, France, Japan, the United Kingdom and the United States devoted the largest share of their GNP to this type of investment as compared with other countries.

IV.2.1 The United States

A. Domestic Environment

i) Organization and Regulation of Telecommunications in the United States

Provided by the private sector, all inter-state and international public telecommunications services are regulated in the United States by the FCC (Federal Communications Commission): telephone, radio, cable distribution, etc. In each state, the main role of the PUCs (Public Utilities Commissions) is to grant or refuse tariffs proposed by suppliers of telecommunications services. The policy is to encourage the most open competition possible between the various suppliers and operating companies.

The telecommunications field is protected by the NTIA (National Telecommunications and Information Agency), which was created in 1978, and which formulates general policies and protects users' rights.

At the end of a seven-year anti-trust suit, the U.S. Department of Justice forced AT & T, on January 8, 1982, to sell its twenty-two telephone operating subsidiaries. This decison significantly changed the rules of competition in the telecommunications market and appears to be today's most noteworthy phenomenon in organization and regulation in the United States.

ii) Government and Foreign Competition

The liberal characteristics of the American economic system are fully reflected in the telecommunications sector where, as noted earlier, government intervenes in private industry only to maintain free competition. The decision by the FCC and the Department of Justice bears witness to this, as does the federal government's decision to call for tenders when purchasing interconnection equipment for its own needs.

This, however, does not mean a policy of economic *laisser-faire* since the FCC and the government also intervene in fiscal regulation. Proof of this is the FCC's study (Docket 79-63) of AT & T's request to increase its return on investment from 9.6% to 15%[58] and the request by telephone operating companies for accelerated depreciation because of competition and the speed of technological change which, according to operating companies, reduce the useful life of terminal equipment and render the existing depreciation rules obsolete.

Since the Carterfone decision in 1968, the American terminal equipment market has been open to competition from more than 900 firms, including European, Japanese and Canadian suppliers. Most of its foreign trade is still conducted with Canada, but Japan follows close behind. Although in 1979 American imports of telephone and telegraph equipment amounted to $274 million, these imports rose by 66% to $454 million in 1980. Canada and Japan have mainly benefited from this increase in American imports, their market

	Sales 1981 ($ millions)	R & D in 1981 %	R & D in 1981 ($ millions)	Staff
Western Electric	13 008	7.76	1 000	177 000 (1980)
ITT	17 306 (1)	6.35	1 099	324 000
Rolm	295 (2)	6.78	20	4 414
Harris	1 551 (3)	5.3	83	25 800
IBM (Consolidated Sales)	29 100	5.5	1 612	355 000

(1) including $5480 million in telecommunications equipment
(2) including $243 million in telecommunications
(3) including $374.3 million in telecommunications

Source: Annual Reports

Market Estimate (1982)
(U.S. $ Billion)

Telephone	
AT & T	61.4
Other	13.0
Total	**74.4**
Telegraph (Western Union)	0.8
Mobile Radio	0.2
International Telecommunications	0.8
Interconnection	0.6
Cable Distribution	3.2
Total	**80.0**

Source: AT & T statistical reports, USITA (United States Independent Telephone Association) and forecasts in Arthur D. Little, *World Telecommunications Survey II*, 1980.

shares rising by 54% and 42% respectively since 1979. It appears that the trend toward increased imports will continue. This would considerably reduce American foreign trade surpluses for this type of goods ($173 million in 1979, $95 million in 1980). American exports in this sector rose from $447 million in 1979 to $549 million in 1980, an increase of 23%, with Canada absorbing $78 million out of this total in 1980, compared to $64 million in 1979. However, the expansion of international markets, recent negotiations with Japan, the elimination of certain barriers caused by technological changes, and high American performance in this area could ensure continued foreign trade surpluses in this sector.

iii) Industrial and Technological Capacity of the United States

Since the United States represent by far the leading supplier of telecommunications equipment, the largest market in the world, the undisputed leader in advanced technology, the greatest financial power and the home-base of three world-scale multinationals (Western Electric, ITT and GTE) and many telecommunications companies, its competitive strength in the international telecommunications market does not need to be overemphasized. The impact on the telecommunications industry of its numerous government-supported advanced technology research programs, particularly military and space research programs (NASA), add to the power of private laboratories (Bell Laboratories, for example) and of the R & D divisions of large firms.

Besides these firms, other dynamic companies, such as Harris and Rolm have expanded and quickly reached considerable size.

Finally, many smaller companies share the market with the larger ones and the rate at which new companies are created is the highest in the world in the field of high technology.

B. The American Market and its Participants

Current sales in the American telecommunications market are estimated at US $ 80 billion, telephony accounting for 93% of this total.

Equipment expenditures are exceeding $18 billion in 1982 and are expected to grow by 8% per year until 1985[59] and by 7% thereafter until 1990.

Equipment expenditure forecasts by system are as follows until 1990 ($000,000):

	Market Estimate for 1980 $	Forecasts for 1985 $	1990 $	Average Annual Growth Rate 1980-85 %	1986-90 %
Telephone	11 325.0	16 740.4	23 599.9	8.1	7
Telegraph, telex and data transmission	2 358.7	3 634.6	5 709.5	9.0	9
Satellite communications	113.0	175.4	443.4	19.5	10
Mobile radio and radio telephone	1 426.9	1 690.9	2 180.7	3.5	5
Paging Systems	26.1	33.3	41.5	5.0	4
Cable television	197.0	289.5	363.3	8.0	5
Total	**15 446.7**	**22 665.0**	**32 338.3**	**8.0**	**7**

Source: Arthur D. Little. *World Telecommunications Survey II*,1980

Since the recent FCC decision, two phenomena have emerged in the American telecommunications market and seem likely to be accentuated in the future.

- *first, the entry of new competitors of A T & T as operating companies.* On the domestic scene, not only have long-established companies such as MCI, SP Communications, RCS American, ASC, Telenet, and Tymnet seen their revenues increase and new service opportunities open up, but also newcomers are finding their own place in this expanding market. For example, Share Com providing long-distance services at low cost (33% less) since 1980 through a wholesale purchase system of WATS[8] lines (Wide Area Transmission Service), and re-selling them to users, expects sales of $2.7 million in 1982[60]. Voice Data Systems Inc. has just gone into electronic mail/voice store-and-forward systems. Commercial Software Inc. and Data Dynamics are two other newcomers to soft-

ware[8], word processing and electronic mail since 1980. Data Dynamics estimates revenues of $50 million between now and 1987;

- *second, the probable entry of AT & T into computer terminals,* and many other segments of the market, will no doubt provoke *vigorous competition from IBM,* which is expected to develop further its position in telecommunications (particularly PABX and later the major industrial networks, and possibly satellite communications)[61]. The battlefield for the two giants could well be that of the office-of-the-future.

The voice/data PBXs of Rolm and Datapoint have rapidly eroded AT & T's share of the market in this area. This share fell from 80% in 1977 to 54% in 1982.

The competitive environment of the American market for telecommunications equipment suppliers seems likely to remain turbulent for a number of reasons:

- the FCC, which has authority to maintain the status quo in telecommunications, seems increasingly favourable to the requests and initiatives of small suppliers or distributors whose indirect goal is to upset the current state of the market — for example, by creating a new service (numerous examples of data transmission and video distribution);
- many new competitors are moving into niches of the market, for example, private telephones;
- telecommunications will attract diversification investments by companies currently operating in declining sectors, or having oil revenues. Telecommunications is becoming a fashionable industry. Many will be attracted to this industry, and although not all will be successful, they will exert competitive pressure;
- distinctions between systems will become blurred (e.g. between "voice" networks and "data" networks);
- AT & T will enter the interconnection market;
- cable television will expand;
- satellite communications equipment will grow significantly (20% per year).

The above factors will create growth in:

- the number of products;
- the number of markets (needs);
- the number of competitors.

Success will be enjoyed by those who put the right product on the right market at the right time; but to do this the proper technology is required.

At a lower agregate level, estimates published in the January 13, 1982 edition of *Electronics* indicate the following evolution for electronic equipment on the American market (current $ million U.S.):

The U.S. Market for Electronic Equipment (in current U.S. $ millions)

(millions of U.S. dollars)	1980	1981	1982	1985
Communications equipment, total	5,700.2	6,426.1	7,234.0	1,000.7
Radio, total	1,747.3	1,930.9	2,132.3	2,772
Aviation mobile (incl. ground support)	65.1	71.2	77.9	98
Marine mobile (incl. recreational)	35.1	37.0	39.0	49
Land mobile (mobile and base stations)	1,100.0	1,213.1	1,336.6	1,691
Amateur (mobile and base stations)	25.5	27.8	30.4	36
Citizens' band (mobile and base stations)	60.8	61.4	62.0	61
Microwave (incl. antennas), total	228.5	256.1	286.9	408
Analog	195.7	213.8	232.6	299
Digital	32.8	42.3	54.3	109
Broadcast (a-m and fm, incl. antennas)	55.5	59.4	63.6	76
Satellite earth stations	176.8	204.9	235.9	350
Radar (incl. weather and navigation), total	170.1	178.8	187.6	246
Telemetry (industrial only)	70.0	76.5	81.0	105
Telecommunications, total	1,627.0	1,801.5	2,008.6	2,735
Voice-switching systems, total	1,583.0	1,736.5	1,912.1	2,459
Central office	562.0	613.5	688.1	875
PABX	1,021.0	1,123.0	1,224.0	1,584
Data-switching systems	44.0	65.0	96.5	276
Fiber-optic communications systems, total	92.3	144.0	227.5	466
Modules and subsystems	23.5	39.3	59.5	130
Complete systems	68.8	104.7	168.0	336
Pocket pagers, total	81.0	97.0	114.0	164
Tone only	71.0	84.0	97.0	139
Tone plus	10.0	13.0	17.0	25
Data-communications equipment, total	1,393.3	1,620.9	1,837.9	2,624
Acoustic (modems), total	405.0	483.5	532.0	710
Low-speed (less than 2,400 b/s)	122.5	146.0	160.0	210
High-speed (2,400 b/s and over)	282.5	337.5	372.0	500
Multiplexers	147.5	192.1	231.5	377
Programmable concentrators	131.5	151.2	191.1	297
Front-end communications processors	522.3	590.0	660.8	925
Message-switching systems	187.0	204.1	222.5	315
Facsimile terminals	148.3	166.3	191.2	290
Television equipment, total	370.9	410.2	453.9	605
Broadcast equipment, total	123.3	131.4	140.3	170
Transmitters	18.1	19.5	20.9	25
Antennas	18.7	21.2	24.0	34
Cameras	36.0	38.1	40.2	47
Auxiliary equipment	50.5	52.6	52.2	64
CATV, total	197.0	220.9	246.8	343
Studio and head-end	46.5	55.0	63.2	95
Distribution (amps, supplies, etc)	88.0	98.0	109.1	145
Transmission (except for fiber-optic)	33.0	36.4	40.0	53
Converters	29.5	31.5	34.5	50
CCTV, total	50.6	57.9	66.8	92
Cameras	33.6	37.9	42.8	58
Monitors	17.0	20.0	24.0	34

Source: *Electronics*, January 13, 1982, p.133

IV.2.2 Canada

The Canadian telecommunications market has been the subject of several studies and reports, among which:

- the Clarke report: *A Report by the Sector Task Force on the Canadian Electronics Industry* (chaired by L.D. Clarke, 1978);
- the Clyne report: *"Telecommunications and Canada"* (1979);
- the Davies report: *Marketing in the Telecommunications Industry*, by J.D. Davies (Northern Telecom Ltd.) (1980);

i) Organization and Regulation of Telecommunications in Canada

The Canadian telecommunications services market is dominated by private companies regulated by the Canadian Radio-television and Telecommunications Commission (CRTC). The CRTC, created by an Act of Parliament in 1976, has jurisdiction over all matters relating to federal telecommunications.

The role of the Department of Communications, created in 1969, is basically one of coordination, information and research, the object being to provide Canadians with the best service and access to communications. Research is conducted by the Communications Research Centre (CRC), which is the second-largest telecommunications R & D centre in Canada (the largest being Bell-Northern Research Ltd.).

A series of acts regulate telecommunications distribution in Canada: for example, the *Broadcasting Act* regulates radio broadcasting, the *Radio Act* regulates the granting of licences for radio and space telecommunications. These Acts assign spectrum management to the Department of Communications.

Lastly, the RTPC (Restrictive Trade Practices Commission) is closely linked to the telecommunications industry in Canada even though its mandate does not specify any industry in particular. Equity relations and cooperation between Bell Canada and its subsidiary, Northern Telecom, have been the subject of extensive hearings by the RTPC in order to keep the telecommunications market open to competition.

ii) Government and Foreign Competition

Even though the private sector provides public telecommunications services in Canada, as in the United States, our country's limitations have given rise to a different philosophy with regard to regulation and government attitude towards exterior markets: first, only one Canadian telecommunications equipment manufacturer, Northern Telecom, has a sales volume of over U.S. $1 billion, thereby earning recognition as one of the thirteen major world multinationals. Well-known companies like AEL Microtel or Mitel are very

much smaller. Second, the Canadian domestic market is one-tenth the size of the American market and contains greater disparities than the United States in population distribution and industrial activities. Under these conditions, even though the Canadian government recognizes that competition among manufacturers has beneficial effects on the development of the market, it would be economically irrational for Canada to decide to deregulate, as has recently occurred in the United States, or to terminate the special relationship that exist beween certain Canadian marketing companies and telecommunications equipment manufacturers. Decisions such as these would result in the loss of the critical size needed for Canadian manufacturers to be active on world markets. They would also make it impossible to obtain a sound return on R & D investment within a reasonable time and would cut Canadian manufacturers off from field testing of new products resulting from their R & D efforts.

Research and development is of fundamental importance in the telecommunications sector. Even though Telidon has often been cited as an example of the public sector's effort in this area, it is in basic and applied research, through the Communications Research Centre, and in various fields such as satellite communications, radio, opto-electronics, radar, and microwaves, that government assistance to Canadian industry might prove to be a determining factor. We cannot expect a company, even one the size of Northern Telecom, to develop on its own both basic and applied research in a number of diverse yet inter-related fields. It must be realized, however, that the private Bell-Northern laboratories are still the largest industrial research centre in Canada.

Government action to protect the domestic market and support the international expansion of Canadian manufacturers is limited by factors that cannot always be controlled. For example, tariff protection is often circumvented by international competitors' strategies to establish subsidiaries. In addition, in the framework of the GATT agreements, it is unreasonable to hope that we can both protect our market and obtain concessions from our trading partners. The battle is thus waged with indirect measures such as non-tariff barriers (purchasing policies), a system of assistance and support to industry in international negotiations, financial assistance, and so on. *The question remains: to what extent does Canada's aid system enable our national manufacturers to be competitive in foreign markets, in both exports and foreign investments?*

Phase III of this study will address this very question.

iii) Canada's Industrial and Technological Capacity

Canada has been a pioneer in areas of advanced telecommunications technology such as domestic satellite communications, digital switching and fibre optics transmission systems.

It appears, however, that despite the individual successes of firms like Northern Telecom or Mitel, Canada's industrial capacity does not compare favourably with that of its major international competitors. Table IV.2.2 reveals that the largest Canadian telecommunications equipment manufacturer competes with foreign industrial groups that are often more powerful, more diversified and able to use development chain strategies to their advantage in a much broader range of applications.

Since these groups are able to finance more diverse R & D activities, using budgets that are larger in absolute terms and often supplemented by government funds, it is reasonable to assume that these competitors now have the opportunity to catch up to Canadian industry in those fields where it excels today and, even more dangerous in the long term, to be first in introducing new technologies. Fujitsu's entry into the field of fibre optic applications and that of AT & T into new market segments, the looming battle between AT & T and IBM and the strengthening of Siemens' position in North America are only a few of the changes in power relationships that could threaten the Canadian telecommunications equipment industry.

Analysis of the evolution of international specialization in certain Canadian high technology industries[62] has shown that, despite a noteworthy increase in exports, Canada has been growing less self-sufficient in telecommunications equipment in recent years, whereas foreign products have been penetrating the Canadian market at an increasing rate. A recent study of the electronics sector, published by Canadian Electronics Engineering[63], comes to the same conclusions.

Despite Northern Telecom's size and vitality, AEL Microtel's reorganization efforts, Mitel's success and the existence of almost one hundred smaller firms[64], many of which anticipate significant growth rates (SPAR Aerospace, SED, Systcoms International, Glenayre Electronics, Gandalf), *analysis suggests that the undeniable potential of Canadian technology cannot be developed, or the domestic market mastered over the long term, unless Canada's industrial capacity is strengthened and research and development efforts stepped up.* A policy must be designed and implemented with a view to increase Canada's power in the international marketplace. Government has a key-role to play, both in research and development and by stimulating private industry and providing it with various forms of assistance in order to better meet international competition.

B. The Canadian Market and its Participants

The telecommunications equipment market in Canada appears to have topped Can $2 billion in 1981, and forecasts indicate that this figure should double between now and 1990.

In millions of US dollars, the growth of sales may be broken down as follows:

(million of US $)	Market Estimate for 1980 $	Forecasts for 1985 $	1990 $	Average Annual Growth Rate 1980-85 %	1986-90 %
Telephone	1,313.2	1 973.9	2,904.7	8.5	8.0
Telegraph, telex and data transmission	122.6	188.4	291.0	9.0	9.0
Satellite communications	9.8	15.0	20.3	8.8	6.0
Mobile radio and radio telephone	125.0	160.0	214.1	5.0	6.0
Paging Systems	7.0	11.1	14.3	9.6	5.2
Cable television	80.0	102.1	130.3	5.0	5.0
Total	**1,657.6**	**2,450.5**	**3,574.7**	**8.1**	**7.8**

Source: Ajustments of Arthur D. Little's data in *World Telecommunications Survey II*, 1980, from the industry's preliminary estimates.

With sales of around Can $2.6 billion in 1981 (half of them in Canada), Northern Telecom dominates this market, with AEL Microtel a distant second with sales of $188.9 million in the same year. Mitel holds a strong position in only certain specific segments of the market (PABX) and had sales of $111 million in 1981. With an extremely rapid growth rate, Mitel's objective for 1985 is $1 billion, while for the same period Northern Telecom anticipates an increase from $2.6 billion to $5 billion.

The strategy of the two companies is based on intensive R & D efforts and the penetration of international markets, as demonstrated by their sales distribution:

Sales in 1981	Sales in Canada	Sales in the United States	Sales in Other Countries	Total in CAN. $ million
Northern Telecom	1,334.6 52%	1,047.0(*) 40.7%	189.3 7.3%	2,570.0 100%
Mitel	20%	64.0%	16.0%	100%
Objectives for 1985:				
Northern Telecom	32%	58.0%	10.0%	5,000
Mitel				1,000

Source: Financial reports and corporate estimates.

(*) Northern Telecom operates 16 plants in the United States.

On the Canadian telephone market, the evolution of technological change indicates that both switching and transmission systems will be expanded and updated with digital technologies. Fifty per cent of transmis-

sions are already done using digital technology. It is estimated that, in 1985, three-quarters of long-distance exchanges and 15% of local exchanges will be digital.

But who will benefit from an expanded Canadian market? The presence in Canada of subsidiaries of foreign firms such as L.M. Ericsson, Philips, GEC (AEI Telecommunications Canada Ltd), Siemens, ITT and Plessey, and Canadian imports of foreign products assembled in the United States represent a share of total sales in Canada that might grow in the future. Thus even though the United States absorbs only 64% of our exports, (Can $730 million in 1980), Canada imports 80% of these same products from the United States ($362 million in 1980). On the other hand—and this is a major concern—trade in components is producing a deficit for Canada, despite significant efforts of Northern Telecom [65] and Mitel in the field of LSI and VLSI circuits. According to the statistical estimates of the Maclean-Hunter Research Bureau in its most recent study of the structure of Canadian foreign trade in electronic products [66], the value of Canadian imports of electronic components rose to $909 million in 1981, compared to exports of $293.1 million, for a deficit of $616.8 million.

The following tables taken from this study show that the Canadian deficit in the electronics sector has grown continuously over the past five years. This situation is affecting the Canadian telecommunications equipment industry, a major user of electronic components, and its development opportunities (cost of supplies, delivery periods, specifications, reliability and regularity of supply limit the rate of expansion).

Electronic products by major category
(Can. $000's)

Exports	**1977**	**1978**	**1979**	**1980**	**1981***
Telecommunications equipment	220,672	272,538	454,605	643,591	779,500
Semiconductors	26,039	41,319	63,961	138,919	225,000
Components	137,058	189,921	206,429	244,268	293,100
Computers (1)	297,948	438,834	656,202	775,977	983,000
Office machinery	56,098	62,956	78,205	77,285	88,000
Instruments	68,937	75,734	102,322	106,779	125,000
Consumer products	55,861	94,830	104,718	71,566	86,500
Total	**862,613**	**1,176,132**	**1,666,442**	**2,058,385**	**2,580,100**

*Maclean-Hunter Research Bureau estimates.
(1) Includes some items that are shown in the "*Office Machinery*" classification imports.
Source: Statistics Canada.

Imports	**1977**	**1978**	**1979**	**1980**	**1981***
Telecommunications equipment	348,089	376,525	400,700	444,391	537,000
Semiconductors	75,124	121,018	320,966	492,635	573,000
Components	400,747	502,926	683,053	750,212	909,900

Electronic products by major category (cont'd) ($000's)

Imports	1977	1978	1979	1980	1981*
Computers	559,185	861,160	1,112,451	1,663,479	2,515,000
Office machinery	95,055	60,801	62,258	69,695	78,000
Instruments	124,907	154,408	189,091	230,304	269,000
Consumer products	463,480	569,268	607,634	617,001	827,700
Total	**2,066,587**	**2,646,106**	**3,376,153**	**4,267,717**	**5,709,600**

*Maclean-Hunter Research Bureau estimates.
Source: Statistics Canada.

Production	1977	1978	1979	1980*	1981*
Telecommunications equipment	832,127	997,456	1,147,310	1,370,000	1,560,000
Semiconductors	12,500	20,000*	34,156	60,000	75,000
Components	244,275	355,191	425,209	500,000	565,000
Computers	75,345	100,000*	125,000	144,000	176,000
Office machinery	110,025	119,154	239,641	267,000	320,000
Instruments	136,137	147,274	158,000	175,000	193,000
Consumer products	177,863	137,953	176,117	170,000	205,000
Total	**1,588,272**	**1,787,028**	**2,305,433**	**2,686,000**	**3,094,000**

*Maclean-Hunter Research Bureau estimates.

Apparent consumption (1)	1977	1978	1979	1980*	1981*
Telecommunications equipment	959,544	1,101,443	1,093,405	1,170,800	1,317,500
Semiconductors	61,585	99,699	291,161	413,716	423,000
Components	507,964	668,196	901,833	1,005,944	1,181,800
Computers	336,582	522,326	581,249	1,031,502	1,708,000
Office machinery	148,982	116,999	223,694	259,410	310,000
Instruments	192,107	225,948	244,769	298,525	337,000
Consumer products	585,482	612,391	679,033	715,435	946,200
Total	**2,792,246**	**3,247,002**	**4,015,144**	**4,895,332**	**6,223,500**

(1) Domestic production plus imports minus exports.
*Maclean-Hunter Research Bureau estimates.
Source: Statistics Canada.

Source: *Canadian Electronics Engineering*, January 1982.

Imports of electronic products 1978-1981 ($000's)

Telecommunications equipment	1978	1979	1980	1981*
Telephone apparatus, equipment and parts	92,061	115,851	113,456	116,000
Commercial comm. equipment, n.e.s.	83,792	85,334	111,368	148,000
Radio, TV, broadcast transmit. eqpt.	38,434	36,086	39,555	41,000
Video tape	16,818	21,139	25,817	44,000
Radio transmitting, receiving units	40,723	28,388	32,250	54,000
Telegraph apparatus & parts	22,321	22,338	21,999	21,000
Alarm & signal systems & parts	32,440	30,863	28,330	31,000
Radar equipment & parts, n.e.s	21,526	28,821	34,742	39,000
Sonar echo sounding equipment & parts	8,571	13,650	10,790	9,000
Railroad & transit signal systems & parts	19,839	18,230	26,084	34,000
Sub-Total	**376,525**	**400,700**	**444,391**	**537,000**
Semiconductors				
Integrated circuits	52,624	104,883	157,756	157,000
Transistors	38,896	51,277	49,786	37,000
Other semiconductors	23,022	134,152	246,541	320,000

Imports of electronic products (cont'd) 1978-1981 ($000's)

Semiconductors	1978	1979	1980	1981*
Semiconductors parts	6,476	30,654	38,552	59,000
Sub-Total	**121,018**	**320,966**	**492,635**	**573,000**
Components				
Speakers and parts	71,536	82,809	77,049	95,000
Receiving antennas and mountings	9,998	12,080	9,924	12,000
Capacitors, electronic, and parts	35,182	52,792	53,877	52,000
Resistors, electronic, and parts	16,056	25,549	21,565	22,000
Transformers, electronic, and parts	17,605	21,905	23,309	27,000
Sound amplifiers	29,971	36,549	35,708	42,000
Parts for phonographs & record players	46,189	46,259	43,574	55,000
Chassis for TV, radio and phonographs	22,405	41,942	54,252	81,000
Tuners	13,695	14,315	16,247	21,000
Electronic tubes	14,182	22,867	32,294	38,000
Electronic tube parts	15,825	20,840	32,382	48,000
P.C. boards	9,113	13,928	18,831	17,000
TV picture tubes	8,364	14,940	13,939	28,000
Parts for tape players and recorders	8,900	12,838	13,056	20,000
Crystals (mounted) and holders	2,590	3,323	3,469	3,400
Inductors, coils, and parts	5,542	7,775	10,920	10,500
Power packs and parts	5,057	5,692	6,345	9,000
Microphone and parts	6,612	6,935	7,620	10,000
Other components, n.e.s	164,104	239,715	275,851	319,000
Sub-Total	**502,926**	**683,053**	**750,212**	**909,900**
Computers				
Electronic computers and parts	853,200	1,103,454	1,652,774	2,500,00
Computer tapes	7,960	8,997	10,705	15,000
Sub-Total	**861,160**	**1,112,451**	**1,663,479**	**2,515,000**
Office machinery				
Calculating machines and parts	51,016	56,627	60,484	65,000
Card punch, sorting and tabulating machinery and parts	9,785	5,631	9,211	13,000
Sub-Total	**60,801**	**62,258**	**69,695**	**78,000**
Instruments, testing and measuring				
Oscilloscopes and graphs	13,460	15,300	17,067	21,000
Signal gen. & test. oscilliators	7,678	8,184	8,122	12,000
Elect. property meas. instr. & parts	15,433	16,850	23,634	32,000
Elect. property record instruments	8,393	11,259	14,433	17,000
Elect. measuring & test. instr., n.e.s	42,102	58,908	66,509	80,000
Nuclear radiation detection & measure	8,364	9,281	10,425	13,000
X-ray equipment and parts	58,978	69,309	90,114	94,000
Sub-Total	**154,408**	**189,091**	**230,304**	**269,000**
Consumer products				
Tape recorders and players	73,178	93,188	111,531	182,000
Magnetic tape, n.e.s	30,072	36,455	45,104	57,000
TV receiving sets, color	207,506	196,169	155,128	151,000
TV receiving sets, other	21,634	33,863	26,142	34,000
Automobile radio receiving sets	60,387	57,405	60,942	75,000
Other radio receiving sets, excl. parts	76,042	70,213	77,035	116,000
Coin-operated phonographs	1,590	1,531	1,267	1,000
Phono record players, domestic	2,667	2,574	3,996	3,400
Radio-phono combinations	60,055	78,743	90,562	145,000
Hearing aids and parts	7,815	11,040	11,858	9,300
Microwave ovens	28,322	26,453	33,438	54,000
Sub-Total	**569,268**	**607,634**	**617,001**	**827,700**
GRAND TOTAL	**2,646,106**	**3,376,153**	**4,267,717**	**5,709,600**

*Maclean-Hunter Research Bureau estimates.
n.e.s — not elsewhere specified
Source: Statistics Canada

Source: *Canadian Electronics Engineering*, January 1982.

Exports of electronic equipment ($000's)

Telecommunications equipment	1977	1978	1979	1980	1981*
Telephone apparatus, equipment and parts	94,947	122,782	231,130	300,223	315,000
Telegraph apparatus, equipment and parts	2,828	4,405	2,430	902	3,000
Radar equipment and related devices and parts	12,524	13,996	11,046	13,439	19,000
Radio transmitting receiving units	11,662	14,266	14,888	23,788	23,500
Radio, TV broadcasting, transmitting equipment and parts, n.e.s	11,808	14,330	19,154	45,702	33,000
Commercial telecommunications equipment, n.e.s	86,903	102,759	175,957	259,537	386,000
Sub-Total	**220,672**	**272,538**	**454,605**	**643,591**	**779,500**
Semiconductors					
Semiconductors and parts	**26,039**	**41,319**	**63,961**	**138,919**	**225,000**
Components					
Sound amplifiers, excluding parts	2,367	2,561	2,792	2,705	8,000
Electronic tubes and parts	18,065	38,166	41,665	43,915	41,000
Electronic resistors and parts	6,554	6,401	7,166	5,362	6,000
Transformers, electronic type, and parts	3,113	1,259	1,472	1,770	2,000
Printed circuit boards	8,804	15,133	22,455	27,984	36,000
Chassis for radio, TV, phonograh	1,572	1,693	2,009	446	100
Electronic equipment components, n.e.s	95,857	122,945	126,698	160,719	196,000
Receiving antennas	726	1,763	2,172	1,367	4,000
Sub-Total	**137,058**	**189,921**	**206,429**	**244,268**	**293,100**
Computers					
Card punching, sorting and tabulating machines and electronic computers and parts	**297,948**	**438,834**	**656,202**	**775,977**	**983,000**
Office machinery					
Office machines and equipment & parts n.e.s(1)	**56,098**	**62,956**	**78,205**	**77,285**	**88,000**
Instruments					
Electrical and electronic properties measuring, and testing	11,277	11,807	22,401	23,665	20,000
Laboratory and scientific instruments, equipment and parts, n.e.s (2)	34,698	34,070	45,138	49,372	67,000
X-ray and related equipment and parts	22,962	29,857	34,783	33,742	38,000
Sub-Total	**68,937**	**75,734**	**102,322**	**106,779**	**125,000**
Consumer products					
TV receiving sets, excluding combinations	17,937	43,149	30,353	31,826	37,000
Radio receiving sets	33,648	46,177	68,230	36,356	22,000
Combination radio-phonograph sets	4,276	5,504	6,135	3,384	27,500
Sub-Total	**55,861**	**94,830**	**104,718**	**71,566**	**86,500**
GRAND TOTAL	**862,613**	**1,176,132**	**1,666,442**	**2,058,385**	**2,580,100**

*Maclean-Hunter Research Bureau estimates.

(1) Excludes adding machines and parts, typewriters and typewriter parts, accessories and attachments.

(2) Includes magnetic and radiation detectors.

n.e.s — Not elsewhere specified

Source: Statistics Canada

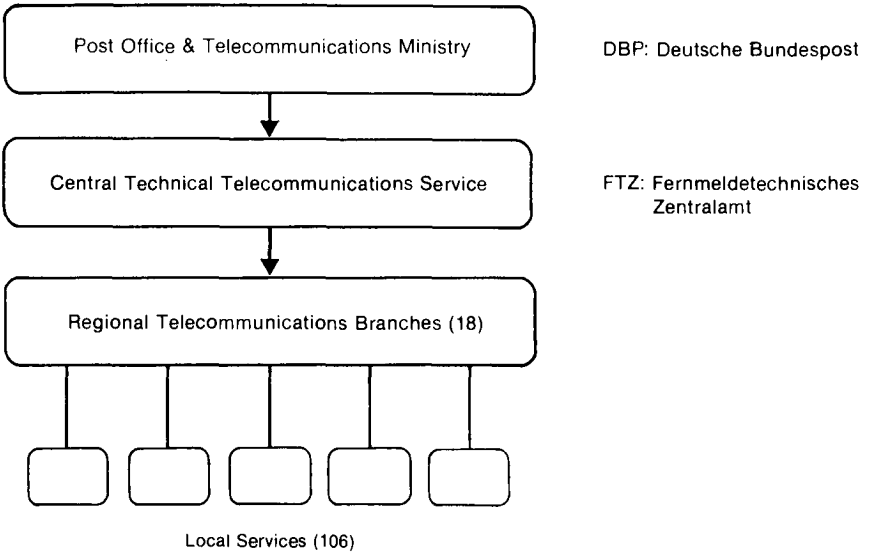
Source: *Canadian Electronics Engineering*, January 1982.

IV.2.3 West Germany (F.R.G.)

A. Domestic Environment

i) Organization and Regulation of Telecommunications in West Germany

The organization of telecommunications in West Germany can be represented as follows:



The DBP, the largest service organization in West Germany, regulates the entire telecommunications sector. It provides public telecommunications services, operates radio telecommunications, administers and regulates spectrum use and radio and television broadcasting services.

In addition, the DBP has two specific duties in the area of telecommunications:

- it plans telecommunications equipment needs;
- it establishes regulations in this field through its Central Technical Service (FTZ).

Technical standards laid down by the DBP for the construction of telecommunications hardware are exacting and detailed. Regulations on interconnection are also fairly severe: individual subscribers must buy from and have their telephones maintained by DBP technical services. The

modems needed to transmit data may be obtained only through the DBP. Private PBX exchanges may be purchased from private producers (whose equipment must first be approved by the FTZ), but must be installed by DBP technicians. This stringent regulation of both equipment and interconnection is often criticized because of its effects on innovation and on the price of telecommunications equipment. However, pressures exerted by the EEC to liberalize the telecommunications equipment market (particularly terminals) should soon ease the regulations.

ii) Government and Foreign Competition

We should note two particular aspects of the organization of telecommunications in West Germany:

- contrary to most other PTT public services, DBP receives no other government assistance and must finance itself;
- contrary to its French or British equivalents, the Central Technical Telecommunications Service (FTZ) conducts no major R & D activities. According to an AEG-Telefunken director, "telecommunications equipment in West Germany is developed exclusively with the industry's own funds and at its own risk"[67]. However, this quote conflicts with German government statements[68].

The West German telecommunications industry has a long export tradition and, as a result, has established a solid base in the markets of industrialized and developing countries.

At the domestic level, the industry also enjoys a privileged position with its major client, DBP, which absorbs 80% of the telecommunications equipment market.

Pressure exerted by DBP in order to unify technology (less diversity in equipment) has caused the high degree of concentration observed in the telecommunications equipment manufacturing sector. In addition, the rather strict regulations imposed by DBP on the technical characteristics of equipment does not encourage market liberalization. In general, we can thus assume that West German companies in the telecommunications equipment manufacturing sector are highly protected from both foreign and domestic competition.

iii) West Germany's Industrial and Technological Capacities

West Germany's telecommunications sector is as vigorous as the country's economy. Its manufacturers enjoy an international reputation with developing countries.

The major challenge of the period 1980-1990 will be to convert from analog switching and transmission to digital systems (a challenge which DBP, it appears, is in no hurry to face, according to some observers).

Siemens is by far the leader among West German manufacturers, with sales of telecommunications, telegraph and signal equipment in the order of

$5 billion U.S., part of a consolidated sales figure of $17.6 billion in 1980. In 1981, Siemens' consolidated sales figure was estimated at $19.1 billion.

The size of this multinational firm — which employs more than 330,000 persons in 129 countries and spends 9.5% of its consolidated sales figure on R & D ($1.65 billion U.S. in 1980) — and the breadth of its activities (computing, electrical energy, telegraphy and signalling, electrical installations, medical techniques and telecommunications) place the company second behind ITT in the telecommunications field. Siemens offers a wide range of telecommunications equipment. It dominates the domestic telex equipment market (66% of the West German market), the domestic public switching (48%) and private switching (33%) market, and is strong in the telephone equipment (33%) and in the transmission cable market. Siemens is still the world leader in telex equipment with gross sales of hardware for telegraphy, computer communications, railroad signal systems and general signal equipment of about $1.5 billion in 1981. Having firmly established itself in the major world markets, the Siemens group continues to grow through its foreign subsidiaries[69] and through cooperation agreements with foreign partners[70]. It is also increasingly oriented toward markets for terminals (text and data transmission), digital switching and fibre optics[71].

Standard Elektrik Lorenz (SEL), a subsidiary of ITT, is the second largest manufacturer of telecommunications equipment in West Germany. Its presence is felt in public switching (30% of the market) and in telex equipment (second manufacturer after Siemens); it is also active in private automatic branch exchanges (Unimat 4080, a PABX of over 100 lines) and in electronic office equipment (teleprinter LD 2001), and has established itself firmly in electronic data processing (ITT 380-X computer and ITT 3280 display system), which is a rapidly expanding market.

In electronic data processing, *Nixdorf* has acquired a world-wide reputation. Established in 29 countries, Nixdorf hopes to be more active in electronic office equipment and to apply recent technical progress in semiconductors, especially VLSI.

Lastly, the *AEG-Telefunken* group (138,000 employees, consolidated sales figure of $8.1 billion U.S. in 1981, 22% of which was for telecommunications equipment and transportation systems) could play a major role on the telecommunications market, particularly in the transmission field, either directly or through its subsidiaries and affiliates. To this end, however, a viable solution still has to be found in response to this group's recent financial collapse.

B. The West German Market and its Participants

Accounting for 87.6% of equipment expenditures in 1980, the telephone occupies the major segment of the telecommunications equipment market in West Germany (DBP being the largest purchaser). In 1980, DBP connected

the twenty millionth telephone line, and it is estimated that in 1985, 25 million lines will exist (90% of West German households will have a telephone line). However, DBP's planned expenditures for 1982 (US $4.88 billion) barely exceed the 1981 figures. The recent saturation of the telephone market could be a partial reason for this situation. Contrary to France and Great Britain, West Germany is adopting digital technology very slowly. Only in the late 1980's will the massive introduction of digital technology (both in switching and fibre optics transmission) be a factor in the revival of the domestic telecommunications equipment market. It is expected, however, that as of 1985, the market for private automatic branch exchanges (PABX) will develop significantly. For the moment, growth in the PABX private sector is slow[72].

It is expected that the market for telegraph, telex and data transmission equipment will grow in the 1980s at an average annual rate of 6.5%. Following the trend of the past five years, the telex will tend more and more to replace the telegraph and we may expect a rapid boom in the market for terminals resulting from development of digital technology in data transmission.

There will be moderate growth in the market for radio transmission equipment, the exception being the radio paging services market, which could rise from $4.9 million in 1980 to $17.3 million at the end of the decade.

For internal political reasons (legal and territorial jurisdiction problems), the cable television market will develop later (to close to $100 million by 1990).

A decision by DBP to step up conversion to electronics, however, could help accelerate growth beyond its planned rate. Such a decision seems

The German Telecommunications (in US $ millions)

	Market Estimate	Forecasts for		Average Annual Growth Rate in %	
	1980 $	1985 $	1990 $	1980-85 %	1986-90 %
Telephone	1,569.9	1,474.3	1,311.8	-1.2	-2
Telegraph, telex and data transmission	76.2	103.6	125.8	6.6	3
Satellite communications	13.6	17.4	23.5	5.1	6
Mobile radio and radio telephone	127.6	132.7	138.5	0.8	1
Paging Systems	4.9	12.5	17.3	21.0	7
Cable television	0.0	10.0	98.1	-	58
Total	**1,792.2**	**1,750.5**	**1,715.0**	**-0.4**	**0**

Source: Arthur D. Little, *World Telecommunications Survey II*,1980.

unlikely given the existence of relatively new exchange equipment; more than 50% of present equipment was installed less than ten years ago.

The most favourable trends appear mainly in the market for specialized terminals for data and text transmission.

Lastly, in the field of broad-band transmission networks, the Bigfon project (fibre optics) has received $66 million in recent months.

Significant developments are also expected in videotex between now and 1985 (Bildschirmtext).

IV.2.4 United Kingdom

A. Domestic Environment

i) Organization and Regulation of Telecommunications

The British Post Office controls and administers national and international public telecommunications in the United Kingdom. The BPO became a Crown corporation independent from the public service in 1969. The Post Office and Telecommunications Ministry exercises some control over the BPO in determining policies and investment in communications.

In June 1979, following government changes in the telecommunications sector, the BPO was reorganized internally. British Telecom, a government agency independent from the BPO, was created to meet market requirements more adequately, particularly by way of system modernization.

Private telecommunications are under the authority of the Home Office and under the administrative wing of the Home Office Radio Regulation Department, while government parapublic services are regulated by the Telecommunications Branch.

C & W (Cable & Wireless Ltd). is another Crown corporation totally independent from the BPO, providing international consultation and start-up services in both public and private telecommunications sectors. It controls 10% of the world's satellite earth stations and, alternately with the BPO, occupies a seat within Intelsat.

The BPO also participates in Euronet, a project designed to link the data networks of European countries. Several non-member countries of the EEC, such as Switzerland, Norway and Spain, are interested in the project.

As in West Germany, PBX link-ups to the public telephone network must be approved by the government agency which also provides equipment and maintenance services. But this market is now opening up gradually, while awaiting the deregulation expected for October 1983 at the latest.

ii) Government and Foreign Competition

The United Kingdom's equipment purchasing policy is rather nationalistic. Supply contracts are given first to domestic companies and the United

Kingdom buys abroad only if it cannot otherwise obtain equipment. Europe is the second supplier, but when the United Kingdom cannot supply equipment, it is rarely available from other European countries. There is little foreign investment in the networks controlled by the BPO, except for Siemens facsimiles, Mitsubishi earth stations and L.M. Ericsson transmission links. In the modernization projects announced by British Telecom at the end of 1981, the program to install 150 new large TXE-4A semi-electronic local exchanges and to extend 54 TXE-4 exchanges already in service will result in annual expenditures of US $384 million[73]. Domestic suppliers (Plessey Telecommunications Ltd., GEC Telecommunications Ltd. and Standard Telephone & Cables, a British subsidiary of ITT) will share orders for this project.

The purpose of the British government's policy is to modernize its equipment. This will involve enlarging the telephone network, increasing the number of subscribers, and replacing out-of-date Strowger switching equipment. The telegraph, telex and data transmission systems market should grow considerably in the 1980s (see market estimates in section B, *The U.K. Market and Its Participants).*

Despite the prevailing climate of budget austerity in 1981 and 1982, British Telecom proposes, in addition to the TXE-4 exchanges project, to establish a parallel network designed to provide modern services to British companies. This network will depend on the installation of 35 digital exchanges (Systems X) and fibre optic links. Domestic suppliers will share an initial order of U.S. $29 million and are seeing new perspectives open up with British Telecom's plans to convert to long distance links by fibre optics cables around 1985.

Furthermore, the deregulation expected between now and October 1983 for telephone terminals, PABX and value-added services should encourage private competition with the government agency. In 1982, British Telecom already had phone centres, and British and foreign firms are beginning to penetrate the private interconnection market. Lastly, British Telecom has just announced the introduction of Teletex and electronic mail services in the near future[74].

iii) Industrial and Technological Capacities of the United Kingdom

Even though the United Kingdom has long been recognized as one of the world leaders in such fields as underwater cable transmission and satellite communication systems, its progress in digital switching is somewhat slower than that of other major supplier countries. Work on System X did not begin until December 1977, and only in 1982 did the first exchanges begin using this system in public telecommunications services.

The initial investment of U.S. $300 to $400 million was made in the development of System X in 1977. One of the results of this project was the

creation of BTS (British Telecommunications Systems) by BPO, Plessey, GEC and STC to develop this technology jointly on an international scale.

iv) Overview of the Five Major British Market Suppliers

Britain's telecom capacity rests mainly on five major suppliers: Plessey, GEC, STC, the Pye Group (subsidiary of Philips) and Racal.

Plessey

This group offers a fairly broad range of products and specializes in Strowger telephone switching, Crossbar 5005, TXE 2 rod switch , TXE 4 and digital switching (System X). Its consolidated sales amounted to US $1.955 billion in 1981 decreasing from $1.968 in 1980. However, total sales of telecommunications equipment increased from $787 million in 1980 to $850 million in 1981.

The group also works in telegraph switching and road and railroad signal systems. Plessey operates seven plants in the United Kingdom which employed approximately 16,000 workers in 1980. It also has manufacturing plants in Brazil, Australia, Canada, South Africa, U.S.A. and Italy for a total of more than 47,000 people employed over the world.

Plessey's development policy is directed toward integrated services digital networks and also aims at meeting rural needs worldwide.

GEC (General Electric Company Ltd.)

The General Electric Company Ltd. is comprised of approximately 80 companies operating in Great Britain and overseas. The largest in this group are GEC Telecommunications, Marconi Communication Systems Ltd., Telephone Cables Ltd., Marconi Instruments Ltd. and Associated Automation Ltd. Consolidated sales in 1980 and 1981 were respectively $8.2 and $8.3 billion with about 16% coming from telecommunications equipment.

GEC Telecommunications Ltd. is one of the BPO's major suppliers of switching and transmission equipment. Sales in this sector totalled U.S. $400 million in 1978-1979. The company also supplies multiplexing systems.

Marconi Communication Systems Ltd. has supplied the BPO with two satellite earth stations, one for Intelsat and the other as part of the European space program.

Associated Automation Ltd. supplies telephone booths and Telephone Cables Ltd. a variety of cables and wire, and more recently, fibre optics for transmission systems.

Marconi Instruments Ltd. supplies equipment for measuring and testing telecommunications equipment and microprocessors manufactured by GEC.

The GEC group takes an active role in the System X implementation program as a member of the BTS consortium and as a supplier of electronic pairs , telephones, PBXs and parts.

The British Telecommunications Market (in US $ millions)

	Market Estimate	Forecasts for		Average Annual Growth Rate in %	
	1980 $	1985 $	1990 $	1980-85 %	1986-90 %
Telephone	974.0	1,651.5	2,804.9	11.1	11
Telegraph, telex and data transmission	73.0	173.6	342.4	18.4	15
Satellite communications	3.8	8.8	22.0	18.4	20
Mobile radio and radio telephone	68.5	140.5	261.7	15.4	13
Paging Systems	10.8	24.1	41.4	17.5	11
Cable television	0.4	0.6	1.4	12.6	11
Total	**1,130.5**	**1,999.5**	**3,473.9**	**12.1**	**12**

Source: Arthur D. Little, *World Telecommunications Survey II*,1980.

In 1979, this group's telecommunications equipment revenues totalled U.S. $1.7 billion, of which $1.3 billion was derived from exports (mainly to the United States).

Standard Telephones and Cables Ltd. (STC)

STC is a former member of an American conglomerate. In 1979, 15% of its shares were sold to private interest in Great Britain. The company employs 36,000 people in the United Kingdom and sells a range of products that includes telephone sets, telephone switching equipment, transmission equipment, parts and fibre optics. The company also belongs to BTS, which is responsible for implementing System X.

In 1978, its sales totalled U.S. $1.1 billion , $822 million of which was from telecommunications.

The Pye Group

The Pye Group employs approximately 14,000 people, and had sales of approximately U.S. $400 million in 1980. The two divisions most closely involved in public telecommunications in the United Kingdom are Pye TMC Ltd. and Pye Telecommunications Ltd.

Pye TMC Ltd. manufactures two groups of products: hardware designed for the subscribers and switching equipment. Production is focussed on telephone equipment, electronic keyboard and automatic paging systems, and in peripheral switching equipment.

Pye Telecommunications Ltd. and Pye TMC produce most of the Pye group's profits. Pye Telecommunications Ltd. division is the leader in the

mobile radio sector where it holds 60% of the U.K. market and 7% of the West German market. It is also Europe's largest exporter of mobile radios. Since October 1979 Philips owns a 39% interest in the Pye Group.

Racal

Racal Electronics, founded in 1950, is among the major English telecommunications equipment manufacturers. Thirty per cent of its commercial activity takes place in the United Kingdom, mostly outside public networks. Its range of products includes modems, switching equipment, security systems, line printers[g] and message switching systems.

B. The U.K. Market and its Participants

According to the estimates produced by Arthur D. Little Inc., the United Kingdom market will rise from U.S. $1.1 billion to close to $3.5 billion between 1980 and 1990.

Although expanding during the period under study, it appears that the British public services market will remain closed to foreign suppliers, unless the latter establish subsidiaries, as ITT has done with STC (Standard Telephone & Cables Ltd.), or establish joint operations such as those which led to the creation of BTS (described in section iii). Domestic competition primarily involves the five national producers mentioned above.

With the expected deregulation of the interconnection and private PBX markets, and given British Telecom's effort to provide services to companies, market opportunities for certain foreign products should arise in the near future. The sale of Danish and Swedish telephone models distributed through British Telecom's new phone centres and Mitel's success on the British PBX market are steps in this direction.

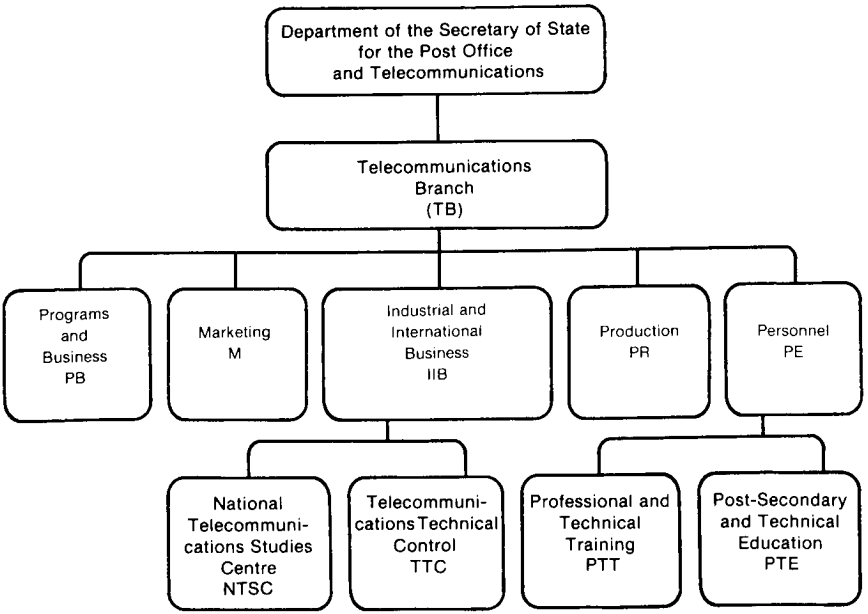
IV.2.5 FRANCE

A. Domestic Environment

i) Organization and Regulation of Telecommunications in France

Accountable to the Department of the Secretary of State for the Post Office and Telecommunications, the Telecommunications Branch (TB) regulates the entire telecommunications sector in France, including equipment procurement, standards, installing and managing all telephone services across the country.

The simplified organization chart presented below shows the five major branches of the TB:



The Industrial and International Business Branch (IIB) plays a key role in this organization. The French industrial telecommunications strategy depends essentially on this branch, whose mandate is to establish industrial policies, to research and develop new products, and to establish international agreements and export policies.

Through the broad range of activities assigned to it, the Telecommunications Branch determines the conditions for implementing French industrial policy. Much more than an administrative body in the traditional sense of the term, the IIB is an active force, and its conduct is guided by the major options of the French Economic Plan. TB works very closely with the industry, conducts major research and development projects through the NTSC[75] and makes a major contribution to professional, scientific and technical training[76]. Lastly, the size of orders received by French equipment manufacturers give them a strong domestic base, a necessary condition for successful competition in foreign markets. The changes which have occurred in various electronics sectors in France, particularly the restructuring of the telecommunications industry begun in 1976, and the modernization of the French telephone network, underline TB's role in preparing and implementing government policies in this key sector of the economy.

ii) Government and Foreign Competition

1976 was a turning point for French telecommunications. It was the first year of the VIIth Plan (1976-1980) and a year of industrial reorganization. It was also the year in which the French launched an important program to modernize the national telephone network, using the time division technology.

Although there were only 6.2 million subscriber lines in 1974 placing France well behind other European countries, the French government gave priority in the VIIth Plan to improving the telephone network and to creating a world-competitive telecommunications industry in France. Budget appropriations in the order of U.S. $30 billion were provided to increase the number of subscriber lines from 6.2 million in 1974 to 20 million by the end of 1982[77].

The VIIth Plan forecast the following evolution for the major lines in service[78]:

	1973	1974	1975	1976	1977	1978	1979	1980
Millions of lines	7.5	8.23	9.95	11.50	13.60	15.50	17.40	19.30
Increase	-	1.08	1.72	1.80	1.85	1.90	1.90	1.90

PTT orders for switching equipment were as follows from 1975 to 1980 (expressed in thousands of lines)[79]:

	1975	1976	1977	1978	1979	1980
Electronic Systems						
Time Division	100	200	350	590	1150	2565
Space Division	-	120	410	710	850	
Electromechanical Systems						
Crossbar	1685	2050	2130	1450	675	135
Total	**1785**	**2370**	**2890**	**2750**	**2675**	**2700**

The number of telephone lines in service increased from 15.8 million at the end of 1980 to 17.65 million at the end of 1981. It should reach 19.4 million in 1982, which is even more than the objective established in the Plan[80] (28 million by 1987 and 34 million by 1992).

The growth revealed by the above figures and the evolution of switching toward fully electronic systems (PTT administrative agencies will discontinue orders for electromechanical systems after 1982) clearly indicate the major changes that have taken place in France.

Another significant change is the industrial reorganization carried out in May 1976, in which the IIB had three major objectives: to reduce its reliance on traditional suppliers (ITT, Ericsson and CGE) and to introduce new competition, to place most of the telephone equipment manufacturing potential under French control and to increase exports. In this way, the government encouraged the re-purchase of LMT (Le Matériel Téléphonique, subsidiary of ITT in France), LTT (Lignes Téléphoniques et Télégraphiques, subsidiary of LMT) and SFTE (Société Française des Téléphones Ericsson, subsidiary of L.M. Ericsson) by the Thomson-CSF group which thereby became the TB's major supplier, ahead of CGE (CIT-Alcatel). CGE (Compagnie Générale d'Électricité) strengthened its position in time division technology by acquiring SLE-Citerel from the Thomson group in exchange for its earlier participation in SFTE, and subsequently, through the January 1980 agreement, in which it took over two thirds of public telephone activities from the AOIP (Association des Ouvriers en Instruments de Précision).

The reorganization had the following results: the French share of the overall market increased from 43% in 1974 to 71% in 1977 and from 19% to 80% in the public exchange switching equipment market over the same period[81]. The second result was the elimination from the French switching equipment market of Siemens (SAT space division system) and Philips (TRT space division system), two of the largest European manufacturers[82], and the virtual closing of the market to other foreign suppliers. The "AXE" and "Metaconta" systems manufactured under licence by LMT (now Thomson-CSF) and CGCT (Compagnie Générale de Constructions Téléphoniques, a French subsidiary of ITT) were preferred over all competitors in space division techniques, while the E 10 system of CGE (CIT-Alcatel) was the only time division system retained by the French government. The third result of this policy was to induce French manufacturers to penetrate international markets, beginning in 1977-78. It was at this time that PTT orders began to drop *(see figures above)*. The objectives of the VIIth Plan and of the IIB anticipated the need for French international penetration, and production capacity was already sufficient. By 1976, CGE and Thomson-CSF had already created an export consortium (Telinter) and subsequently put in tenders to Peru, Colombia and Venezuela, proposing a range of French hardware (CIT-Alcatel, LMT, CGCT)[83]. Since that time, the French industrial strategy has gone well beyond the area of telecommunications. This strategy has led to the formulation of a special plan, the *Plan Composants Electroniques* (Electronic Components Plan), designed within the framework of the VIIth and now the VIIIth Plan (1981-1985). The strategy calls for the diversification and regrouping of major French industrial organizations and for associations with foreign firms. Near Marseille, for example, Saint-Gobain-Pont à Mousson and National Semi-Conductor (USA) created a

production unit for MOS[8] semiconductors (Metal oxide semiconductors) under the name of Eurotechnique. Matra and Harris Corp. (USA) have established Matra Harris Semiconductors in Nantes to produce MOS circuits, and Matra has also entered into partnership with General Automation[84]. In 1976, Thomson-CSF and Northern Telecom opened the way to international industrial agreements by negotiating the production under licence of the SL-1 system and the distribution of Northern Telecom's Contempra telephone sets in France.

iii) France's Industrial and Technological Capacities

The industrial reorganization we just described provides a general idea of current French capacities. It appears that with the nationalization policy in effect since 1981-1982, France is moving toward a bipolarization of the industry around the two major groups, CGE and Thomson-CSF, and toward the creation of a new national electronics industry. CGE, Thomson-CSF, Matra, and Saint-Gobain are now completely nationalized. Considering the nationalization of almost the entire banking sector, which is a major user of telematics and a major financing intermediary, and the nationalization of the computer industry with Honeywell-Bull-CII, we might well think that industrial synergy and development chain strategies will increase and multiply in the near future. It remains to be seen whether what France has undertaken through government intervention, as Japan has done differently at the structural level, may not be halted in the long-term by administrative red-tape and inefficiency. Experience shows that there is a fine line between success (e.g., Renault, Airbus Industries) and failure (e.g., Plan-Calcul in the 1960s with Compagnie Internationale d'Informatique (CII), difficulties with the Concorde supersonic jet).

One of the assets of the French telecommunications industry is undoubtedly its technological mastery of time division electronics switching[85] . But CIT-Alcatel must face the competition of powerful groups in foreign markets with advanced technology[86] and better developed international infrastructures. There are a number of favourable elements for French manufacturers: CIT-Alcatel can count on support from the CGE group (sales of U.S. $9.4 billion in 1980); Thomson-CSF can count on Thomson-Brandt (sales of U.S. $8 billion in 1980); the government has tried to bring together the two groups in export markets (particularly through the creation of Telinter); both groups work together in international markets by making industrial agreements with foreign partners[87] or by establishing plants abroad. It is not certain, however, whether they can use international infrastructures as developed as those of ITT, Siemens, Philips, NEC, Hitachi or Ericsson to establish their international position in the entire range of telecommunications equipment.

Even though the French government does much research through the

NTSC or by granting research contracts to companies and private laboratories[88], long-term success in telecommunications equipment sales abroad still depends not only on tested and recognized technology, but also on the quality of the French marketing network abroad. L.M. Ericsson, ITT and Siemens recognized this fact long ago, as did Northern Telecom and Japanese firms. Thomson and CIT-Alcatel, through recent acquisitions in the United States[89], are intensifying their efforts in this direction but, it appears, a bit late.

Evolution of the French Telephone Industry Between 1978 and 1980

		1978	1979	1980
French Production		11,446	11,746	12,820
+ Imports		447	600	631
- Exports		1,126	1,250	1,540
= **Apparent Consumption**	(a)	**10,767**	**11,096**	**11,911**
	(b)	**2,576**	**2,760**	**2,638**

(a) in millions of francs.
(b) in US $ millions, at the average end-of-year rates of exchange, from the *International Financial Statistics*, International Monetary Fund.

Source: 1981 Annual Report of the Groupement des Industries Électroniques Françaises.

B. The French Market and its Participants

The vitality of the French telecommunications market is attributable mainly to government involvement as described above and also to the efforts of firms which, though smaller than Thomson-CSF or CIT-Alcatel, have shown a great deal of initiative. CGCT is one of the PTTs' major suppliers, and is also a very active exporter. TRT, SAT, SAGEM, CSEE[90], Matra, and Jeumont-Schneider are among the most active firms, particularly in the interconnection market. The Canadian firm Mitel, with a recent project to establish two production units in the Vosges Mountains (1000 employees, investments of approximately 150 million francs over 3 years) will contribute to the French private switching and export markets[91].

French telecommunication equipment manufacturers, like their North-American and Japanese counterparts, are betting heavily on the technological convergence of EDP and telecommunications[92]. Lastly, French innovations include significant efforts in satellite communications (Telcom 1), initiatives in the area of fibre optic links (City of Biarritz) and new services (a trial electronic telephone directory in Brittany, development of the Transpac

Forecasts for the French Market

	Market Forecast 1980 $	Forecasts for 1985 $	1990 $	Average Annual Growth Rate in % 1980-85 %	1986-90 %
Telephone	2,480	3,017	3,000	4.0	0.0
Telegraph, telex and data transmission	158	260	332	10.5	5.0
Satellite communications	9	17	37	14.1	17.0
Mobile radio and radio telephone	90	129	173	7.5	6.0
Paging Systems	6	12	18	15.4	9.0
Total	**2,743**	**3,435**	**3,560**	**4.6**	**0.7**

Source: Adjustments to Arthur D. Little's figures, *World Telecommunications Survey II*, 1980; figures have been rounded off. Cable television does not appear because of the special characteristics of the French television systems (SECAM[g] process incompatible with the PAL[g] process of neighbouring countries).

network for packet switched data transmission , development of videotex and inexpensive facsimile equipment).

As a result of the decrease in orders by PTTs, the most noteworthy developments will occur mainly in private markets and in exports. Exports could account for 50% of French production by 1985[93].

Given these observations and the evolution of telephony and telegraphy from 1978 to 1980, it appears that the estimates by Arthur D. Little[94] should be adjusted for the French market.

IV.2.6 The Netherlands

A. The Domestic Telecommunications Environment in the Netherlands

i) Organization and Regulation

Under the direction of the Ministry of Transport and Public Works, the PTT Administration controls telecommunications in the Netherlands, but does not directly finance research. In this field, the Administration's role is limited to defining technical standards and auditing their application. As a government organization, it is subject to political decisions and must have all new services or tariffs approved by Parliament. All equipment linked directly to the public network — PBXs, modems and other hardware — must be approved by the PTTs.

ii) The Government and Foreign Competition

PTT equipment policies are strongly influenced by the country's social and political context. Like the rest of the EEC, the Netherlands is experiencing a period of inflation and unemployment. In these conditions, local suppliers, primarily Philips, but also L.M. Ericsson which has a factory in Holland, will probably obtain almost all of PTT's orders. As a result, ITT and Siemens, other traditional PTT suppliers, will see their market share decrease significantly.

Foreign firms wishing to penetrate the market will probably have to do so through industrial agreements with Philips or L.M. Ericsson.

iii) Industrial and Technological Capacities

With a staff of 400,000 throughout the world, 30,000 of whom were in the telecommunications sector in 1981 (24,000 in research and development, 2,500 in telecommunications and 4,000 in basic research), and telecommunications sales of U.S. $1.8 billion.[95], Philips has given the Netherlands a solid footing in the entire range of equipment in this sector: radio, transmission, electronic switching (PRX series), and electronic office equipment. Philips' strong presence in Europe, North America and other parts of the world, and its policy of industrial and commercial cooperation with L.M. Ericsson in the domestic market, in Saudi Arabia and in Latin America (AXE System) all provide the Netherlands with first-rate industrial and technological capacities.

After Philips, ETM (Ericsson Telefoomaatschappij B.V.), a subsidiary of L.M. Ericsson, is the second-largest supplier of the Netherlands' PTT Administration and the country's second-largest manufacturer of telecommunications equipment. It benefits from the research and development efforts of its parent company.

B. The Netherlands Market and Its Participants

Although accumulated investments forecast for 1978 in the PTTs' five-year plan for 1979-1983 stood at $3.3 billion for telephony and $233 million for telegraphy and data transmission, the PTT administration forecasts a decline in the annual growth rate (of approximately 3% to 4%) and saturation of current telephone service by around 1990. In 1985, authorities should begin replacing existing electromechanical exchanges with time division systems. The domestic markets, hitherto closed, could then open up.

Given the development of new services, the modernization of the network through the introduction of SPC technology, which should bring the percentage of subscribers connected by stored-command exchanges to 50% by 1983, the extension of the telex network (particularly with ITT's Metaconta 10-C and Siemens' T-1000), automation of the public mobile radio telephone system (Tekade-Philips equipment) and investments already made, the telecommunications equipment market should evolve as follows in the 1980s:

The Dutch Telecommunications Market (in US $ millions)

	Market Estimates	Forecasts for		Average Annual Growth Rate in %	
	1980 $	1985 $	1990 $	1980-85 %	1986-90 %
Telephone	465	539.0	721.0	3.0	6.0
Telegraph, telex and data transmission	60	114.0	175.0	13.8	9.0
Satellite communications	3	5.0	9.0	12.2	13.0
Mobile radio and radio telephone	27	56.0	68.0	16.0	4.0
Paging Systems	1	1.7	2.4	10.8	7.0
Cable television	14	15.4	14.7	1.9	1.0
Total	**570**	**731.1**	**990.1**	**5.1**	**6.2**

Source: The PTT Plan data, at the exchange rate of 1 Florin = US $0.5506, and an adjustment of estimates produced by Arthur D. Little, *World Telecommunications Survey II*, 1980. Note the low growth rate in cable distribution equipment, because more than 50% of households were already linked to a cable television network in 1980, thus permitting broadcasts of the programs of neighbouring countries (Belgium, Germany) into this small country.

IV.2.7 Sweden

A. Domestic Telecommunications Environment in Sweden

i) Organization and Regulation

A state-owned company, *Televerkert,* monitors and regulates Swedish public telecommunications. Its responsibilities are those normally assigned to a Ministry of Communications, but also those of a research and development agency, a consulting bureau and an equipment manufacturer. These duties are performed by various subsidiaries: Swedtel for consulting, Ellemtel for research, Teli and Tefab for manufacturing. The Swedish group, L.M. Ericsson, owns 50% of Ellemtel.

ii) Government and Foreign Competition

Three-quarters of Televerkert's telecommunications equipment needs are met by its own manufacturing subsidiaries, Teli and Tefab. Televerkert rarely purchases equipment from companies other than its own manufacturing units or from L.M. Ericsson. The purchase of PABX (SL-l) from Northern Telecom in 1978 was an exception to the rule made necessary by the technological superiority of this equipment. Storno (General Electric), Motorola, TRT, STS, Philips and Mitsubishi also penetrated the Swedish market, but for specific, and usually non-renewable, equipment contracts.

L.M. Ericsson is still Televerkert's largest outside supplier and the two cooperate closely in research, consultation and production. But L.M. Erics-

son's largest markets are overseas. The protected domestic market offers L.M. Ericsson only a small outlet for approximately 15% of its consolidated sales.

iii) Industrial and Technological Capacities

With close to 70,000 employees in 1981, 27,000 of whom are in Sweden, (total staff was 65,000 in 1978) and consolidated sales of U.S. $3.2 billion in 1981, L.M. Ericsson is one of the largest multinationals in the telecommunications equipment field. Drawing 20% of its 1981 revenues from Sweden, 30% from the rest of Europe, 19% from Latin America, and 19% from Africa, Asia and Australia, L.M. Ericsson offers a complete range of telephone equipment. Telephone and telex exchanges represented 31% of its 1981 sales (45% in 1980), network equipment (cables and wires) 22% (14% in 1980), and subscriber exchanges, telephone hardware and intercommunication systems approximately 11% (13% in 1980). Its presence in North America is still fairly small (12% in 1981 and less than 1% of its sales in 1980) and is limited mainly to distribution activities. Most of the group's basic research is carried out in Sweden at a research centre employing 4,700 people at the end of 1981, and working in cooperation with Televerkert. L.M. Ericsson's R & D budget amounted to $281 million in 1981 (i.e. 8.5% of consolidated sales).

L.M. Ericsson was one of the first multinationals to understand the nationalistic sentiments of Third World countries. It has firmly established itself in these regions, especially in South America, by agreeing to form joint ventures with local partners and to help host countries organize their telecommunications networks.

On the domestic scene, Teli, a subsidiary of Televerkert, employs more than 3,500 persons, while Tefab has been increasing Teli's capacities since 1966, and is taking contracts for private companies.

The Swedish Telecommunications Market

Millions of U.S. $	Market Estimates for 1980 $	Forecasts for 1985 $	1990 $	Average Annual Growth Rate in % 1980-85 %	1986-90 %
Telephone	151.8	184.8	231.7	4.0	5
Telegraph, telex and Data transmission	5.8	7.1	8.5	4.1	4
Satellite communications	1.2	1.4	2.7	4.0	14
Mobile radio and Radio telephone	7.0	8.5	10.4	4.0	4
Paging Systems	0.3	0.3	0.4	4.0	4
Total	**166.1**	**202.2**	**253.7**	**4.0**	**5**

Source: Arthur D. Little, *World Telecommunications Survey II*, 1980.

B. The Swedish Market

With a telephone density of 79.67 telephones per 100 inhabitants[96] Sweden now leads the United States (79.26 telephones per 100 inhabitants). As in other developed countries, while traditional telegraph services have declined, several new services have been created since the end of the 1970s. Examples include *Fonotelex* (a service combining telephone and telex), public telephone service for Scandinavian airlines passengers, a public radio paging service with approximately 5,000 subscribers, and a national emergency service (SOB-AB) sending alarms to 20 centres across the country in case of a national alert. With such a level of development, and despite the Swedish government's estimate that modernization and extension of facilities will require U.S. $330 million ($99 million of this for purchasing AXE exchanges), equipment expenditures should increase only minimally between now and 1990, except for satellite communications during the second half of the decade.

IV.2.8 Japan

A. Domestic Environment

i) Organization and Regulation of Telecommunications in Japan

All matters concerning the organization and regulation of Japan's telecommunications market fall under the Post Office and Telecommunications Ministry. This Ministry has the following general responsibilities, which in Canada belong to the CRTC and the Department of Communications:

establishment of telecommunications policies;
management of radio frequency spectrum;
management of research and coordination with Japanese equipment suppliers;
representation on international organizations.

Almost all public communications are handled by two companies:

Nippon Telegraph & Telephone (NTT), a state-owned company that owns and directs the telephone network, telegraph, digital data transmission, and other telecommunications systems throughout Japan;
Kokusai Denshin Denwa (KDD), a private company responsible for international telecommunications.

The three bodies (POT Ministry, NTT and KDD) work in close cooperation. Even though KDD is a private company, its revenues are dictated by tariffs authorized by the Ministry. NTT's and KDD's policies are formulated in consultation with the Ministry.

In Japan, private telecommunications play a much larger role that in other developed countries. Installation of a private network does not require authorization by the Ministry, which need only be advised of the fact. This explains the regular expansion, alongside that of the public system, of private telecommunications networks (8% per year) using microwave and short-wave, facsimile or mobile radio technology.

KDD has a monopoly in international telephone, telex and television services. With purchases in the order of U.S. $3.3 billion in 1982[97], and a staff of 350,000, NTT is the giant in Japanese telecommunications services. NTT plays a major role in research and development, carrying out its activity in three laboratories: Musashino, Ibaraki and Yokosuka.

These laboratories test products submitted by suppliers and contribute to the development of new products (making approximately 2,000 patent applications per year). As a result, in recent years, the Musashino Laboratory has specialized in digital switching and has developed the D.10, D.20 and DDX-2 systems, while Ibaraki has concentrated on fibre optics and Yoko-suka on terminals and transmission systems (e.g. PCM-400M).

NTT's R & D spares KDD investment in research and considerably lightens the burden of Japanese telecommunications equipment manufacturers in an industry where the R & D budget usually represents 8% to 10% of revenues.

ii) The Japanese Government and Foreign Competition

Japanese business circles and government appear to have realized that Japan's continued economic growth depends on its client countries' ability to control their foreign trade structure and, consequently, their financial stability and spiralling inflation. The need for a new trade balance between Japan and its international partners has led the latter, particularly the United States and the European Economic Community, to pressure for easier access to the Japanese market for their products and for a more moderate flow of Japanese products onto their own domestic markets.

Despite assurances given by Japan to GATT[98] and the decision by the Japanese government in December 1980 to proceed with international calls for tender for large equipment contracts for NTT beginning in 1981, it must be recognized that the Japanese market is opening very slowly. International calls for tender issued before April 1982 were mainly for equipment that could be considered minor (for example, oscilloscopes, digital frequency measurement equipment, VHF/UHF frequency counters, micro-wave frequency counters, vehicles to erect telephone poles, etc), and not the large equipment traditionally purchased from Japanese firms. Thus, in 1979-1980, almost half of NTT's equipment and supply purchases (U.S. $1.4 billion) were shared among four firms: Nippon Electric ($570 million), Fujitsu (close to $400 million), Oki Electric Industry and Hitachi[99]. In the same year, these four

companies received 92% of orders in a data transmission market of close to $400 million. Fujitsu and NEC alone received 82% of the $355 million spent by NTT on transmission equipment, whereas 50% of the $350 million for electronic exchange purchases went to NEC and Oki[100].

Despite the recent successes of foreign firms in the Japanese market, (Motorola, for example), it is not expected that Japanese imports will suddendly increase from their current level (approximately 5% of total purchases) to 15% or 20%. It is too early to make precise estimates of the size of the potential import market. The following factors are hard to quantify: the difficulties of foreign firms in being accepted on the official list of NTT suppliers, the procedures for obtaining import licences and having new hardware approved (particularly technical specifications), the lack of knowledge of NTT's decision-making process and NTT's use of traditional suppliers to maintain the system's uniformity. These factors nevertheless determine the size of the market open to foreign firms. At best, there is reason to hope for a market of over U.S. $250 million in 1982-1983 and each year after that. It will be necessary to monitor the successes of firms like Motorola, which, in 1982, has obtained a contract for U.S. $9 million to supply paging systems to NTT[101], and to examine the role of the political factor in the future, to better evaluate the degree to which the Japanese market is opening up.

iii) Japan's Industrial and Technological Capacities

Having made up for its previous lag in equipment, technology and production capacity, Japan is the strongest newcomer on the world telecommunications equipment market in the 1980s. The major Japanese telecommunications companies—Nippon Electric Company (NEC), Fujitsu, Oki Electric and Hitachi—are now structured and have a range of competitive products enabling them to compete successfully in foreign markets with North American and European manufacturers. These four companies supply most Japanese telephone exchanges.

Nippon Electric Company (NEC) is NTT's major supplier, fulfilling 60% of its needs. It manufactures a wide range of products including all telecommunications sub-systems, terminals, switching, transmission and radio equipment. This manufacturer is linked financially to the Sumitomo group. With consolidated sales of US $4.8 billion in 1981, NEC employs about 64,000 people. Its telecommunications equipment sales amounted to US $1.7 billion in 1981.

Fujitsu is the second-largest telecommunications equipment supplier in Japan. The leading Japanese manufacturer of computers, it dominated 30% of the PBX market in 1981. Its major strength is in switching systems and terminals. This company has financial links with the Fuji Electric group (DKB, Dai-Ichi Kangyo Bank) and is studied in detail in Phase II of this study. Consolidated sales amounted to US $2.6 billion in 1981 with US $554

million from telecommunications equipment sales. The number of people employed by Fujitsu was about 34,000 in 1981.

Oki Electric mainly supplies telephone and telex switching equipment. It has financial links with the Fuji Bank, one of its major clients for terminals. Total sales amounted to US $846 million in 1981 with a work force of 12,000 people.

Hitachi manufactures a wide range of communications and information equipment, electronic products and components. Having concentrated on the Japanese market until the end of the 1970s, it appears that Hitachi hopes to strengthen its presence in foreign markets in the 1980s. With consolidated sales of US $15.3 billion in 1981, Hitachi employed 151,000 people and derived US $3.0 billion from electronic equipment sales that year.

These four suppliers constitute the core of Japan's industrial and technological capacities in telecommunications equipment. But this picture would be incomplete if it did not consider the specific characteristics of the Japanese industrial structure, and particularly the role of such key institutional actors as NTT, MITI (Ministry of International Trade and Industry) and the Japanese banking system.

The major manufacturers have been members of a particular type of industrial group (the keiretsus) for many years, with close ties in capital, management, business relationships, financing and information [102]. *These structures undoubtedly offer Japanese manufacturers an ideal opportunity to benefit from the industrial synergy of development chain strategies.* We should also note that the keiretsus always include in their midst a bank which plays a key role in financing and testing new products (for example, the Sumitomo bank, the Fuji bank, the Dai-Ichi Kangyo bank). Finally, since 1978, the trend of Japanese groups toward *industrial cooperation with foreign groups* has become stronger. Fuji Electric and Siemens, for example, have been cooperating for several years and have strengthened this cooperation by creating a joint venture in Japan, Fuji Electric Components Ltd.; Hitachi, Fujitsu, and Oki are joining groups like Siemens, Amdahl, Intel, Memorex and Sperry Univac in various fields. *Japanese groups are beginning to cooperate amongst themselves* in research and development. An example of this is the integrated circuits research program, which was launched in March 1976 with the creation of The Association for Research on VLSI Technology, in which Fujitsu, Hitachi, Mitsubishi, Nippon Electric (NEC) and Toshiba took part in cooperation with MITI and NTT.

With regard to financing investments in production capacity, research and development, and working capital for the completion of contracts and improvements in productivity, two factors giving Japanese firms an advantage over their foreign competitors should be borne in mind: (a) *the particular characteristics of financing in Japan* and (b) the use of a *financial lever* amplified by the sectorial diversification of companies (development chain

strategies), by favourable fiscal regulations and by extremely competitive interest rates[103]. Finally, the existence of a network of approximately 250 subcontracting companies enables the leaders in electronics to concentrate their efforts on the key sectors.

All these observations lead us to believe that Japan's industrial and technological capacities rest mainly on original industrial structures and on a carefully developed industrial strategy designed for the long term, in an overall framework, and in coordination with government and the private sector. NTT spends 2% of its revenues on R & D but greatly benefits from direct and indirect governmental assistance. Yet, one must look beyond this assistance to find the key to Japan's success: it rests in the design of a comprehensive industrial strategy that takes advantage of a unique industrial structure.

The Japanese Telecommunications Market (in US $ millions)

	Market Estimates	Forecasts for		Average Annual Growth Rate in %	
	1980	1985	1990	1980-85	1986-90
	$	$	$	%	%
Telephone	3,975.8	4,828.6	5,302.4	4.0	2
Telegraph, telex and data transmission	182.6	232.4	267.4	4.9	3
Satellite communications	7.4	12.4	18.8	10.9	9
Mobile radio and radio telephone	44.8	62.4	89.3	6.8	7
Paging Systems	12.9	16.4	18.0	4.9	2
Cable television	65.9	120.4	128.0	16.2	6
Total	**4,289.4**	**5,272.6**	**5,823.9**	**4.1**	**2**

Source: Estimates by Arthur D. Little, *World Telecommunications Survey II*, 1980 adjusted according to 1980-1982 statistics in *Electronics*, January 13, 1982 and observations of growth rates in cable television in the United States and Canada.

B. The Japanese Market and Its Participants

In 1981, the Japanese telecommunications equipment market exceeded U.S. $4 billion. Approximately 5% of this total ($200 million) originated from foreign suppliers. Since Japan has caught up with the rest of the world in the telephone field, which represents over 90% of the market, overall growth in telephone equipment is estimated at over 5% per year between now and 1990. On the other hand, mobile radio, satellite communications and cable television equipment should grow at a rate of over 5% during the same period.

In terms of strictly electronic equipment, private switching systems for telephone and data transmission should grow at a faster rate than public network switching: 11.7% compared to 8%, data transmission systems should grow at more than 16%, facsimile transmission systems and terminals at rates of 17% and 23% respectively [104]. Cable television, which represented a market of $65.9 million in 1980 should rise to $89.1 million in 1982, an annual growth rate of 16.2%, which, if it continues, would suggest a total of $120 million by 1985.

Observers of the Japanese telecommunications industry note that, following the successful tests conducted in 1981, NTT intends to step up its efforts in fibre optic transmission and telecopy facsimile services. Digital microwave communications, mobile radio services (radio telephone and automobile) are also expected to expand.

As already mentioned, it is still too early to estimate the share of the market for public network equipment that foreign firms could take over in the future. The success of Motorola or Siemens, however, and current opportunities available on the computer-controlled PBX market show that this market should finally open up, at least partially.

CONCLUSION

A. General Market Trends: Explanatory Factors

Four main factors account for the market evolution and regional modifications in telecommunications equipment:

- the recognized importance of R & D activities by firms and governments;
- the market penetration mode chosen by manufacturers;
- financing;
- the political factor.

1. The recognized importance of research and development activities conducted both by manufacturing firms or operating companies and by governments. Major manufacturers allocate increasingly large sums to R & D activities, as demonstrated by the case of Northern Telecom in Canada [105]. Governments of industrialized countries with state-owned corporations often participate directly in R & D, a good example being that of CNET [106] in France. This lever is clearly being used more and more often as a core strategy by major manufacturers and certain smaller but more aggressive firms such as Mitel of Canada. Its consequence on markets and products is clear: product and technological obsolescence accelerate year after year.

2. The type of market penetration chosen by manufacturers, considered in chapter three and in this chapter. Here we simply mention the increasing importance that countries attach to investment in domestic manufacturing, either directly or in conjunction with foreign capital. Prominent examples include Latin America (Brazilian foreign investment policy, ITT, Ericsson and Siemens), and Asia, where joint ventures become the norm. Nor do industrialized countries escape these situations, witnessed by the United States and its *Buy American Act*, a strong incentive applying both to institutional state and government purchases and to private corporations, Canada's provincial preferences on procurement or France and Holland, where the PTT administration has criteria for selecting suppliers and close ties with national manufacturers for product design and contract acceptance, even in the case of foreign subsidiaries such as ITT or Ericsson located in those countries.

The form of market penetration used by large firms obviously influences the nature of the supply in these markets and, consequently, the technological evolution and purchasing behaviour of these countries.

3. The importance of purchase financing for telecommunications equipment is clear to all concerned. We will simply mention here that changes in markets and in the most costly categories of equipment are conditioned by the ease with which countries can obtain purchase financing through bilateral agreements between governments and through the array of supplier credits offered by various international competitors. Hence the importance of interest rates, guarantees and insurance offered by the various supplier countries, who must remain competitive in the export market. Multilateral aid does not really affect the evolution of markets and equipment, even though it can be said that the World Bank's assistance programmes in Africa somewhat lessened the dependence of many nations upon their former colonial masters. Financing facilities granted to foreign customers result from political choices by supplier countries. Thus, they direct the evolution of demand and technology in their client countries.

4. The political factor influences the evolution of markets and regional changes of equipment in four ways:

- direct or indirect intervention;
- ways in which political cooperative policies and support systems are implemented;
- government sensitivity to lobbying pressures;
- government efforts in terms of industrial policy.

a) Direct or indirect intervention in contract negotiations by governments of supplier countries. For example, France and Japan do not hesitate to involve their highest officials (President of the Republic or Prime Minister) and the United States does not hesitate to use the argument of global economic assistance or defence. Canada, however, traditionally leaves the marketing role to the private sector.

b) Ways in which political cooperative policies and support aid systems are implemented. A striking comparison may be made between Canada's cooperation policy and that of France or Germany. In Canada, CIDA implements the government-defined cooperation policy. It grants funds to recipient countries and selects the experts and cooperants who will be placed at their disposal. By comparison, the liaison between CIDA and the industry appears to be limited to making information available. However, Canada has neither developed nor institutionalized any specific channels for feeding this information to the industry, nor has it established mechanisms to identify and follow up on projects. German and French cooperation has been implemented in very different

manners. In terms of channels, for example, France has an agency which promotes French technologies abroad. ACTIM (Agence de Coopération Technique Industrielle et Économique) brings foreign trainees to France in order to familiarize them with French techniques and equipment. These trainees, who are actual or future decision-makers will obviously be influenced in their attitudes and choices regarding equipment purchases. In addition, ACTIM sends French technicians abroad, a move that also helps promote French products. In Germany, cooperant engineers or experts posted abroad for a number of years often come from the private sector (consulting engineering firms, manufacturers) and not necessarily from the public sector. The German manufacturing sector thus has first-rate local informants, and can present bids based not only on specific technical knowledge about the host country but also on local mentalities, attitudes and practices.

Although services offered by the Export Development Corporation (EDC) for example, are comparable to foreign aid systems, their range is not as varied. For example, the Compagnie Française d'Assurance pour le Commerce Extérieur (COFACE) offers a broader range of insurance policies: insurance against economic risks is non-existent in Canada [107].

Canada's ability to compete in terms of interest rates is still not clear. This factor rests primarily on a political decision of vital importance for telecommunications, since equipment purchases are generally financed on a long-term basis. These points will be discussed in more detail in phase III of this study.

c) Government sensitivity to lobbying pressures. The effect of this dimension of the political factor is felt in domestic markets, as illustrated by the case of Fujitsu in the United States [108](the *Buy American Act*), or in France (PTT purchasing policy). Other effects are found in special bilateral aid agreements or when negotiating certain large contracts such as the Soviet Transsiberian radar surveillance project, in which Thompson-CSF benefitted from helpful government intervention.

d) Government efforts in terms of industrial policy. The French example, in which the State has decided to return control of ITT and Ericsson subsidiaries in France to French interests (Thomson-CSF), or French government efforts to encourage Thomson and CGE to bid jointly in certain markets [109], points out the importance of the political factor in the final determination of demand and in the choice of technology, especially in the Third-World countries. Whereas French equipment used to be scarce outside France and its former colonies, it has now penetrated markets such as South America, the Middle East and Asia.

For all these reasons, it is clear that the political factor exerts a considerable influence on the world telecommunications market, and

that the political dimension of multilateral agreements (Euronet, for example) influences the nature of the projects and the definition of equipment standards.

B. International Marketing Prospects for Telecommunications Equipment

Telecommunications is a key sector of the world economy in the early 1980s. A factor in economic and social progress, telecommunications will probably contribute more than anything else to increasing the productivity of industrialized countries between now and the year 2000.

Technologies, needs and markets change rapidly. Equipment suppliers will have to take up many challenges in a continually changing environment. In a capital-intensive industry such as this—particularly in R & D—only small errors are permissible, but when a company is seeking to penetrate a world market, the smallest error can take on alarming proportions and jeopardize that company's survival. Thus, over the long term, only two types of companies are likely survive in such an environment:

- large multinational groups[110] taking on numerous technological challenges in a wide range of products and in all world markets;
- specialized companies that generally take a technological gamble on a limited range of products and bet on one market, attempting to establish a foothold, to then expand internationally.

Between the large and small companies, there will be little room for medium-sized companies in the future competitive environment of telecommunications. The bipolarisation between large and small companies is frequent in all capital-intensive industries. A number of factors will contribute to the development of this trend:

- the world oligopoly in telecommunications, which results in higher entry costs for new competitors seeking access to technologies and markets over the entire range of product lines;
- inflation of R & D costs, which rise more rapidly than other items in the operating budget. Northern Telecom is a clear example of this, its R & D rate having almost doubled in 5 years[111];
- computerization of all telecommunications sub-systems, which encourages telecommunications equipment manufacturers to step up basic electronics research in addition to applied research. This increases

research costs and changes the environment for potential discoveries. Research is growing and changing throughout the entire electronics development chain. Companies spanning a wide area of the development chain (e.g., Siemens, Fujitsu) stand to gain more potential benefits from their R & D. For this reason, other large multinationals will probably attempt to cover more of the electronics development chain through vertical integration, either upwards (e.g., AT & T acquiring strength in data processing via Olivetti), or downwards, (e.g., IBM getting into telecommunications applications).

Both firms and governments recognize the increasing importance of R & D as a survival factor in the international competition of the telecommunications market.

Three philosophies are emerging regarding the interaction between government and equipment manufacturers:

- *integration* (for example in France or Japan). To all intents and purposes, whether or not the «visible» competitor in an international market is CIT-Alcatel or Thomson, important business decisions are made in close cooperation with the technological, financial, human, and political support of the French government;
- *cooperation* (for example in Sweden). A government agency (usually the P & T Ministry) offers considerable assistance to an equipment manufacturer for a special research program, or guarantees the manufacturer a fixed income to finance its research programs, by establishing tariffs or by granting a monopoly over that equipment in the domestic market;
- *abstention* (for example in the United States). The non-intervention of the American government in backing private companies on foreign markets is extremely relative in as much as the political weight of the United States gives it the power to tip the scales in favour of an American supplier in certain Third World countries.

It appears that the time has come for Canada to make a decision. The comparison of its financial resources with those of other countries, the effectiveness of the interaction between its government and telecommunications equipment manufacturers, the knowledge to be gained from the experience of major international competitors and their international marketing strategies might assist in making that decision. The question will be discussed in Phases II and III of this study.

The international telecommunications market is a political one, which cannot be explained solely in economic terms. The political factor is all-pervasive. It affects the level of assistance given to a manufacturer by its government, it influences bilateral agreements with client countries, it shapes national policy in terms of subsidized R & D, protectionist measures, etc.

Thus, it can facilitate the task of marketing for a manufacturer who conceives his own strategy within the framework of a national policy.

Does this mean that the telecommunications equipment manufacturer cannot determine his own strategies and depends entirely on a national industrial strategy he does not control? The cases we shall study in Phase II of this study clearly show that each company has some strategic room for manoeuvre, although limited in scope by the policy of its home country, but sufficient to enable it to conquer certain foreign markets. It is up to the company to use to advantage what manoeuvering room it has, and to try to increase it.

As General Beaufre once said: *"The essence of strategy is the struggle for the freedom of action."*[112]

Appendix: Trends in the Office-of-the-Future

I. Converging technologies

Whereas the French neologism "bureautique" is a combination of "bureau" (office) and "informatique" (data processing), and generally refers to the automation of clerical tasks, the English language uses more concrete expressions — "office automation" or, in a more futuristic perspective, "office of the future".

Whether presented in oral, written, graphic or video form, office work generally consists of obtaining, storing, sorting, processing, presenting, reproducing, classifying and communicating information within and outside an organization. *To present office automation as simply a process by which these tasks are automated is to provide an incomplete definition stemming from an essentially mechanistic perspective.*

Generations of products have succeeded one another, each bringing increasingly complex degrees of automation to individual tasks. For example, mechanical typewriters were replaced by electrical, then by electronic machines and, in the 1980s by word processors. Reproduction techniques using alcohol were replaced by stencils and then by the photocopier. The technical evolution of products has always brought with it a certain degree of automation. If office duties were completely automated, humans would eventually not have to intervene. Such a scenario, already a reality with the advent of robotics in manufacturing, is neither desirable nor theoretically conceivable in business administration which is the prime target for office automation. At best, automating certain tasks may solve some of the major problems in today's and tomorrow's offices, it could improve office staff productivity at a time of inflating salaries, accelerate, facilitate and enrich certain tasks, and improve working conditions. However, outside of repetitive tasks, automation cannot totally replace human intervention in office activities. Since administrative duties are often closely related, office automation is restricted to sequential or interdependent tasks, and thus only to a limited number of them.

However, given the conditions in which information is used, *office work cannot be reduced to a group of completely programmable activities.* Information is used for certain tasks involving routine administrative operations, such as automatically renewing a stock when it reaches a critical level. However, even this task cannot be handled solely by the machine in situations where suppliers have changed prices, where the usual suppliers have closed down operations, suffered strikes or have temporary shortages, during trans-

portation strikes, etc. These situations not only require routine office tasks, but also call for administrative decisions. Although decision-making models form part of the data processing capacities of modern machines, these models can be applied in only a limited number of areas, and there is no way that all administrative decisions could be programmed in advance, modelled and stored in machines. They are merely tools that assist managers, and not machines (as perfect as they may be), to carry out their responsibilities. It would be difficult to imagine an office-of-the future system in which the most sophisticated equipment and the interconnection of intelligent machines might essentially eliminate office staff[113]. The intelligence of equipment is limited[114] and the fundamental issue is not competition between human and artificial intelligence, but how humans use this artificial intelligence. Human intervention continues to be necessary, at least in terms of the control, command functions and use of these systems.

Automation, one hopes, will produce superior work performance from both management and office staff. The result will be a relative decrease in the number of office employees; thus, one might logically expect reduced salary costs as a result of automation. However, this opinion, widely held in business circles, is erroneous. In the United States, a pioneer in this area, the number of managers increased by about 3% annually between 1975 and 1980, and their salaries grew by 8% annually, while professional and technical staff grew by 4.5% annually and their salaries by over 12% annually. Secretaries and typing staff increased by less than 1% annually, while their salaries grew by 7% per annum during the same period[115].

In Canada, keyboard and electronic console operators commanded annual salaries of $35,000 in 1982. *The effects of the office-of-the-future will probably be reflected less in the total cost of office personnel than in profound changes in the nature of office work and in the performance (hence, the productivity) of staff assigned to this work.* This will affect the job specification, the skills required and the corresponding salaries. On the basis of office equipment currently on the market, forecast changes, the experiments of firms introducing the office-of-the-future into their organization, and the opinions of office-of-the-future specialists, we are moving toward job versatility which requires multiple skills. The integration of voice/data/message systems will mean that secretarial staff will have to be proficient in much more complex areas than those which relate to the simple operation of a keyboard. For senior managers, communications with office staff will have to involve different organizational approaches and ways of thinking based on the new and more technical requirements of job specifications and labour relations.

Extensive research is being conducted on the impact of the office of the future on working conditions, employment, productivity and organizational management. Results are sometimes contradictory[116]. For example, does office automation create or destroy jobs? Does it really help improve man-

agement? These are not fundamentally new questions. They have been raised at every technological revolution. Economic history is replete with examples, such as that of the textile industry and, more recently, computers. Nevertheless, employee pressure and increasing government awareness have motivated Labour Canada to establish a study group to examine microelectronics and to evaluate the effectiveness of current provisions of the Canada Labour Code with respect to technological changes relating to office automation. The following synoptic table summarizes some of the most frequently asked questions concerning the development of the office-of-the-future.

Questions about office automation	**Possible answers or key variables**
Does office automation create or destroy jobs?	- creates jobs, according to studies of Arthur D. Little, Bureau of Labor Statistics; - destroys jobs, according to the United Kingdom's Science Policy Research Unit; - the only proof of a direct cause-and-effect relationship between unemployment and technology may be the disappearance of certain jobs compensated by the creation of other jobs. Seventy percent of all new jobs are created in new industries, especially in high-tech fields[117].
Does office automation improve working conditions?	- yes, if work is enriched. This presumes an effort to promote technical training and good interpersonal communications. - no, if the office-of-the future concept remains mechanical, i.e. dominated by the task/means/results trilogy, without reference to the social context of the office. Alienation and hostility, stress or lack of motivation among staff, and appearance of a manipulating elite are possible risks.
Does office automation improve productivity?	- yes, in terms of average performance during office working hours. This productivity varies according to the type of office personnel and is difficult to measure at senior levels; - no, if equipment-use procedures are too complex, if staff training is inadequate and if interpersonal relations do not change.
Does office automation improve the management of organizations?	- yes, if relevant information is not lost in the over-abundance of information provided by high-performance systems, and if the staff is trained to handle the multiple dimensions of the equipment and, in particular, make optimum use of all resources; - no, if introduction of office automation into the organization is poorly planned (errors in selection of equipment);

Will the office-of-the-future be dominated by integrated systems?	- the answer depends on the type of user, given the pressures of the supply side (marketing strategies of equipment suppliers), the users' ability to evaluate equipment in relation to needs, and othe influencing factors such as service companies, office-of-the-future consultants and teaching program contents. It also depends on the economic impact of the technological convergence and advances in software.
Are integrated systems the ideal solution for the office-of-the-future?	- even if all conditions were favorable to generalized use of integrated systems over the long-term, the answer is not obvious, because the issue involves concepts of short and long-term costs, vested interests of suppliers (even if problems of technological and equipment compatibility are completely resolved) and the development stage of user organizations.
Will the office-of-the-future be dominated by the data processing or the telecommunications industry?	- this is a non issue, to the extent that the development chain strategy phenomenon is gradually erasing the boundaries of each industry with the diffusion of technological innovation from one sector to another. Product offerings of firms tend to resemble one another. Thus, entire sectors may escape the domination of traditional suppliers. The most refined supplier strategies in terms of progressive segmentation and innovation should play a major role through development chains[118]. Because of the penetration of its equipment in sectors where data processing needs are particularly important in relation to other needs, the computer industry seems to have a built-in advantage over telecommunications. In terms of satisfying their office-of-the-future needs, the door to these segments is already open to this industry. But mastery of communication techniques, particularly for transmission purposes, is a key element in the office-of-the-future market. Thus, telecommunications firms have a powerful lever for entering these segments of the market.
Does long-term development of the office-of-the-future industry imply continuing government support?	- although this appears to be the view held by countries like Japan and France, and although Canada established an ambitious Office Communications Systems Program in November 1980, this issue should be examined in the broader context of the electronics industry, given the convergence of various electronics sub-sectors in this market. All this depends on which industrial strategies the government selects, and what philosophy it adopts regarding government intervention in industry. Incentives, purchasing policies, financing, the creation of research infrastructures, direct intervention and other initiatives are all powerful levers to help establish an industry, just as the long-term

	success of firms engaged in office automation depends on their decisions about product range. Even though the success of products depends upon appropriate technological choices encouraged by government, the success of firms in office-of-the-future markets is primarily dependent on their own decisions regarding the range and quality of their marketing, as illustrated by the success of Japanese firms.
Will technological convergence generate new markets?	– the rapid development of the office-of-the-future market appears to be proof of this trend. The opportunities brought about by converging technologies create market dynamics characterized by the emergence of new needs, the appearance of new demand, increased supply and competition, innovation and a diversified range of products. Reduced production costs brought about by converging technologies (and by longer production runs) help firms tap new, unexploited or little-developed markets (example: microcomputing and SMBs, and office-of-the-future products designed for small organizations).

The above synoptic analysis appears to reject the narrow view of the office-of-the-future as a process where tasks are automated and where there are three main components: tasks, means and results. It may be better to consider it as the expression of a new market concept drawn *both* from the convergence of technologies (dynamics induced by supply) and from the pressures on potential demand (costs, productivity, user-friendliness, etc.).

We have already stressed that, with the gradual eradication of boundaries between various equipment categories resulting from converging technologies, firms producing office equipment must redefine their markets and penetrate new ones. In the future, it will be more important to create or develop new markets than to penetrate unexploited ones. Today's technical solutions fill new, previously unrelated functions, which give rise to new needs e.g. electronic mail, word processing, job versatility. *As long as there was no technological response to these needs, the markets (i.e. the needs) for corresponding products did not exist. As soon as a possible response appears, the need becomes apparent and market dynamics are set in motion: emergence and development of demand, increased supply and competition, diversified product range, and innovation. The process once initiated then finds its own dynamics within the system.*

As technologies converge, new markets form and develop. For example, technologies formerly as unrelated as glass-making, biology[119] and telecom-

munications are sometimes required to co-exist in certain applications (equipment, manufacturing or testing processes) and the resulting generation of products reminds us of known biological mechanisms, such as mutations and the creation of new species.

Is the office-of-the-future market really the desired result of the development chain strategies designed by economic agents (firms, governments), or is it the climax of a deterministic process in which technologies converge at a given time (i.e. technologies from different origins are used to create technical solutions for old and new needs)? Do new technical solutions create new needs and new markets? Or are evolving needs (such as different working conditions, different capital and manpower costs, a different environment in a broad sense, including the internationalization of high-tech industries) the source of technological change? Aside from noting certain facts (the existence of development chain strategies, industrial osmosis, rapidly expanding real and potential markets), it is difficult to find a theoretical explanation, and future research is certainly called for. Current developments of the office-of-the-future market point out the value of such research.

II. Characteristics and trends in the office-of-the-future equipment market

The office-of-the-future market is very difficult to quantify both in geographical terms and in term of product range because of the lack of accuracy in the way statistics presented in various studies are compiled, and owing to the classifications which vary from one study to the next and to the diffuse nature of product classifications. However, by drawing from various information sources [120], we can evaluate the overall world market for office-of-the-future equipment. It should increase from nearly U.S. $20 billion in 1980 to almost $40 billion in 1985, with an average annual growth rate of over 14% during this period [121].

The market's geographical structure could evolve as follows:

	1980		1985		Average Annual Growth Rate
	$	%	$	%	
United States	12.0	65	20.0	55	10.9%
Canada	1.7	9	4.5	12	21.5%
Europe	4.9	26	11.9	33	19.4%
Total (in U.S. $ billion)	**18.6**	**100**	**36.4**	**100**	**14.4%**

Office Equipment Sales in the United States from 1980 to 1985

U.S. $ billion	1980 $	1980 %	1985 $	1985 %	Average Annual Growth Rate 1980-1985
Word-processing Equipment	3.5	29.5	5.8	28.6	10.2%
Copying Equipment	4.7	39.2	8.7	43.2	13.0%
Office Communications Equipment	3.8	31.3	5.7	28.2	8.6%
Total	**12.0**	**100.0**	**20.2**	**100.0**	**10.9%**

The breakdown of demand by product category in the American market (two-thirds of the world market in 1980 and over one-half in 1985) seems to parallel the distribution of world sales that is forecasted in studies conducted by the Quantum Science Corporation.

These structural characteristics reveal that the value of copying equipment represents a substantial share of the total. In order to ascertain this market's strategic dimension in terms of competition, we must analyse in greater detail the trends and characteristics of products in the three equipment classes. Almost all of the data are taken from the MAPTEK USA 1981 study by the Quantum Science Corporation.

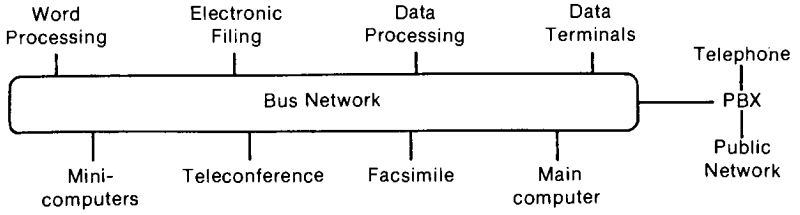
These figures show that sales of text editing equipment have grown from 19.9% to 32.7% of the total. In this category, full-page machines are in the lead, with an average annual growth of over 30%, while single-line 256-character machines increase by only about 16% annually. The more rapid

Typing and Text Preparation Equipment

U.S.$ billion	1980 $	1980 %	1985 $	1985 %	Average Annual Growth Rate
Electric Typewriters	957.1	27.3	571.5	9.9	-9.8%
	(918.5)		(475.1)		(-12.3%)
Electronic Typewriters	393.0	11.2	797.1	13.7	15.2%
	(157.9)		(585.5)		(29.9%)
Text Editing Equipment	697.4	19.9	1896.7	32.7	22.1%
	(57.0)		(208.2)		(29.5%)
Shared Processor Systems	392.4	11.2	1064.0	18.3	22.0%
	(9.2)		(29.2)		(26.0%)
Other	1060.1	30.3	1470.7	25.4	
Total	**3500.0**	**100.0**	**5800.0**	**100.0**	**10.6%**

The figures in parentheses correspond to the number of units in thousands.

growth of full-page machines is due to their ability to adapt to most word processing needs and conditions and to the ease with which they may be used. Sales of shared processor systems also increase substantially in relation to other stand-alone equipment[8]. Firms such as Datapoint, Wang, Exxon or Xerox are developing further integrated systems. Their interconnection with subordinate processing "slave machines" is leading to the concept of an overall integrated system in which many machines are linked together by coaxial cable-based local area networks of the bus[8] type. Xerox's Ethernet and Wang's Wangnet serve these multiple purposes. as illustrated below:



With 83% of the shared processor systems and 15% of the half-page machine market in the United States, Wang controlled over 22% of the world word processing market in 1980, followed by AES/Lanier (approximately 12%) and Xerox (nearly 10%).

This category of office equipment, second in importance only to the telephone and the typewriter, is dominated by Xerox in the top of the line and by the Japanese in the lower end of the line. Prices of high-speed copiers are dropping, low-speed copiers are being perfected (reduction, assembly, acceptance of various formats) and coated paper is being abandoned in favour of

Copying Equipment

U.S. $ million	1980 $	%	1985 $	%	Average Annual Growth Rate
Low-Speed Copiers	1833 (321.6)	39	2246 (522.4)	26	4.1% (10.2%)
Medium-Speed Copiers	1013 (50.4)	21	1379 (70.4)	16	6.4% (6.9%)
High-Speed Copiers	1579 (29.4)	34	4705 (88.8)	54	24.4% (24.7%)
Other	282	6	347	4	4.2%
Total	**4704**	**100**	**8677**	**100**	**13.0%**

Office Communications Equipment

U.S. $ million	1980		1985		Average Annual
	$	%	$	%	Growth Rate
PABX	2205	58.7	3385	59.8	9.0%
	(2919.0)		(4102.0)		(7.0%)
Keyboard Systems	834.7	22.2	1573.0	27.8	13.5%
	(1357.0)		(2080.0)		(8.9%)
Other Telephone Systems	461.6	12.3	206.7	3.6	-14.8%
	(1099.0)		(795.0)		(-6.3%)
Facsimile Equipment[10]	254.4	6.8	496.5	8.8	14.3%
	(61.8)		(105.9)		(11.4%)
Total	**3755.7**	**100.0**	**5661.2**	**100.0**	**8.6%**

ordinary paper. The key to success in this market lies in distribution and after-sale service.

Facsimile equipment will experience the fastest growth rate in this product category. However, its share is relatively modest (7% to 9% of the total), PABXs accounting for most of the market, with close to 60%. The trend toward digital PABX will continue with the integration of voice and data capabilities and other functions. Northern Telecom's Displayphone is an example of equipment that offers this broader range of capabilities. The fastest growth should occur in the medium range (100 to 500 lines), reaching $900 million in 1985.

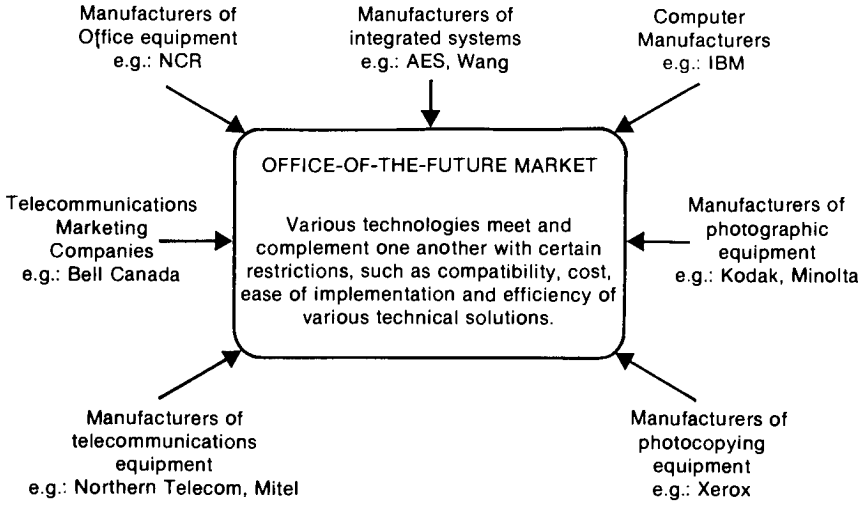
The market is expected to grow with the introduction of inexpensive Japanese products and the standardizaiton of digital access modes.

Shipments of teleconference equipment should grow from $9.3 million in 1980 to $206 million in 1985.

Moreover, products in the videotex market could conceivably be used also for the office of the future, although videotex technology has so far been designed for general public use, but the business sector, for example, could also have use for the electronic telephone directory or other applications of videotex techniques. The diagram on the next page illustrates the competitive interface on the office-of-the-future.

Office-of-the-future marketing strategies will probably be dominated by three major types of restrictions:

- research and development / technology / products restrictions: one of the major problems here is that of equipment compatibility for interconnection purposes;



- financing and cost restrictions: mainly in R & D, product distribution and price policy;
- competitive capacity: for example, AES fell victim to this and was able to recover only through last-minute restructuring. Strong research, sale and management organizations seem to be the keys to success in this rapidly evolving market.

These observations suggest that changes will occur in the distribution of office automation systems and equipment. In addition to direct marketing, increased use will be made of distribution channels that include distributors or agents and retail stores (owned, franchised, or independent). Mitel, IBM and Xerox are examples of firms that are turning toward the simultaneous use of multiple distribution channels.

Increased competition will certainly result in competitors joining forces, using product differentiation strategies or gambling on price strategies. In a field where products quickly become obsolete because of technological changes, the use of such marketing strategies may lead to overwhelming success for some but also to the dismal failure of those who have not carefully thought out their competitive strategy.

Notes and References

1. Due to the far-reaching effects, the rapid pace and the diversity of its applications in a growing number of industries, technological change shapes the conditions of manufacturing in such a way that it is not exaggerated to speak of a third industrial revolution in the last quarter of this century (micro-electronics, biotechnology) succeeding the first two industrial revolutions (mechanization in the XVIIIth and XIXth centuries, electricity-petroleum-chemistry in the early XXth century).
2. See the term "development chain", p. 6 *et sequ.*
3. See Graph II.1 (Evolution of World Demand for Finished Products 1960-1976), p. 31.
4. J. Lesourne, *Les mille sentiers de l'avenir.*
5. In particular, see the MITI-80 document, in which the industrial strategy of Japan for the next decade is outlined.
6. See, in particular, various reports of the Science Council of Canada since 1970 (for example, special study No. 22 of December 1971 on multinational corporations, direct foreign investments and Canada's science policy). This warning is only now beginning to influence political opinion in Canada. Among more recent publications of the Science Council of Canada, see also the following: *The Weakest Link* by John N.H. Britton and James M. Gilmour (1978) and *Le maillon consolidé*, report No. 29 by the Committee on Industrial Policy (1979).
7. See Graph II.1, p. 31.
8. J. Parent, "Filières de produit, stades de production et branches d'activités", *Revue d'Économie Industrielle*, No. 7, June 1979, pp. 89-91.
9. Strictly speaking, vertical integration is the merging of several enterprises operating at different stages in the manufacturing process; by extending its chain of operations forward and/or backward, a vertically integrated firm seeks first of all to regulate and safeguard its procurement and flows of operations towards the market of the end product. See Henry Mintzberg, *The Structuring of Organizations*, Prentice-Hall, 1979, pp.327 and 403-410.
10. J.H. Lorenzi and J.L. Truel, *Se diversifier par les stratégies de filières*, p. 98 *et sequ.*
11. Mick McLean, *Rapport sectoriel: L'industrie électronique.*
12. Edmond Sciberras, *Multinational Companies and National Economic Policies*, p.49
13. On purpose, distinctive details between basic research, applied research and product development will not be considered here.
14. SOURCE: CIT-Alcatel documents.
15. Northern Telecom has about 70% of the Bell Canada telecom equipment procurement, mainly in the areas of switching and transmission. The French share of the overall market in

the public exchange switching equipment market was 80% divided between Thomson-CSF and CIT-Alcatel after the major restructuring of the French telecommunications equipment sector in 1976-77.

16. Technological breakthrough in the sense of the passage from a given technology to another one, resulting in the gradual substitution of the latter to the former within a time span that may vary according to the industrial sector considered (the passage, for example, from analog to digital technology in telecommunications).
17. *L'industrie dans une conjoncture difficile: technologie et balance des paiements; Le maillon le plus faible; Le maillon consolidé.*
18. L. Séguin-Dulude, "Les flux technologiques industriels: une analyse exploratoire du potentiel canadien".
19. Petr Hanel, *The Relationship Existing Between the R & D Activity of Canadian Manufacturing Industries and Their Performance in the International Market; The change of Manufacturing Exports as a Function of R & D and Price Changes; L'évolution de la compétitivité technologique 1963-1976; U.S.-Canada trade in Manufactured Products.* Petr Hanel and Kristian Palda, *Innovation and Export Performance in Canadian Manufacturing.*
20. Ministry of State for Science and Technology, *Canadian Trade in Technology-Intensive Manufacturers 1964-1976*, and J.D. MacDonald, "Canadian Innovation: A National Imperative".
21. W.H. Gauvin, *Contributions of Research and Development to Economic Growth.*
22. *Financial Post*, February 27, 1982, pp.4 and 9.
23. J.D. McDonald, *Canadian Innovation: A National Imperative.*
24. The 1981 annual report of Northern Telecom Ltd. states on page 24 that the net R & D investment expressed as a percentage of consolidated turnover was 7% in 1979, 6.9% in 1980 and 7.1% in 1981, or $132.6 million, $140.9 million and $181.6 million respectively. This investment should reach $230 million in 1982 and $375 million in 1983. From 1977 to 1979, Mitel devoted 14.3%, 13.25% and 10% respectively to R & D. (See also O.W. McAleer, *Digital Technology Impacts on Canadian Telecommunications*).
25. The percentage is 1.37% if one includes invisible R & D expenditures (i.e. R & D expenditures that benefit Canadian subsidiaries of foreign companies which make R & D results available to their subsidiaries without requiring compensation payments).
26. J.D. MacDonald, op. cit., p.15.
27. The electronic equipment sector (which includes the telecommunications equipment sector) represents slightly more than 3% of the GNP in Western countries (See Serafini and Andrieu, *The Information Revolution and its Implications for Canada*). The subsector of telecommunications equipment accounted for less than 0.5% of the Canadian GNP in 1980 and 1981. Table IV.2.2 in Chapter IV allows comparison for different countries in 1971, 1975 and 1979.
28. Arthur D. Little, Inc., *World Telecommunications Study II*, 1980.
29. The observations presented on page 40 justify the decision to keep to a uniform base rather than use different, incompatible sources. Furthermore, as far as we are aware, no more recent study of such scope exists that would enable us to present comparative data.
30. See definition of this expression in paragraph I.2.
31. See the 1981 annual report of Northern Telecom Ltd., p.5.
32. See *Fortune*, March 22, 1982.
33. The 1981 annual report of Northern Telecom Ltd. (pp.12-21) gives the background to the development and applications of semiconductors, and an accurate account of trends in manufacturing and applying LSI circuits, particularly in the field of combined telephone and computing technologies, and ending with the era of intelligent terminals[g].
34. Fibre optics currently in use are multimode fibres[g], but the future lies in single mode fibres[g]. However, many technical obstacles, particularly coupling with a laser source, must be

overcome before their use is mastered (see especially, *Science et Technologie*, February 1982, pp. 18-25). Graded-index fibre[8] optic cables, such as Selfoc, launched by the Nippon Corporation, must overcome the problem of mass-production at reasonable cost. The problem of appropriate breaks has not yet been resolved (see James Martin, *Future developments in telecommunications*, pp. 458-460).

35. Chiefly due to the width of their passband, which helps route a higher volume of information than any traditional transmission system.
36. B.C. Tel (the British Colombia Telephone Company) owns 10.5% of telephones in Canada.
37. "Monopoly" is used for a market in which there is only one producer or vendor; "monopsony" is a market in which there is only one purchaser.
38. Since regulations govern service but not equipment manufacturing, the integrated company may be tempted to manipulate internal assignment costs in order to maximize its real profits.
39. Northern Telecom has about 70% of the Bell Canada Telecom equipment procurement, a percentage upon which the big dollar items of switching and transmission make a significant impact. In other areas, however, Northern Telecom faces real competition from other suppliers buying for the Bell Canada procurement market.
40. Federal Communication Commission. See *U.S. Industrial Outlook 1981*, Chap. 25, pp. 301-302 and *Business Communications Review*, March-April 1982, p. 40 *et sequ.*
41. See *Telcom Highlights*, April 8, 1981, p. 10.
42. See Bulletin No. 19 of l'Institut de recherches économiques et sociales sur les télécommunications.
43. See *Business Week*, "Japan's Strategy for the 80s", p.88 *et sequ.*, December 14, 1981.
44. Since public service common carriers are the principal purchasers of telecommunications equipment, a specialized firm in this sector will not get involved in research unless it has the support of the carrier with which it does most of its business.
45. FSS (Fully Separate Subsidiaries), according to decision CI II (Computer Inquiry II) of the Federal Communication Commission.
46. Solomon Brothers, *Converging Strategies in Information*, Second Edition, New York, January 28, 1981 and John F. McLaughlin and Anne E. Birinyi, *Mapping the Information Business*.
47. In particular, of the cooperation between the major Japanese international trading companies, the Sogoshoshas, and the Japanese manufacturing sector.
48. C. Stoffaës, *La grande menace industrielle*, p.110.
49. See Gérard Lafay, *Dynamique de la spécialisation internationale*.
50. A product's apparent domestic market or domestic consumption is the difference between domestic production (value of deliveries) and the net trade balance for the product in question.
51. Department of Industry, Trade and Commerce, Ottawa, 1979.
52. See J.H. Lorenzi and J.L. Truel, *Se diversifier par les stratégies de filières*, p.98 *et sequ*; an "industrializing sectorial strategy" in a sector fosters the technological, business and financial growth of other sectors until they become autonomous.
53. European Economic Community, *La Société européenne face aux nouvelles technologies de l'information; pour une réponse communautaire*; the EEC notes that European industry covers only unequal fractions of the market (30% of the world telecommunications market, 16% in EDP and 10% in components).
54. MITI: Ministry of International Trade and Industry.
55. IRFI, *Rapport Ramsès*, p.188
56. The data used here were provided by the OECD using CICI (SITC) categories. Since 1975, the OECD has not published overall trade statistics for each product category; the figure given here is an estimate based on trends observed in the past. Thus exports of the following countries have been considered: France, Italy, the Netherlands, United Kingdom, Canada,

USA, Japan, Spain and Sweden represented 85% of OECD exports (the remaining 15% coming from Belgium, Luxembourg, Denmark, Ireland, Australia, New Zealand, Austria, Finland, Greece, Iceland, Norway, Portugal, Switzerland and Turkey.)

57. CCITT: International Telegraph and Telephone Consultative Committee.
CCIR: International Radio Consultative Committee.
58. *U.S. Industrial Outlook 1981*, Chap. 25."Telephone and Telegraph Equipment", p.302.
59. SOURCE: Arthur D. Little, *World Telecommunications Survey II*, 1980 and *U.S. Industrial Outlook 1981*, Chap. 25, "Telephone and Telegraph Equipment", p.300.
60. *Venture*, April 1982, pp.53-55.
61. See Solomon Brothers, *Converging Strategies in Information*, Second Edition, New York, January 28, 1982 and the publications of J.F. McLaughlin and Anne E. Birinyi, *Mapping the Information Business*, 1979 and 1980.
62. See paragraph III.2.2
63. *Canadian Electronics Engineering*, Review and Forecasts, January 1982, p.22 *et sequ.*
64. A description of the various national and foreign-based telecommunications equipment manufacturers in Canada may be found in *The Supply of Communications Equipment in Canada*, Department of Communications, Ottawa, 1981. A detailed list of manufacturers and their products appears in *Canada in the World of Electronics*, Department of Industry, Trade and Commerce, Ottawa.
65. See Northern Telecom's 1981 Annual Report and *Maclean's*, "High Tech's New Stars", February 8, 1982, p.26 *et sequ.*
66. *Canadian Electronics Engineering*, January 1982.
67. See the article "German Telecommunications" in *Telecommunications*, Vol. 14, no. 10, October 1980, p.40.
68. Research and Technology Minister Andreas Von Buelow said in 1981 that he would like to see business take over more of the long-term R & D supported by government. In the 1975 to 1980 period, the Ministry put $1.2 billion into microelectronics R & D, $1.1 billion into data processing R & D, and annual aid to industry doubled. In an earlier report the Ministry reported that business funded only 49% of industrial development in 1978. (SOURCE: Northern Telecom).
69. One of Siemens' most recent foreign establishments was in Kirkland, Québec, in March 1982, to manufacture the Micro-EPABX system.
70. For example, with Thomson-CSF in Egypt, with Fuji Electric for components, with Fujitsu in EDP, and with Norpak for videotex (Telidon).
71. See *Telecommunications*, Vol. 14, No. 10, October 1980.
72. *Electronics*, January 13, 1982.
73. *Electronics*, January 1982, p.141.
74. *Electronics*, January 13, 1982.
75. It was through these NTSC projects (National Telecommunications Studies Centre) that France was able to move into time-division electronic switching (system E 10 manufactured by CIT-Alcatel using TDM[8] (time division multiplexing[8] techniques).
76. Particularly by the École Nationale des PTT.
77. *Telecommunications*, "Progress in French Telecommunications Services" by C.E. White, March 1980, p.64.
78. French Government, PAP No. 4, VIIth Plan.
79. Finance Bill 1979, Volume XX (Post Office and Telecommunications)
80. Because of the number of lines absorbed and the delay between the time an order is taken and the time when facilities begin operations (18 months, on average), the annual increase in the number of lines in service does not correspond to the number of orders recorded in the same year.
81. See pp.119-124 in *Eurocconomics, Telecommunications*,"The Next Ten Years, Prospects for European Manufacturers", 1980.

82. SAT: Société Anonyme de Télécommunications; TRT: Télécommunications Radioélectroniques et Téléphoniques.
83. *Le Figaro*, Nov. 27, 1976 and May 24, 1978; *Les Échos*, June 1, 1978; *L'Usine Nouvelle*, Feb. 17, 1977; various industrial newletters (INF-Telecom, etc.).
84. *Datar Newsletter from France, No. 25, 1982 (2).*
85. *According to Ambroise Roux, President of CGE, CIT-Alcatel will control a third of the world market for this technique in 1981, due to its System E10. In November 1981, 25 countries had already ordered 7,600,000 lines (SOURCE: Le Monde,* November 10, 1981, p.45).
86. Northern Telecom's DMS Series, L.M. Ericsson's "Axe" time division version, time division systems of NEC, Siemens, ITT and GTE.
87. For example Thomson-CSF with Siemens in Egypt.
88. According to the *Rapport d'activité de la DAII, 1981* and annual reports and publications of French manufacturers, the IIAD devoted 1.7 billion francs to R & D in 1980 ($380 million U.S.): $320 million was given to private companies and laboratories for study contracts, $38 million for studies conducted by NTSC and TTCS and $22 million for the Ariane space program. Thomson-CSF and CIT-Alcatel do not reveal their telecommunications R & D expenditures directly, but since 1980 Thomson-CSF has devoted more than 25% of its electronic components division's sales figure to R & D. Thus, of $700 million in sales in 1980, R & D represented approximately $175 million, 30% of this state-financed (the equivalent of $53 million), which brings Thomson-CSF's own R & D percentage to approximately 17%.
89. Particularly through its participation in Lynch Communications in the United States which will increase from 15% to 40% (*Le Monde*, September 22, 1981, p.46).
90. Respectively: Télécommunications Radioélectroniques et Téléphoniques, Société Anonyme de Télécommunications, Société d'Applications Générales d'Électricité et de Mécanique, Compagnie de Signaux et d'Entreprises Électriques.
91. *Le Monde*, November 3, 1981, p.33.
92. The word "telematics", a blend of "télécommunications" and "informatique", found in Nora-Mine's *Report on the Computerized Society* (1978) reveals this trend. The office of the future is the first example.
93. According to statements by M. Théry, Director General of Telecommunications (*Telecommunications*, March 1980, p. 63).
94. *World Telecommunications Survey II*, 1980.
95. Annual Reports; *L'Expansion*, January 22 and February 4, 1982, pp.52-55.
96. Siemens, *International Telephone Statistics*, 1982.
97. *Fortune*, March 22, 1982, p.61. In 1980, purchases of NTT equipment and supplies totalled approximately U.S. $1.4 billion (*Fortune*, op. cit., p.98).
98. General Agreement on Tariffs and Trade
99. *Business Week*, December 14, 1981, p.98.
100. Ibid.
101. *Business Week*, March 20, 1982, p.132.
102. See J. Gresser, *High Technology and Japanese Industrial Policy: A Strategy for the U.S.*, Subcommittee on Trade Office, The Committee on Ways and Means, U.S. House of Representatives, Oct. 1980. See also *Business Week*, "Japan's Strategy for the '80s", December 14, 1980.
103. These various elements are studied in detail in Phase III of this study. Financing mechanisms in Japan are based traditionally on high saving (individuals' propensity to save) and a high rate of indebtedness of firms, made possible by the interdependence between banks and industry and by low interest rates (in 1981, the Development Bank of Japan accorded a preferred rate of 7.5% for investments in high technology). We note that, since 1980-1981, Japanese electronics firms have been more and more self-financing (11% of their needs).

Their traditional financial leverage was reduced due to a high level of self-financing made possible by liquid funds derived from mass electronic products (tape recorders, television, cameras, video equipment etc.) and accelerated depreciation and deductions of certain R & D expenditures for tax purposes.

104. *Electronics*, January 13, 1982 (estimates for 1982 on the basis of annual growth rates since 1980).
105. See figures in paragraph I.3.
106. Centre National d'Études des Télécommunications.
107. This type of insurance applies against fluctuations in the exporting firm's manufacturing costs, caused by factors beyond its control.
108. Western Electric was recently chosen as the winner against Fujitsu in a bid for an AT & T contract to establish the Washington-New York-Boston link using fibre optics technology (SOURCE: *Fortune*, March 22, 1982).
109. Particularly in Venezuela. CGE = Compagnie Générale d'Électricité.
110. See Table IV.1.3, p.
111. R & D rate = Annual R & D Expenditures/Annual Sales.
112. Général Beaufre, *Introduction à la stratégie*, Frederick A. Praeger, Paris, 1965.
113. The expression "intelligent" machines refers to equipment that is capable of conducting on its own a series of operations that may be relatively complex, connected, or simultaneous, and which usually require the judgement and intervention of one or a number of persons. The development of intelligent machines is related to progress in microelectronics (microprocessors) and programming (software).
114. Japan is currently conducting research on artificial intelligence under the aegis of the Ministry of International Trade and Industry (MITI) and the Ministry of Education (Tsukuba project). See *Le Nouvel Observateur*, April 3, 1982, p. 36 *et sequ.*
115. *Fortune*, "Office Automation and Business Communications", Oct. 5, 1981, p. 20.
116. See, in particular, studies quoted in *The Electronic Office in Canada*, Department of Communications, May 1982, pp. 17 to 28.
117. Studies of the Institute for Research on Public Policy on behalf of the Department of Communications in 1980, study of the U.S. National Commission on Technology, Automation and Economic Progress, the Outlook for Technological Change and Unemployment (1966), studies by the Massachussetts Institute of Technology in the 1970s, excerpts taken from *The Electronic Office in Canada*, Department of Communications, Ottawa, May 1982, p. 19 *et sequ.*
118. For example, Japanese suppliers have extended their markets for products originally designed for the general public to industry and government, and Mitel has expanded from small and medium PBX systems toward larger systems with its SX-2000. The segmentation concept is no more a part of the telecommunications industry than it is of the data processing industry, just as technology developed initially in data processing (e.g. digital technology) is no more a part of that industry than it is of telecommunications.
119. Biotechnology is one of the major industries of tomorrow. It already has application in the chemical and food industries, and calls for sophisticated electronic equipment for fermentation purposes.
120. In particular, *Quantum Science Corporation* (MAPTEK USA Office Systems Strategy Program, 1981), *L'Expansion* (Spécial Informatique, September 19, October 1980, pp. 177-215), *The Electronic Office in Canada* (1972) and *The Office of the Future*, (1981), Department of Communications, Ottawa, *Fortune*, "Office Automation & Business Communications", October 5, 1981, and various other sources.
121. Japan is not included in this estimate.
122. Digital facsimile equipment will show an average annual growth rate of 20.7% for the period, which will come mainly from Japanese suppliers.

Glossary

Active device–A device in which applied power controls or modulates a system.

Analog signal–A signal is analog when its variation, which represents a situation, is continuous, contrary to a digital signal, which is discrete.

Analog transmission–Transmission of a continuously variable signal, such as digital data.

AXE–Model of PABX made by the Swedish company Ericsson.

Bank teller terminal–A system which can be used by a bank customer, at any hour, to make bank operations without the presence of a teller.

Bus coaxial cable–Cable which joins many stations in an office or a building; all the signals from and to all stations pass through this single cable.

Cable television–A communications system which distributes broadcast programs and original programs and services by means of a coaxial cable.

Chip–A small device, which is composed of a support (silicon wafer) on which an electronic circuit is imprinted (transistor, diode, etc).

Coaxial cable–Cable having a central conductor, generally copper, insulated and surrounded by a second conductor of a larger diameter.

Coaxial cable transmission–Transmission of signals (digital, radio, TV, etc.) by means of a coaxial cable between two or more locations.

Code converter–Device used to make translation of alphanumeric data into a form acceptable to a computer.

Codec–A device whose function is to encode and decode electronic signals, in the same unit.

Components–Any kind of electric or electronic elementary device, such as wires, diodes, transistors or resistors which is part of an electric or electronic unit.

Crossbar–In an exchange, a crossbar system is composed of a bar, rotated by a solenoid, used to make switched connections between circuits to connect incoming cables to outgoing lines.

Cross switching–See Crossbar.

Crosspoint–A switch forming part of a matrix to switch circuits in an exchange. At the beginning, they were electromechanical.

Crosspoint analogic switch–See Crosspoint.

CRT (cathode ray tube)–A device used to display information in which the information to be displayed is sent as an electrical impulse, and is converted to light from a luminescent screen.

Digital data transmission–Digital transmission is used for the transmission of data, with less error rate and more speed than with analog transmission on telephone lines.

Digital switching–Interconnection of electronic circuits by means of an order, transmitted in digital form, without mechanical devices.

Digital telecommunication A telecommunication system in which the digital technique is employed instead of the analog technique.

Discrete component–Components which enter a circuit, but are composed of individual transistors, capacitors, resistors, and diodes.

Displayphone–A telephone, made by Northern Telecom, which integrates voices and data communications in a single physical package. It essentially contains a telephone set, an autodialer, a dump terminal and a modem.

Electronic mail–A system providing person-to-person communication of messages using electronic means for entry, transmission and delivery of information in a visual form.

Facsimile–A system for the transmission of images. The image is scanned at the transmitter, reconstructed at the receiving station, and duplicated on some form of paper.

FDM (frequency division multiplex)–A system of transmission in which characters of bits belonging to separate messages modulate a series of separate carriers transmitted simultaneously on a single circuit.

FDM coaxial cable–On this cable, many electromagnetic signals are transmitted on different frequencies, on separate carriers.

Fiber optics–A system that transmits voice, data and video by beaming light waves through very thin glass fibre.

Hertzian networks–Networks in which the transmission is made by electromagnetic propagation instead of by wire.

Integrated circuit–Module which constitutes a complete circuit made by hundreds of very small electronic components deposited by a special process.

Integrated digital network–A telecommunication network in which all transmissions are in digital form, instead of analog form (like in the telephone transmission).

Integrated telephone and data-graphic display terminal–Terminal allowing to send and receive voice and data signals (see Displayphone).

Intelligent terminal–A terminal which has storage capacity and processing power, thus enabling complex logical functions to be performed within the terminal in support of the user application, or to accommodate high-level control functions required by the interface of the network.

K (32K, 64K, 128K)–In informatics, symbol standing for the number 1024 (2^{10}). This symbol usually means kilo, that is to say one thousand.

LED (light emitting diode)–A device often used to provide a visual display on the screen of communication devices.

LSI (large scale integration)–The accumulation of a large number of circuits (500 or more) on a single chip of a semi-conductor.

Microprocessor–A small micro-electronic device providing a powerful central processing unit for a computer on a single chip, with interfaces to enable it to communicate with various peripheral unit for the input, storage and output of data. The central element of a microcomputer.

MITI–Name of the Japanese industry and international trade department.

Mobile radio–A radio system in a vehicle which can be connected by radio transmission to a telephone network.

Modem–This term is a contraction of modulator/demodulator. Modems are devices used to interface communication equipment (e.g. terminals and nodes) to a transmission line.

MOS memory–Memory built with a MOS. Buffer memories and Read-Only Memories are generally of this kind.

Multimode fiber–An optic fiber which supports propagation of more than one mode or wavelength.

Multi-pair telephone cable–Any telephone cable having more than one pair of wires.

Multiplex devices–A device that allows to transmit many different signals on the same pair of wires using FDM or TDM (see these words).

PABX/PBX–Any kind of private exchange, either automatic or not, which allows a customer's private telephone network to be connected with the public one.

Packet data transmission–By the use of short standardized packets, operation in which a network is able to store and forward messages very rapidly, typically in a fraction of a second.

PAL (phase alternation by line)–A color television broadcasting system developed first in West Germany and the United Kingdom.

Passive device–A device (relay, switches, coupler, capacitor, etc.) which plays a static role in a circuit or system, without use of a current.

PCM (pulse code modulation)–A method of converting an analog signal to a digital signal. This process consists of modulating a pulse train in accordance with a code.

Prestel–The name of the public videotex in Great Britain. Systems created by British Telecom.

Printer–A device which can copy on paper a program or data.

Private automatic exchanges–See PABX/PBX.

Private exchanges–See PABX/PBX.

Radio telephone–A telephone which uses a short wave radio to communicate with a telephone network. This installation can be fixed, or mobile.

RAM (random access memory)–A type of storage device used in computers to retrieve information directly, with very short access times mesured in microseconds.

Repeater–A type of amplifier, used at regular intervals along a transmission channel to regenerate message signals and overcome various impairments such as alternation and crosstalk.

Rotary dial–In a switched system, the conventional telephone dialing method which creates a series of pulses to identify the called station.

SECAM (sequential)–A color broadcasting system developed in France, and also used in the Soviet Union.

Semiconductor–A material whose conductivity is between that of conductors and isolators, and whose resistivity can sometimes be changes by light, or an electric or magnetic field.

Shared processor system–System in which a microprocessor is used by several devices in turn.

Single mode fiber–An optic fiber in which only one wavelength can propagate.

Software–The internal programs or routines prepared professionally to simplify programming and computer operations or to manage a system.

SPC (stored-program control)–It is made by a machine in which the instructions which specify the operations to be performed are stored in the form of coded information. Thus a computer can operate by its instructions.

Stand-alone program–Any program that operates independently of system control; generally, it is either self-loading or loaded by another stand-alone program.

Switch–Any kind of device whose function is to make interconnection between many stations (in telecommunications).

Switching–In interconnecting circuits, operation which establishes a temporary communication between many stations.

Telecommunications A general term expressing data transmission between a computing system and remotly located devices via a unit that performs the necessary format conversion and controls the rate of transmission.

Teletel The name given by the PTT in France to its public videotex system, planned for introduction in France in the early 1980's.

Telex (teletypewriter exchange service)–The name often given to a service based on the use of teletypewriters to send and receive information over a switched network.

Telidon The name given by telecommunication authorities in Canada to the videotex system and, more specifically, to describe the Canadian standard of alphageometric coding used to provide a high resolution display.

Time division multiplexing (TDM)–A form of multiplexing in which a number of separate digital signals are sampled to produce a set of interleaved pulses which are transmitted along a single channel.

Transmission link–Any crosspoint between two wires in a crossbar switching system (see this word).

Videotex–Information system which allows for the collection and retrieval of information through terminals which are specially adapted television receivers. Database is stored in a central computer, and the telephone network, cable, or special line is used for the connection.

Vista–A videotext experience run in Canada in 1982 by Bell Canada and Informat, which used telephone network for transmission.

VLSI (very large scale integration)–The application of micro-electronic technology to the integration of tens of thousands of components on a single silicon chip of small physical size.

WATS-(wide-area telephone service)–Service which provides a dedicated line for incoming or outgoing calls for a flat monthly charge; incoming calls are toll-free to the originator.

Wide band transmission networks–Networks in which one can transmit many signals (radio, TV, others) by using a large scale of different frequencies.

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2. Specific studies on telecommunications and sources of data

Various estimates and forecasts of telecommunications equipment markets for the 1980s are available in published form from such research organizations as Arthur D. Little Inc., Frost & Sullivan, MacIntosh, Quantum Science Corp., Euroeconomics or O.E.C.D. Yet, the data issued by these organizations lend themselves to comparisons and statistical adjustments with some degree of difficulty concerning the composition and evolution of the market over time. Three main reasons account for this difficult task: classifications may be different from one study to the other (either in terms of region, product class or systems definitions), forecasting models used in these studies fail to appear (only the underlying hypotheses to these models are

occasionally presented; the primary data used for correlation and regression analysis and statistical estimation formulae are most often not presented and therefore make it impossible to evaluate the validity of the various forecasts), and finally different statistical units (reference years used for currency conversion on a constant dollar basis) are not the same from one study to the other.

In other respects two sources offered the advantage of recent data on a world basis when this research was conducted: Arthur D. Little Inc., *World Telecommunications Study II (1980)* for telecommunications equipment and Quantum Science Corporation, *MAPTEK USA*, Office Systems Strategy Program (1981) for office equipment. They have been used to a large extent even if, in some cases, forecasts might be inaccurate. As a matter of fact, in a perspective of unveiling world trends, more can be learned from relative values, proportions and trends than from absolute values at a given time. Arthur D. Little Inc.'s last estimates were made public when this research was completed (*The Changing Basis of Competition in the '80s*, the Fifth ADL Executive Forum in International Telecommunications) Boston, 17-20 Oct. 1982). They do not fundamentally alter the global estimates presented here by regions and by systems (Tables II.2 and II.3).

Many other publications have been resorted to in order to complete our information; access to these publications and to the information sources mentioned above would never have been possible without efficient assistance from the Department of Communications and Bell Northern Research library services. Among these publications annual reports from major telecommunications manufacturers, certain publications from government and international organizations, specialized magazines and journals as well as various press articles are to be mentioned. A non exhaustive list of such publications appears below.

Periodicals and other sources of information on telecommunications:

Business Communications Review
Business Week
Canadian Electronics Engineering
Commerce Canada
Communications News
Datar Newsletter from France, No. 25, 1982 (2)
Electronics
Financial Post
Fortune
Le Figaro

L'Expansion
Le Monde
Le Nouvel Observateur
Les Échos
L'Usine Nouvelle
Maclean's
Revue d'Économie Industrielle
Revue Française des Télécommunications
Science et Technologie
Telecommunications
Telecommunication Journal
Telephony
U.S. Industrial Outlook (U.S. Department of Commerce)
Venture

Miscellaneous:

Major manufacturers' annual reports
Siemens: International Telephone Statistics
Telcom Report
Annual reports and statistics from ITU (International Telecommunication Union), USITA (United States Independent Telephone Association)
Groupement des Industries Électroniques Françaises (French Electronics Industry Association).
Annual reports and various publications from PTT administrations and common carriers.