AN ASSESSMENT AND FORECAST OF TECHNOLOGICAL DEVELOPMENTS IN THE OFFICE COMMUNICATIONS SYSTEMS (OCS) INDUSTRY AND ITS SUPPLY/DEMAND CONSIDERATIONS

VOLUME 1

Robertson Nickerson
Limited

RobertsonNickerson Limited CONSULTING ENGINEERS & MANAGEMENT CONSULTANTS
75 ALBERT STREET, SUITE 610, OTTAWA, ONTARIO K1P 5E7 CANADA (613) 238-4625

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VOLUME 1

PREPARED FOR:
DEPARTMENT OF COMMUNICATIONS
DEPARTMENT OF REGIONAL INDUSTRIAL EXPANSION
DEPARTMENT OF SUPPLY AND SERVICES
OTTAWA, CANADA

PREPARED BY:

ROBERTSON NICKERSON LIMITED
75 ALBERT STREET
SUITE 610
OTTAWA, ONTARIO
K1P 5E7

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AN ASSESSMENT AND FORECAST OF TECHNOLOGICAL DEVELOPMENTS IN THE OFFICE COMMUNICATIONS SYSTEMS (OCS) INDUSTRY AND ITS SUPPLY/DEMAND CONSIDERATIONS

CHAPTER 1 - EXECUTIVE SUMMARY

CHAPTER 1

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1.0 EXECUTIVE SUMMARY

1.1 Introduction

This report was prepared for the Department of Communications under DSS Contract No. 0ST82-00199 (March 30, 1984). It covers Office Communications Systems (OCS), broken down by the following product sectors: workstations, PABXs, LANs, storage peripherals, input/output devices and software. The market analysis covers the following end users in both Canada and the United States: Health, Education, Manufacturing, Resource Industries, Insurance and Banking, Transportation and Communications, and Governments.

There are six Chapters to the report: Summary (1), Markets (2), Technology (3), Canadian Industry (4), Federal Programs (5), and Conclusions and Recommendations (6).

The data for the report was obtained through an interview and questionnaire program, use of a Technology Panel of experts, and an analysis of published data. All secondary research information is contained in a computerized OCS Data Bank, searchable by indices keyed to the various elements of this report.

1.2 Office Communications Systems (OCS)

The North American OCS market will be worth about $10.7 billion in 1985 and will grow rapidly to $17.0 billion by 1988. Almost all this growth is for integrated systems and equipment. While most firms are currently at the "Partial" automation level, about 75 to 85 percent of all organizations expect to achieve "Full" automation within the next five years.

Most Canadian firms fall into the niche or commodity categories (See Chapter 4.1 for definitions). Northern Telecom is the only one with the capability to be a total systems supplier. Canada has a number of very highly successful firms in other areas but generally, by world standards, most are quite small. As a result, the industry is relatively weak. If this trend is allowed to continue, the resulting trade deficit will grow into the billions.

This report outlines a number of actions which can be taken by industry and government to begin to correct the situation. Detailed conclusions and recommendations for each product sector are outlined in Chapter 6. In general however, while Canadian firms have the technological capability to compete in the marketplace, most do not have the financial and marketing strength. Without reducing its level of focus on technology, the OCS industry must improve its marketing capabilities by adopting modern marketing techniques and systems and acquiring experienced people. Since success or failure will be based to a great extent on penetration of the United States market, corporate strategy should be aimed at this from the start. This implies a knowledge of the United States marketplace, the factors essential to success in that market, and the competition. The industry also needs to avoid mass markets of the "retail" type where price and distribution factors generally outweigh any possible technical advantage which their product may have. The most successful companies have adopted a niche strategy by focusing on a very specialized product area and avoiding the mass markets.

In technology, it must be recognized that, with some exceptions, the United States market is often faster to adopt technological advances. Therefore, Canadian firms can be at a disadvantage in new product development aimed at the Canadian marketplace. Many firms have experienced the need to sell first into the United States before achieving significant Canadian penetration. The implication for firms developing advanced state-of-the-art products, therefore, is to develop with the export market first in mind. This also has implications for government R&D incentive programs. Firstly, most firms feel that the application and approvals process takes too much time and effort. In the OCS area, in particular, with technology changing so swiftly, this presents very serious problems. If the process is long, products may be obsolescent before they are developed. Separate programs with greater speed and flexibility may therefore be required for high tech OCS product development. Further, if the Canadian buyer is slow in adopting new technology, then the OCS field trials type of project is essential. Such programs can effectively create a Canadian market, in advance of its normal evolution, and thereby place

Canadian suppliers on an equal position with United States suppliers. Could a form of field trials program also be implemented with the private sector? If so, perhaps government funding for R&D could be used in a co-operative manner with large Canadian corporations, similar to that in the recent OCS trials in government departments.

Most firms support current Canadian government R&D financing programs, including the field trials, but the majority would like more tax breaks and more direct government procurement of Canadian OCS equipment and systems. The problem is that R&D funding is only a very small portion of the financing needed to successfully launch a new product. Therefore, more comprehensive financing is needed to allow Canadian firms to reach the size levels essential to successful competition in this market.

The OCS industry must be export oriented to survive. With some exceptions, the Canadian market is about 5 percent of the United States market. As a result, United States companies find it easier than Canadian firms to achieve size and scale. This gives them a competitive edge in Canadian home markets. Canadian firms must therefore aim their corporate strategy directly at the United States. Government can be of assistance through such financing measures as the PEMD program. Other measures such as tariff elimination and tax breaks aimed at export production should also be considered.

1.3 Workstations

The North American market for workstations will be over $7 billion in 1985 and is growing rapidly. The main growth is in networked microcomputer based workstations. By 1988, these will make up over 50 percent of the total market. The standalone and clustered word processor market is declining and the standalone microcomputer market is only growing slowly.

Technology trends are towards the emergence of 32 bit microcomputers (which will bring mainframe power to the desk), greater memory (up to 1 Mbyte) and greater fixed storage. By 1988, 50 percent of all workstations will have fixed storage and 70 percent of these will have between 5 and 20 Mbytes. At the low end of the market, prices will continue to decline, with the shrinking of standalone microcomputers, such as the IBM PC, into a small chip set.

Canadian firms should view this market with caution. The competition is intense and the only two Canadian manufacturers of microcomputers have recently ceased production. Some niche suppliers remain but it is unlikely that any new manufacturers will be successful in penetrating the market. We expect that success in this marketplace will be decided, not so much by technology, as by price, financial, and marketing strength. Smaller firms will only survive if:

1) They are low cost suppliers, primarily manufacturing IBM compatable machines.

2) They serve very specialized niche markets with low to medium volume production and with a high technology content.

The current major vendors, AES and MICOM, are in the process of transition. They are attempting to move from the word processor market, which is in decline, to the microcomputer based workstation and office systems market, which is growing rapidly. Both firms must move quickly to establish their position in this new market. Both need new products and new distribution/marketing channels. Both will have to learn how to sell into an integrated office systems market which is very different from their traditional customer base. We recommend that government support AES and MICOM since, if they fail, the likely result will be a 1988 trade deficit in this product sector, of over $600 million annually. Although forms of R&D assistance are essential, the primary factor for success will lie in achieving wide North American distribution, brand name recognition, and automated low cost production.

1.4 PABXs

The North American market will be about $5 billion in 1985, but is not growing significantly. Most of the market is in upgrading and replacement, rather than new installations. Led by Northern Telecom, Canadian firms are strong in digital telecommunications technology and are in a good competitive position. However, the market is changing with the convergence of telecommunications and computer technologies. To be successful, the majors must form allegiances with the major computer hardware vendors and must achieve compatability of their PABX offerings within a multi-vendor environment.

Other factors for success include continuing technological innovation and the provision of value added features such as voice mail and electronic mail. In technology, the next few years will see continuing integration of low speed voice and data communications onto one network, with the major device being the PABX, integrated with local area networks by gateway devices. While some wideband traffic will develop, the overwhelming majority of bits will come individual terminals and personal computers at low speed. This will open the door to major growth in packet switching networks.

Besides Northern Telecom and Mitel, the other major PABX vendors are subsidiaries of foreign multinationals. With the continuing deregulation of the North American market, they cannot succeed in Canada if they operate on a branch plant basis. They must adopt a world product mandate strategy (see

Chapter 6 for definition and details), and build a Canadian operation producing unique products for a North American market.

Given the historical strength of this industry sector, we believe it should be of first priority. In the highly competitive OCS marketplace, Canada needs to build on its strengths. Government can assist through R&D tax credits but also through government procurement. A policy emphasizing the PABX as the core to future OCS systems in government departments, combined with a multi-vendor (Open World) policy would do much to ensure the future success of this industry sector.

1.5 LANs

The North American Local Area Network (LAN) market will be $1.1 billion in 1985 and will grow rapidly to $2.0 billion in 1988. Despite the rapid growth, Canadian industry should treat this market with caution. As the technology matures and standards evolve, there will be a shakeout in the industry, similar to that in the personal computer industry. The entry of IBM and other majors, will take most of the market, drastically reducing that available to the remaining firms. Canadian firms should concentrate on high performance LANs and seek links to the major PABX and office systems suppliers. Firms should avoid the lower cost, "retail type" LAN market where success will be based on price and distribution, rather than on a superior product.

Survivors are expected to be:

1) Large firms selling LANs as part of their overall system offerings.

2) Smaller firms selling very high performance LANs for specialized applications.

3) Firms selling low cost LANs, with a strategy primarily based on price and distribution strength, rather than on the technological strength of the offering.

It is suggested that government encourage the growth of this industry, only in 1) and 2). Given that the PABX-

LAN controversy is likely to be resolved in favour of a PABX-LAN hybrid network, government procurement policy could also aid this industry by utilizing a PABX-LAN hybrid network, with PABX gateway, as the core to departmental office automation.

Protocols are the most important technological issue in LAN systems. Research is continuing towards the objective of reducing the computing overhead per packet to about 100 microseconds. This will permit effective transfer rates much closer to the 10-30 Mbps basic transfer rate of high performance LANs. With respect to access method, the token passing LAN seems, at the present time, likely to represent the preferred technology for future integrated office communications systems. However, all methods have their merits and both CSMA/CD and the slotted ring are also likely to find their niche in the market-place.

1.6 Storage Peripherals

The North American storage peripherals market will reach $3 billion in 1988. The largest market is for magnetic based systems. Optical disk systems are just beginning to penetrate the market and will achieve a 20 percent share by 1988.

In the non-mainframe storage peripherals market, the trend is to increased fixed storage. Over 50 percent of all workstations are expected to have fixed storage by 1988, and 70 percent of these will have between 5 and 20 Mbytes. Trends in floppies are towards increased densities, smaller size and lower cost.

These are highly competitive markets with intense competition expected from Japan. Despite these competitive pressures, this is not an area which Canadian industry or government can afford to ignore. The Canadian market itself is quite large, and without Canadian production, the trade deficit in this product sector would be over $700 million by 1988.

There is currently a small Canadian industry in floppies and these companies should be encouraged and assisted to expand. The key to success lies in achieving large scale, low cost production through automation, while maintaining strict quality standards.

With the growing optical disk market, Canada needs a presence in this industry. This can best be achieved in the short term by encouraging the firms already in the business, to manufacture in Canada on a world product mandate basis.

This strategy will require financial incentives or possibly an industry/government co-operative program in optical disk technology.

1.7 Input/Output Peripherals

The North American market for OCR, FAX and Laser printers was worth $2.5 billion in 1985. The largest and fastest growing market is in Laser printers, particularly in the desk top versions (under $10,000). Competition in these markets is intense. While there are several excellent Canadian firms, the industry is weak and is expected to stay that way. There do not appear to be opportunities for new Canadian vendors, unless they have a very unique product, or are multinational subsidiaries with major financial and marketing capabilities.

The lack of a major Canadian industry presence in this sector will cause a $600 million trade deficit in this product area by 1988. Therefore, it should be of major concern to government. With the competitive factors in mind, it seems likely that the only way to build an early position in this sector will be to work through the current suppliers, all of whom are foreign multinationals. Government should therefore seek to encourage the multinationals to invest in Canadian production on a world product mandate basis. Over the longer term, government should also consider targeting laser printing technology as a priority item, and develop an industry/government approach to this market. Canada does have leaders in laser technology, although they have not yet applied their technology to this product sector.

1.8 Software

The North American "packaged" office automation software market was worth $800 million in 1985, with a strong growth rate. (See Section 6.7 of Chapter 6 for details on the type of software included in the above). While Canada has a strong software industry, developing custom and other "packaged" systems, it is weak in the OCS sector. There are no major Canadian suppliers of the software products included in this report. Further, with the dominance of the large U.S. suppliers, and a continuing shakeout in the industry, it is generally agreed that it would be difficult, if not impossible, for a new Canadian firm to enter the market at this time. The exception would be very specialized software, targetted to a specific vertical market sector (e.g. forestry related business applications).

We would not recommend that Canadian firms enter this product area. The industry has some strength in "packaged" fourth generation productivity tools, larger scale packaged software such as Officesmiths' electronic filing cabinet, and systems integration software from the OCS field trials. It would be better to concentrate on these areas, where technology is a larger factor in success, than price and distribution.

Should government wish to build a Canadian industry in this sector, recommendations have been given in Section 6.7 of Chapter 6.

CHAPTER 2 - MARKET IDENTIFICATION

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2.0 MARKET IDENTIFICATION

2.1 Introduction

This Chapter deals with the Office Communications Systems (OCS) market and its various components. The overall market has been analyzed in terms of its two main elements:

1) Non-integrated systems

2) Integrated systems

Chapter 3 describes the evolution of OCS towards integrated systems, with the merging of three discrete fields of technology: communications, computers and office equipment. Chapter 2 will also analyze this evolution in market terms.

In addition to the overall picture, the markets for key components of Office Communications Systems have also been described. These components are:

1) Workstations

2) PABXs

3) LANs

4) Storage peripherals

5) Input and output devices

6) OCS "packaged" software

The markets for the above systems and equipment have been analyzed in terms of the following end user industry sectors:

1) Health
   Offices only. Not including dedicated medical/ health systems associated with treatment.

2) Education
   Offices only. Not including computer aided learning or other classroom systems.

3) Manufacturing
   Offices only. Not including production related or shop floor systems.

4) Resource industries
   Offices only. Not including production related systems.

5) Insurance and Banking
   Offices only. Not including electronic banking and systems/equipment at the retail/customer service level.

6) Transportation and Communications

Government markets have also been reviewed and are described in Section 2.9.

Market analysis (except for government markets) is based on over 2,000 questionnaires mailed to a structured sample of firms in the above industry sectors. The response rate was good at 12 percent in Canada and 7 percent in the United States. This has been supplemented by interviews and discussions with industry and government contacts. The United States government market forecast comes from an analysis of data provided by computer manipulation of information from the Federal Procurement Data System. Canadian government information comes from the Public Accounts expenditures and other procurement data. Besides the analysis in this report all questionnaire and other data is available on line on the Office Communications Systems data bank, described in Chapter 1.

All U.S. market figures are given in U.S. dollars and Canadian market figures are in Canadian dollars. All forecasts are in 1983 dollars, so growth is real growth, exclusive of inflation. The source for all information in this Chapter is Robertson Nickerson Limited, unless otherwise specified as being extracted from published sources.

2.2 The Office Communications Systems Market

2.2.1 Introduction

This report deals primarily with markets only within the sectors detailed in Section 2.1. However, an analysis has also been done on the total OCS market, based on estimates from a variety of sources. These include published reports, discussions with industry and government experts, and so on.

From these sources, an analysis of the office systems market has been prepared and is presented in Table 2-1 and Figure 2-1. As indicated, the U.S. office automation market has been estimated at $9-15 billion in 1982, growing to $22-37 billion in 1988 for an average growth rate of about 25% per year over the 1982 base. By comparison, the A. D. Little forecast for 1982-1988 is similar. (See Figure 2-2.) It estimates the 1982 market at $8.9 billion, rising to $36.6 billion in 1988. (Note: Excluding the data processing computer (mainframe) portion of the market.)

A. D. Little also forecast the integrated to non-integrated portion of the market at 5 percent in 1982 and 63 percent in 1988. On the basis of our analysis (see Section 2.2.2), companies reported about 20 to 30 percent integration in 1983, rising to 68 to 73 percent in 1988. So the 1988 levels are very compatable with A.D. Little's forecast, but show a slightly higher pace of integration in the early years. By A. D. Little's forecast, integration would have reached about 21 percent by 1984. In fact, it reached that level about a year earlier.

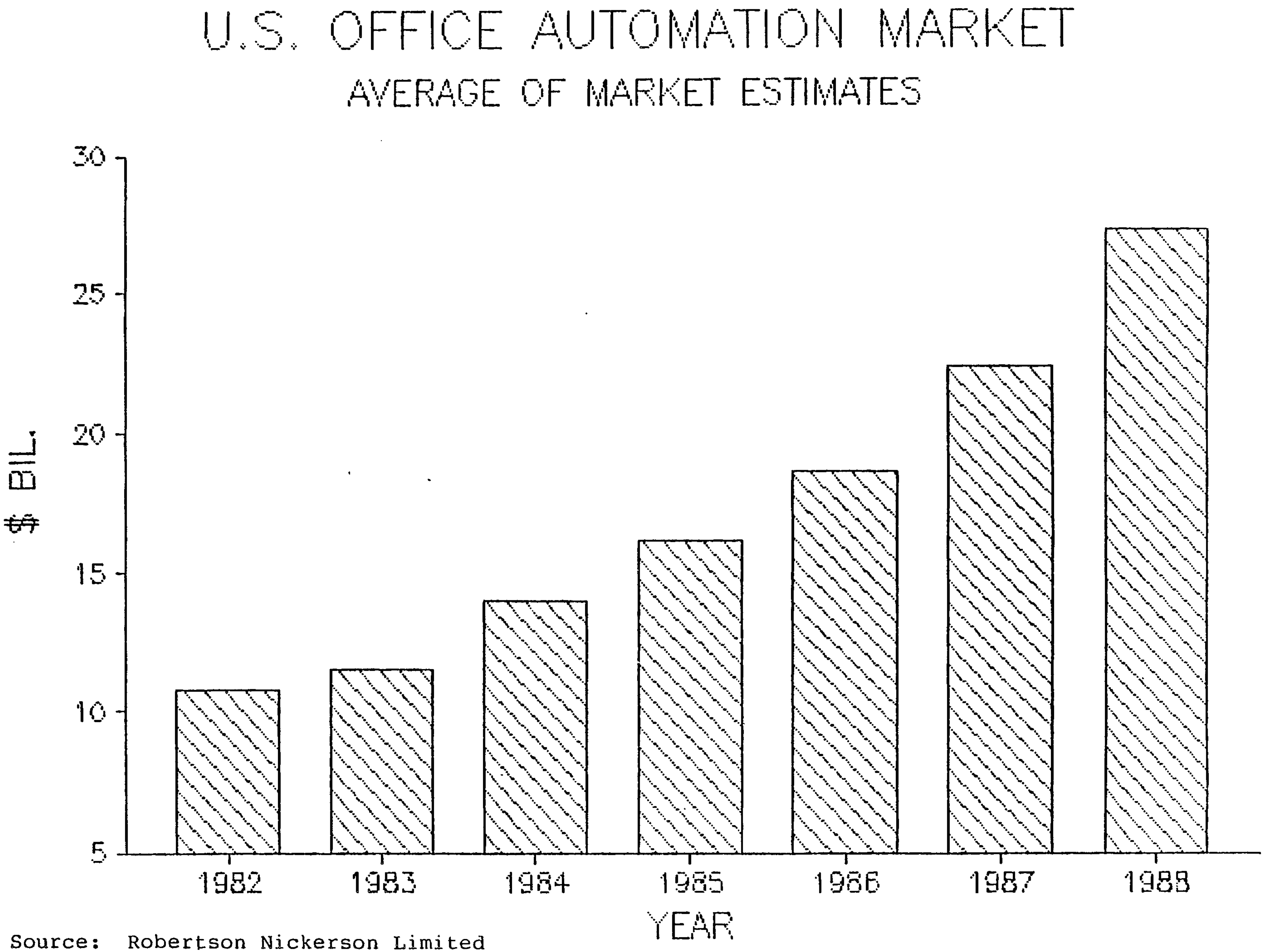
TABLE 2-1

THE U.S. OFFICE AUTOMATION MARKET
(Billions - US)

YEAR	HIGH	AVERAGE	LOW
1982	15.0	10.8	9.1
1983	12.7	11.5	10.0
1984	15.0	14.0	12.9
1985	18.0	16.2	15.0
1986	20.7	18.7	17.5
1987	26.8	22.4	19.9
1988	36.6	27.3	22.3

Source: Robertson Nickerson Limited

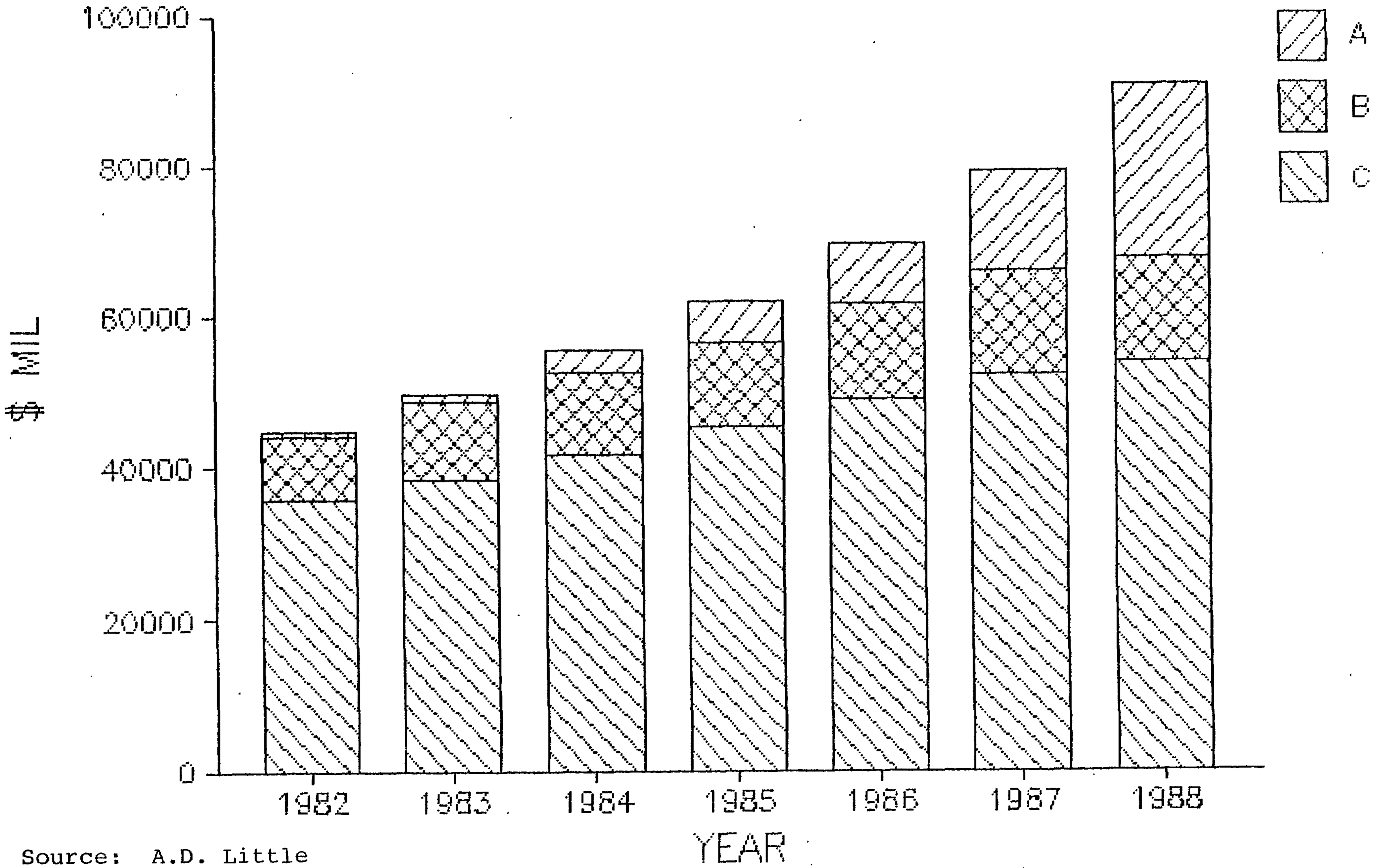
FIGURE 2 - 1



Source: Robertson Nickerson Limited

FIGURE 2 - 2

U.S. OFFICE INFORMATION SYSTEMS MARKET



Source: A.D. Little

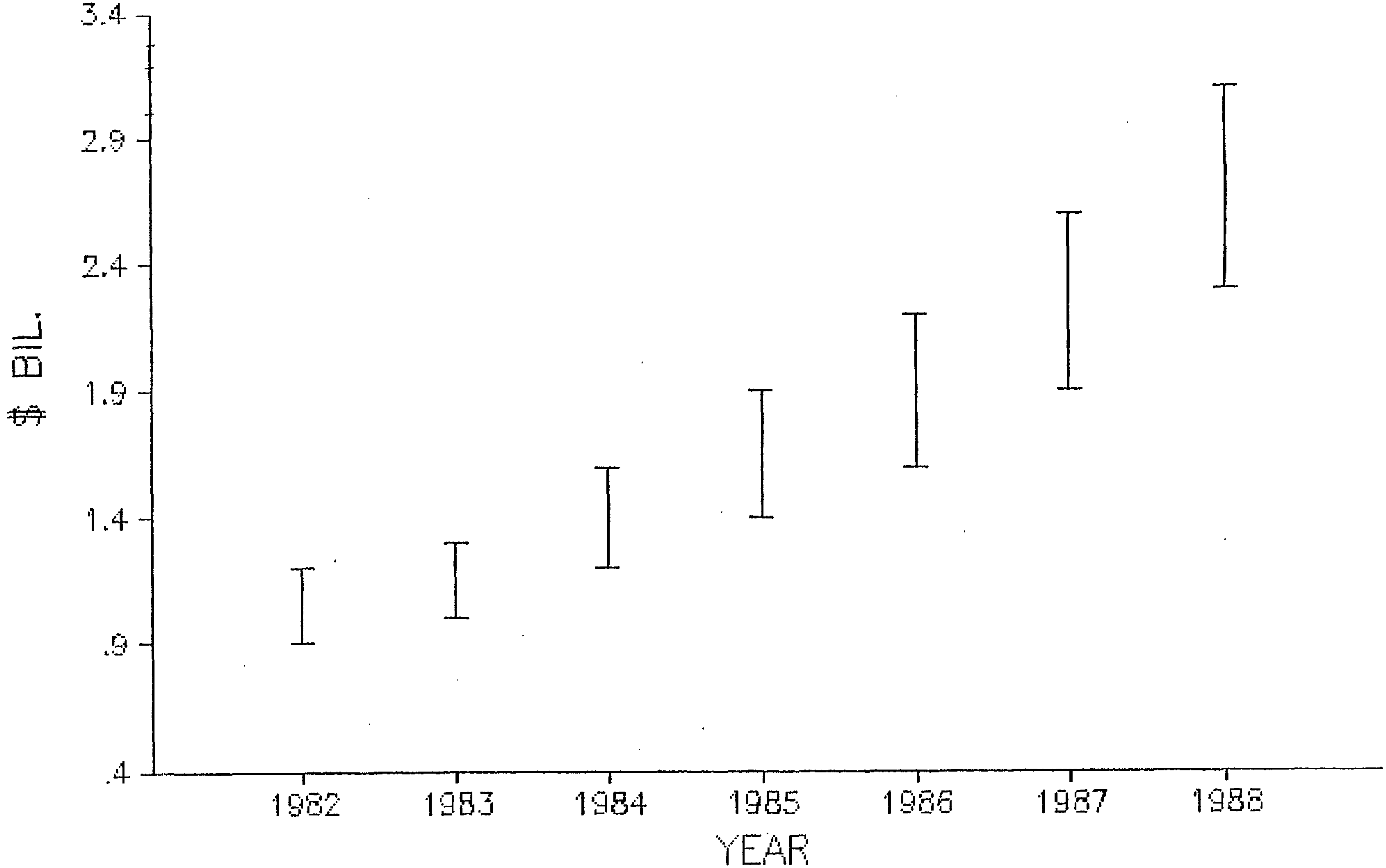
A=INTEGRATED OFFICE
B=NON-INTEGRATED
C=DATA PROCESSING

In Canada, there are few recent market estimates for the total Office Communications Systems market. A market estimate has been prepared, based on a variety of industry contacts and comparison with U.S. data. This is presented in Figure 2-3. This indicates a total market of $0.9 to $1.2 billion in 1982 rising to $2.3 to $3.1 billion in 1988, for an average growth rate of 26.2 percent per year over the 1982 base.

FIGURE 2 - 3

ESTIMATED CANADIAN

OFFICE AUTOMATION MARKET



Source: Robertson Nickerson Limited

2.2.2 OCS Markets

This section presents the results of the market analysis for the six industry sectors outlined in Section 2.1. The U.S. market (exclusive of mainframe and minicomputers) is \$5.6 billion, rising to \$13.5 billion in 1988, an average growth rate of 28.4 percent per year (in real terms), over the 1983 base (see Table 2-2). The Canadian market is \$291 million rising to \$762 million by 1988, an average growth rate of 32.4 percent per year. While the Canadian market is growing at a slightly faster pace than the United States, it still represents a much smaller market than that in the United States, i.e. approximately 5.2 percent of the U.S. in 1983, and 5.6 percent in 1988. (Many believe the Canadian market should be about 10 percent of the United States market. However, this is not a good "rule of thumb" and the Canadian market can vary widely.)

As might be expected, the integrated office automation market shows tremendous growth (See Figure 2-4). In the United States, it will grow from \$1.8 billion in 1983 to \$9.8 billion in 1988, an average growth rate of 89.2 percent per year. In fact, virtually all the growth in the market is in integrated systems and equipment. The non-integrated market shows a slight increase to 1985, with the market then starting to decline in 1986. By 1988, the non-integrated market will be slightly below the 1983 market (in real terms). Interestingly, the A.D. Little report of 1983 forecast a very similar market growth but with leveling off in 1988. It would appear now, however, that integration is proceeding at a faster pace than originally thought.

TABLE 2-2

OFFICE AUTOMATION MARKET, 1983-1988
(In Millions of 1983 dollars)

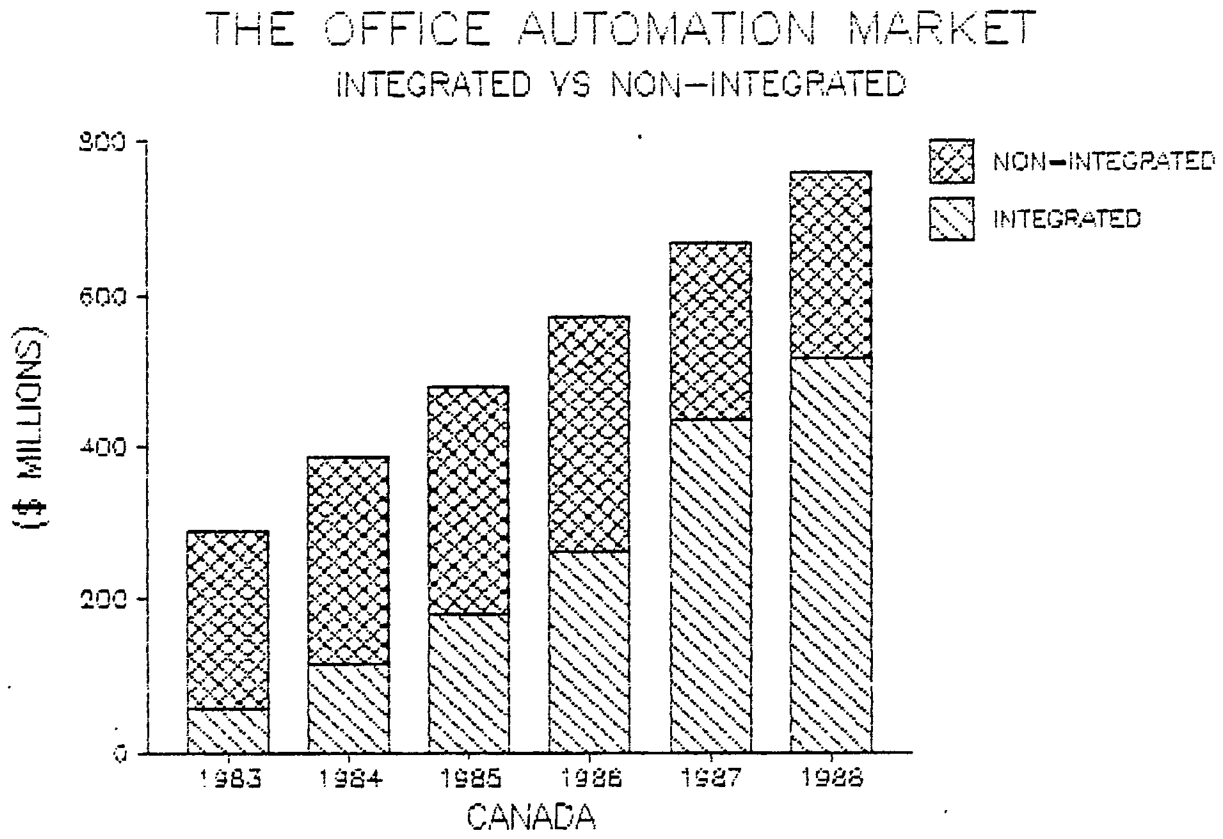
CANADA

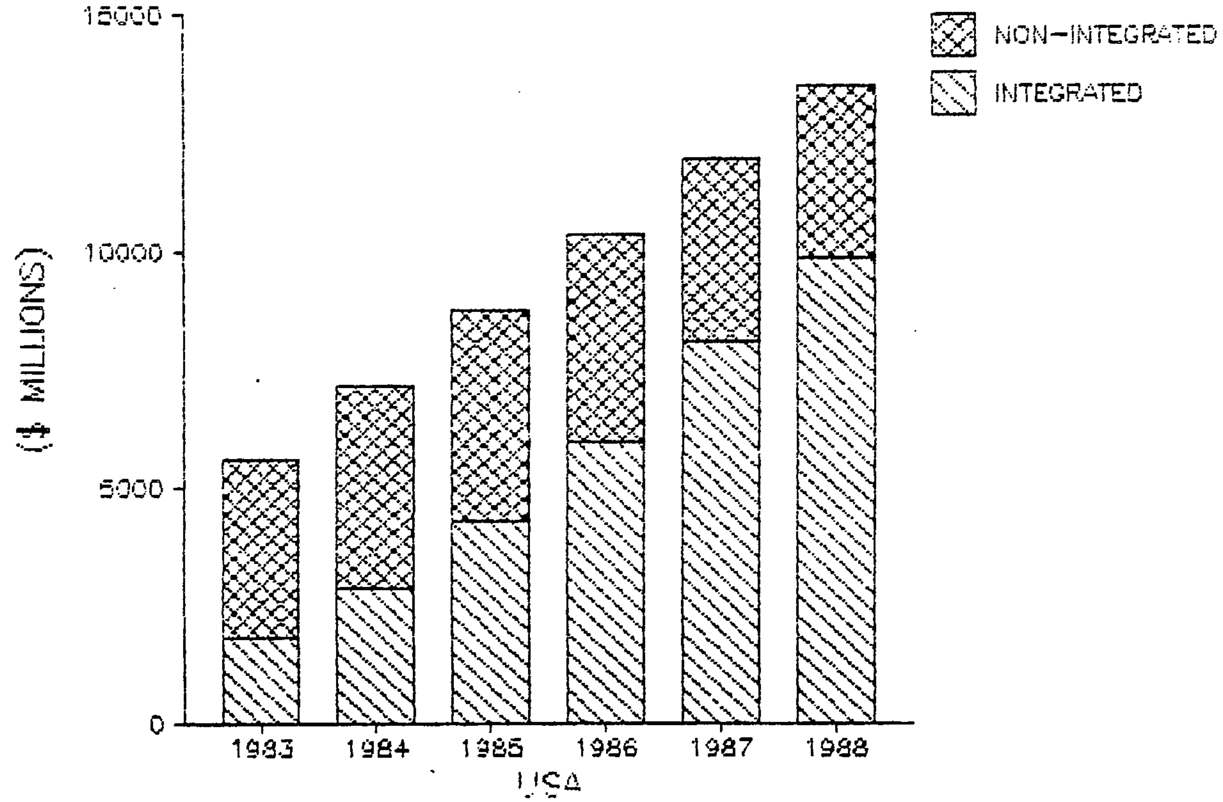
	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Integrated Systems	57	115	182	264	434	516	161.1
Non-Integrated Systems	234	270	297	309	234	246	1.0
TOTAL	291	385	479	573	668	762	32.4

UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Integrated Systems	1,805	2,860	4,290	6,000	8,130	9,854	89.2
Non-Integrated Systems	3,794	4,328	4,487	4,367	3,826	3,691	-0.5
TOTAL	5,599	7,188	8,777	10,367	11,956	13,545	28.4

FIGURE 2-4


THE OFFICE AUTOMATION MARKET
INTEGRATED VS NON-INTEGRATED
($ MILLIONS)
800
600
400
200
0
NON-INTEGRATED
INTEGRATED
1983
1984
1985
1986
1987
1988
CANADA


($ MILLIONS)
15000
10000
5000
0
NON-INTEGRATED
INTEGRATED
1983
1984
1985
1986
1987
1988
USA

In Canada, the market is very similar. Virtually all of the market growth is in integrated systems and equipment. However, the average annual growth rate for integrated systems is 161.1 percent, about double that of the United States. The non-integrated systems market in Canada shows a slight rise to 1986 when it begins to fall, winding up in 1988 at about the 1983 level; very similar to the United States.

Table 2-3 and Figures 2-5 and 2-6 show the market by size of organization. In the U.S., the market amongst small to medium sized companies is about 11 percent of the total market, with an average annual growth rate of 26.2 percent per year. This is about the same as the growth rate in the large organizations, at about 28.7 percent per year. As such, smaller organizations appear to be adopting office automation at about the same rate as their larger counterparts.

In Canada, the situation is slightly different, as we have included smaller companies in the total. The market amonst the small to medium sized companies makes up about 26% of the total market. The growth rate is somewhat higher than in the U.S. at about 32.1 percent per year. Again, there is no significant difference in the rate of growth in large versus small to medium organizations.

Table 2-4 shows the market by industry sector. The largest market in the U.S. is in manufacturing, with a little over three times the market size of any other sector. The ranking by market size from largest to smallest is as follows:

TABLE 2-3

OFFICE AUTOMATION MARKET, 1983-1988

BY SIZE OF ORGANIZATION
(In millions of 1983 dollars)

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
CANADA							
	$	$	$	$	$	$	%
Large	214	284	354	424	494	564	32.7
Small/Medium	76	101	125	149	174	198	32.1
TOTAL	291	385	479	573	668	762	32.3
UNITED STATES							
	$	$	$	$	$	$	%
Large	4,951	6,371	7,791	9,212	10,632	12,052	28.7
Small/Medium	647	817	986	1,155	1,324	1,494	26.2
TOTAL	5,599	7,188	8,777	10,367	11,956	13,545	28.2

FIGURE 2-5

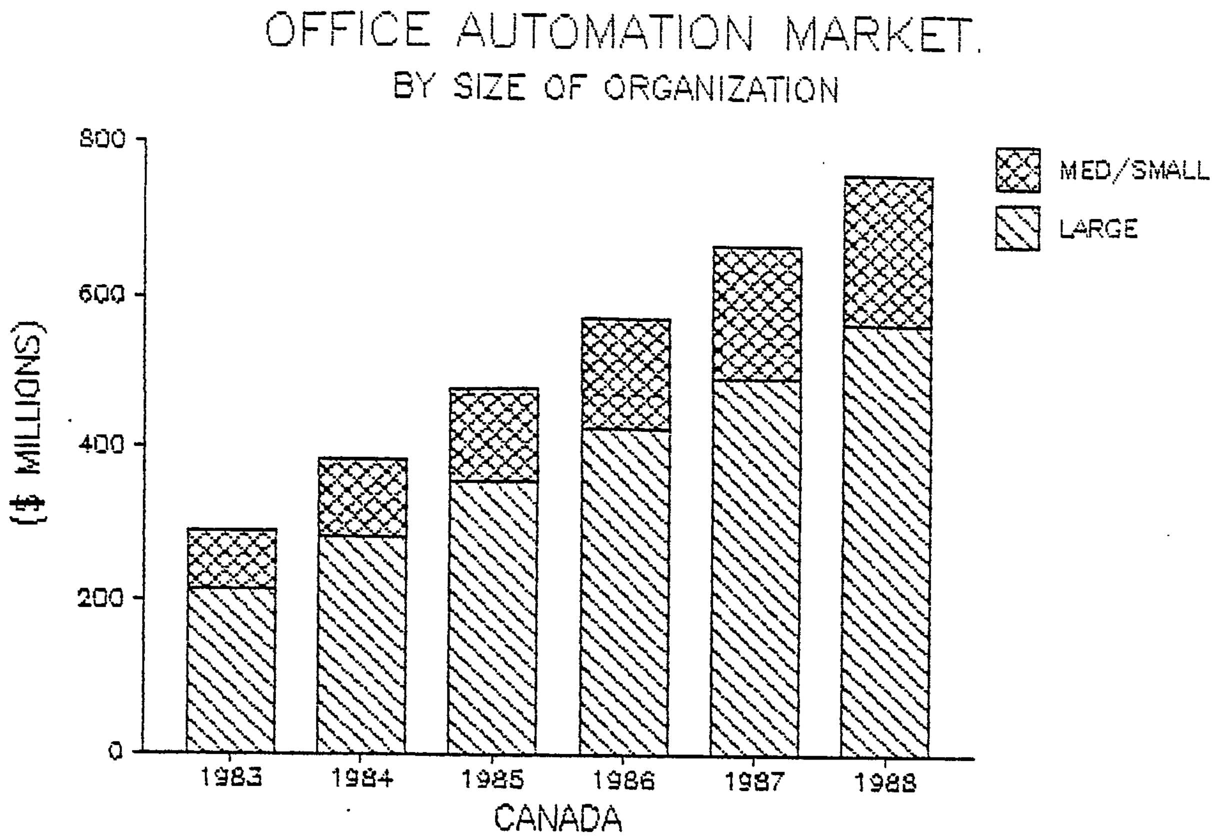


FIGURE 2-6

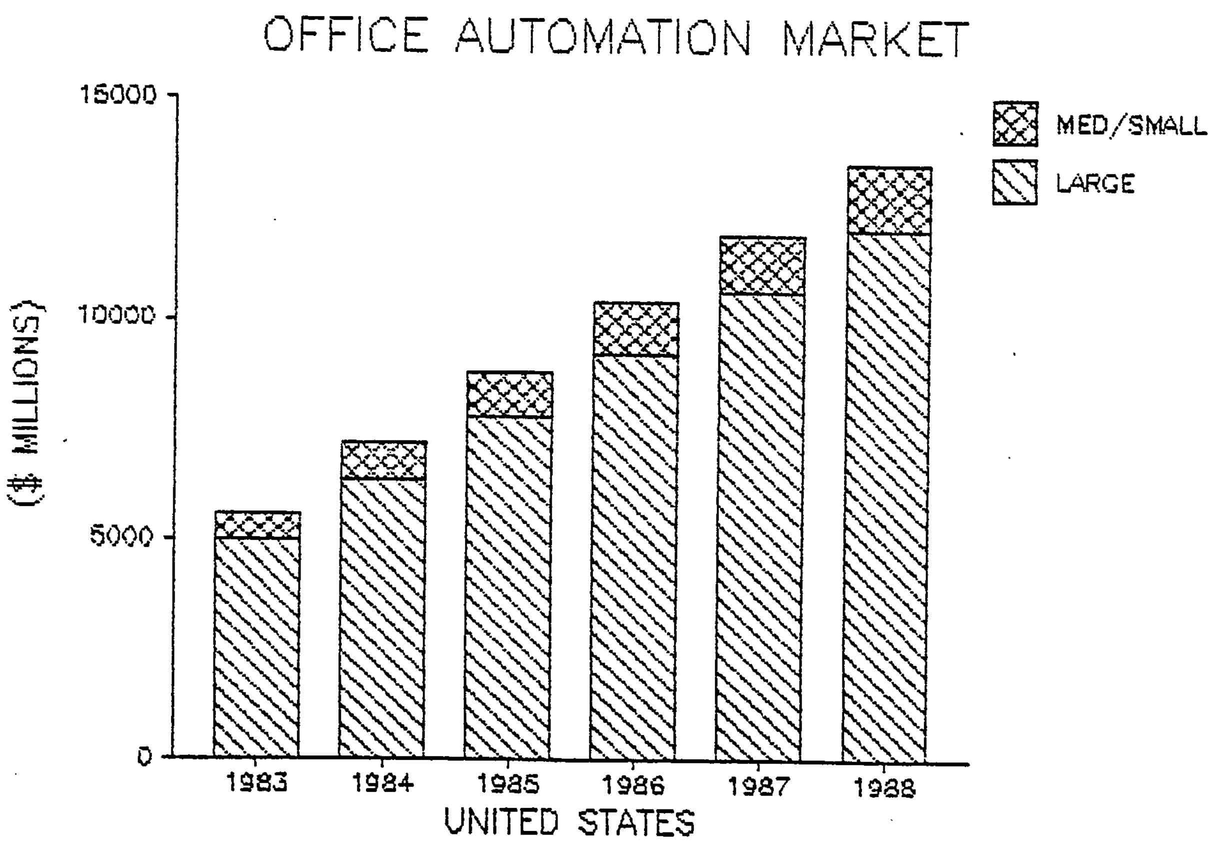


TABLE 2-4

OFFICE AUTOMATION MARKET, 1983-1988
BY INDUSTRY SECTOR
(In millions of 1983 dollars)

C A N A D A

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	19	20	21	23	24	26	7.4
Health	16	21	25	29	33	37	26.2
Insurance	30	45	60	75	89	104	49.3
Manufacturing	118	155	192	229	266	303	31.4
Resource	46	56	67	77	87	98	22.6
Trans. & Comm.	61	88	114	141	167	194	43.6
TOTAL	291	385	479	573	668	762	32.4

U N I T E D   S T A T E S

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	199	254	309	364	420	475	27.7
Health	103	128	152	177	202	227	24.1
Insurance	703	934	1,164	1,395	1,625	1,856	32.8
Manufacturing	3,494	4,408	5,322	6,236	7,149	8,063	26.1
Resource	869	1,158	1,447	1,736	2,025	2,313	33.2
Trans. & Comm.	203	307	383	459	535	611	40.2
TOTAL	5,599	7,188	8,777	10,367	11,956	13,545	28.4

U.S.A. - * Manufacturing
* Resource industries
* Insurance
* Transportation and Communications
* Education
* Health

The large market size for the manufacturing sector is due to the large number of firms in this industry, compared to the other sectors. Growth rates in all sectors are relatively consistent ranging from an average 24.1 percent per year (Health) to about 32 to 40 percent in the insurance, resource and transportation and communications sectors.

The largest market in Canada is also in the manufacturing sector. However, the Canadian market is relatively small by comparison with the U.S., at between 3.4 percent (1983) and 3.8 percent (1988) of the U.S. market; although the growth rate is slightly higher than that in the U.S. (31.4 percent versus 26.1 percent). The ranking of the Canadian market by size from largest to smallest, is as follows:

Canada - * Manufacturing
* Transportation and Communications
* Insurance
* Resource
* Health
* Education

This distribution is slightly different than in the U.S., with the main difference being the ranking of the transportation and communications sector. This reflects a relatively high Canadian market size in this industry, compared to the United States. The size comparison is shown in Table 2-5. Whereas the market in the manufacturing sector in Canada is only 3 to 4 percent of the U.S., the transportation and communications sector is 30 to 32 percent of the U.S. market. This indicates a relatively strong Canadian industry in this sector, and a high pace of adoption of office automation.

Figure 2-7 shows the integrated systems portion of the total market. In Canada, as in the United States, the largest market is in manufacturing, followed in Canada by the transportation and communications sector. In the United States, the second and third largest markets are not transportation and communications, but insurance and the resource sector, then followed by transportation and communications.

TABLE 2-5

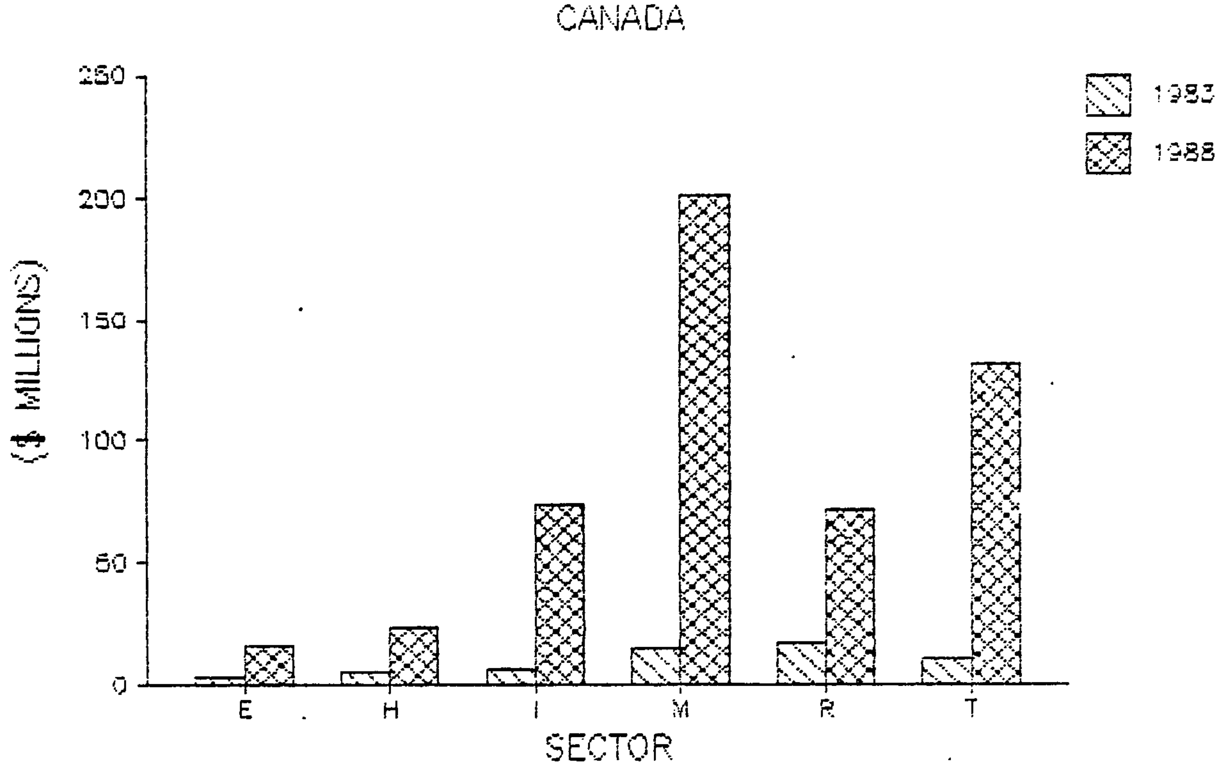
CANADIAN MARKET SIZE

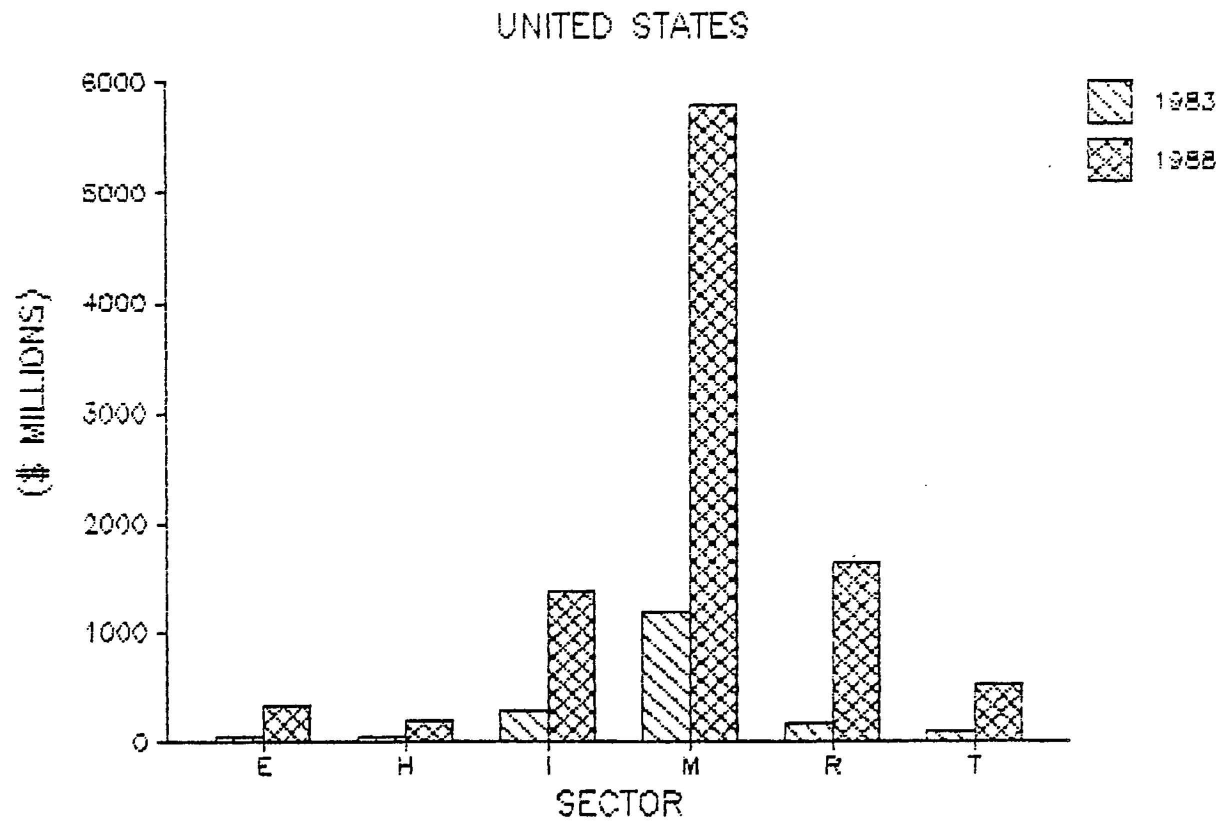
AS A PERCENTAGE OF THE UNITED STATES MARKET

SECTOR	1983	1988
Education	9.5%	5.5%
Health	15.5%	16.3%
Insurance	4.3%	5.6%
Manufacturing	3.4%	3.8%
Resource	5.3%	4.2%
Trans. & Comm.	30.0%	31.7%

FIGURE 2-7

INTEGRATED SYSTEMS MARKET ($ MIL)





2.2.3 Current State of Automation

Figure 2-8 shows the current state of office automation in Canada and the U.S. This is based on the following definitions:

* EARLY AUTOMATION - Automatic typewriters and/or word processors used by clerical staff.

* LIMITED AUTOMATION - Clustered word processors in a centralized group for the organization.

* PARTIAL AUTOMATION - Combination of word processors and microcomputers with some communicating abilites. Random purchases of independent systems.

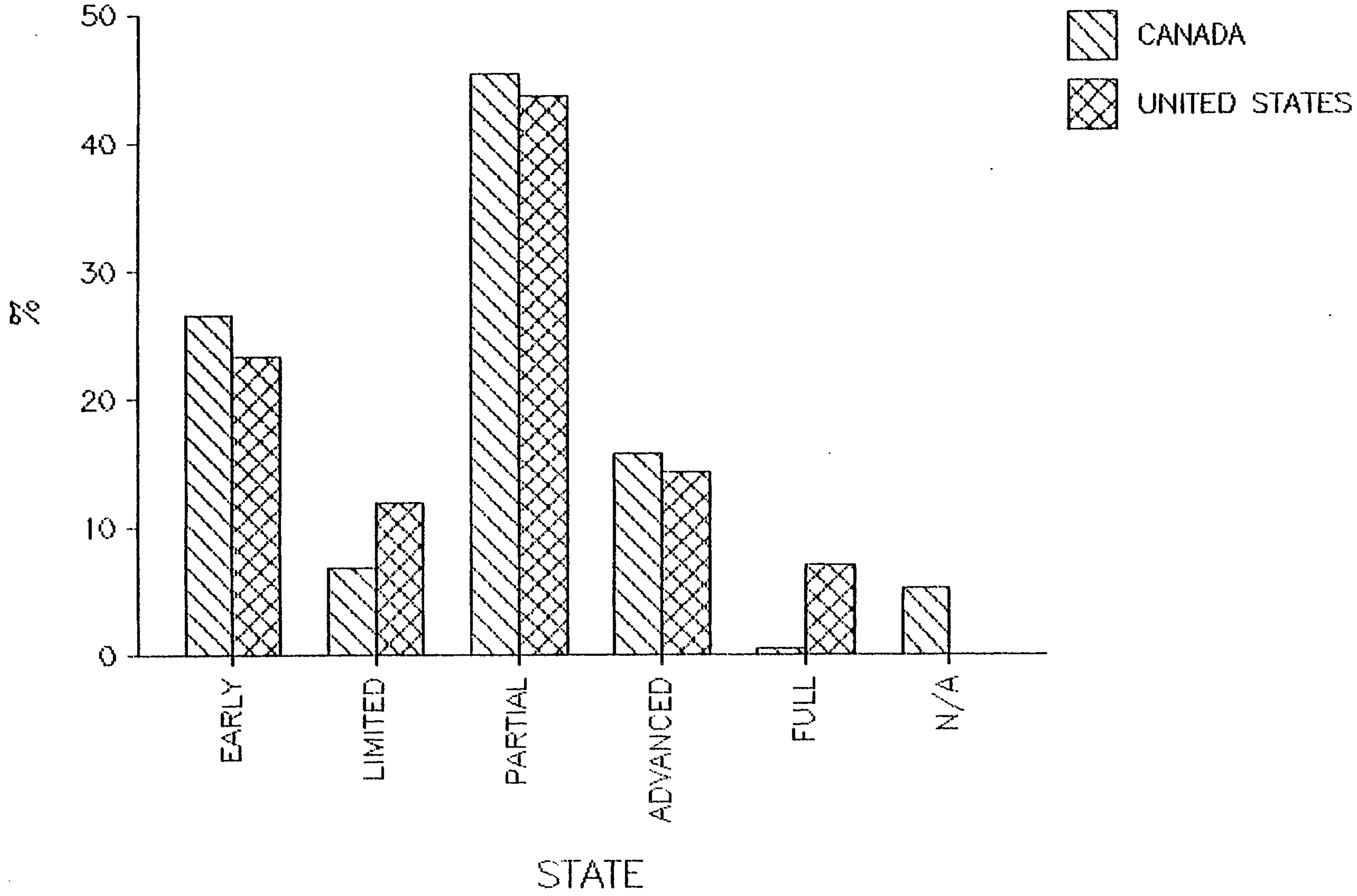
* ADVANCED AUTOMATION - Networking among word processors, microcomputers and peripherals. Improved access to information. Development of a plan for office integration.

* FULL AUTOMATION - Integrated communications and information access allowing distributed data processing, report generation, personal computing and decision support. Users range from executives to support staff.

* NONE OF THE ABOVE

FIGURE 2-8

CURRENT STATE OF OFFICE AUTOMATION (1984)



As indicated, the level of automation in Canada and the U.S. are relatively similar, with the exception of "Full Automation" and "None". There are a larger number of U.S. organizations which have achieved full automation, primarily in the health and insurance sectors. The highest percentage of firms in both Canada and the United States are currently at the "Partial" automation level, with the second highest still at the "Early" level. The small percentage at the "Limited" automation level suggests that organizations may be skipping that level completely and going directly from "Early" to "Partial". This is consistent with the trend towards microcomputers, resulting in a mixture of word processors and micros in many organizations, instead of clustered word processors.

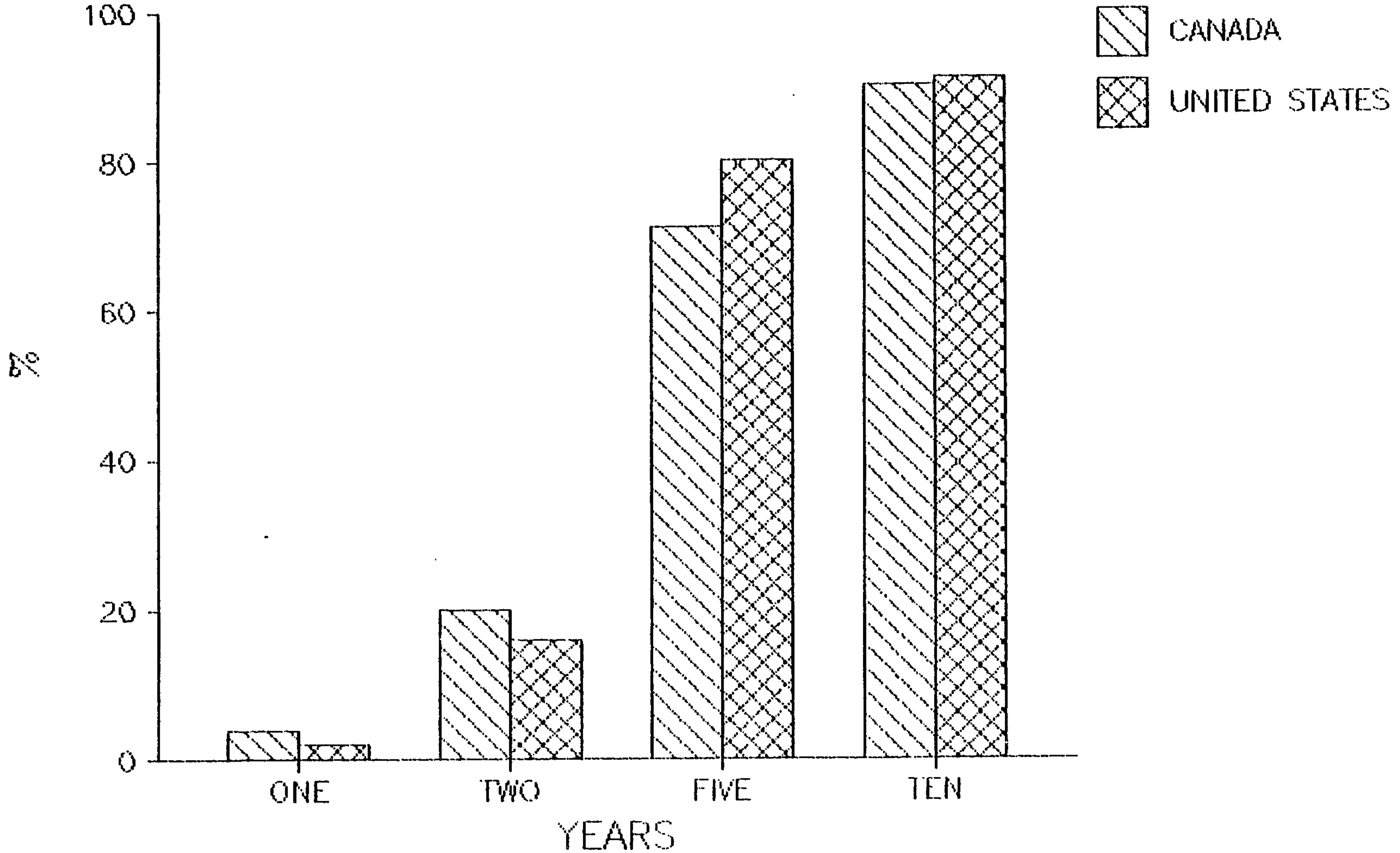
In Canada, the highest percentage of firms reaching the "Advanced" stage of automation in 1984 were in the resource sector, with the second highest being in transportation and communications. In the U.S., it is very similar with transportation and communications first and the resource sector second.

Figure 2-9 shows the response to the question as to when organizations would be "fully automated" in accordance with the above definition. The expectation of organizations in Canada and the United States are very similar, with a suprising 19 to 20 percent expecting full automation within two years, i.e. by 1987. Around 75 to 80 percent expect to achieve full automation within five years, moving to 90 percent of organizations within the decade.

FIGURE 2-9

EXPECTATION OF AUTOMATION - NUMBER OF COMPANIES

CUMULATIVE PERCENTAGES



As indicated in Table 2-6, the sectors in the U.S. expecting to take the longest to achieve full automation are the health and education sectors. This is the same in Canada. In Canada and the U.S., the other sectors are relatively consistent with over 64 to 88 percent of organizations expecting full automation within five years. One exception is the resource sector in the United States which appears from this and previous data, to be agressively persuing office automation. All organizations in the resource sector expects to be fully automated within five years.

TABLE 2-6

PERCENTAGE OF ORGANIZATIONS EXPECTING FULL AUTOMATION WITHIN FIVE YEARS

SECTOR	CANADA	UNITED STATES
Education	58%	64%
Health	57%	75%
Insurance	75%	88%
Manufacturing	81%	83%
Resource	64%	100%
Trans. & Comm.	67%	85%

2.2.4 Factors Holding Back Office Automation

Details are contained in Figures 2-10 (pages 1 to 3) and 2-11 (pages 1 to 3). From this, it is quite obvious that, both in Canada and the U.S., organizations do not believe technology is a major factor holding back office automation. Over 50 percent of organizations in Canada and over 60 percent in the U.S., ranked technology at the 1 and 2 levels in a ranking of 1 to 5 (5 being high impact and 1 being low impact). By contrast, about 80 percent of Canadian and U.S. organizations, ranked "Financial" and "Product Compatibility" at levels of 3 to 5. Similarly, "Corporate Motivation" and "User Acceptance" were ranked at 3 to 5 by about 75 percent of organizations. Generally, therefore, the major factors in order of importance are:

* Financial and product compatability factors

* Corporate motivation and user acceptance

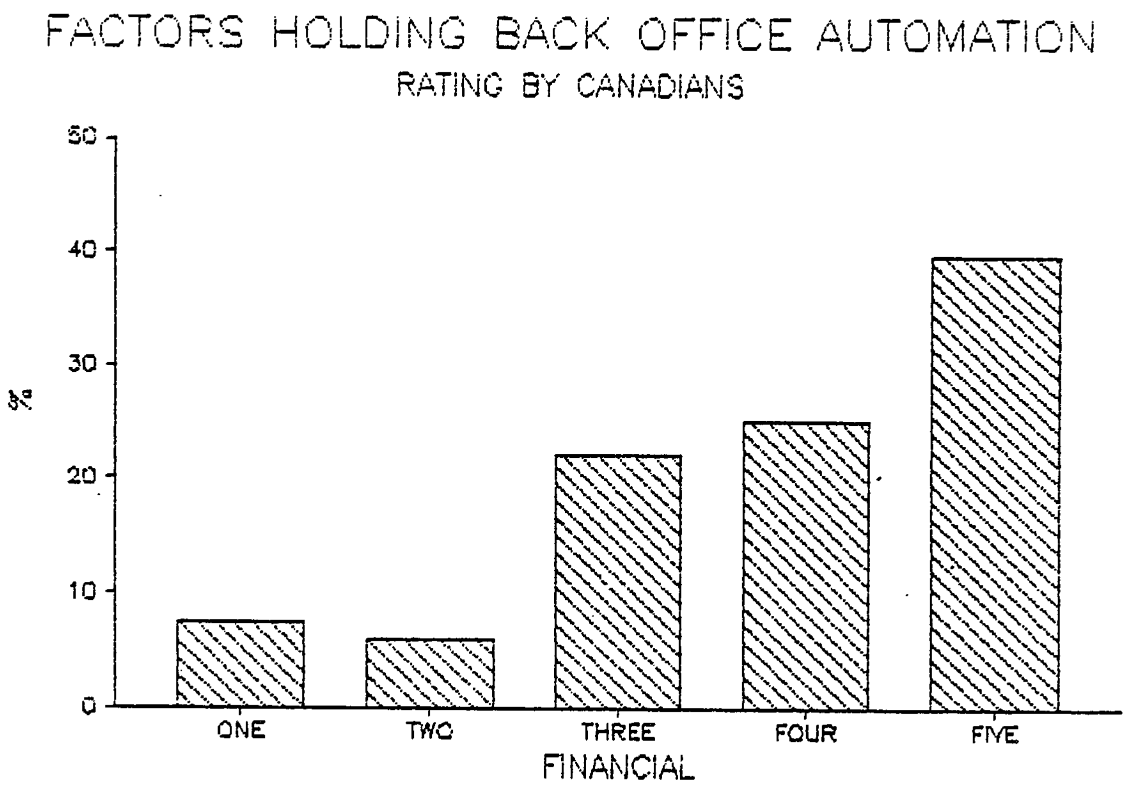
* Technology

Opinion on all these factors was very similar in both Canada and the U.S.

2.2.5 Factors In Selecting A Supplier

The following factors were ranked by organizations as being important in the choice of a supplier:

FIGURE 2-10 (Page 1)



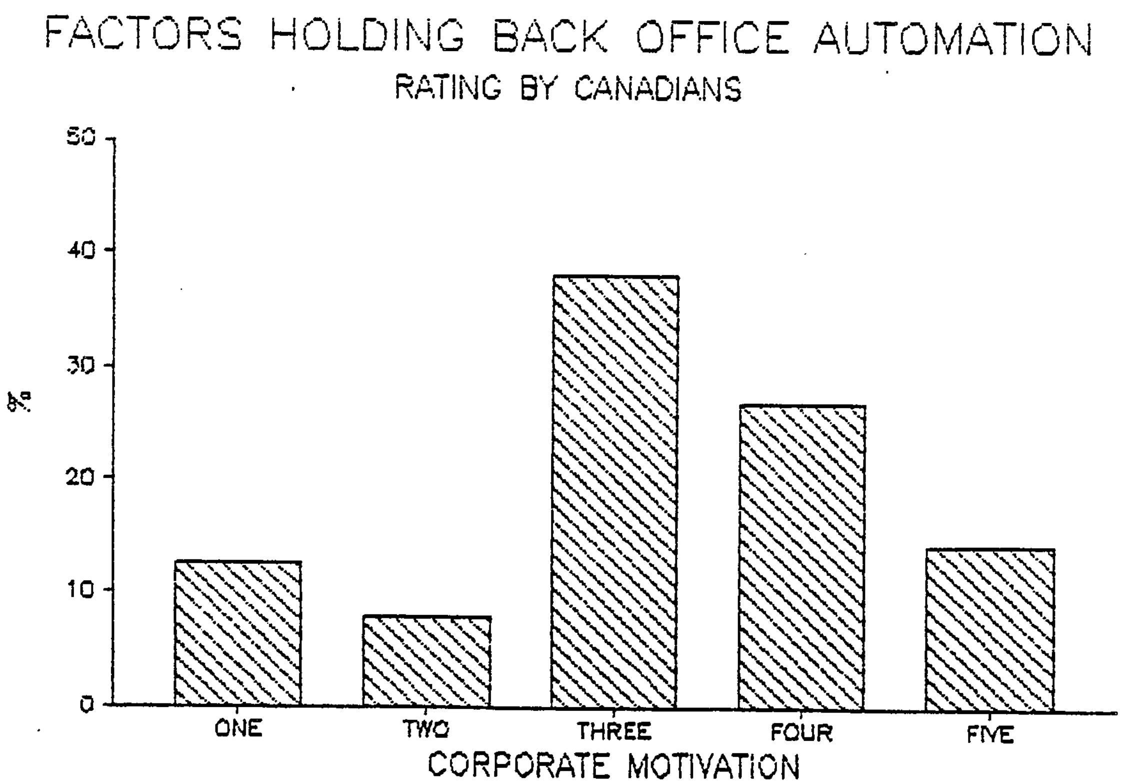
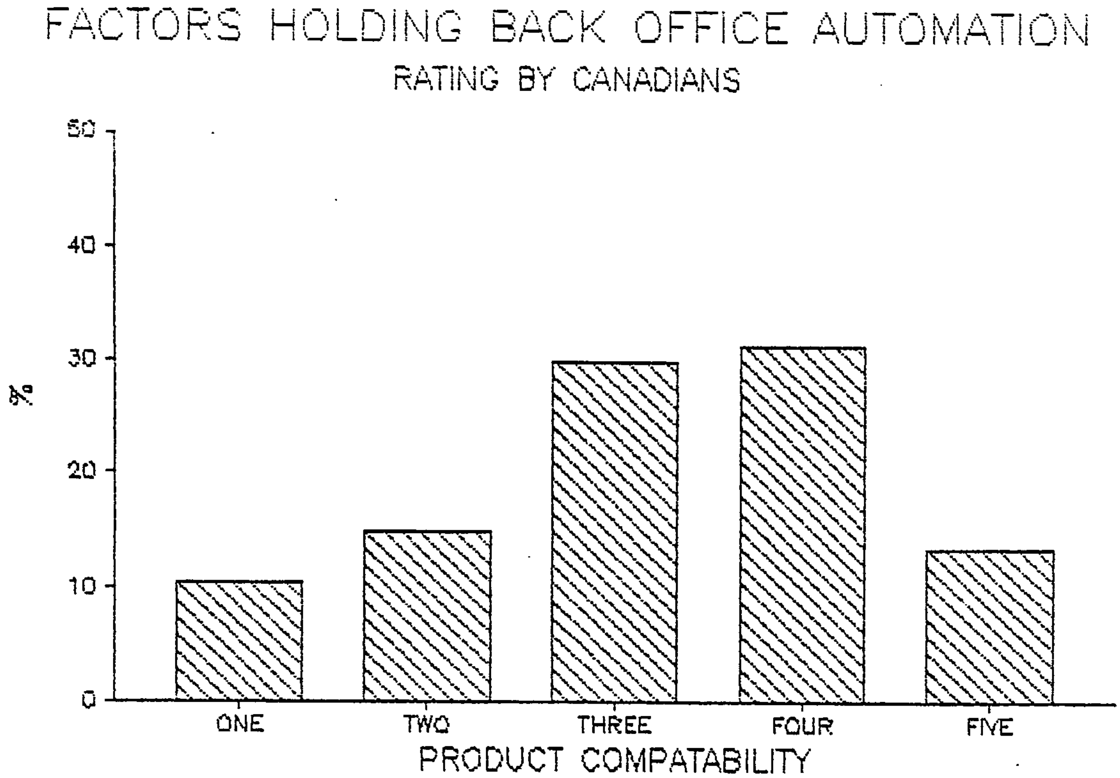


FIGURE 2-10 (Page 2)



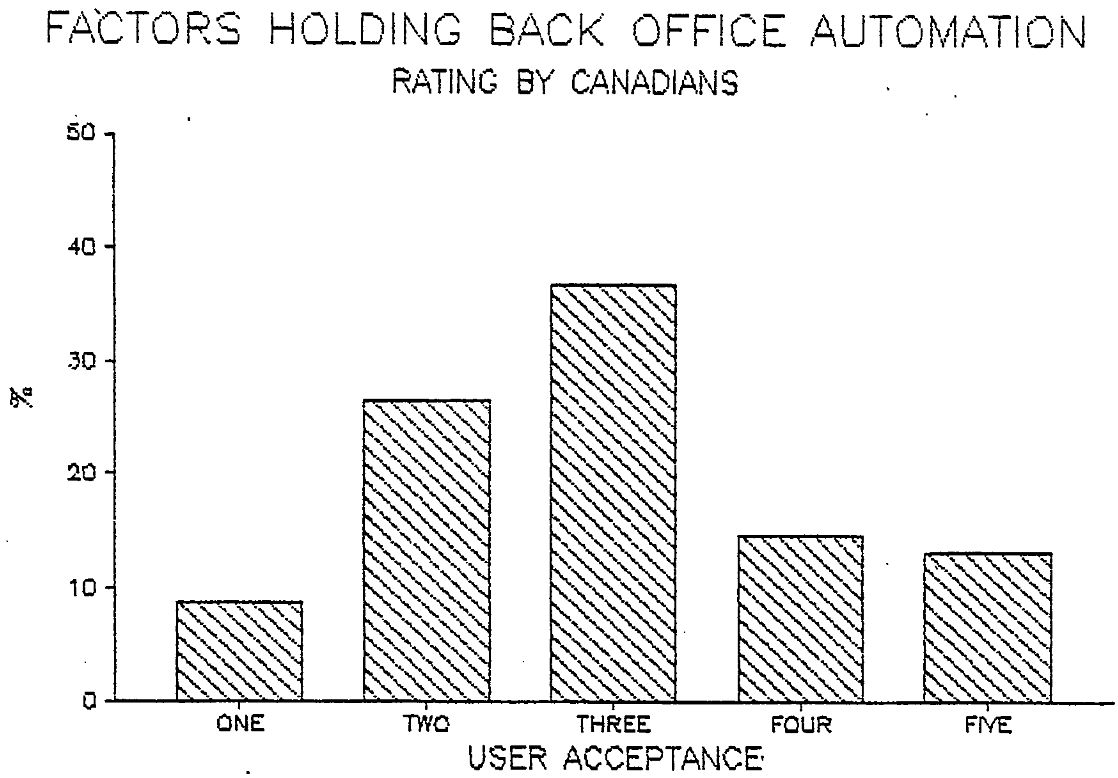


FIGURE 2-10 (Page 3)

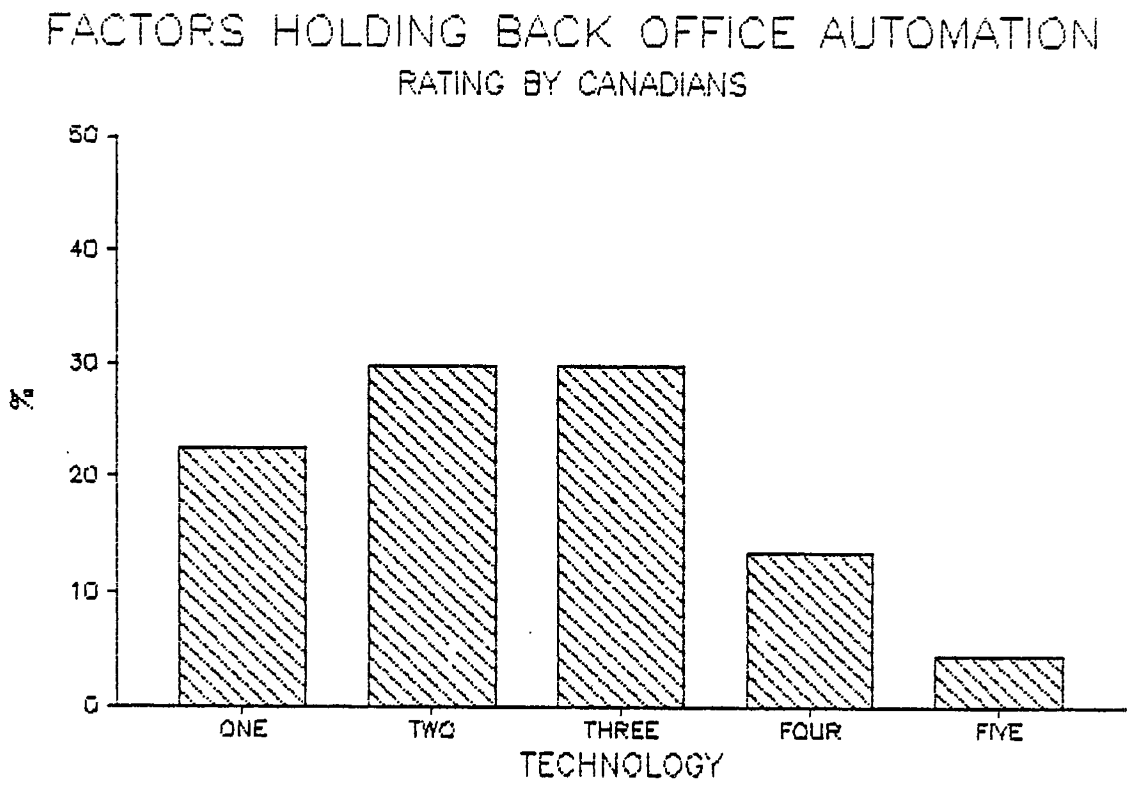
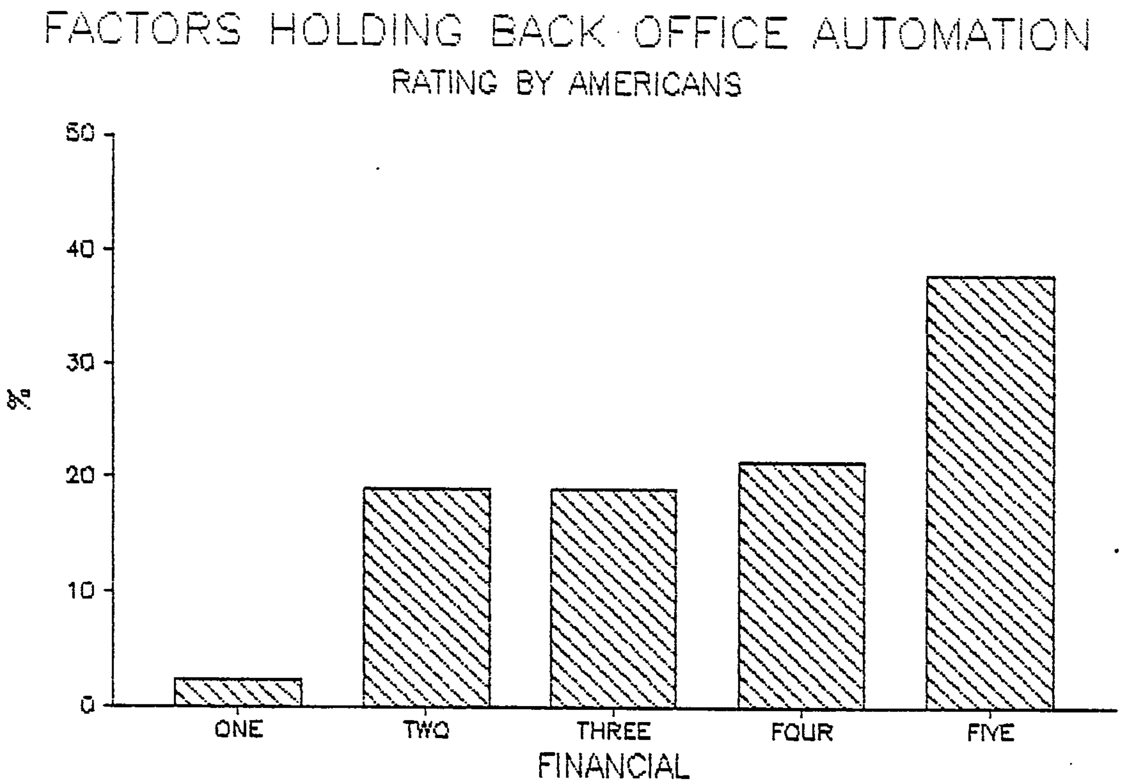


FIGURE 2-11 (Page 1)



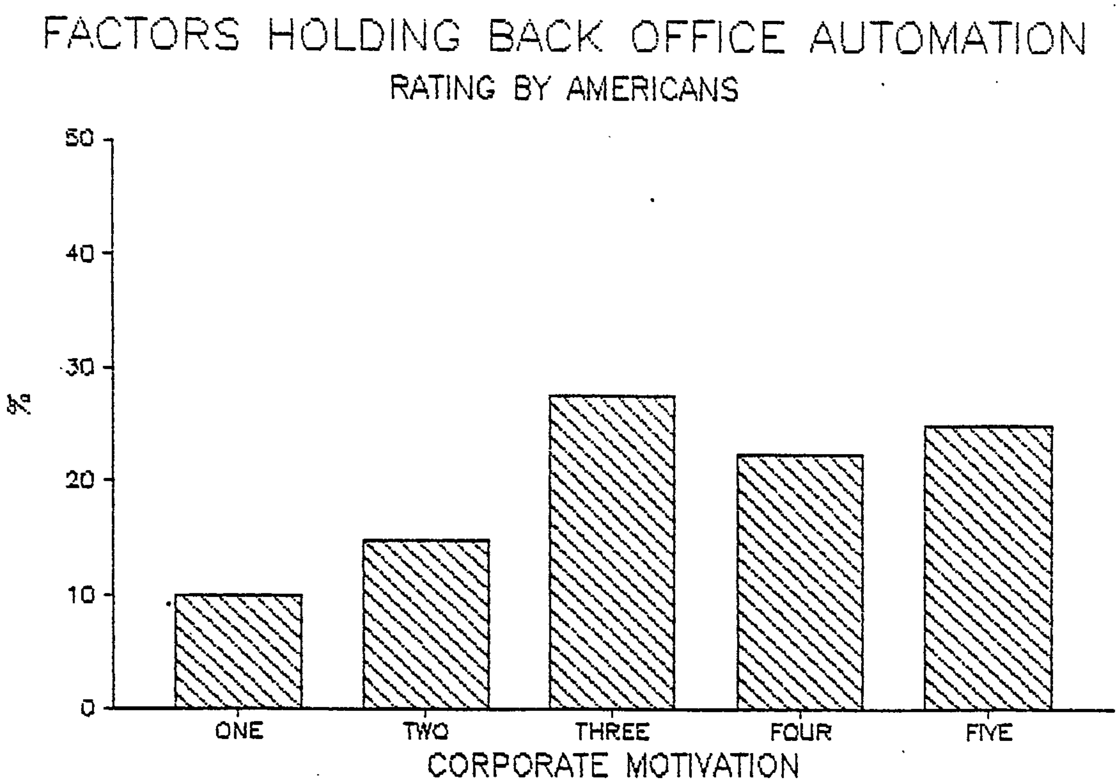
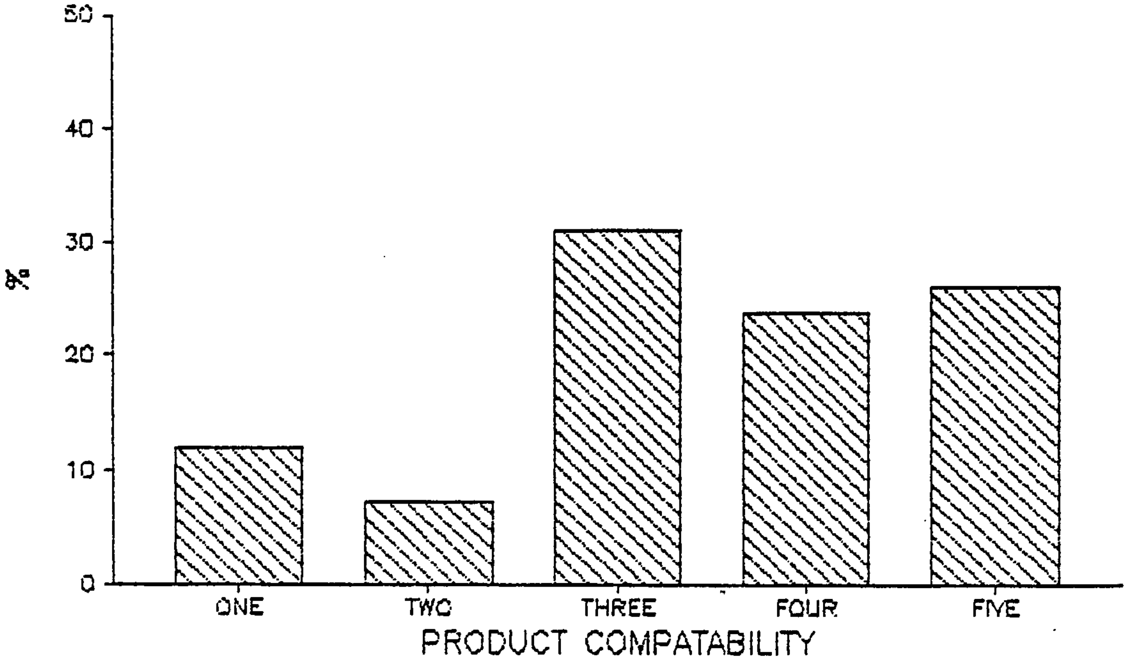


FIGURE 2-11 (Page 2)

FACTORS HOLDING BACK OFFICE AUTOMATION
RATING BY AMERICANS



FACTORS HOLDING BACK OFFICE AUTOMATION
RATING BY AMERICANS

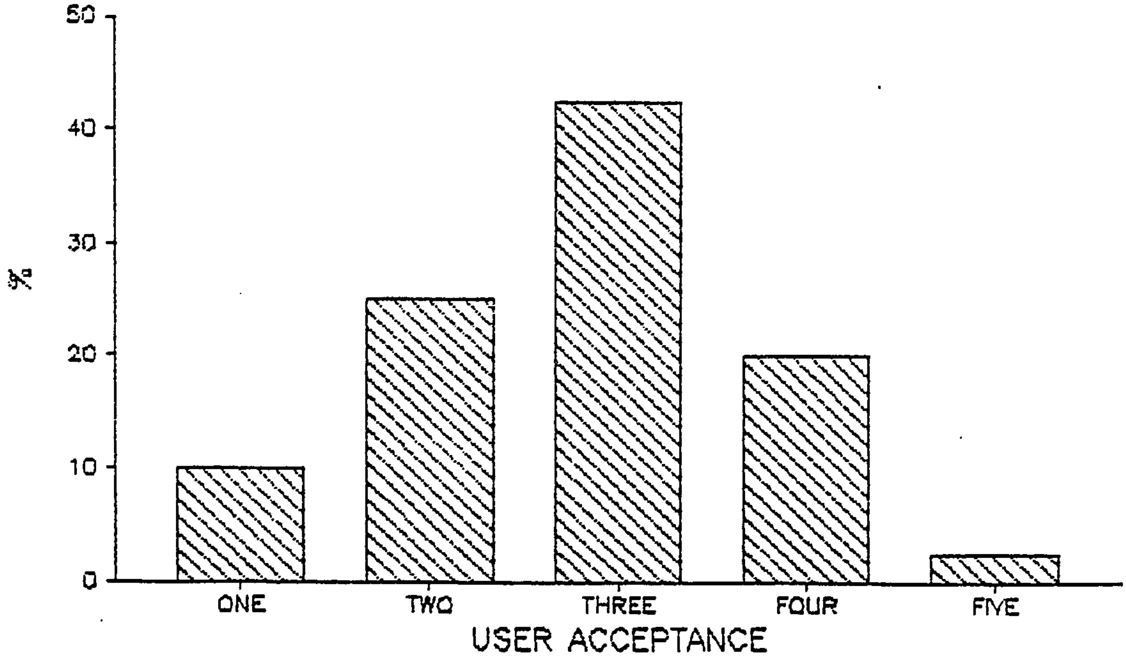
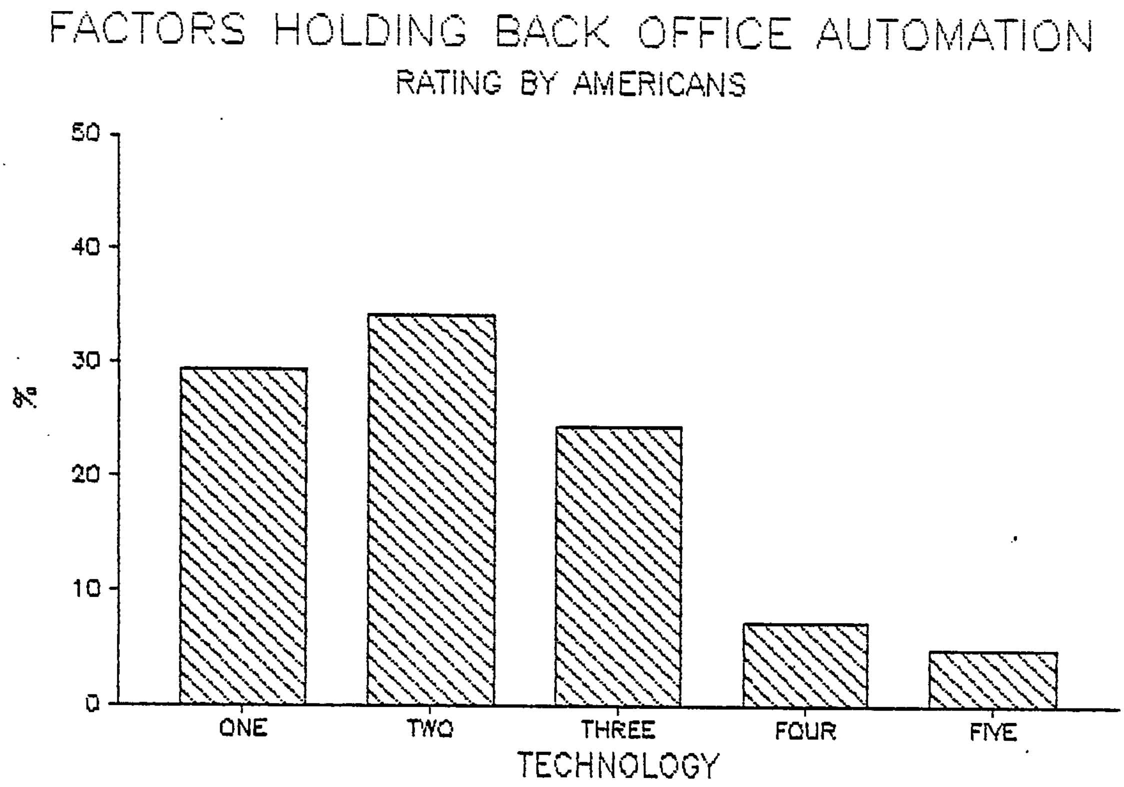


FIGURE 2-11 (Page 3)



* Mainframe/reliability
* Manufacturer's reputation
* Sales personnel/marketing
* Advanced technology
* Price
* Features/Capabilities
* Product scope
* Product compatibility
* Product availability
* Company support

Organizations ranked each of these factors on a scale of 1 to 5 (one being least important). Table 2-7 shows the percentages at the 4 and 5 levels, indicating the factors of most importance. The area ranked the lowest in importance was "sales personnel/ marketing". The highest was "maintenance/reliability", followed closely by "product compatibility", "features/compatibility" and "company support". "Price" was well down the list in relative terms, with about 63.9 percent of respondents ranking it at the fourth and fifth levels of importance, versus 95.1 percent for the "maintenance/reliability" factor.

TABLE 2-7

PERCENTAGE OF RESPONDENTS RANKING EACH FACTOR AT THE FOURTH AND FIFTH LEVELS OF IMPORTANCE

CATEGORY		PERCENT
Maintenance/reliability	-	95.1%
Product compatibility	-	90.6%
Features/capabilities	-	89.4%
Company support	-	87.2%
Product scope	-	75.5%
Manufacturer's reputation	-	72.0%
Price	-	63.9%
Advanced technology	-	62.7%
Product availability	-	60.4%
Sales personnel/marketing	-	24.3%

2.2.6 Approach To The Purchase Of Integrated Systems

Organizations were asked which of the following best described their approach to the integrated office:

* "ONE-STOP SHOPPING" - A supplier offering a complete, integrated system, e.g. IBM, assesses your situation and recommends which of his systems best suits your needs.

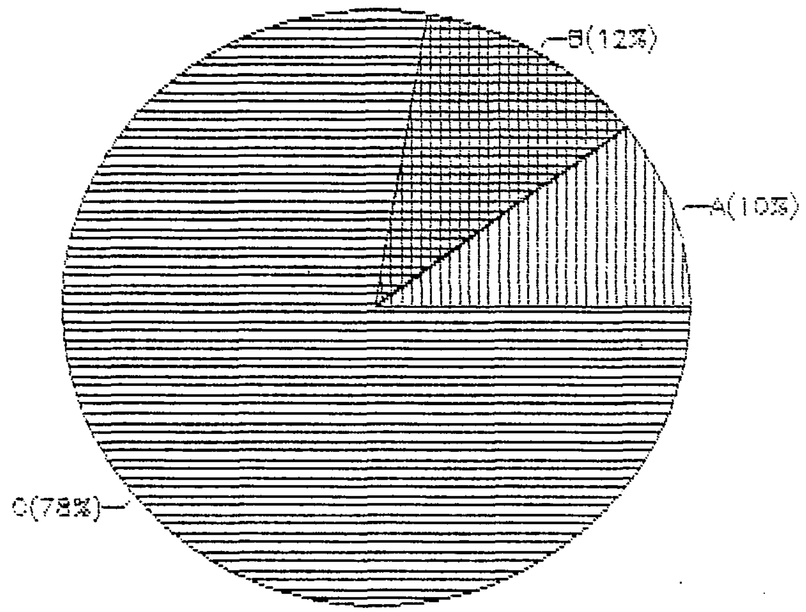
* "CUSTOMIZATION" - An outside consultant specializing in systems integration assesses your situation and recommends and installs available products to best suit your needs.

* "DO-IT-YOURSELF" - In-house staff assess the situation, investigate available products, and proceed to implement the installation of equipment.

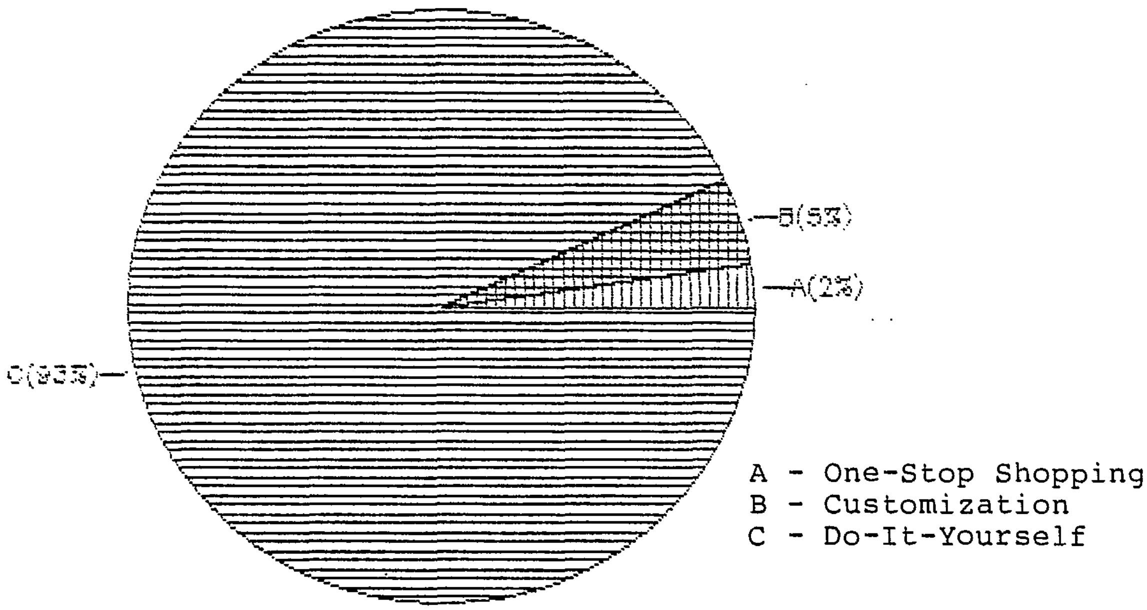
As indicated in Figure 2-12, the majority of organizations in both Canada and the U.S. intend to approach office automation on a "do-it-yourself" basis. They neither expect to simply purchase a complete offering as recommended by one supplier, nor to hire an outside consultant to do the whole thing. 75 percent of organizations in Canada expect to conduct their own assessments and then proceed with implementation. In the U.S., this is even higher at 93 percent.

FIGURE 2-12

APPROACH TO INTEGRATED OFFICE SYSTEMS
CANADA



APPROACH TO INTEGRATED OFFICE SYSTEMS
USA



This does not appear to offer a very good market for total systems integrators. Only 12 percent of organizations in Canada and 5 percent in the U.S. would engage a consultant along the lines indicated above. The wording of the question however, should be kept in mind. This does not mean that there is no market for consultants or integrators, only that they will be engaged to do specific pieces of work rather than a total project. This result was consistent across all industry sectors in both Canada and the United States.

2.3 Workstations

2.3.1 Introduction

This report is concerned only with the workstation markets within the sectors detailed in Section 2.1. However, as in Section 2.2 for the overall OCS market, we have also developed estimates of the total workstation market for all sectors. These estimates are based on various public sources, not on detailed survey information, as are the details in Section 2.3.2.

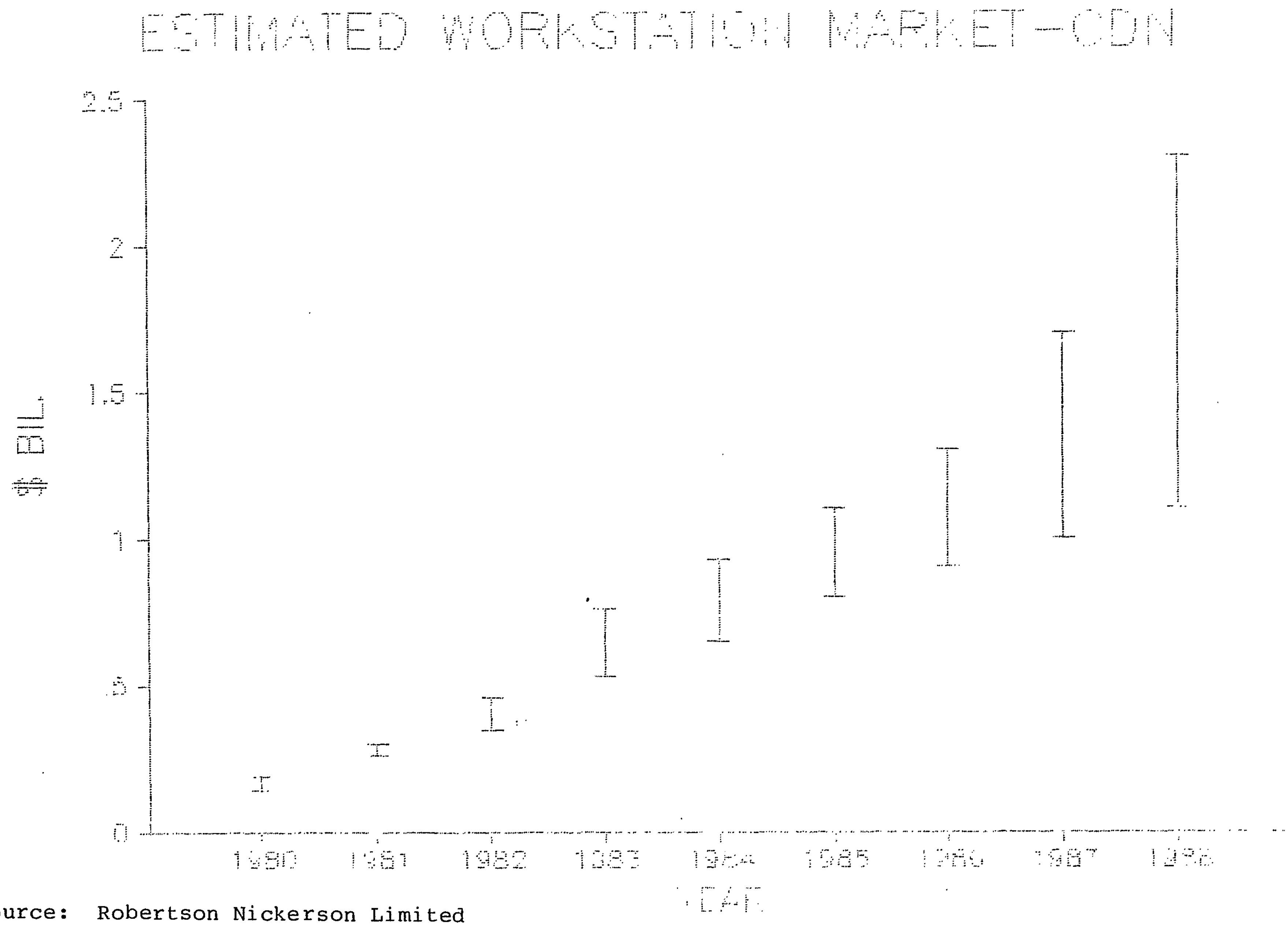
The workstation market is difficult to analyze because it not a generic product. Instead, it can include word processors, desktop microcomputers and specialized products like the integrated voice/data terminal. Other definitions of workstations classify them as products similar to the Xerox Star and Apple Lisa. However, as discussed in Appendix A to this report, these products are not really the multifunctional workstation of the future. Instead, the secretarial workstation will be an offshoot of the clustered word processor system, with increased graphics, data handling, and communications, while the management workstation will be an offshoot of the desktop computer, with the emphasis on software. With the emergence of 32 bit, 1 Mbyte RAM systems with 20 Mbyte storage, the individual will have enough power at his or her fingertips to perform any text, data, graphics or communications tasks that may be required. The differences in workstations will largely depend on the requirements of the individual and the department in which he or she works.

As estimated workstation market has been derived for both Canada and the United States. The estimates are based on combining market size and forecasts for a variety of word processors and desktop microcomputers. An average market estimate was determined, plus an error level. The high/low range is a result of the estimate and the degree of consensus between different sources.

In Canada the estimated workstation market is presented in Figure 2-13. There is a very high uncertainty in the growth rate, hence the considerable spread between the high and low estimates. The word processing portion of the Canadian market is expected to peak at about $300 million in 1985. Figure 2-14 illustrates this changing market. The trend in word processors is from dedicated to multifunctional machines. However, in large secretarial pools there will still be a demand for a machine with superior word processing capabilities. Whether these will still be called word processors, or secretarial workstations, has yet to be determined. Figure 2-15 illustrates the divergence in microcomputer forecasts. The optimistic picture is $3.2 billion by 1988, while the most conservative is less than $1.0 billion.

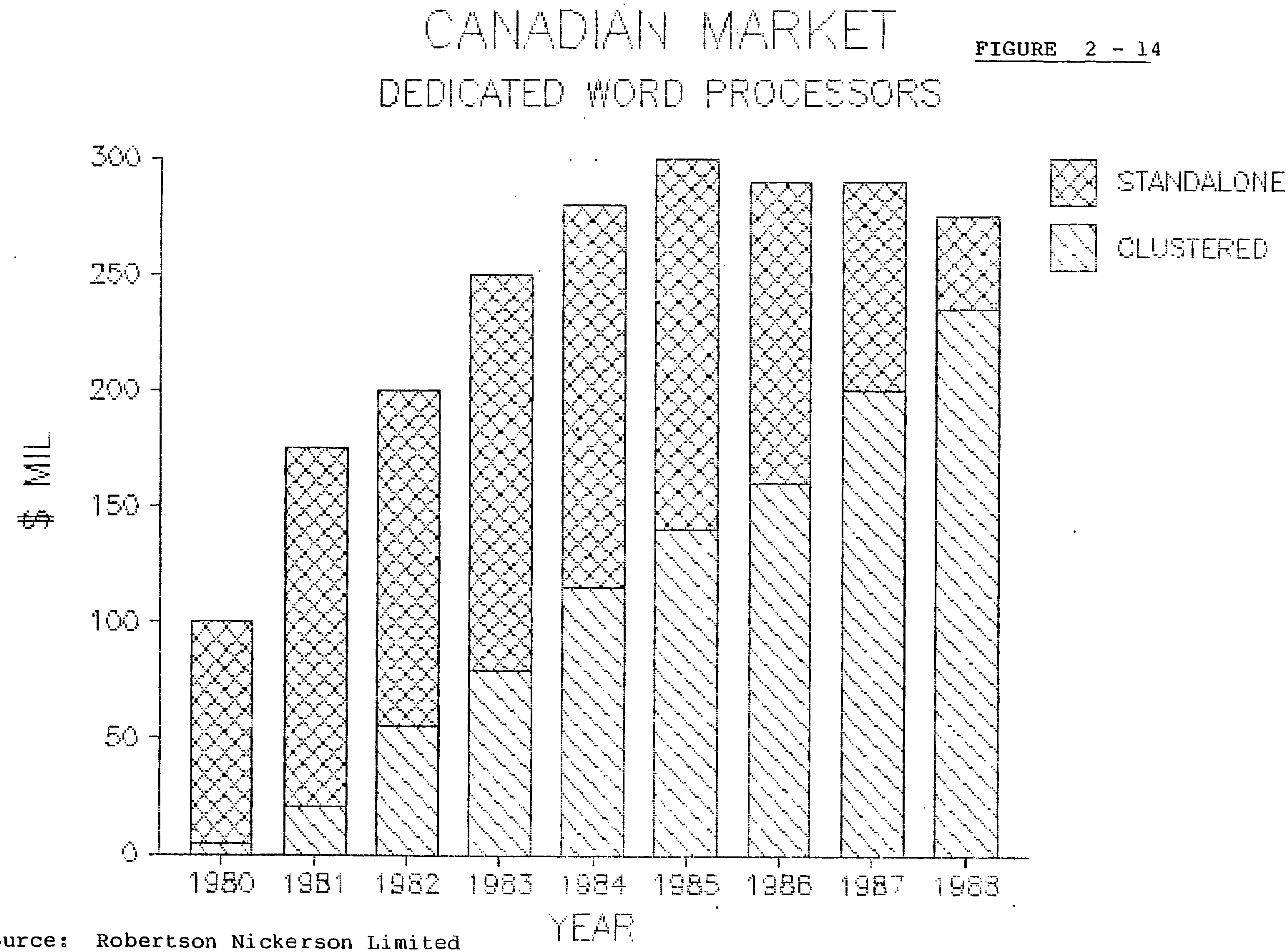
The estimated U.S. market for workstations is presented in Figure 2-16. Because of the larger number of available forecasts and other data it is easier to identify the average estimated market size in the U.S. than in Canada, and to determine the error level based on the consensus between actual projections. The low estimates appear to have a faster growth

FIGURE 2 - 13



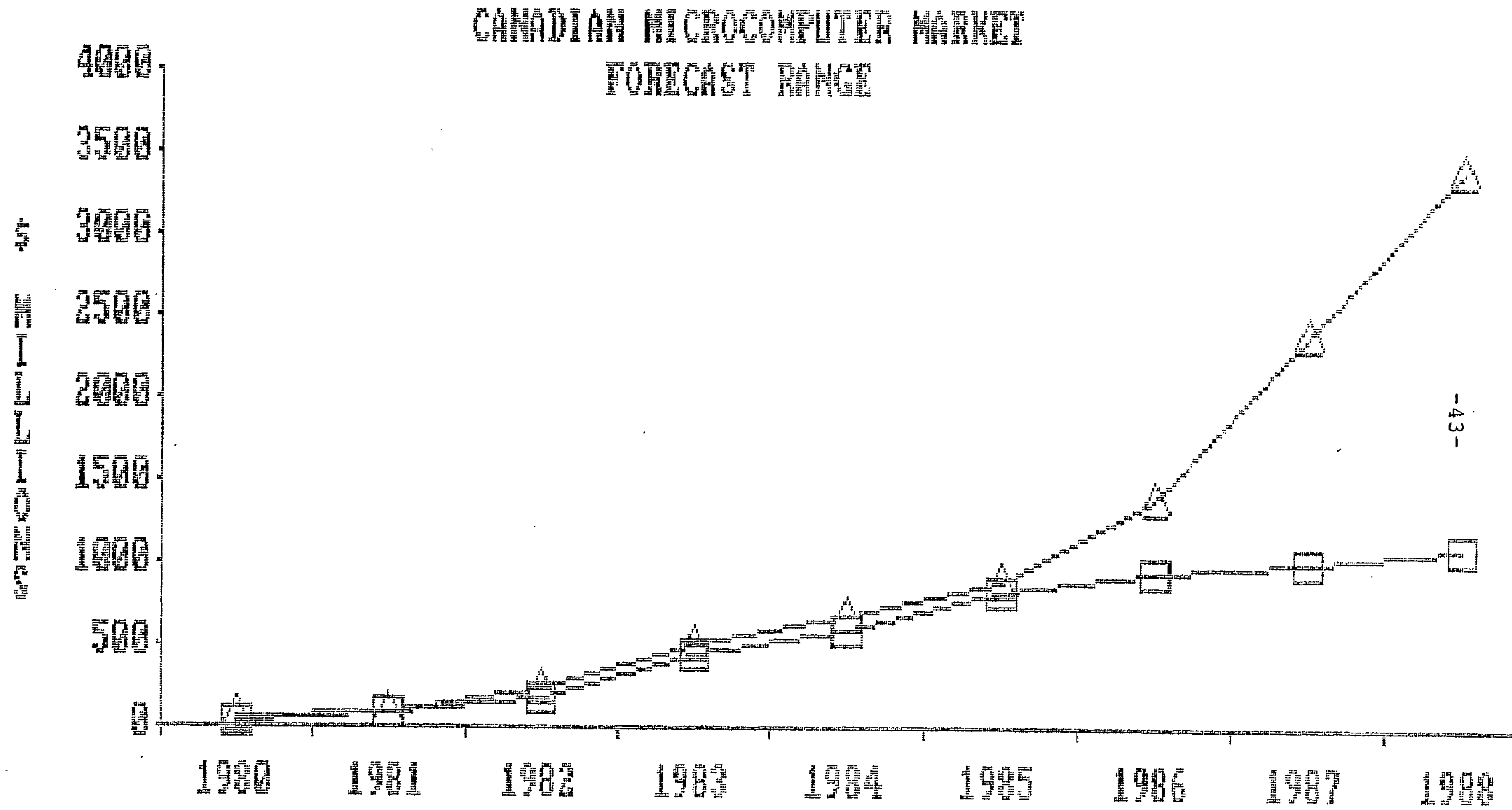
Source: Robertson Nickerson Limited

FIGURE 2 - 14



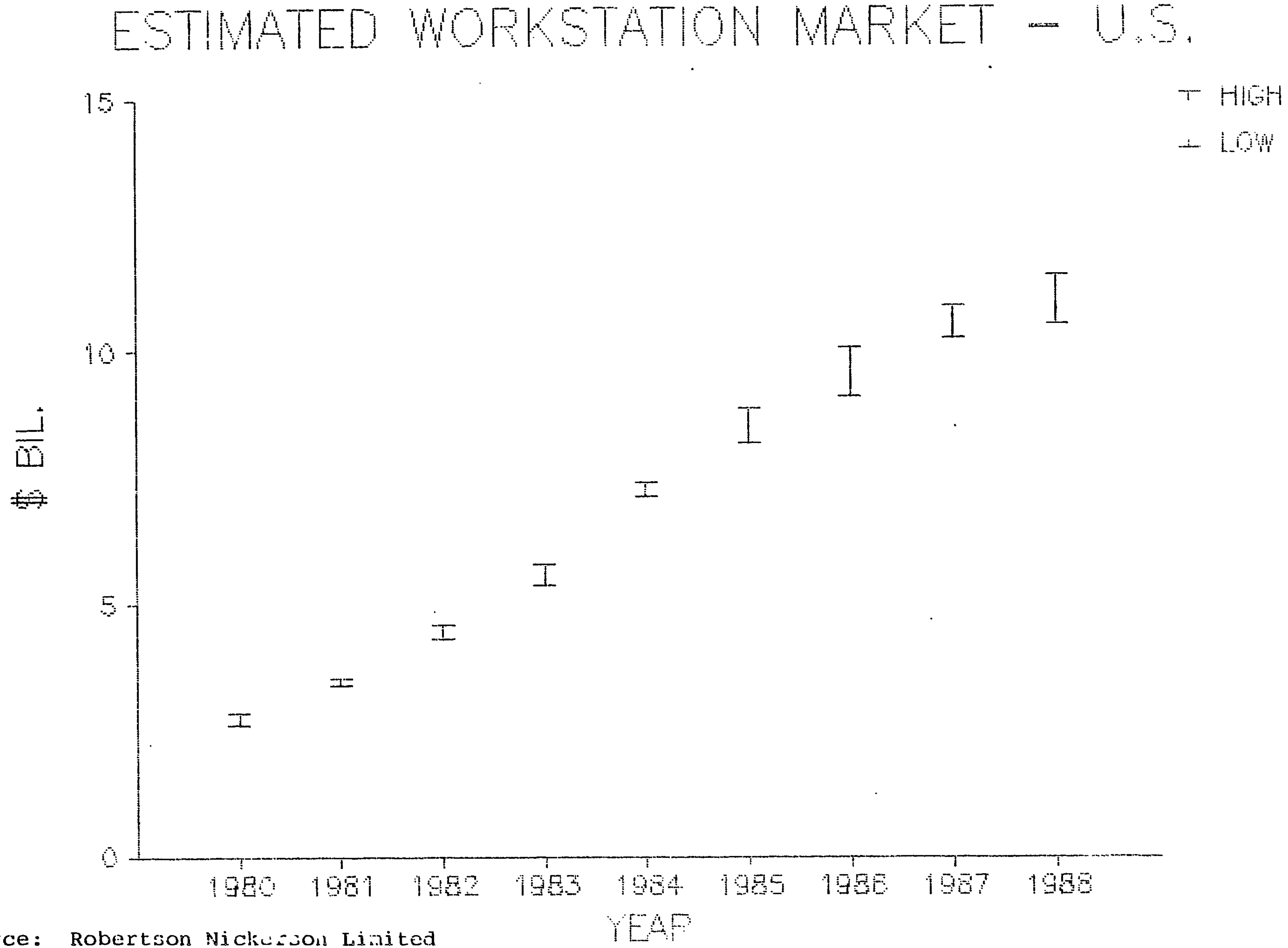
Source: Robertson Nickerson Limited

FIGURE 2 - 15



Source: Robertson Nickerson Limited

FIGURE 2 - 16



Source: Robertson Nickerson Limited

rate in the first four years, with a quicker leveling off, whereas the higher estimate has a higher growth rate in the last four years. However, both are starting to level off by 1988, when the market is estimated to be $10.5 to $11.5 billion.

2.3.2 Workstation Markets

The workstation market in Canada and the United States for the six industry sectors being analyzed, is shown in Table 2-8. The Canadian market is $279 million in 1983 growing to $695 million in 1988. As expected, the greatest growth rate is in networked microcomputers, at an annual growth rate of 130.7 percent per year over the 1983 base year. By contrast, standalone word processors will have a zero growth rate ending up in 1988, at a market slightly less than the 1983 one. The clustered word processor market is better, but is still only growing by 12.8 percent per year, and by 1988 its market share of the total workstation market will have dropped from about 18 percent in 1983 to 12 percent in 1988.

The United States market is $5.3 billion growing to $10.5 billion by 1988. All the growth in the U.S. workstation market is in microcomputers, with the networked microcomputer market growing at an incredible annual rate of 216.8 percent over the 1983 base year. Most of this growth occurs up to 1986, when a slight leveling off begins. The market for both standalone and clustered word processors declines over the 1983 to 1988 period, winding up at a negative 5 to 6 percent annual rate over the 1983 base.

TABLE 2-8

WORKSTATION MARKET, 1983
FOR SIX INDUSTRY SECTORS
(In Millions of 1983 Dollars)

CANADA

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
WORD PROCESSORS							
Standalone	102	98	103	105	113	101	0.
Clustered	50	70	59	62	65	82	12.8
MICROCOMPUTERS							
Standalone	86	113	153	156	185	203	27.2
Networked	41	53	124	168	248	309	130.7
TOTAL	279	334	439	491	610	695	29.8

UNITED STATES

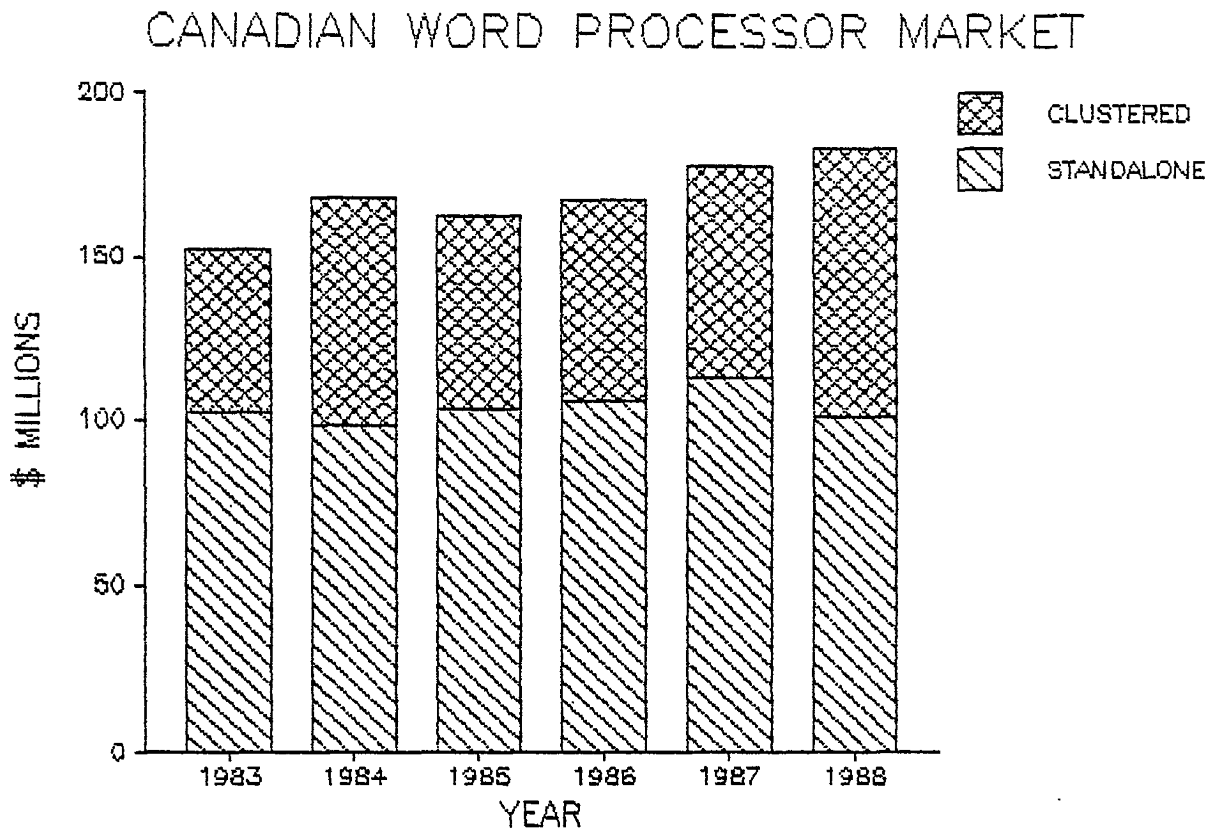
	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
WORD PROCESSORS							
Standalone	783	650	604	561	545	535	-6.3
Clustered	2,992	2,067	1,570	1,600	1,811	2,188	-5.4
MICROCOMPUTERS							
Standalone	1,060	1,488	1,264	1,164	1,362	1,700	12.1
Networked	512	1,027	2,918	3,913	4,638	6,063	216.8
TOTAL	5,348	5,233	6,356	7,238	8,356	10,486	19.2

The above analysis indicates quite clearly and dramatically, the market shift to networked microcomputers in both Canada and the United States. This is graphically shown in Figure 2-17 and 2-18. The slight upturn in 1986 (10 to 16 percent) in the United States total word processor market is due to a slight increase in the clustered work processor market and a small slowing of the decline in standalone word processors.

The figures on market share are even more indicative of this shift in the marketplace. (See Table 2-9) In Canada, the market share held by standalone word processors will decline from 36.6 percent to 14.5 percent. Clustered word processors will also decline, but only from 17.9 to 11.8 percent. Standalone microcomputers will just about hold their share, but networked microcomputers will grow from 14.6 percent to a 44.5 percent share of the workstation market.

In the United States, the figures indicate that the shift to clustered word processors has already taken place. While in Canada standalone word processors had 36.6 percent of the market in 1983, in the United States they had only 14.6 percent. The trend, however, is the same; a decline to 5.1 percent of the market by 1988. In Canada, therefore, the micro revolution has hit hard at the standalone word processor market. However, in the United States, it is the clustered word processor market which is suffering, with a dramatic decline in market share from 55.9 percent in 1983 to a forecast 20.8 percent in 1988. As in Canada, networked microcomputers show the major increase in market share, taking 57.9 percent of the workstation market by 1988.

FIGURE 2-17


CANADIAN WORD PROCESSOR MARKET
200
150
100
50
0
$ MILLIONS
CLUSTERED
STANDALONE
1983
1984
1985
1986
1987
1988
YEAR

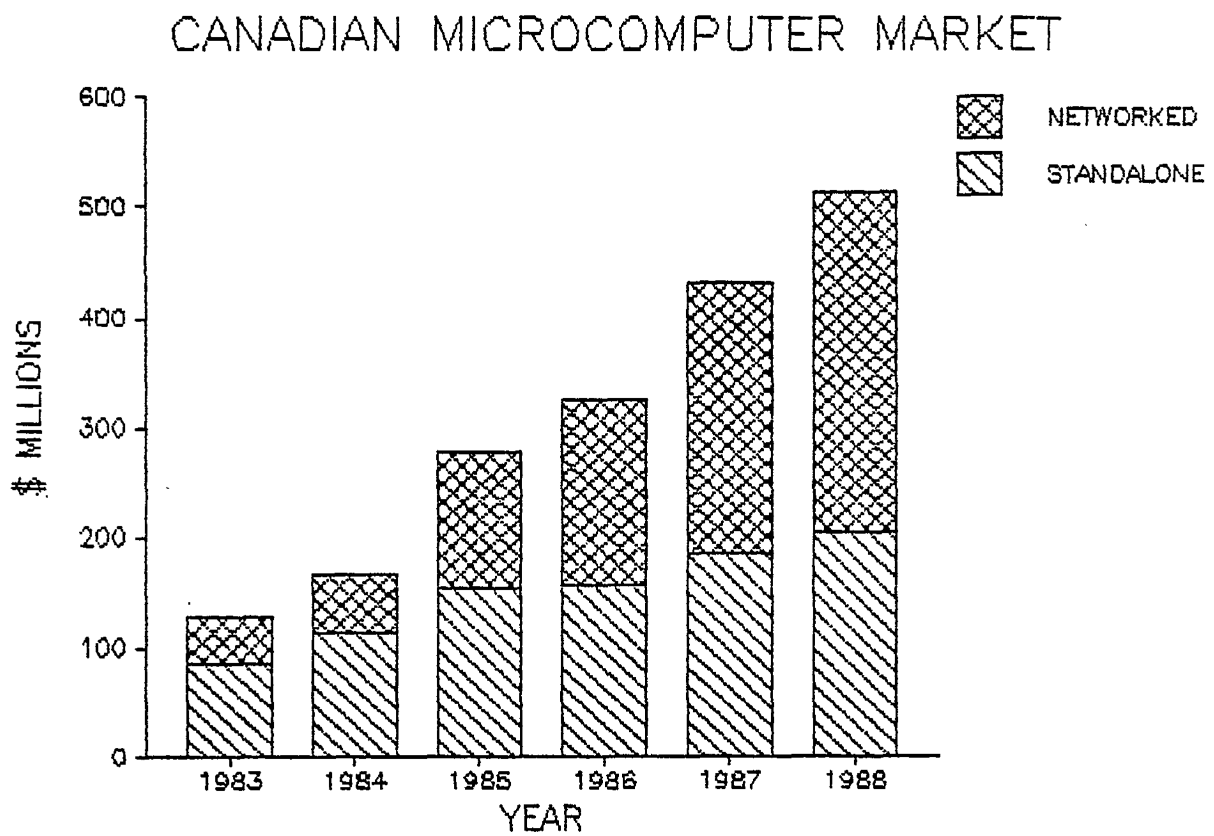
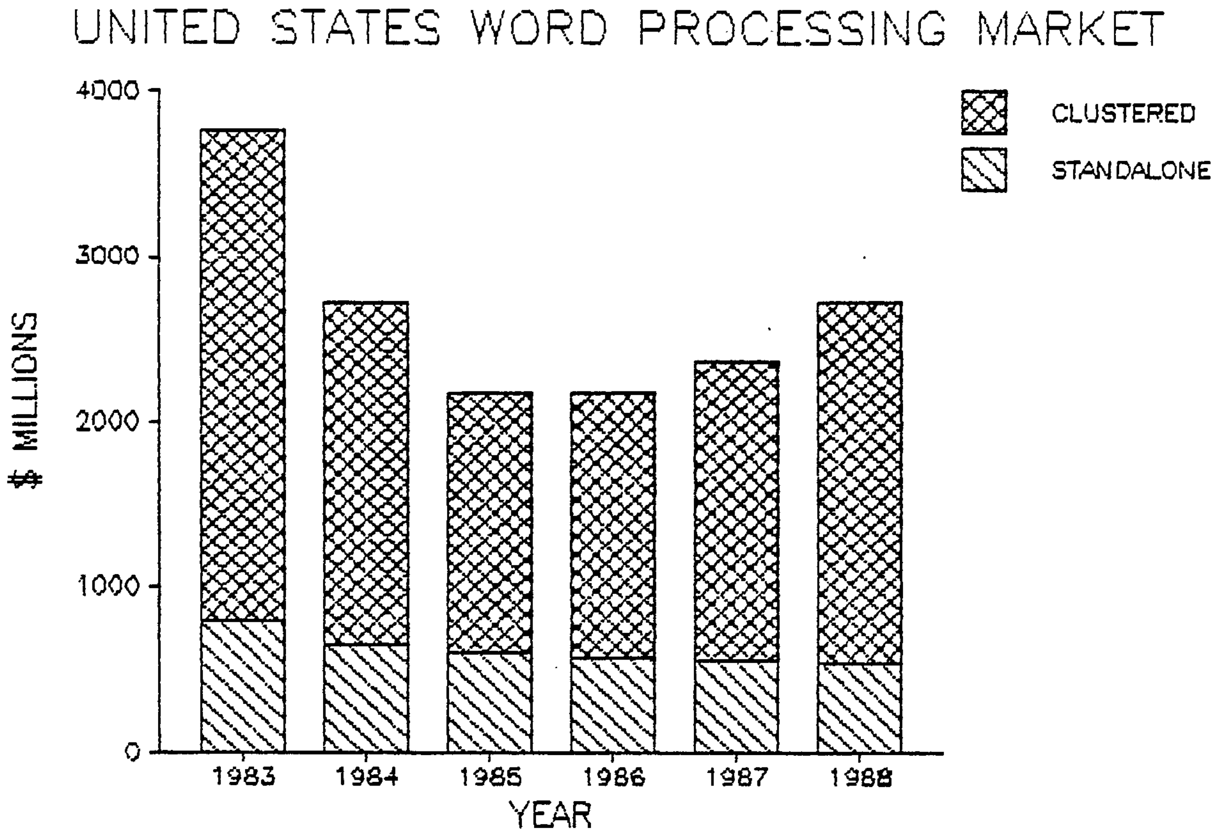

CANADIAN MICROCOMPUTER MARKET
600
500
400
300
200
100
0
$ MILLIONS
NETWORKED
STANDALONE
1983
1984
1985
1986
1987
1988
YEAR

FIGURE 2-18


UNITED STATES WORD PROCESSING MARKET
4000
3000
2000
1000
0
$ MILLIONS
CLUSTERED
STANDALONE
1983
1984
1985
1986
1987
1988
YEAR

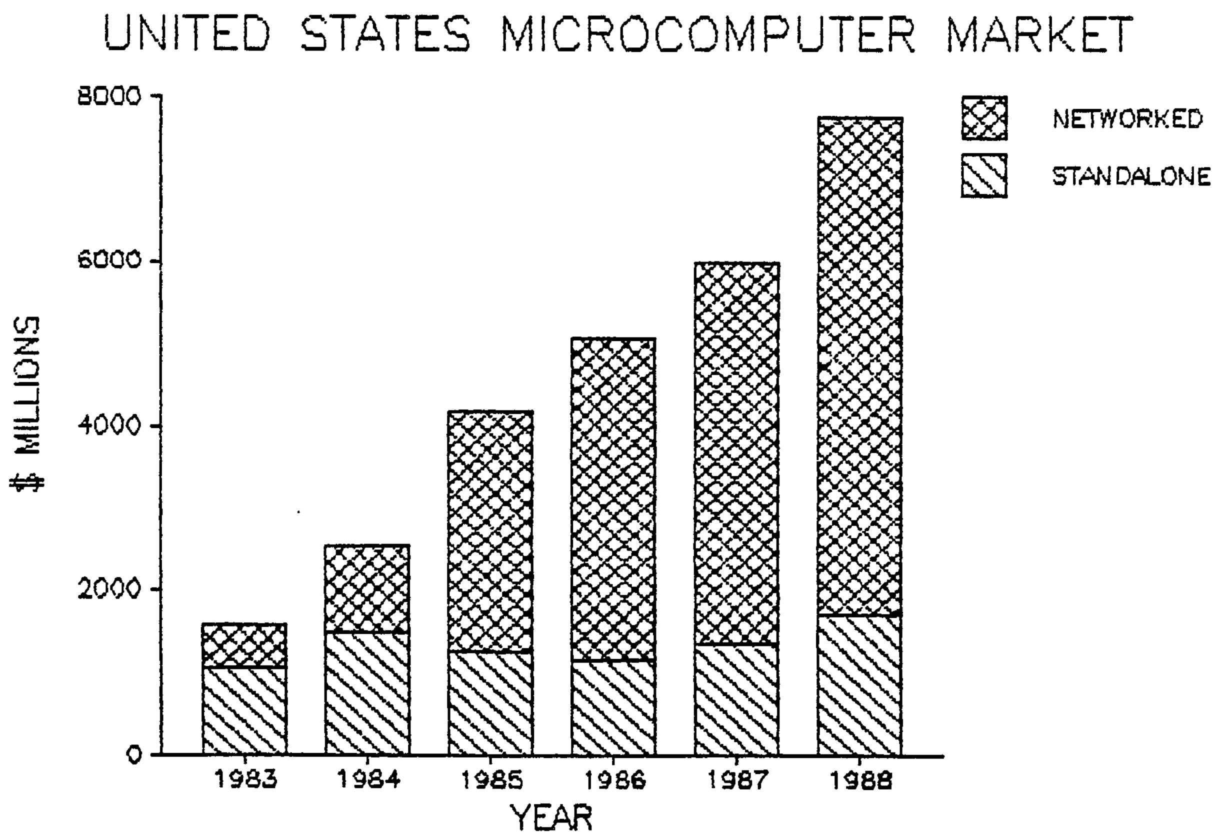

UNITED STATES MICROCOMPUTER MARKET
8000
6000
4000
2000
0
$ MILLIONS
NETWORKED
STANDALONE
1983
1984
1985
1986
1987
1988
YEAR

TABLE 2- 9

WORKSTATION MARKET SHARES (Percent)
1983 VERSUS 1988

CANADA

	1983	1988
WORD PROCESSORS		
Standalone	36.6	14.5
Clustered	17.9	11.8
MICROCOMPUTERS		
Standalone	30.8	29.2
Networked	14.7	44.5

UNITED STATES

	1983	1988
WORD PROCESSORS		
Standalone	14.6	5.1
Clustered	55.9	20.8
MICROCOMPUTERS		
Standalone	19.8	16.2
Networked	9.7	57.9

Table 2-10 shows the workstation market, broken down by industry sector. In Canada, the largest market is in manufacturing, followed by the transportation and communications sectors. In the United States, the largest market is also in manufacturing, followed by the resource industries and insurance sectors. Growth rates are relatively consistent across sectors in the United States. The overall growth rate in Canada is somewhat higher than in the United States (29.8 versus 19.2 percent), with the insurance industry showing a very high rate of growth (46.2 percent) and the education sector a low rate (6.7 percent). The Canadian market is about 5 to 7 percent of the United States market overall.

TABLE 2-10

WORKSTATION MARKET - BY INDUSTRY SECTOR
(In Millions of 1983 Dollars)

CANADA

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	18	18	19	20	22	24	6.7
Health	16	18	24	25	31	34	22.5
Insurance	29	39	55	64	82	96	46.2
Manufacturing	113	134	176	195	243	276	28.8
Resource	44	49	61	66	79	89	20.4
Transportation & Communications	59	76	104	121	153	176	39.7
TOTAL	279	334	439	491	610	695	29.8

UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	190	184	224	254	294	367	18.6
Health	98	93	110	125	141	176	15.9
Insurance	672	680	843	974	1,138	1,438	22.7
Manufacturing	3,338	3,210	3,854	4,353	4,994	6,242	17.4
Resource	830	842	1,048	1,212	1,415	1,790	23.1
Transporation & Communications	220	224	277	320	374	473	23.0
TOTAL	5,348	5,233	6,356	7,238	8,356	10,486	19.2

2.4 PABXs

2.4.1 Introduction

A PABX is an private automatic telephone exchange providing for the transmission of calls internally, and to and from the public telephone network. PABX systems also offer various features such as toll restriction, call costing, re-routing or holding of incoming calls, speed dialing, automatic dialing, message-waiting signalling and so on. There is some conflict in the terminology because, although the PBX (private branch exchange) technically refers to the manual exchange, it is often used synonymously with the PABX designation. PABXs may be digital or analog and may handle voice or data or both. Details on the current and forecast state of PABX technology is given in Chapter 3.

Industry sources indicate that the PABX market will be saturated by the mid-1980's, both in Canada and the United States. Instead of new installations, the market will become predominately a replacement one -- upgrading existing installations.

Section 2.4.2 outlines the market analysis for the six industry sectors with which this report is connected. As indicated, the survey shows a leveling off of the market in 1985/1986.

2.4.2 PABX Market

The PABX market for Canada and the United States, for the six sectors being analyzed, is shown in Table 2-11. These are total expenditure figures for the sectors, including lease and rental. The market was $2.2 billion in 1983 growing to $5.0 billion in 1988. The largest market is in the over 200 line segment, with $2.0 billion in 1983 growing to $4.0 billion in 1988.

As indicated, the highest growth rate is in the under 100 line segment, although that portion of the market will still be only 15.1 percent of the total market by 1988. Consistent with other sources, the market shows rapid growth to 1985 and begins to level off. Instead of new installations, the market is becoming predominately a replacement one - upgrading existing installations.

Figure 2-19 shows the average annual PABX expenditures by line size. As indicated, the over 250 line segment accounts for 74 percent of expenditures in Canada and 88 percent in the United States. In Canada, expenditures on the under 100 and 100 to 250 line segments are about the same at 12 to 14 percent. In the United States, both these segments are somewhat smaller at 5 to 9 percent of average annual expenditures.

Table 2-12 shows the Canadian and United States PABX markets broken down by industry sector. As expected, the

TABLE 2-11

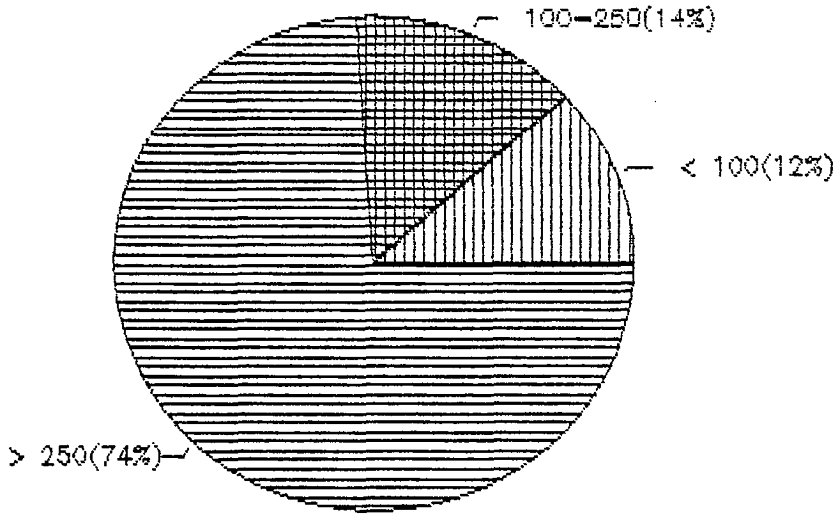
PABX MARKET
FOR SIX INDUSTRY SECTORS
(In Millions of 1983 Dollars)

CANADA & UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
NUMBER OF LINES:							
< 100	63	129	138	396	750	751	218.4
100-250	150	149	170	356	201	253	13.7
> 250	1,981	1,470	4,517	3,750	4,034	3,977	18.4
TOTAL	2,195	1,747	4,825	4,502	4,986	4,981	25.4

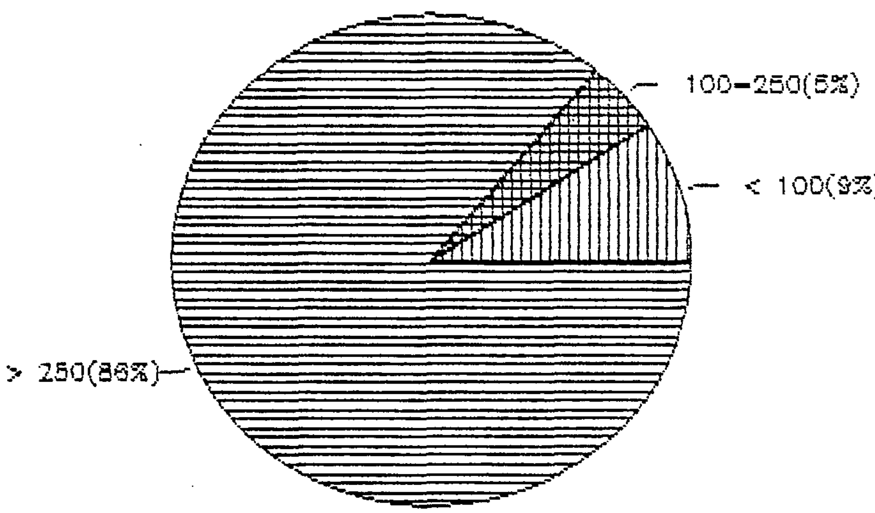
FIGURE 2-19

PABX– AVERAGE ANNUAL EXPENDITURES
BY LINE SIZE



CANADA

PABX– AVERAGE ANNUAL EXPENDITURES
BY LINE SIZE



UNITED STATES

TABLE 2-12

PABX MARKET
BY INDUSTRY SECTOR
(In Millions of 1983 Dollars)

CANADA & UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	81	63	172	159	175	174	23.0
Health	44	34	92	85	93	93	22.3
Insurance	273	226	638	605	677	682	30.0
Manufacturing	1,346	1,053	2,874	2,660	2,929	2,913	23.3
Resource	342	280	789	746	834	839	29.1
Transportation & Communications	108	91	260	247	278	280	31.8
TOTAL	2,195	1,747	4,825	4,502	4,986	4,981	25.4

largest market is in manufacturing at $1.3 billion in 1983 growing to $2.9 billion in 1988. The second and third largest markets are in the resource and insurance sectors. The average annual growth rate over the 1983 base is consistent across all sectors at about 22 to 32 percent. However, most of this growth is in the early years with a leveling off after 1986.

Table 2-13 and Figure 2-20 show the expected use of PABX versus LAN for networking workstations. As indicated, the percentage of standalone workstations is declining rapidly. The decline is about the same in Canada and the United States, from 72-80 percent of total workstations in 1983 to only 28-29 percent in 1988. At the same time the percentage of networked systems is of course climbing at the same rate to a total of 71-72 percent of all workstations by 1988.

In both Canada and the United States, the greatest growth rate is in PABX networked workstations. However, the market share is somewhat different in the United States than in Canada. In Canada, companies expect to network 30 percent of their workstations via a PABX by 1988. This is up from 5 percent in 1983, an average annual increase of 100 percent over the 1983 base. In the United States however, companies expect to network 17 percent of their workstations via a PABX in 1988, with the majority (54 percent) being networked by a LAN.

Market estimates for PABXs in Europe and Japan have been obtained from a variety of sources. The European PABX market is estimated at $930 million, growing to $2.0 billion in

TABLE 2-13

NETWORKING
PABX VERSUS LAN
PERCENTAGE OF TOTAL WORKSTATIONS

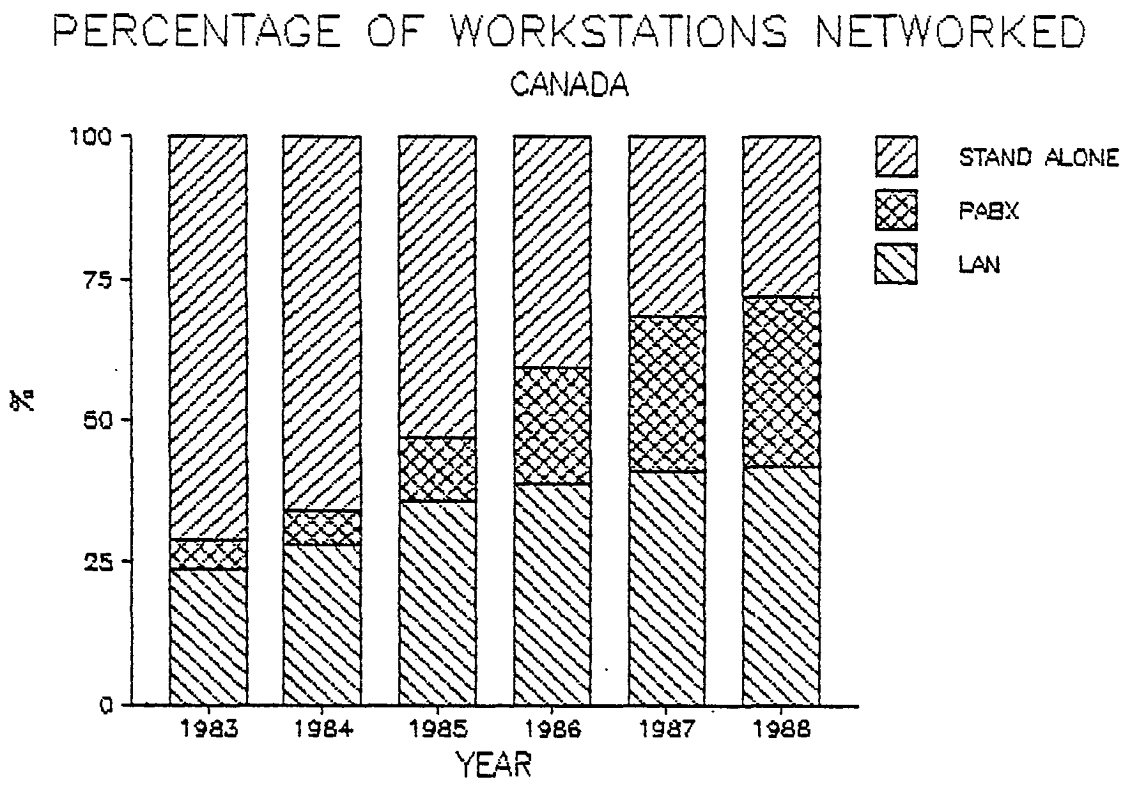
CANADA

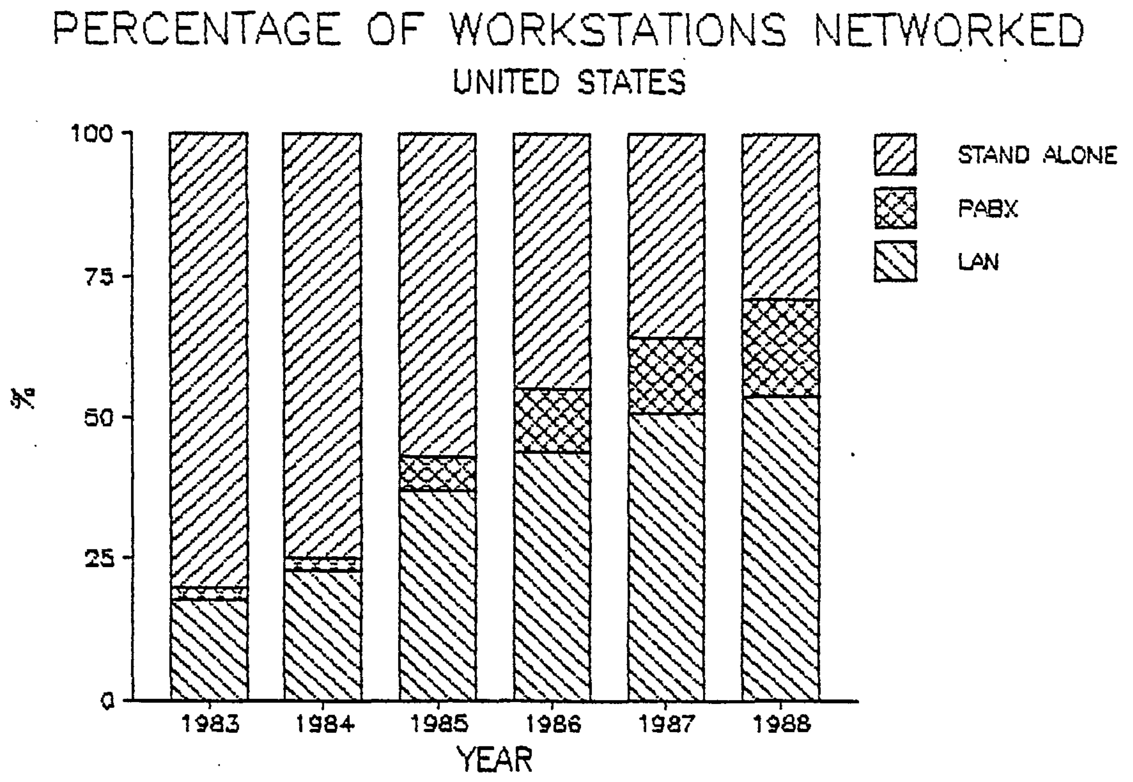
	1983	1984	1985	1986	1987	1988
	%	%	%	%	%	%
LAN	24	28	36	39	41	42
PABX	5	6	11	20	27	30
STANDALONE	72	66	54	41	32	28

UNITED STATES

	1983	1984	1985	1986	1987	1988
	%	%	%	%	%	%
LAN	18	23	37	44	51	54
PABX	2	2	6	11	13	17
STANDALONE	80	76	57	45	36	29

FIGURE 2-20


PERCENTAGE OF WORKSTATIONS NETWORKED
CANADA
100
75
50
25
0
%
1983
1984
1985
1986
1987
1988
YEAR
STAND ALONE
PABX
LAN


PERCENTAGE OF WORKSTATIONS NETWORKED
UNITED STATES
100
75
50
25
0
%
1983
1984
1985
1986
1987
1988
YEAR
STAND ALONE
PABX
LAN

1988. The Japanese market is about $241 million (1983), growing to $518 million in 1988.

2.5 Local Area Networks

2.5.1 Introduction

Section 2.5.2 of this report analyses the Local Area Network (LAN) market within the six industry sectors outlined in Section 2.1 i.e. health, education, manufacturing, resource industries, insurance and banking, and transportation and communications. However, we have also reviewed the total LAN market based on estimates obtained from other sources and this data is presented in this section.

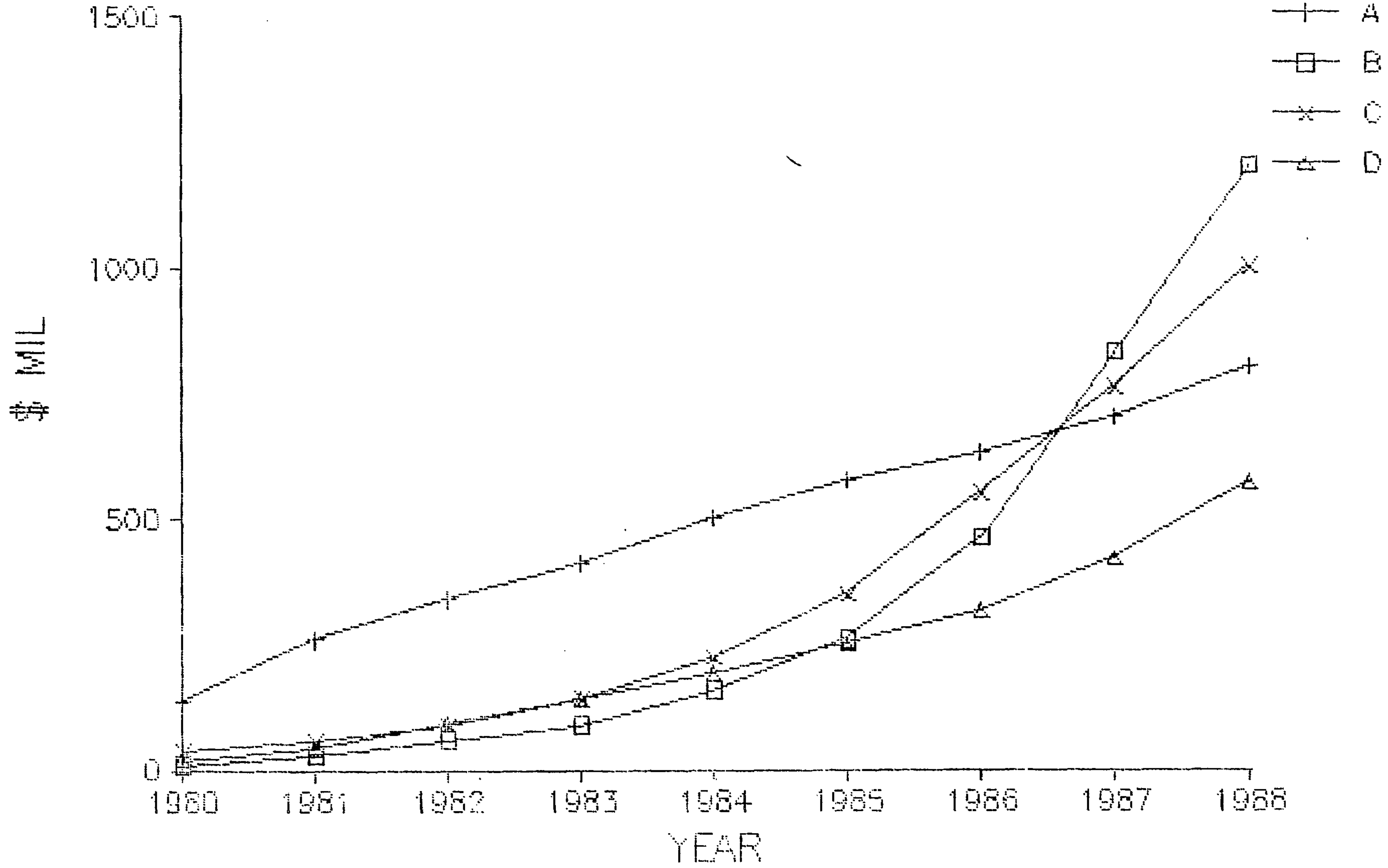
Figure 2-21 shows estimates from four different sources on the U.S. LAN market. The first estimate "A" is by A.D. Little, and includes a variety of peripherals handling computer coded data, voice input, voice mail, protocol conversion and image processing. Estimates "B" and "C" are from Microcommunications and Business Week, respectively, and are for LANs only. The "D" forecast is by International Resource Development. As with PABXs, gaps in the data have been estimated based on the trend line of the forecast. Besides the U.S. market, the European market has also been estimated. It is forecast at $145 million in 1988, growing from a base of $32 million in 1983. The Japanese market was $125.8 million in 1983, rising to $333 million in 1988.

In Canada, Evans Research Corporation estimated the 1982 LAN market at $1.2 million. The market has been estimated to grow to $10 million by 1985 and to $60 million by 1989. Figure 2-22 shows the forecast Canadian LAN market, on the basis of Evans' data.

FIGURE 2-21

U. S. A.

LAN MARKET ESTIMATES



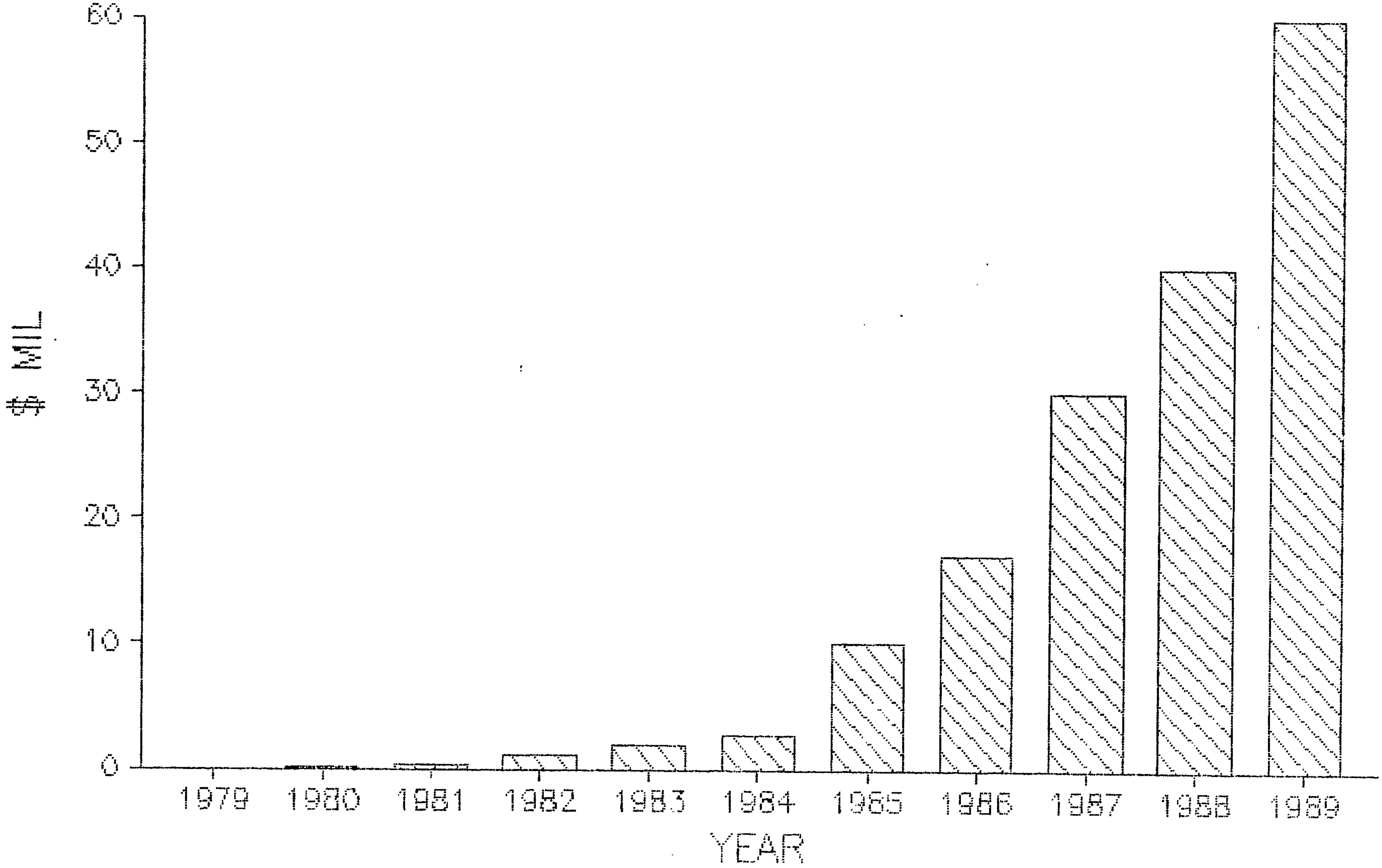
-64-

Robertson.Nickerson
Limited

FIGURE 2-22

CANADIAN

LAN MARKET ESTIMATES



2.5.2 LAN Market

Table 2-14 and Figure 2-23 show the LAN market in Canada and the United States. The Canadian market was about $9 million in 1983, growing to $67 million in 1988. This is an annual growth rate over the 1983 base of 129 percent. The twisted pair LAN held about 44 percent of the market in 1983, growing to about 67 percent of the market in 1988.

The Canadian results are consistent with those in the United States. The United States market is growing at about the same rate, from a total of $239 million in 1983 to $1.9 billion in 1988. Twisted pair holds a somewhat higher market share in the United States with 70 percent in 1983 and 74 percent in 1988.

The Canadian market is about 3.5 to 3.8 percent of the United States market. The growth of the twisted pair LAN market in Canada is somewhat higher than in the United States, starting from a smaller market base in 1983.

Table 2-15 shows the LAN market broken down by industry sector. The largest market in both Canada and the United States is in manufacturing. In Canada, the second largest market is in the transportation and communications sector, while in the United States it is the resource sector. Following are the sectors in order of importance:

TABLE 2-14

LOCAL AREA NETWORK (LAN) MARKET
FOR SIX INDUSTRY SECTORS
(In Millions of 1983 Dollars)

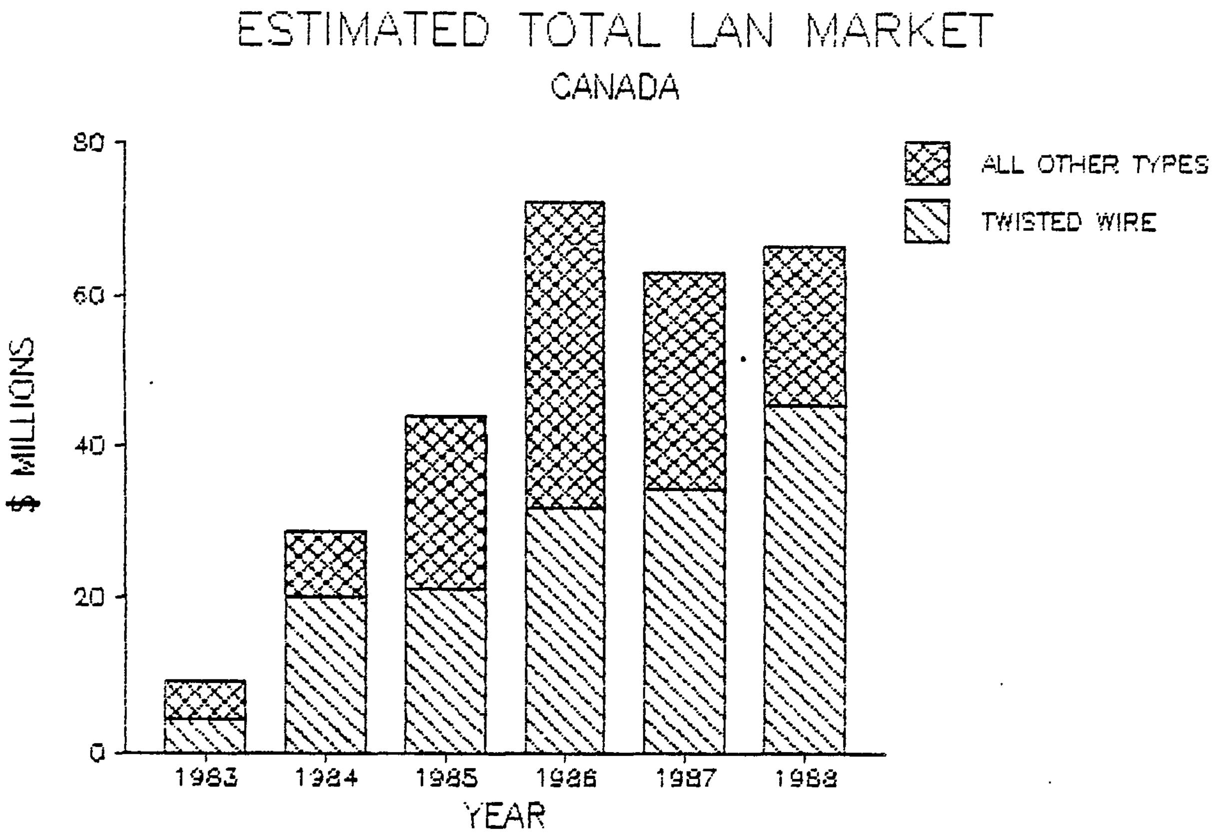
CANADA

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Twisted Pair	4	20	21	32	34	45	205
All Other Types	5	9	22	40	29	21	64
TOTAL	9	29	44	72	63	67	128.9

UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Twisted Pair	167	175	518	1,681	1,440	1,415	149.5
All Other Types	72	249	564	443	485	487	115.3
TOTAL	239	425	1,083	2,125	1,925	1,902	139.2

FIGURE 2-23


ESTIMATED TOTAL LAN MARKET
CANADA
$ MILLIONS
80
60
40
20
0
1983
1984
1985
1986
1987
1988
YEAR
ALL OTHER TYPES
TWISTED WIRE

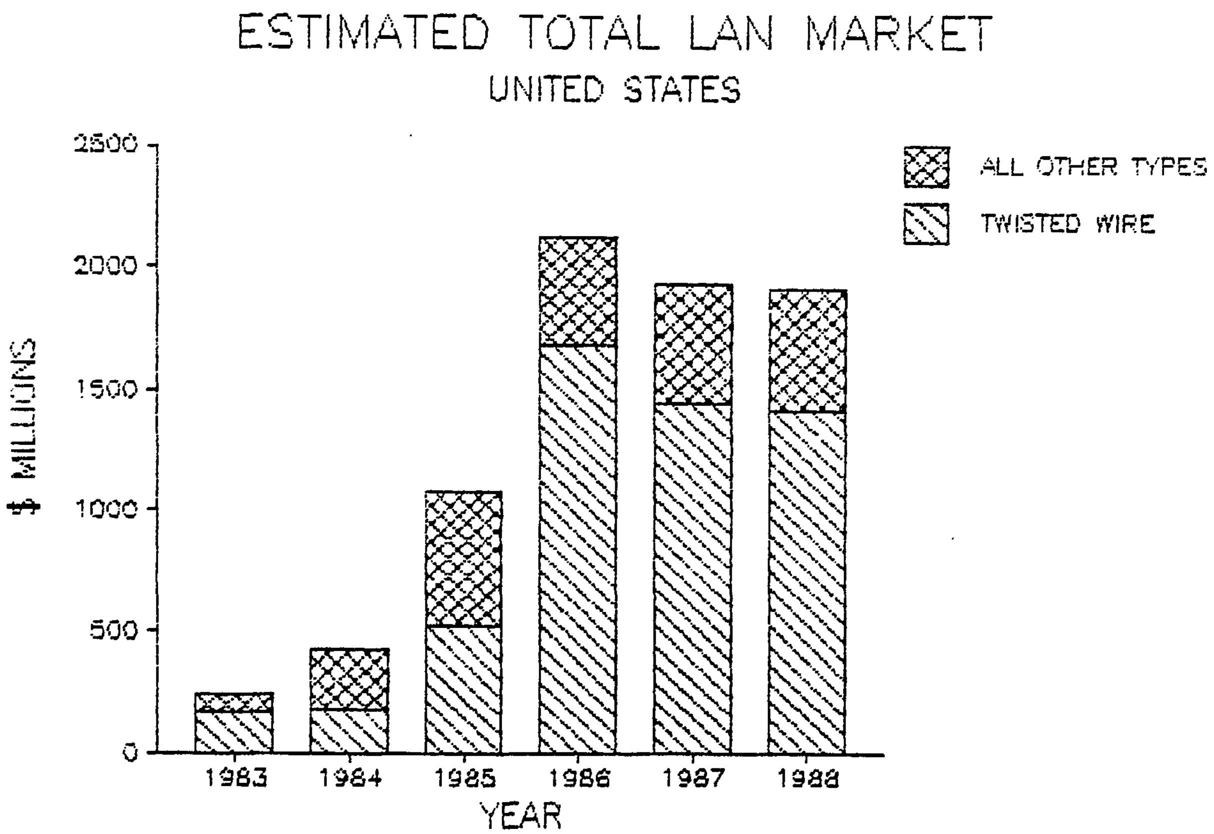

ESTIMATED TOTAL LAN MARKET
UNITED STATES
$ MILLIONS
2500
2000
1500
1000
500
0
1983
1984
1985
1986
1987
1988
YEAR
ALL OTHER TYPES
TWISTED WIRE

TABLE 2-15

LOCAL AREA NETWORK MARKET
BY INDUSTRY SECTOR

CANADA

	1983	1984	1985	1986	1987	1988	AVERAGE GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	.78	1.51	1.93	2.89	2.26	2.29	38.7
Health	.49	1.58	2.30	3.64	3.11	3.25	112.7
Insurance	.92	3.39	5.51	9.42	8.39	9.14	178.7
Manufacturing	3.65	11.68	17.64	28.78	25.09	26.64	125.9
Resource	1.42	4.22	6.15	9.68	8.21	8.62	101.4
Transportation & Communications	1.89	6.63	10.47	17.70	15.75	17.06	160.5
TOTAL	9	29	44	72	63	67	128.8

UNITED STATES

	1983	1984	1985	1986	1987	1988	AVERAGE GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	8	15	38	75	68	67	147.5
Health	4	8	19	36	33	32	140.0
Insurance	30	55	144	286	259	261	154.0
Manufacturing	149	261	657	1,278	1,158	1,132	131.9
Resource	37	68	179	356	322	325	155.7
Transporation & Communications	10	18	47	94	85	86	152.0
TOTAL	239	425	1,083	2,125	1,925	1,902	139.2

Canada

- Manufacturing
- Transportation & Communications
- Insurance
- Resource
- Health
- Education

United States

- Manufacturing
- Resource
- Insurance
- Transportation & Communications
- Education
- Health

As indicated previously, the overall growth rates in Canada and the United States are very similar (128.8 percent versus 139.2 percent). All the sectors in the United States are growing at about the same rate (140 to 156 percent range). In Canada, there appears to be a greater variability between sectors from a low of 39 percent in education to a high of 160 percent in the transportation and communications sector. (Note: Education markets are for office LANs only and do not include LANs in the classroom.)

2.6 Storage Peripherals

2.6.1 Introduction

We have analyzed the market for storage peripherals used in office automation for the six industry sectors under investigation. This detail is provided in Section 2.6.2. However, there are also various estimates for the total market and these are presented in this section. There is no consistency amongst the published estimates and they vary widely.

A.D. Little estimates the U.S. market for storage peripherals at $11.4 billion in 1983, growing to $18.7 billion by 1988. International Resource Development estimates this same market to be $75.4 million in 1981, growing to $796 million by 1987. Other sources estimate the U.S. market as follows:

- Data-storage subsystems (all types), 1982: $4,016.8 Million (1982 World Markets Forecast - Electronics Magazine)

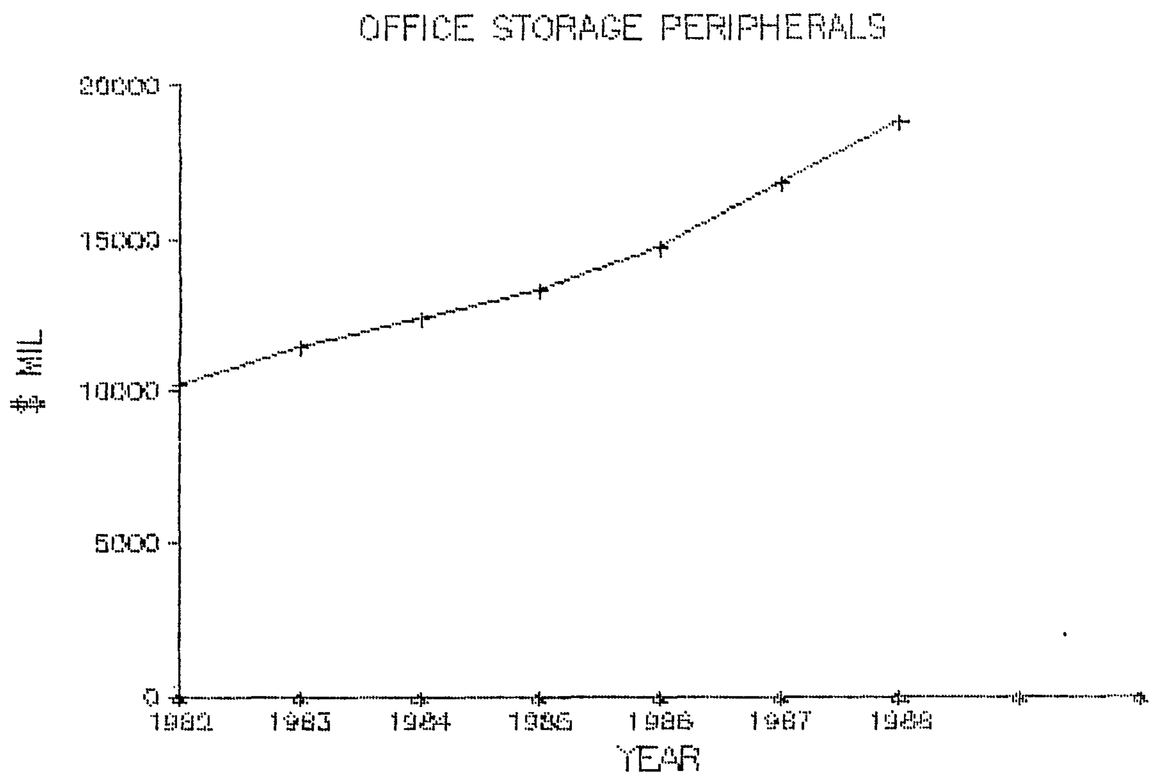
- Auxiliary storage equipment, 1982: $5,080 Million (Electronics Market Data book - EIA)

- Hard disk drives, 1982: $7,000 Million (High Technology - January 1983)

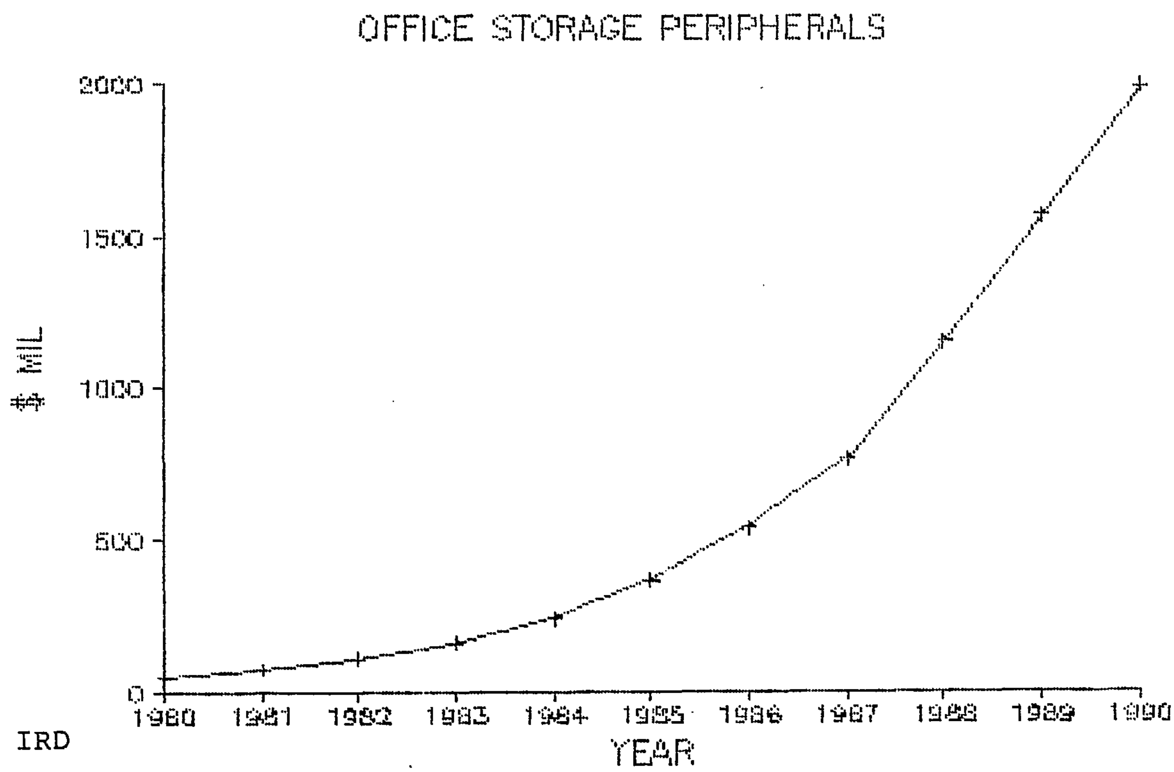
The differences in these estimates depend upon whether all mainframe storage is included, or only that portion directly related to office automation. The A.D. Little forecast includes all storage of all types (except main memory).

The market estimates by A.D. Little and IRD are illustrated in Figure 2-24. Figure 2-25 illustrates the Market Data Book forecasts by type for 1980 and 1985. The European market has been estimated at about $0.6 billion in 1983 growing to $1.2 billion by 1988.

FIGURE 2 - 24



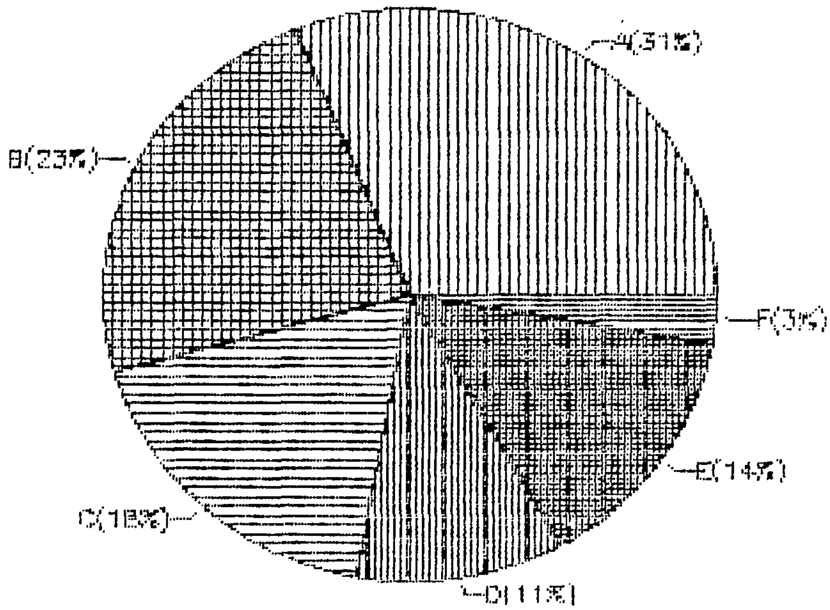
Source: A.D. Little



Source: IRD

FIGURE 2 - 25

U.S. DATA STORAGE
SUB-SYSTEMS MARKET - ALL TYPES



1980

$2797.8 Million

A - Disk Pack

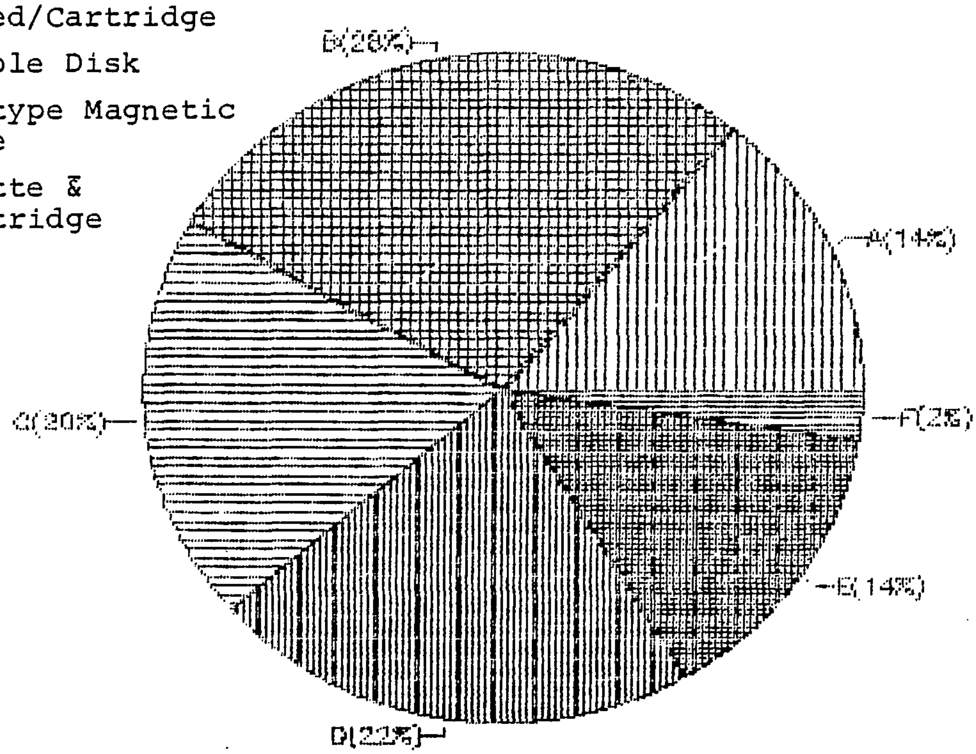
B - Fixed Pack

C - Combination Fixed/Cartridge

D - Flexible Disk

E - Reel-type Magnetic Tape

F - Cassette & Cartridge



1985

$7153 Million

2.6.2 Storage Peripherals Market

The market for storage peripherals used in office automation is outlined in Table 2-16 and Figure 2-26. The Canadian market is expected to grow from $288 million in 1983 to $764 million in 1988, an annual growth rate of 33.1 percent over the 1983 base. The growth rate in the United States is almost the same at 30.5 percent, with the market growing from $1.7 billion in 1983 to $4.3 billion in 1988. The mainframe segment holds the largest market share. It ranges from about 85 percent of the market in Canada (1983) to about 71 percent of the market in the United States. In Canada, there is a higher growth rate in the non-mainframe market, which will, by 1988 reduce the mainframe portion of the market to about 69 percent of the total. This will bring the Canadian market share in 1988 closer to the United States market share (75 percent) for mainframe storage peripherals used to support office automation. The high rate of growth in the non-mainframe market in Canada, to some extent reflects a higher growth rate for the workstation market in Canada. This in turn may reflect a slower rate of adoption of workstations by Canadian firms in earlier years.

Table 2-17 and Figure 2-27 show the market broken down by magnetic versus optical based storage systems (See Chapter 3 for details on optical disk systems). This shows the beginning of the optical market in Canada and the United States in 1985/1986, growing to $176 million in Canada by 1988 and $862 million in the United States. By 1988, optical based systems will hold 20 to 23 percent of the market in Canada and the United States, for storage peripherals. (See Figure 2-28.)

TABLE 2-16

STORAGE PERIPHERALS MARKET
(In Millions of 1983 Dollars)

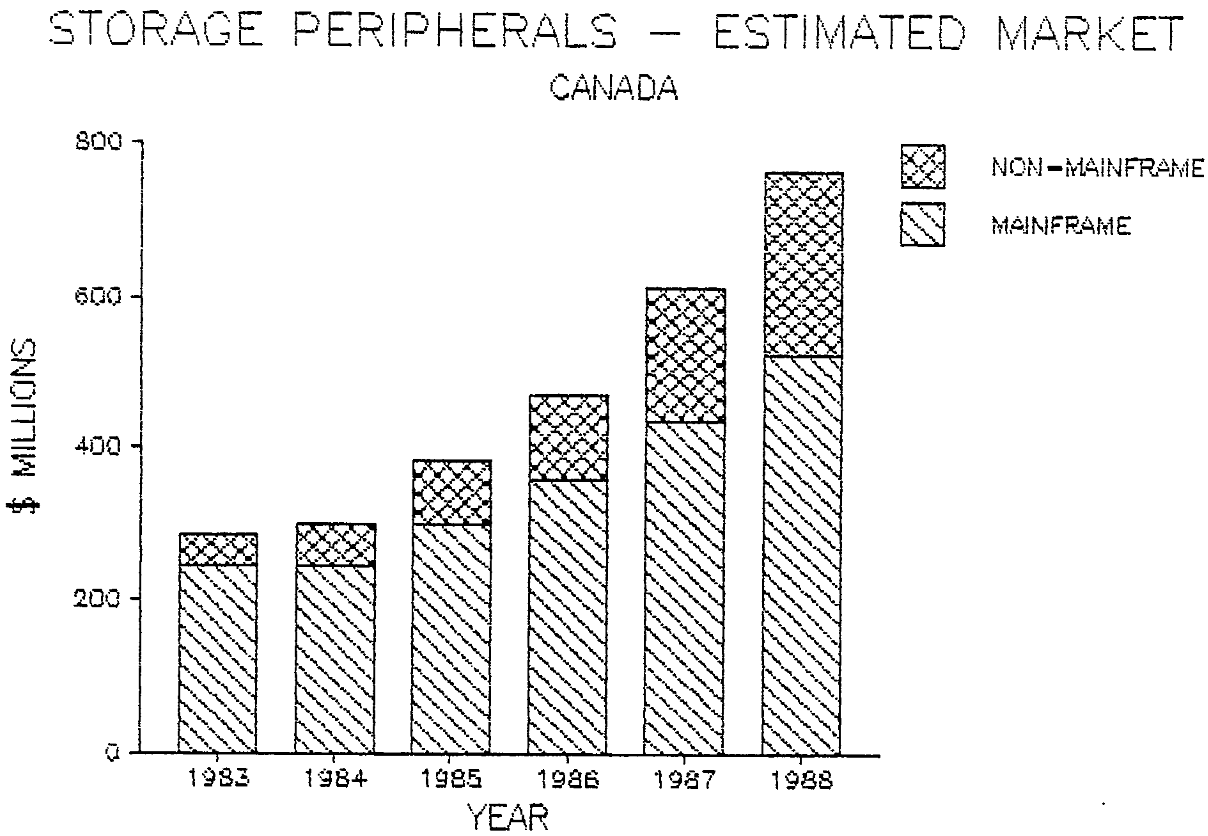
CANADA

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Mainframe	245	245	302	361	435	524	22.7
Non-Mainframe	43	57	83	107	179	240	91.6
TOTAL	288	302	385	468	614	764	33.1

UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Mainframe	1,208	1,252	1,436	1,663	2,440	3,233	33.5
Non-Mainframe	500	865	1,102	1,102	1,117	1,079	23.2
TOTAL	1,708	2,118	2,538	2,766	3,557	4,312	30.5

FIGURE 2-26


STORAGE PERIPHERALS — ESTIMATED MARKET
CANADA
$ MILLIONS
800
600
400
200
0
1983
1984
1985
1986
1987
1988
YEAR
NON—MAINFRAME
MAINFRAME

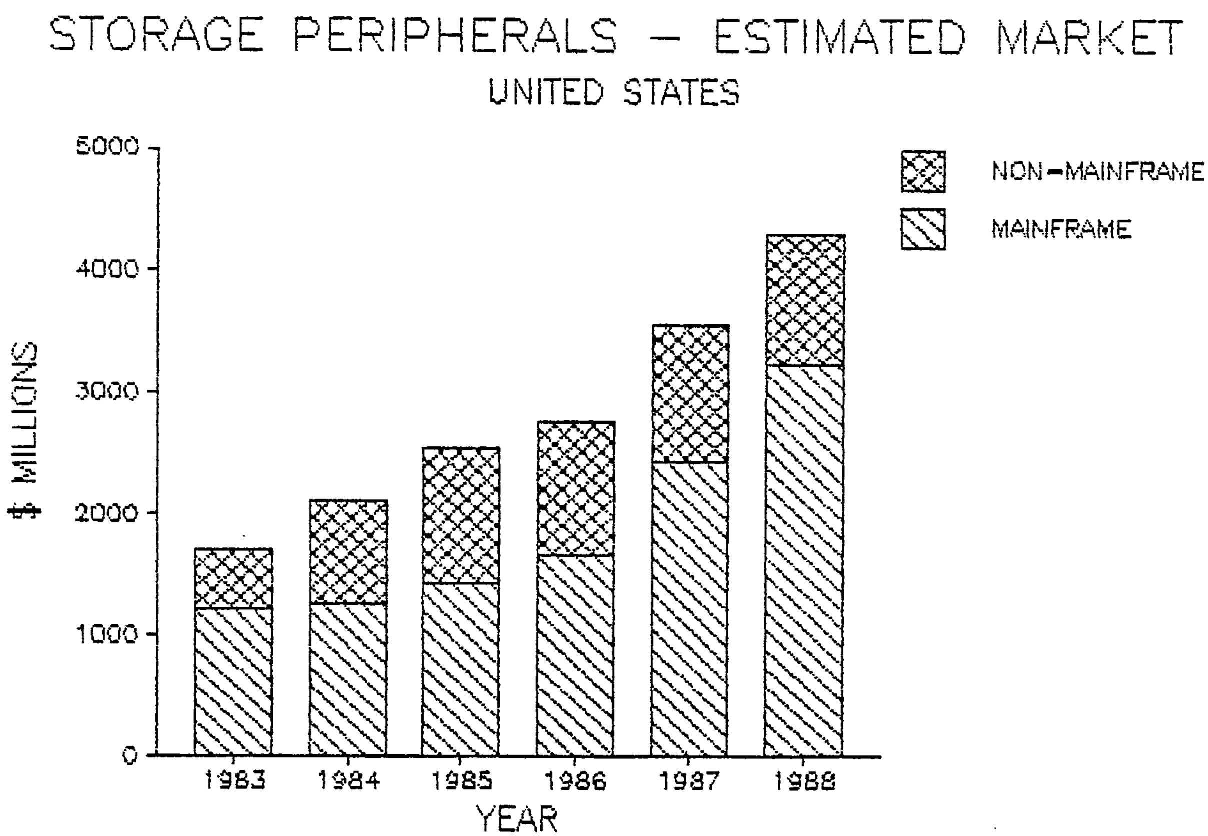

STORAGE PERIPHERALS — ESTIMATED MARKET
UNITED STATES
$ MILLIONS
5000
4000
3000
2000
1000
0
1983
1984
1985
1986
1987
1988
YEAR
NON—MAINFRAME
MAINFRAME

TABLE 2-17

STORAGE PERIPHERALS MARKET
MAGNETIC VERSUS OPTICAL BASED SYSTEMS
(In Millions of 1983 Dollars)

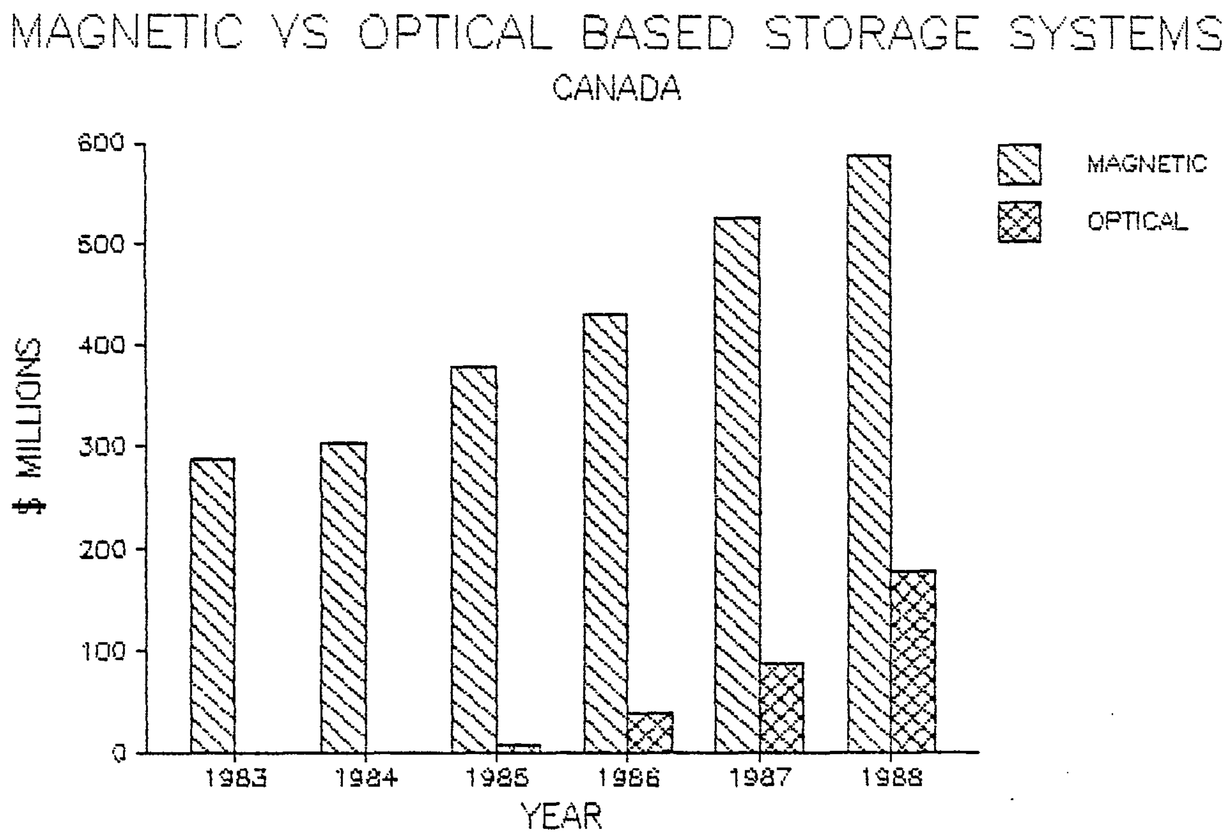
CANADA

	1983	1984	1985	1986	1987	1988
	$	$	$	$	$	$
Magnetic	288	302	377	430	528	588
Optical	0	0	8	37	86	176
TOTAL	288	302	385	468	614	764

UNITED STATES

	1983	1984	1985	1986	1987	1988
	$	$	$	$	$	$
Magnetic	1,708	2,118	2,538	2,627	3,095	3,449
Optical	0	0	0	138	462	862
TOTAL	1,708	2,118	2,538	2,766	3,557	4,312

FIGURE 2-27


MAGNETIC VS OPTICAL BASED STORAGE SYSTEMS
CANADA
600
500
400
300
200
100
0
$ MILLIONS
1983
1984
1985
1986
1987
1988
YEAR
MAGNETIC
OPTICAL

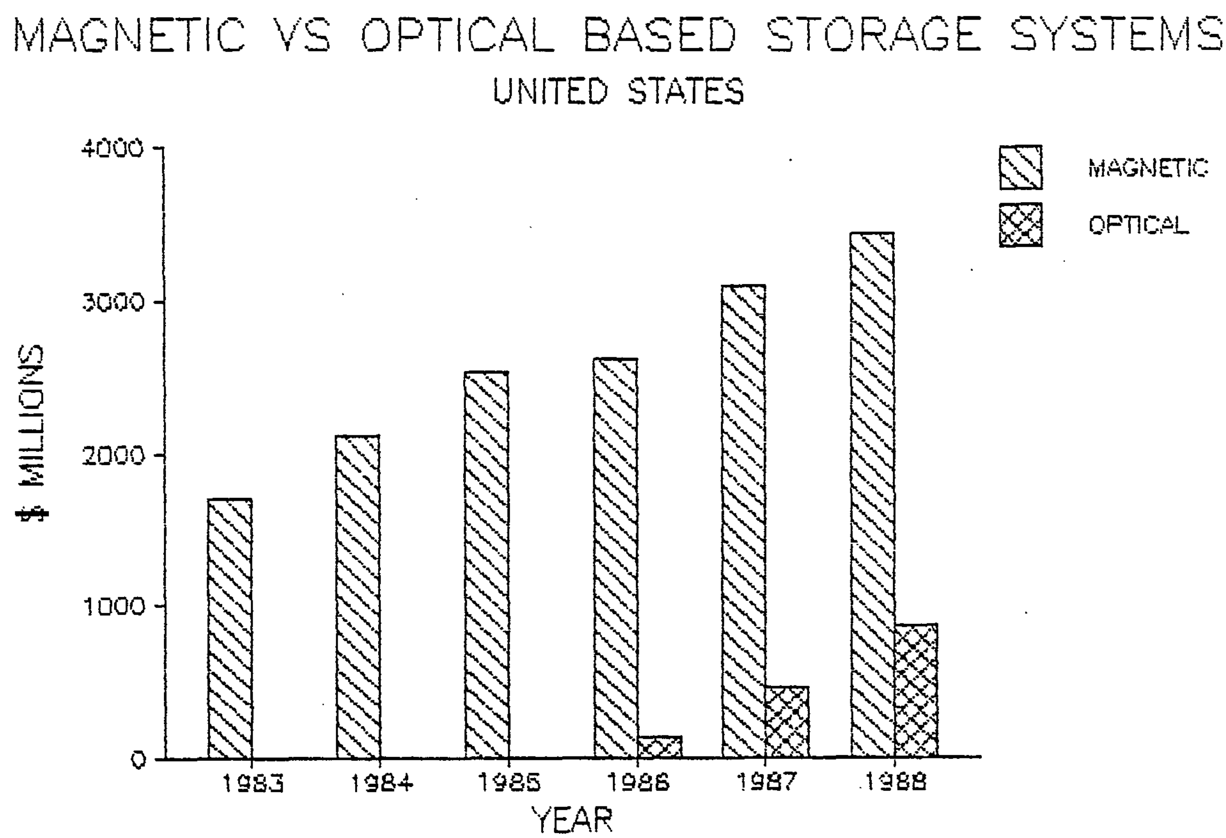
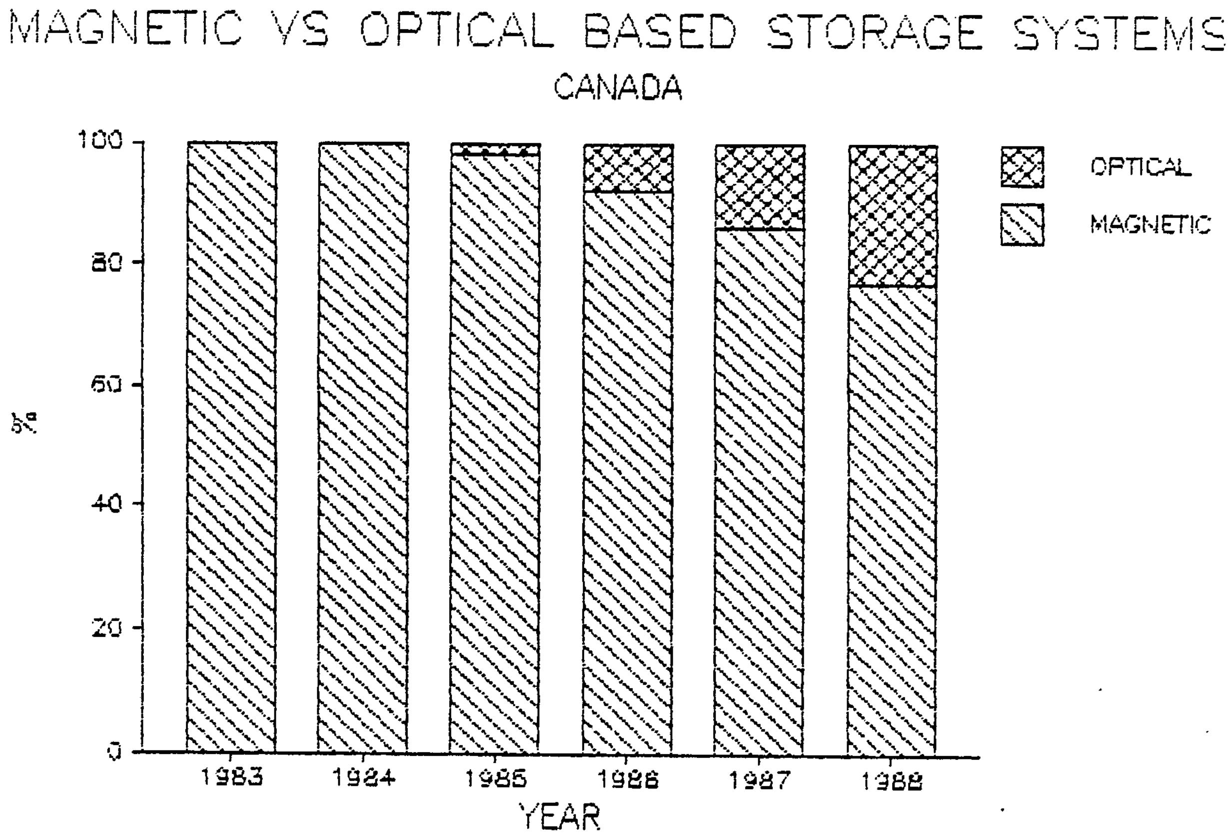
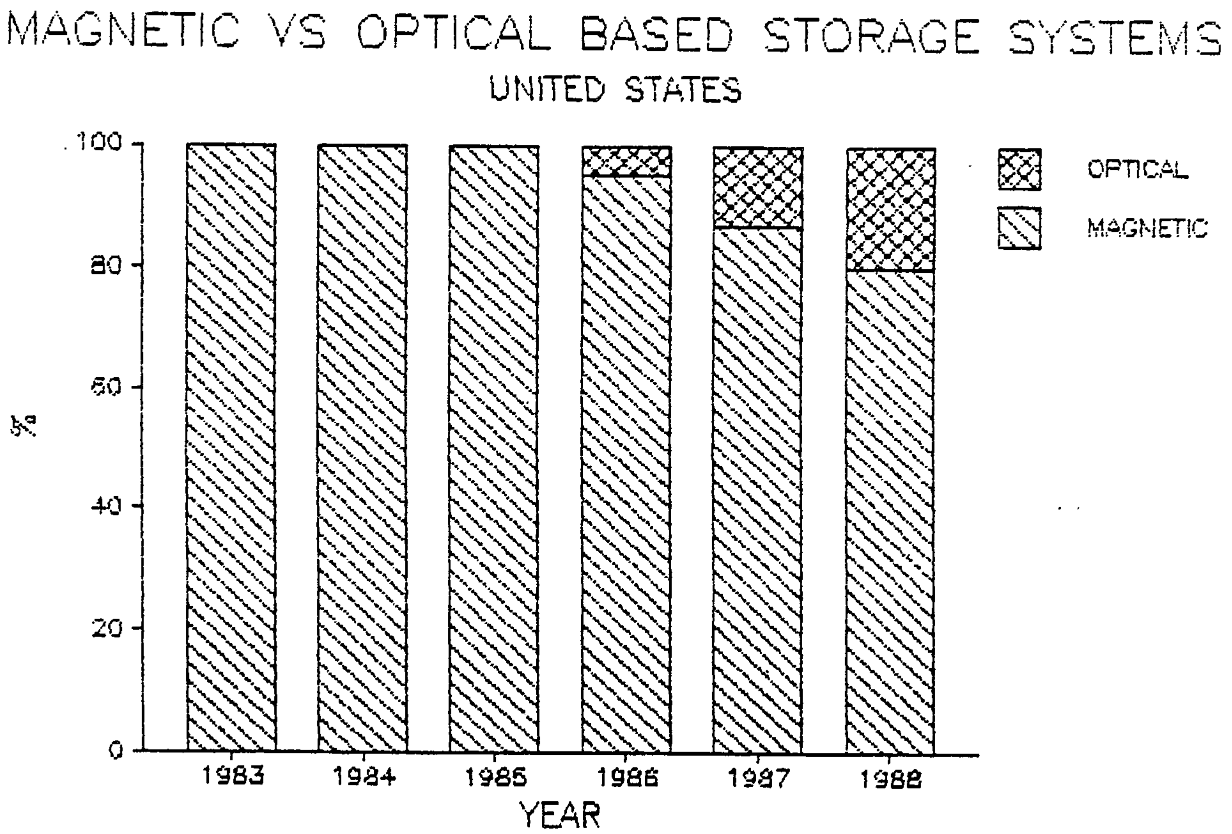

MAGNETIC VS OPTICAL BASED STORAGE SYSTEMS
UNITED STATES
4000
3000
2000
1000
0
$ MILLIONS
1983
1984
1985
1986
1987
1988
YEAR
MAGNETIC
OPTICAL

FIGURE 2-28


MAGNETIC VS OPTICAL BASED STORAGE SYSTEMS
CANADA
100
80
60
40
20
0
%
OPTICAL
MAGNETIC
1983
1984
1985
1986
1987
1988
YEAR


MAGNETIC VS OPTICAL BASED STORAGE SYSTEMS
UNITED STATES
100
80
60
40
20
0
%
OPTICAL
MAGNETIC
1983
1984
1985
1986
1987
1988
YEAR

This is consistent with most industry opinion that optical storage systems will begin to impact the market in the late 1980's.

Table 2-18 shows the market broken down by industry sector. Market share from largest to smallest is as follows:

Canada	United States
* Manufacturing	* Manufacturing
* Transportation and Communications	* Resource
* Resource	* Insurance
* Insurance	* Transportation and Communications
* Health	* Education
* Education	* Health

As indicated, manufacturing is the largest market for storage peripherals in both Canada and the United States. This is followed by the transportation and communications sector in Canada and the resource sector in the United States. Growth rates were relatively consistent across most sectors. In Canada, education has a low growth rate compared to the others

TABLE 2-18

STORAGE PERIPHERALS MARKET
BY INDUSTRY SECTOR
(In Milions of 1983 Dollars)

CANADA

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	19	20	24	24	26	29	10.5
Health	16	17	22	25	29	34	22.5
Insurance	30	32	45	56	82	96	44.0
Manufacturing	117	121	142	184	254	307	32.5
Resource	46	46	62	64	80	102	24.3
Transportation & Communications	61	66	90	115	143	196	44.3
TOTAL	288	302	385	468	614	764	33.1

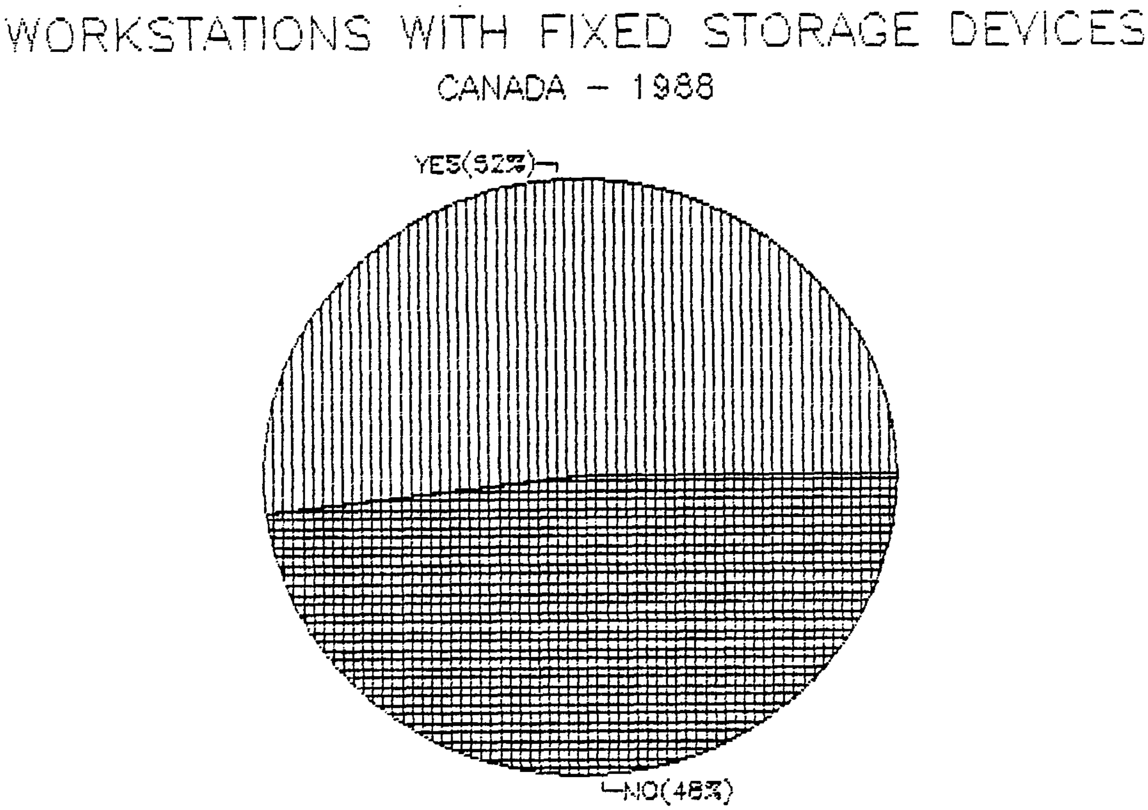
UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	61	75	89	98	126	154	30.5
Health	32	38	45	54	62	78	28.7
Insurance	216	278	342	377	490	596	35.2
Manufacturing	1,066	1,297	1,538	1,654	2,111	2,566	28.1
Resource	265	341	418	463	612	710	33.6
Transportation & Communications	68	89	106	120	156	208	41.2
TOTAL	1,708	2,118	2,538	2,766	3,557	4,312	30.5

and compared to the United States. This is consistent with much of the other results in this report which show education usually at the bottom. (Note: this is non-classroom markets.) Otherwise, annual growth rates in both Canada and the United States range from 22 to 44 percent, over the 1983 base.

Figure 2-29 shows the industry's forecast on the percentage of workstations expected to have fixed storage by 1988. In Canada, 52 percent of workstations will have fixed storage compared to 64 percent in the United States. Figure 2-30 shows the distribution of this storage. In Canada, 35 percent of workstations will have 10-20 Mbytes per workstation and another 29 percent expect to have 5-10 Mbytes. It is very similar in the United States, with a higher percentage (45 percent) expecting 5-10 Mbytes, and 25 percent expecting 10-20 Mbytes. Therefore, in both markets by 1988, about 70 percent of all workstations will have 5 to 20 Mbytes of fixed storage per workstation, only 5 percent will have over 20 Mbytes and the rest (25 percent) will have less than 5 Mbytes. Clearly the market is moving up to larger fixed storage per workstation, but by 1988 it will still be a long way from 100 Mbytes.

FIGURE 2-29


WORKSTATIONS WITH FIXED STORAGE DEVICES
CANADA - 1988
YES(52%)
NO(48%)

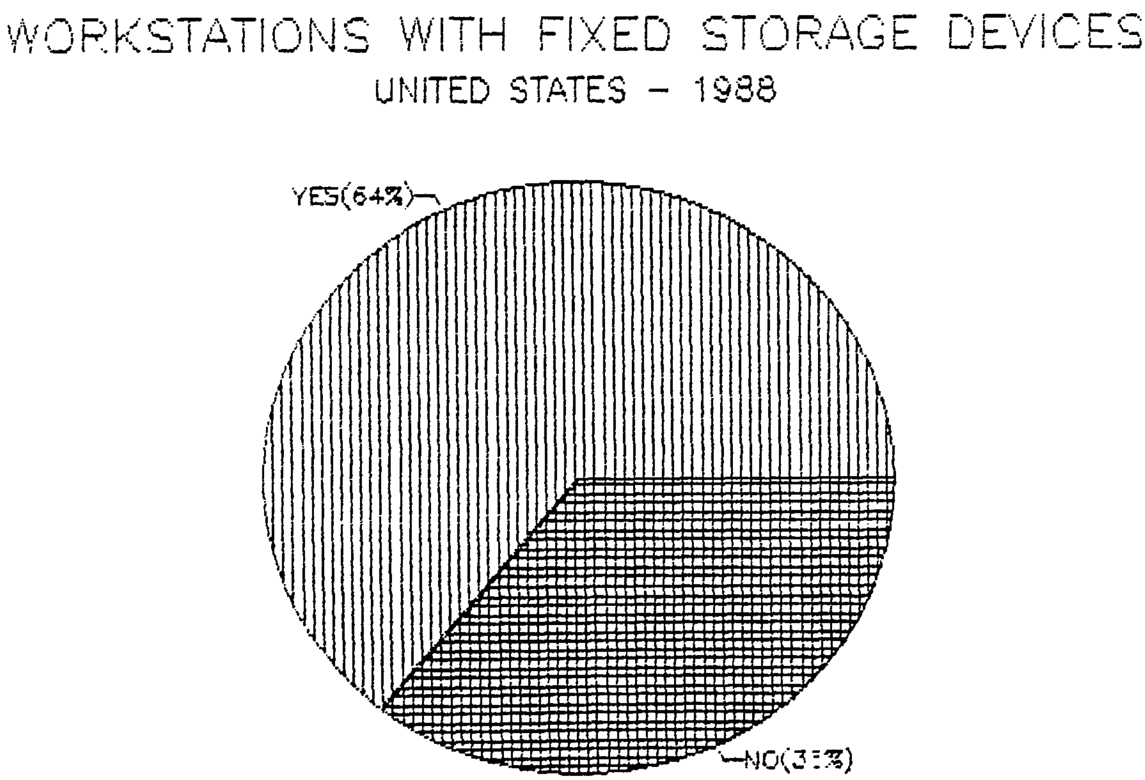
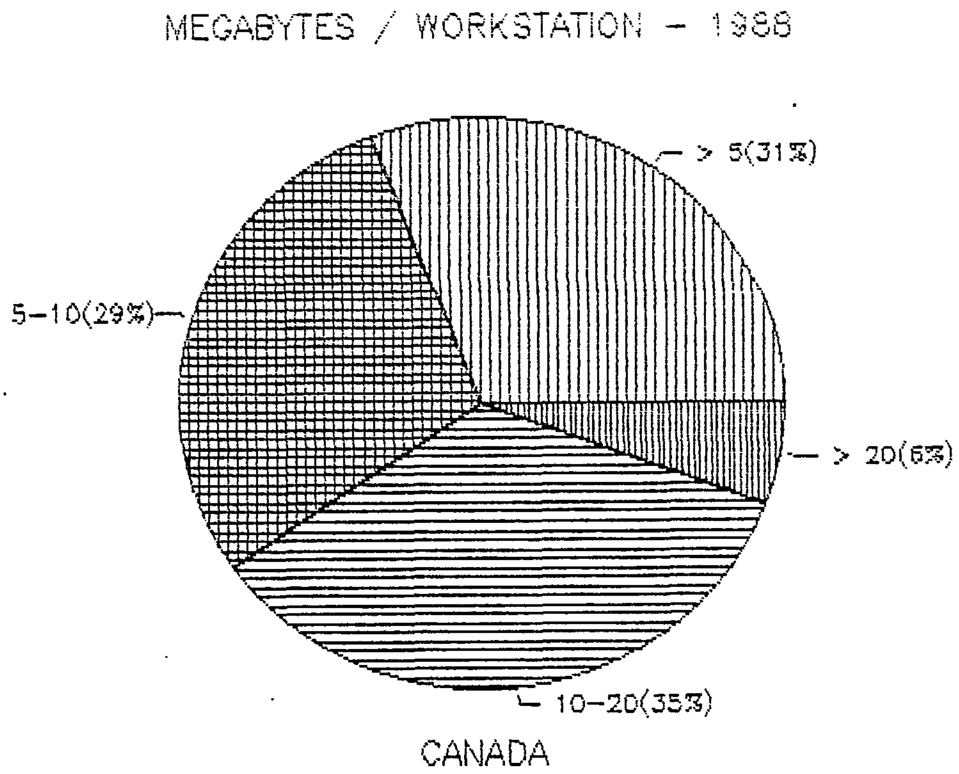
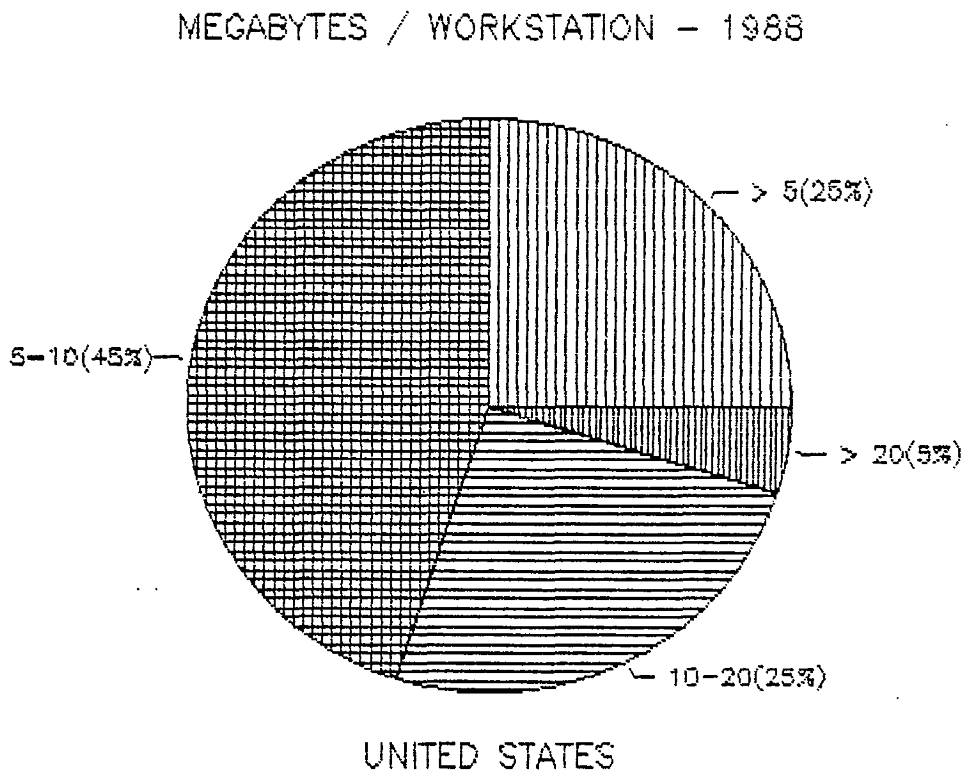

WORKSTATIONS WITH FIXED STORAGE DEVICES
UNITED STATES - 1988
YES(64%)

FIGURE 2-30


MEGABYTES / WORKSTATION - 1988
> 5(31%)
5-10(29%)
> 20(6%)
10-20(35%)
CANADA


MEGABYTES / WORKSTATION - 1988
> 5(25%)
5-10(45%)
> 20(5%)
10-20(25%)
UNITED STATES

2.7 Input/Output Peripherals

2.7.1 Introduction

In accordance with the Terms of Reference, the following sectors of the input/output peripherals market have been analyzed:

* Optical Character Recognition (OCR) Equipment

* Facsimile Devices

* Laser printers

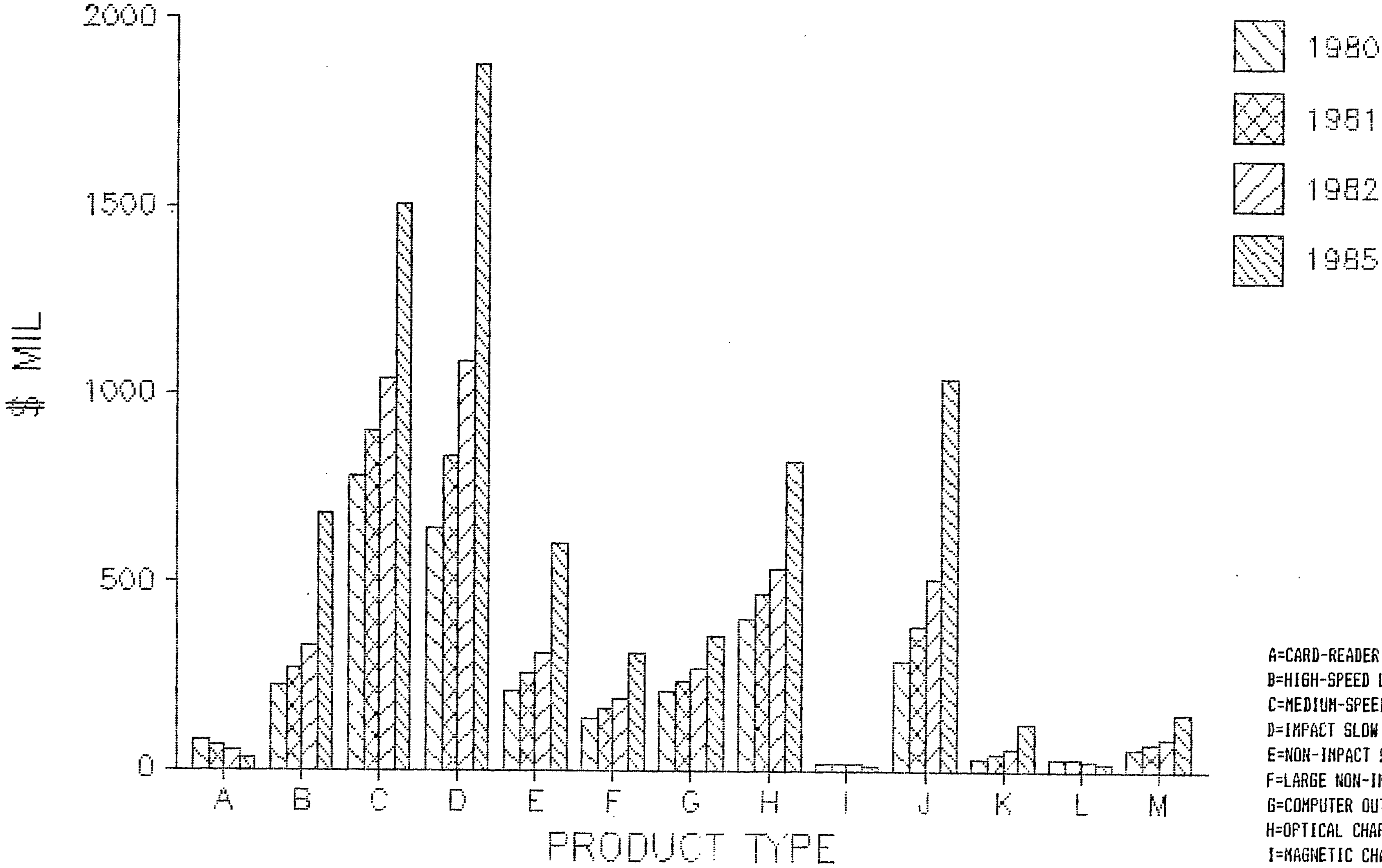
It is generally expected that these three groups will be the most significant growth areas in the input/output peripherals market. Section 2.6.2 details the markets for the above groups based on the survey. Estimates from industry sources on the overall input/output market are outlined in this section.

The total U.S. market for input/output devices is difficult to estimate because of the wide variety of equipment included in the category. The 1982 World Markets Forecast Data Book estimated the U.S. input/output peripherals market at $3.1 billion in 1980, rising to 7.3 billion in 1985. (Not including FAX.) (See Figure 2-31.)

FIGURE 2 - 31

INPUT / OUTPUT PHERIPHERALS

TOTAL U.S. MARKET



A=CARD-READER
B=HIGH-SPEED LINE PR
C=MEDIUM-SPEED (100
D=IMPACT SLOW SERIAL
E=NON-IMPACT SLOW SE
F=LARGE NON-IMPACT P
G=COMPUTER OUTPUT FI
H=OPTICAL CHARACTER
I=MAGNETIC CHARACTER
J=ELECTROMECHANICAL
K=DIGITIZERS, GRAPHI
L=PAPER-TAPE READERS
M=FACSIMILE TRANSMIS

A.D. Little forecast the U.S. document input/output market to be $4.7 billion in 1983, growing to $8.4 billion by 1988. (See Figure 2-32.)

The European market has been estimated at $0.9 billion in 1983 growing to $1.4 billion in 1988. The Japanese market is estimated at $1.5 billion growing to $2.6 billion by 1988.

The total U.S. OCR market has been estimated by various sources at about $440 million in 1983, and is highly fragmented. The traditional OCR markets have been banking, petroleum, government, utilities, insurance and transportation. All of these markets are saturated at the high end. The new OCR growth areas are retailing, manufacturing, mail order, medical and the general office market. However, the office market has been hard to sell because of the price of OCRs ($15,000 and up).

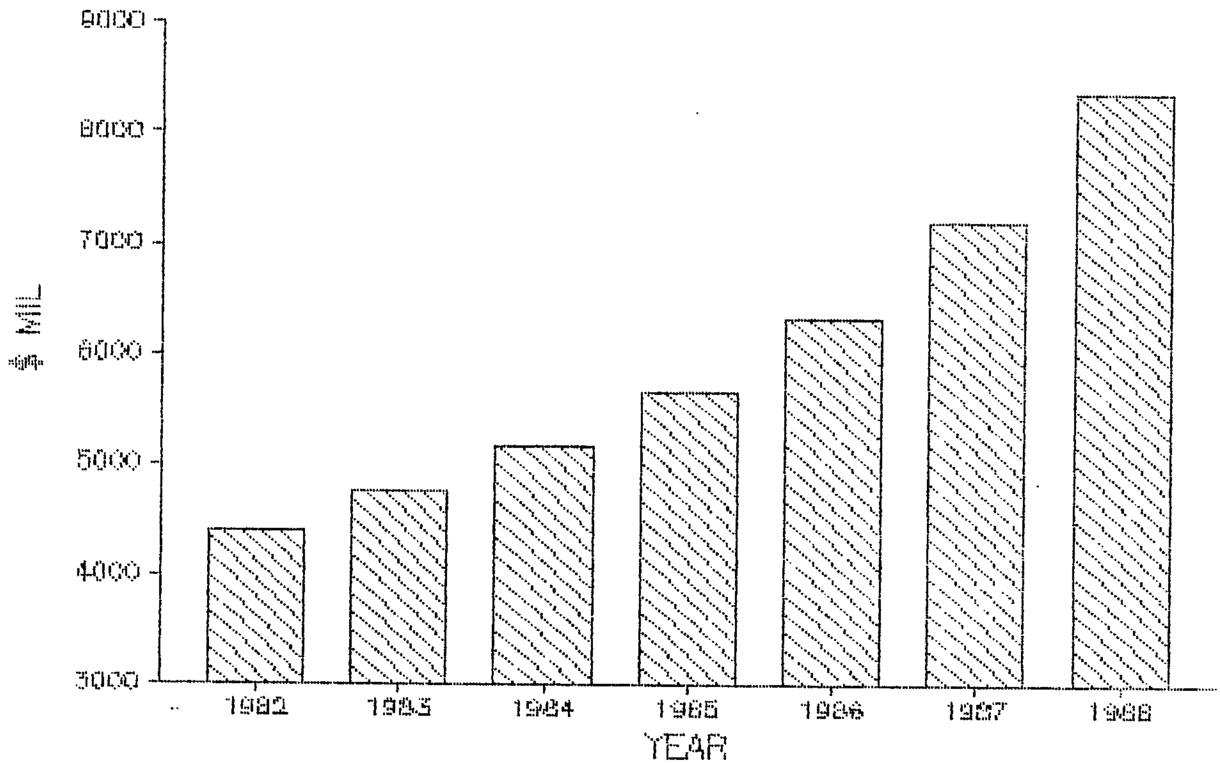
The total 1984 U.S. printer market has been estimated at between $2.9 billion and $11.0 billion. Non-impact printers, which includes laser printers, are estimated to account for 10 to 30 percent of this market. Data Book predicts sales of laser printers to be $1.5 billion in 1985 with 23,000 units as peripherals to word processors and 16,400 units associated with distributed data processing. The estimated growth rate of printing devices is between 20 and 35 percent.

FIGURE 2-32

DOCUMENT INPUT/OUTPUT DEVICES

U. S. MARKET

(In Millions of 1983 Dollars)



Source: A.D. Little

2.7.2 Input/Output Peripherals Market

Table 2-19 details the market for OCR, FAX and Laser Printers for the six industry sectors being analyzed. The total market in Canada in 1983 was $155 million, growing to $597 million in 1988. This is an annual growth rate of 57 percent over the 1983 base. The United States growth rate is very similar at 68 percent, with the market growing from $1.2 billion in 1983 to $5.3 billion in 1988.

The largest market of the three groups is in laser printers (See Figure 2-33). In Canada the market in 1983 was $82 million, growing to $446 million in 1988. This compares to $562 million and $4.2 billion, respectively, in the United States. The Canadian market is between 11 and 15 percent of the U.S. market. The U.S. market is growing at a somewhat higher annual rate than the Canadian (129 percent versus 89 percent). The laser printer market segment priced in the $10K - $100K range is the largest market of the three price ranges in both Canada and the United States. By 1988 it will have 62 percent of the Canadian laser printer market and 72 percent of the United States laser printer market. However, the fastest growing segment of the market is the under $10,000 laser printer. Growth rates range from an annual rate of 490 percent in Canada to 695 percent in the United States (over the 1983 base). The market will grow from only about 4-5 percent of the total market in 1983 to 19-23 percent of the market by 1988. The over $100,000 price range laser printer, shows only slight growth by comparison.

TABLE 2-19

INPUT/OUTPUT PERIPHERALS MARKET
FOR SIX INDUSTRY SECTORS
(In Millions of 1983 Dollars)

CANADA

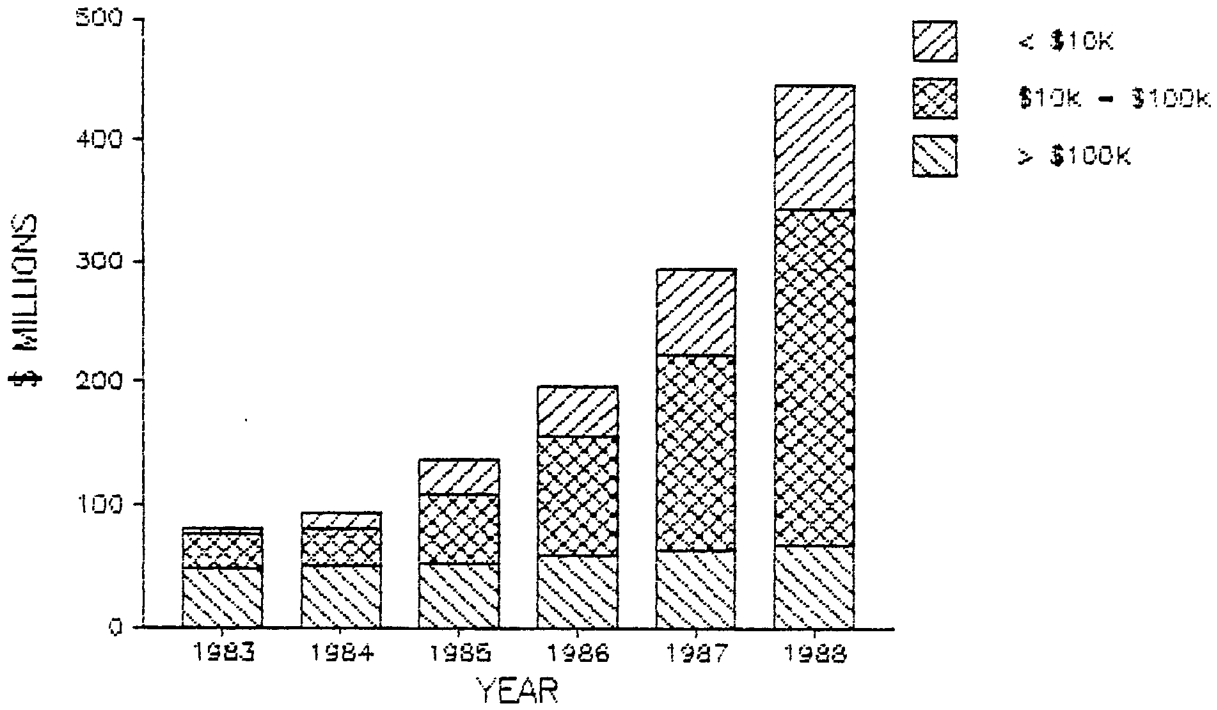
	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
OCR	40	47	43	60	107	114	37.0
FAX	34	35	36	35	34	37	1.8
Laser Printers							
> $100K	50	52	54	60	63	68	7.2
$10K - $100K	28	30	55	95	159	276	177.1
< $10K	4	12	27	41	71	102	490.0
TOTAL	155	175	215	292	434	597	57.0

UNITED STATES

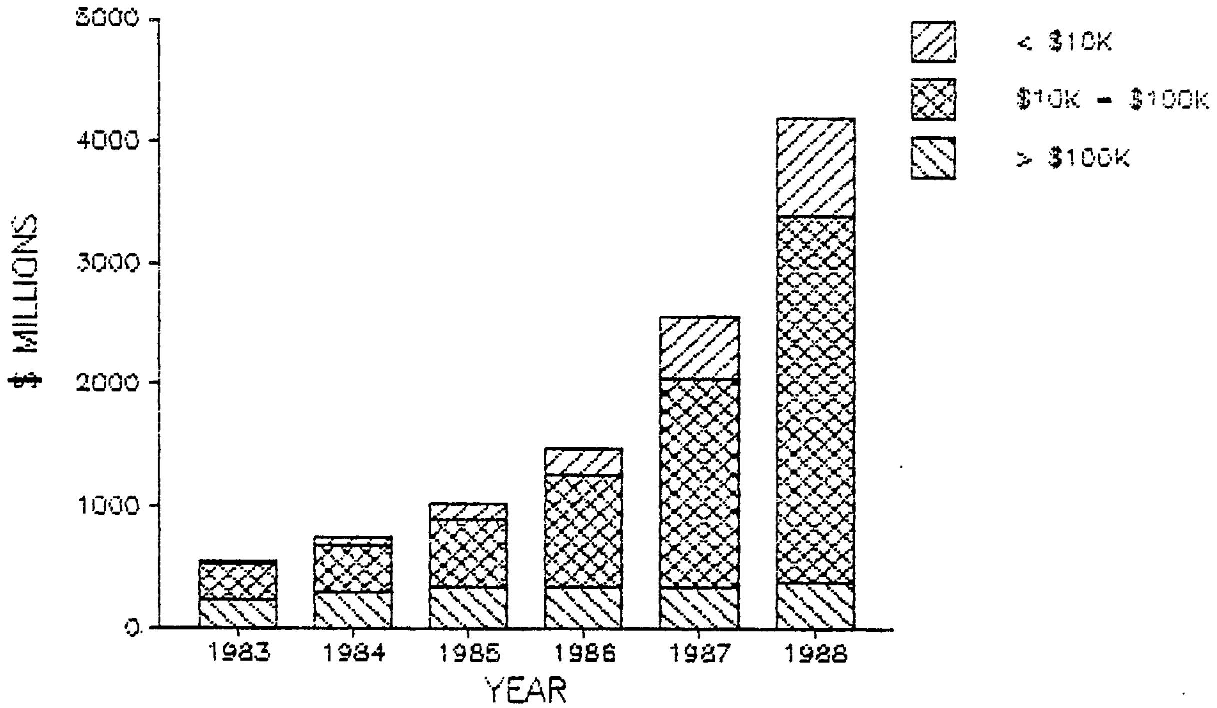
	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
OCR	141	203	297	485	532	626	68.8
FAX	513	519	531	519	535	533	0.8
Laser Printers							
> $100K	239	287	334	334	334	382	12.0
$10K - $100K	301	401	552	926	1,722	3,027	181.1
< $10K	22	65	135	204	520	787	695.5
TOTAL	1,215	1,475	1,850	2,469	3,645	5,355	68.1

FIGURE 2-33

LASER PRINTERS
ESTIMATED CANADIAN MARKET



LASER PRINTERS
ESTIMATED AMERICAN MARKET

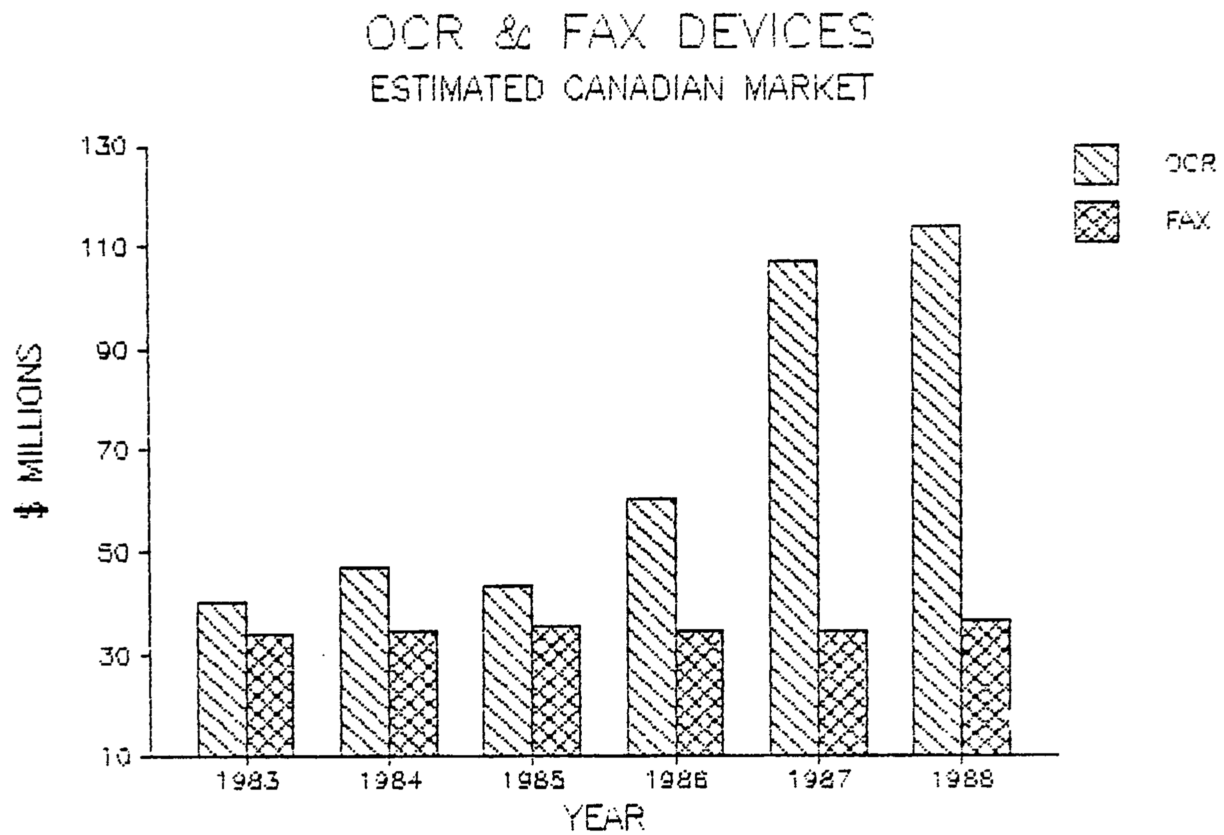


The second largest market is OCR, in both Canada and the United States (See Table 2-19 and Figure 2-34). The OCR market in Canada was about $40 million in 1983 growing to $114 million in 1988, for an annual growth of 37 percent over the 1983 base. The United States market in 1983 was $141 million growing to $626 million by 1988, a somewhat high growth of 68.8 percent per year over the 1983 base.

The FAX market (Figure 2-34) shows little growth in both Canada and the United States. In 1983, the FAX market in Canada was $34 million, rising to $37 million in 1988. In the United States, we see the same leveling, from $513 million in 1983 to $533 million in 1988.

Table 2-20 shows the market for OCR, FAX and Laser Printers by industry sector. The highest growth sectors are the insurance, resource, and transportation and communications sectors. The largest market is in manufacturing at $229 million (1988) in Canada and $2.9 billion (1988) in the United States.

FIGURE 2-34


OCR & FAX DEVICES
ESTIMATED CANADIAN MARKET
130
110
90
70
50
30
10
$ MILLIONS
1983
1984
1985
1986
1987
1988
YEAR
OCR
FAX

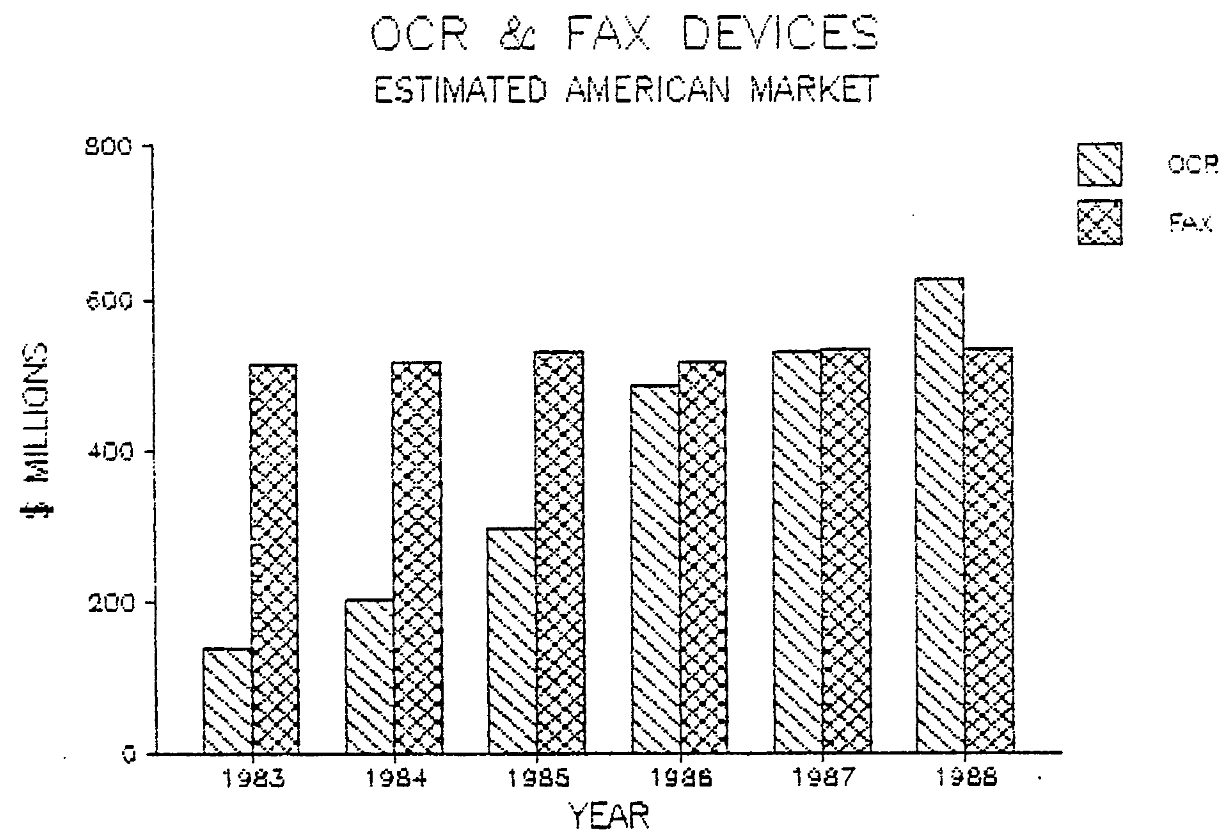

OCR & FAX DEVICES
ESTIMATED AMERICAN MARKET
800
600
400
200
0
$ MILLIONS
1983
1984
1985
1986
1987
1988
YEAR
OCR
FAX

TABLE 2-20

INPUT/OUTPUT PERIPHERALS MARKET
BY INDUSTRY SECTOR
(In Millions of 1983 Dollars)

CANADA

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	10	11	12	14	18	26	32.0
Health	9	10	11	14	18	24	33.3
Insurance	16	20	28	40	66	78	77.5
Manufacturing	63	69	86	115	168	229	52.7
Resource	25	26	30	39	56	86	48.8
Transportation & Communications	32	39	47	70	108	154	76.2
TOTAL	155	175	214	292	434	597	57.0

UNITED STATES

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
Education	46	56	72	102	162	206	69.6
Health	36	49	66	82	98	144	60.0
Insurance	156	225	305	425	609	872	91.8
Manufacturing	731	835	1,029	1,373	1,967	2,899	59.3
Resource	178	222	264	345	579	876	78.4
Transportation & Communications	68	88	114	142	230	358	85.3
TOTAL	1,215	1,475	1,850	2,469	3,645	5,355	68.1

2.8 Software

2.8.1 Introduction

The basic coverage of this section is related only to packaged software as outlined in Section 2.8.2. However, an overview of the total software market has been developed from industry sources and is presented in this section.

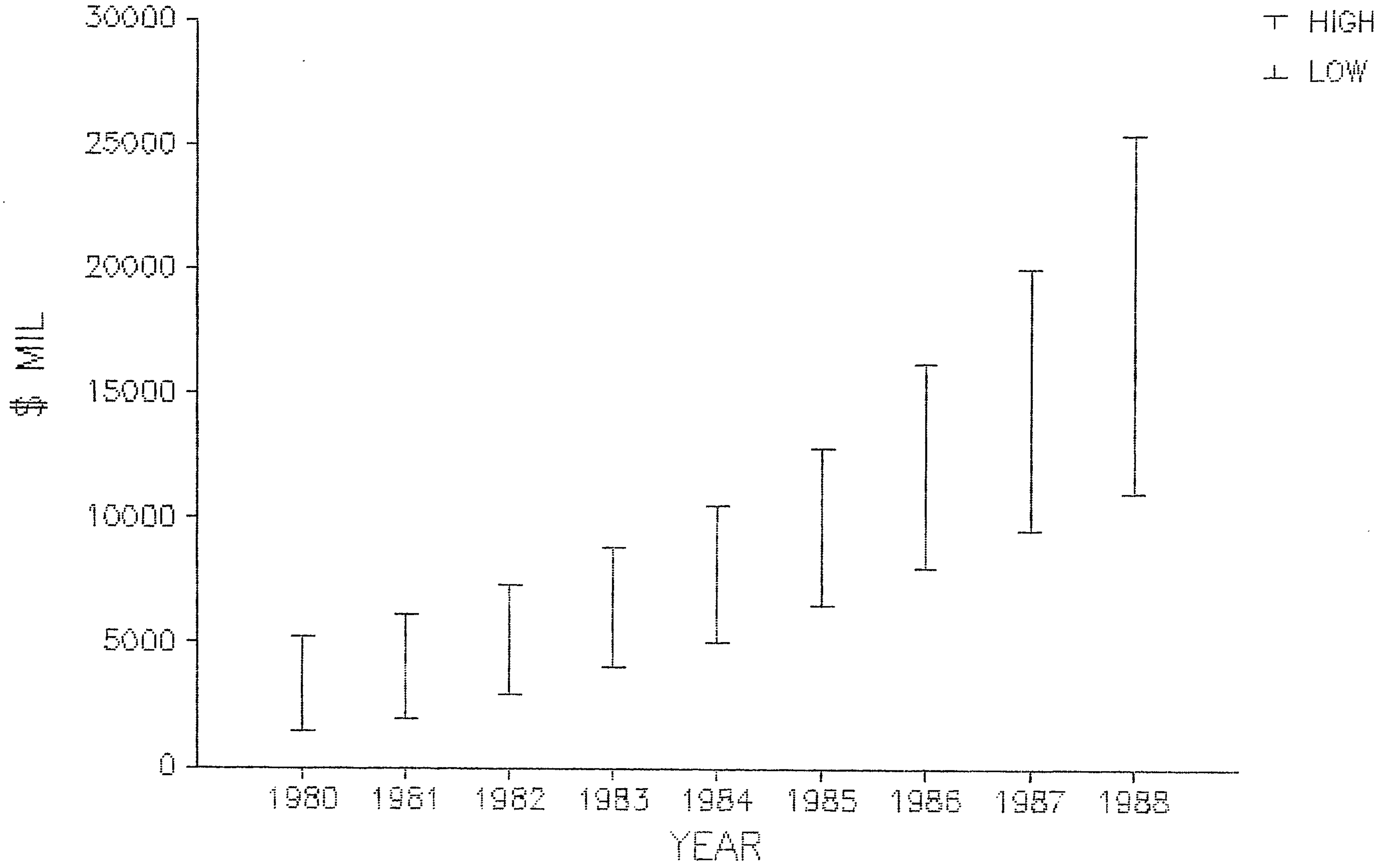
The market range for the total U.S. software market is presented in Figure 2-35. This high/low estimate is derived from a number of different sources, and includes all types of software. There is a wide divergence in opinion over the market and its growth rate, and this is reflected in the wide spread between the high and low market estimates. Figure 2-36 shows a similar high/low estimate for business applications packages.

In Canada, Evans Research Corporation estimated the software market at $457 million in 1980, and $608 million in 1983. The market is expected to reach $5.4 billion by 1990, an annual growth over the 1983 base of 112.6 percent per year. The applications software market was estimated at $114 million and $161 million in 1980 and 1981, respectively. It is estimated that it will reach $2.2 billion by 1990, an annual growth rate of 140.7 percent over the 1981 base. Figure 2-37 shows both the total Canadian software and business applications software markets. The applications software market is for both custom and packaged software.

FIGURE 2 - 35

U.S. SOFTWARE MARKET

ALL TYPES



-97-

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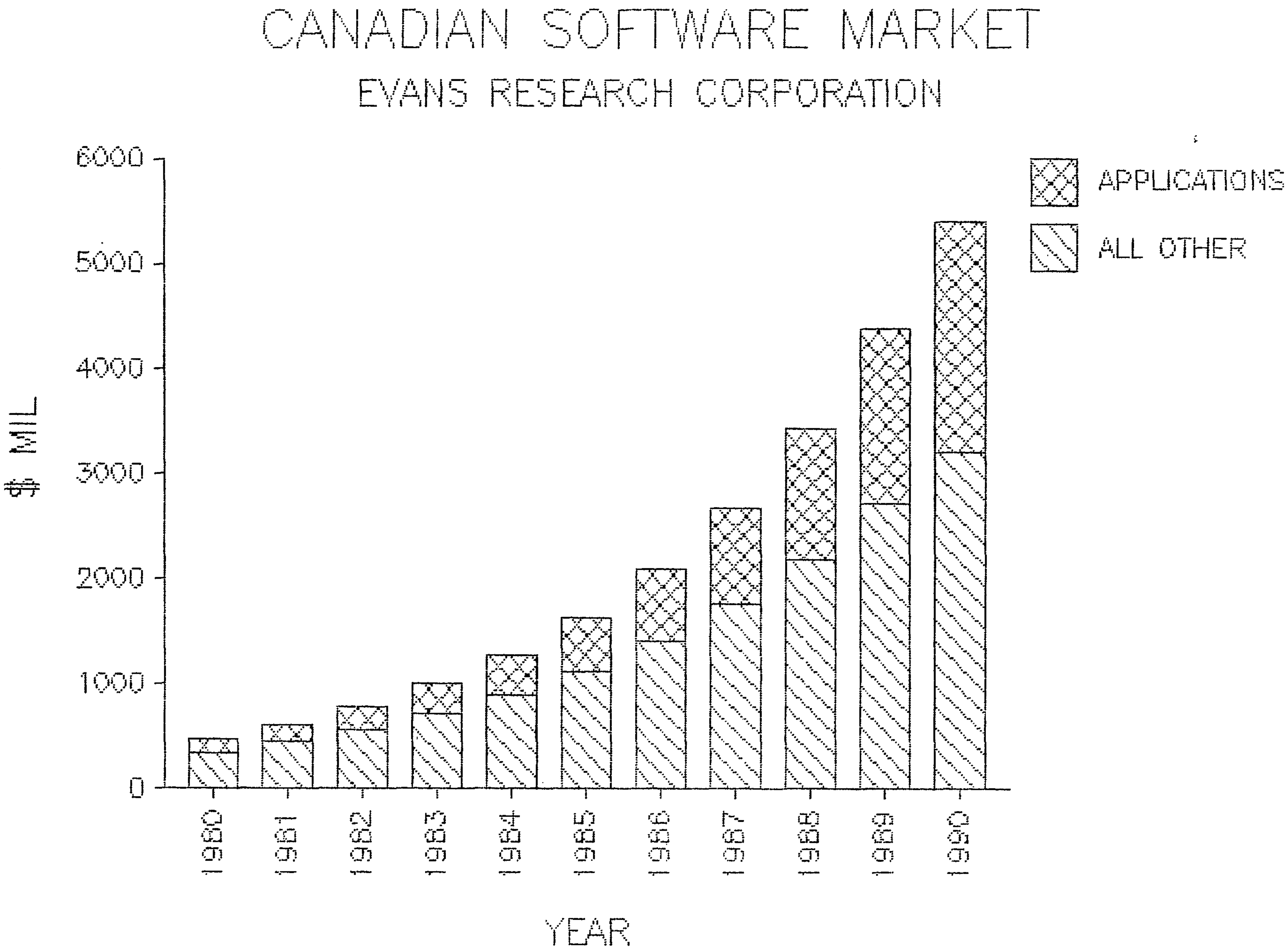
FIGURE 2 - 36

U.S. SOFTWARE MARKET

BUSINESS APPLICATIONS PACKAGES

FIGURE 2- 37



-66-

The European software market is estimated at $2.1 billion in 1983 growing to $8.1 billion in 1988. The Japanese market is estimated at $1.0 billion in 1983, rising to $2.3 billion in 1988.

2.8.2 Software Market

In accordance with the Terms of Reference, this section covers only the following "packaged" office automation software for the six industry sectors being analyzed:

* PERSONAL MANAGEMENT
  Calendars/datebook, schedules/time control, telephone directory, file handling, and report generation.

* DECISION SUPPORT
  Spreadsheets, business graphics, financial modelling, database management.

* CLERICAL/ADMINISTRATIVE
  Electronic mail, word processing, electronic filing.

The market in Canada and the United States is detailed in Table 2-21 and Figure 2-38. In Canada, the market was $37 million in 1983 growing to $139 million in 1988, for an annual growth rate of 55.1 percent over the 1983 base. The growth rate in the United States is very similar at 65.2 percent, from a base of $231 million in 1983 to $984 million in 1988. Note that these software market figures are only for the six industry sectors of education, health, insurance, manufacturing, resource and transportation and communications. It is believed that the market estimates for these sectors are conservative. Companies had some difficulty in determining their total packaged software procurement. These are no central budgets except where the DP

TABLE 2-21

PACKAGED OFFICE AUTOMATION SOFTWARE MARKET
FOR SIX INDUSTRY SECTORS
(In Millions of 1983 Dollars)

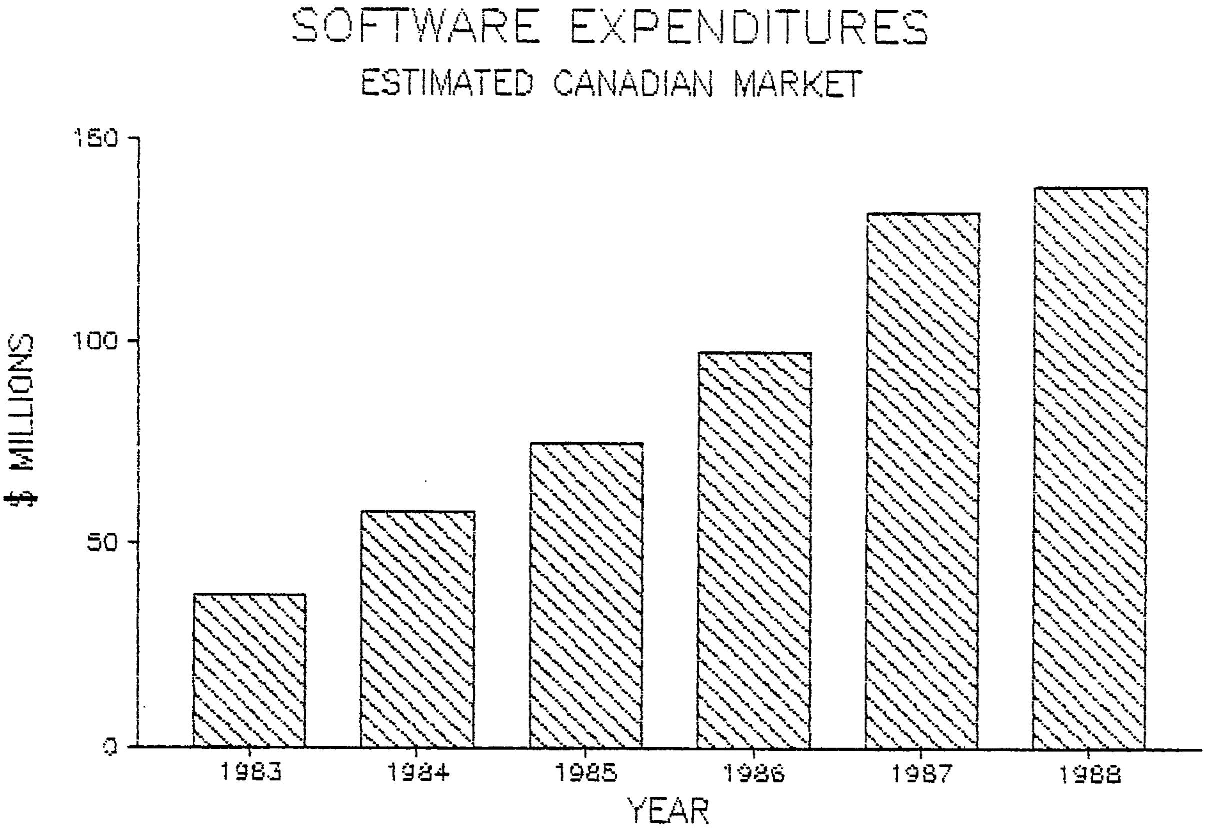
CANADA

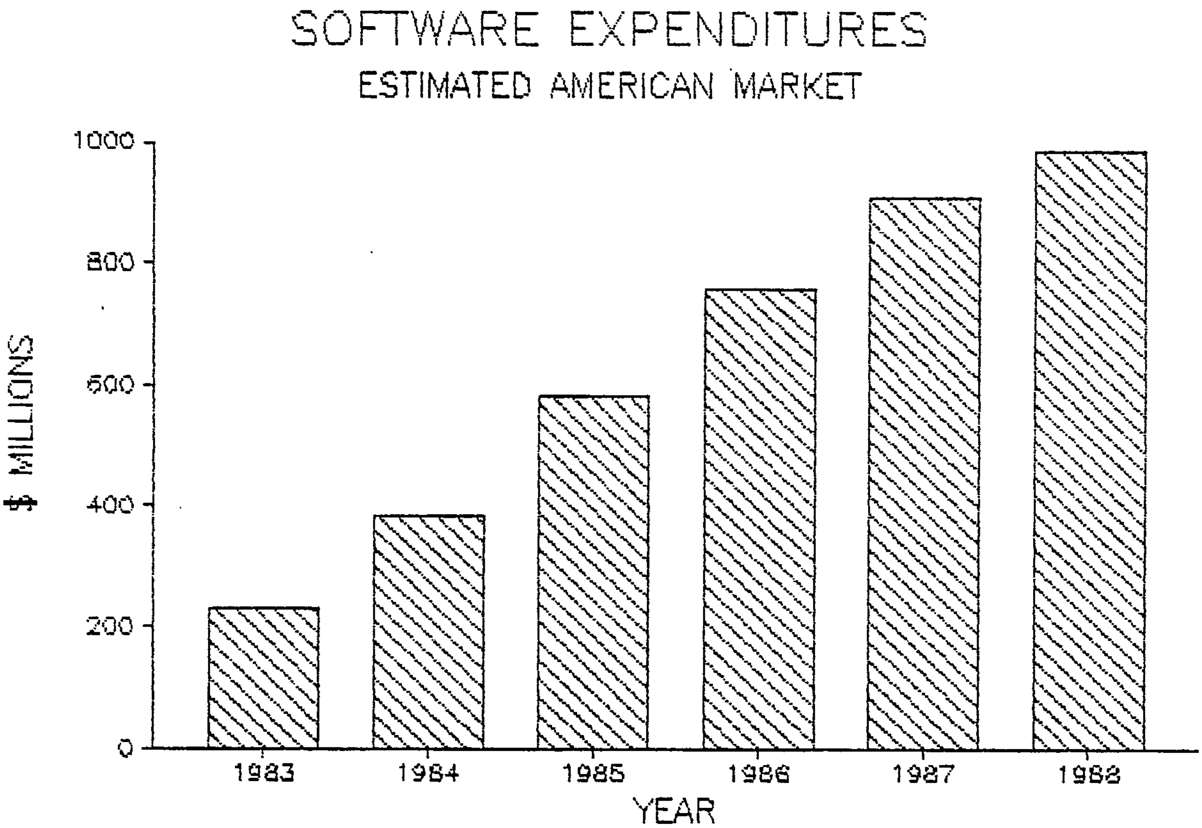
	1983 $	1984 $	1985 $	1986 $	1987 $	1988 $
Personal Management	2	6	9	15	26	30
Decision Support	14	28	36	46	61	61
Administrative	16	20	27	33	4	43
Other	5	4	2	3	4	4
TOTAL	37	58	74	98	132	139

UNITED STATES

	1983 $	1984 $	1985 $	1986 $	1987 $	1988 $
Personal Management	22	41	81	238	159	187
Decision Support	84	168	259	304	341	361
Administrative	112	157	225	279	330	356
Other	12	28	17	49	79	80
TOTAL	231	384	582	760	908	984

FIGURE 2-38


SOFTWARE EXPENDITURES
ESTIMATED CANADIAN MARKET
$ MILLIONS
150
100
50
0
1983
1984
1985
1986
1987
1988
YEAR

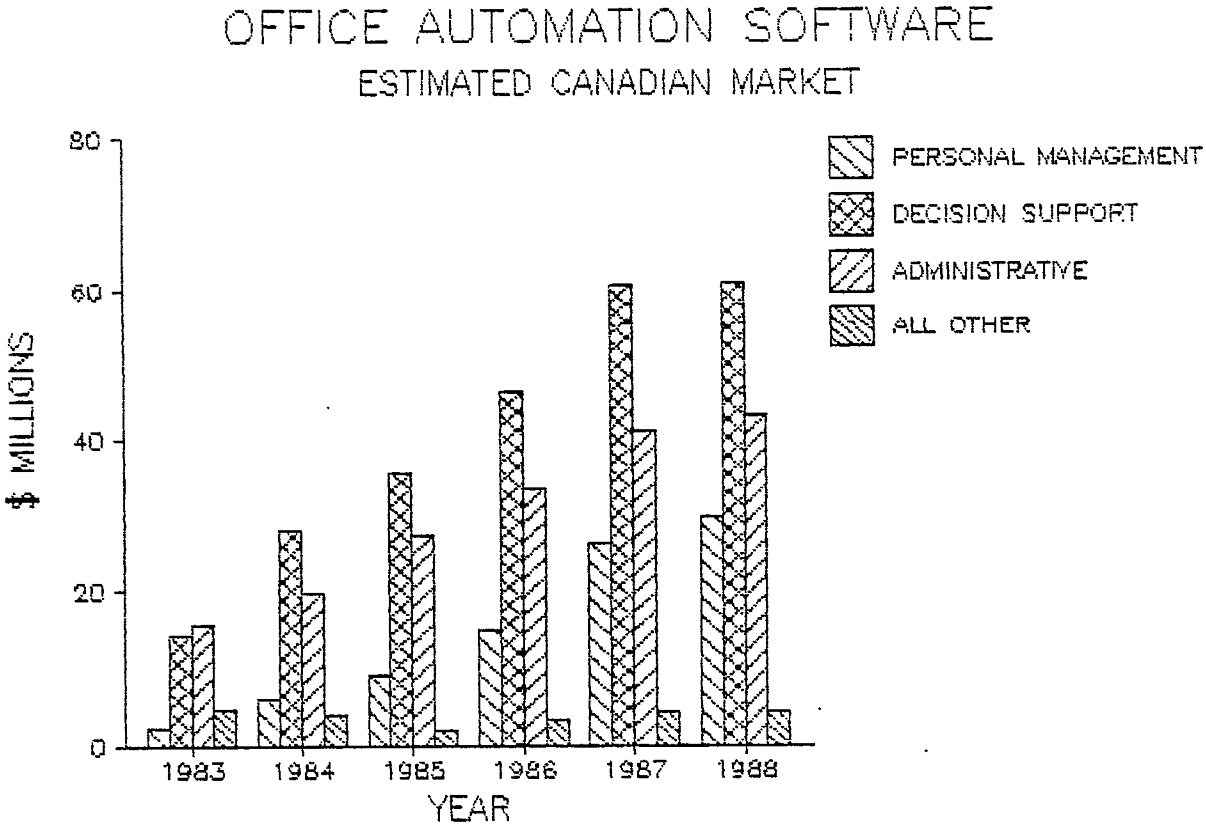

SOFTWARE EXPENDITURES
ESTIMATED AMERICAN MARKET
$ MILLIONS
1000
800
600
400
200
0
1983
1984
1985
1986
1987
1988
YEAR

department has bought in volume for the company. However, with most packaged software selling in the $500 range, virtually any department head can authorize individual purchases. So while the company did estimate its total corporate purchases, there is still likely to be a "hidden" market of individual purchases of packaged software (e.g. Software is often purchased simply as "office supplies" to get around many companies' restrictions on the proliferation of various types of software within the corporation).

The largest market in both Canada and the United States is for decision support software. (See Figure 2-39.) This is followed by administrative software and then personal management software.

Table 2-22 shows the software market breakdown by industry sector. Manufacturing is the largest market in Canada and the United States, followed by the transportation and communications sector in Canada and the resource sector in the United States.

FIGURE 2-39


OFFICE AUTOMATION SOFTWARE
ESTIMATED CANADIAN MARKET
$ MILLIONS
0
20
40
60
80
1983
1984
1985
1986
1987
1988
YEAR
PERSONAL MANAGEMENT
DECISION SUPPORT
ADMINISTRATIVE
ALL OTHER

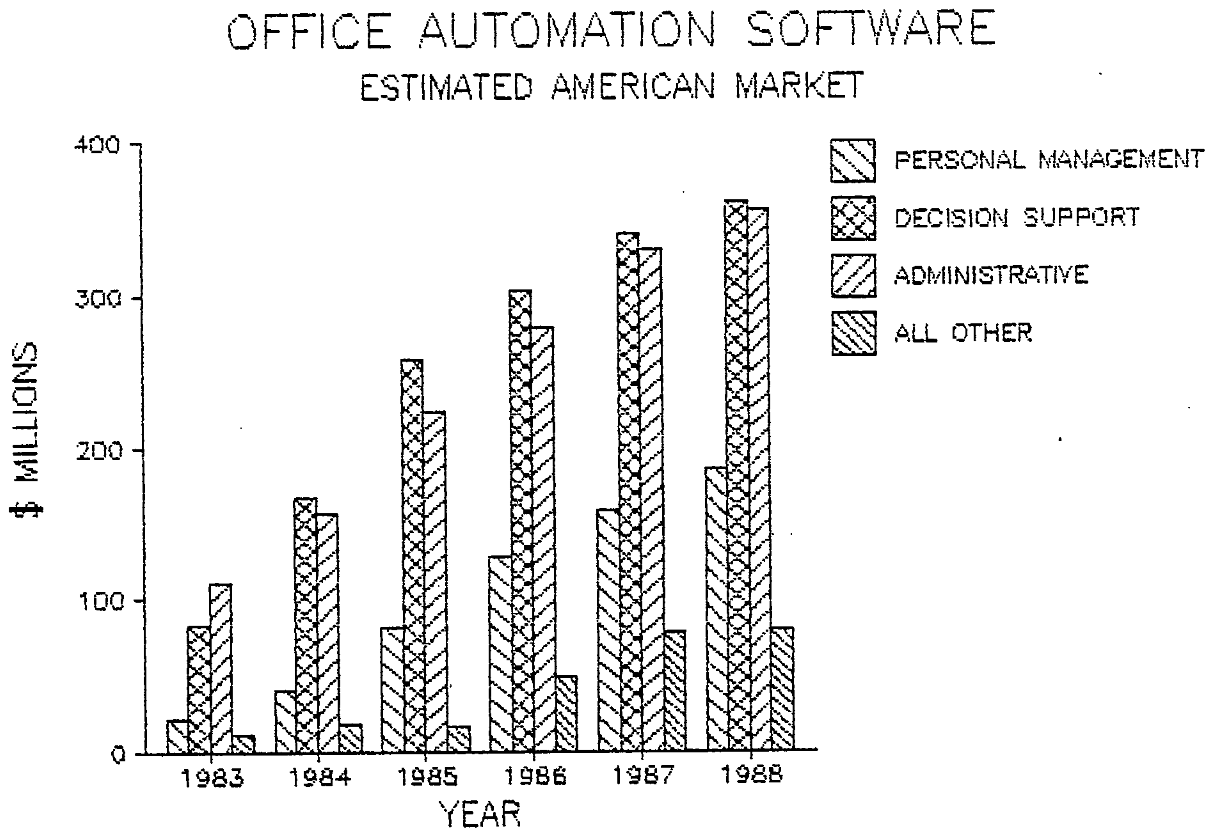

OFFICE AUTOMATION SOFTWARE
ESTIMATED AMERICAN MARKET
$ MILLIONS
0
100
200
300
400
1983
1984
1985
1986
1987
1988
YEAR
PERSONAL MANAGEMENT
DECISION SUPPORT
ADMINISTRATIVE
ALL OTHER

TABLE 2-22

PACKAGED OFFICE AUTOMATION SOFTWARE MARKET
BY INDUSTRY SECTOR
(In Millions of 1983 Dollars)

CANADA

	1983 $	1984 $	1985 $	1986 $	1987 $	1988 $
Education	2	3	3	4	6	6
Health	2	3	4	5	7	7
Insurance	4	7	9	13	17	19
Manufacturing	15	23	30	39	53	55
Resource	6	8	10	13	17	18
Transportation & Communications	8	13	18	24	33	34
TOTAL	37	58	74	98	133	139

UNITED STATES

	1983 $	1984 $	1985 $	1986 $	1987 $	1988 $
Education	9	15	22	28	33	36
Health	5	8	11	14	16	18
Insurance	29	52	81	108	129	145
Manufacturing	144	235	353	457	540	583
Resource	34	58	90	119	148	158
Transportation & Communications	9	16	25	34	40	44
TOTAL	230	384	582	760	906	984

2.9 Government Markets

2.9.1 Canadian Federal and Provincial Governments

The estimated Office Communications System market for the federal government is detailed in Table 2-23. Table 2-24 contains the market estimate for the provincial governments. The data for this analysis was derived from a number of sources, including the Public Accounts of Canada (Details of Expenditures and Revenue), Treasury Board, and contact with various government officials.

The total federal OCS market in 1983 was estimated to be $71 million, and is expected to grow to $119 million by 1988 -- an average annual growth rate of 13.5 percent over the 1983 base. The total workstation market was $22 million in 1983, growing to $53 million in 1988. The word processing market is expected to grow only 6 percent annually, conforming to federal procurement restraint policies. Microcomputer expenditure is expected to grow at a more normal rate of 74.3 percent annually over the 1983 base. This is because microcomputers are inexpensive to purchase, easy to procure by a variety of personal (i.e. not restricted to EDP managers), and can be used by personnel to perform different tasks.

The PABX market was estimated at $21 million in 1983 growing to $26 million in 1988. The federal government is currently in the process of converting their existing analog switches to digital switches. It is anticipated that this

TABLE 2-23

CANADIAN FEDERAL GOVERNMENT MARKET
(In Millions of 1983 Dollars)

	1983	1984	1985	1986	1987	1988	GROWTH %/YEAR
	$	$	$	$	$	$	%
WORKSTATIONS:							
Word Processors	15	16	17	18	19	20	6.7
Microcomputers	7	10	15	20	27	33	36.7
PABX	21	22	23	24	25	26	4.8
LAN	.3	.5	.8	1.3	2.1	3.5	63.5
Storage Peripheral	16	17	18	19	20	21	6.2
Input/Output	2.3	2.5	2.8	3.0	3.3	3.8	10.6
Software (All Types Purchased)	9.0	9.5	10.1	10.7	11.3	12	6.7
TOTAL	71	78	87	96	108	119	10.9

TABLE 2-24

PROVINCIAL GOVERNMENT MARKETS
(In Millions of 1983 Dollars)

	1983	1984	1985	1986	1987	1988
	$	$	$	$	$	$
Atlantic Provinces	4.7	5.2	5.8	6.4	7.2	8.0
Quebec	16.2	17.8	19.9	22.1	24.8	27.3
Ontario	18.8	20.8	23.2	25.6	28.8	31.7
Western Provinces	13.6	14.9	16.6	18.3	20.6	22.8
TOTAL	53.3	58.7	65.5	72.4	81.4	89.8

conversion will be completed by 1987/1988. The federal government is also upgrading their data network to deal with the increasing requirements of teleprocessing, voice store and forward messaging, communicating word processors and workstations, and facsimile devices.

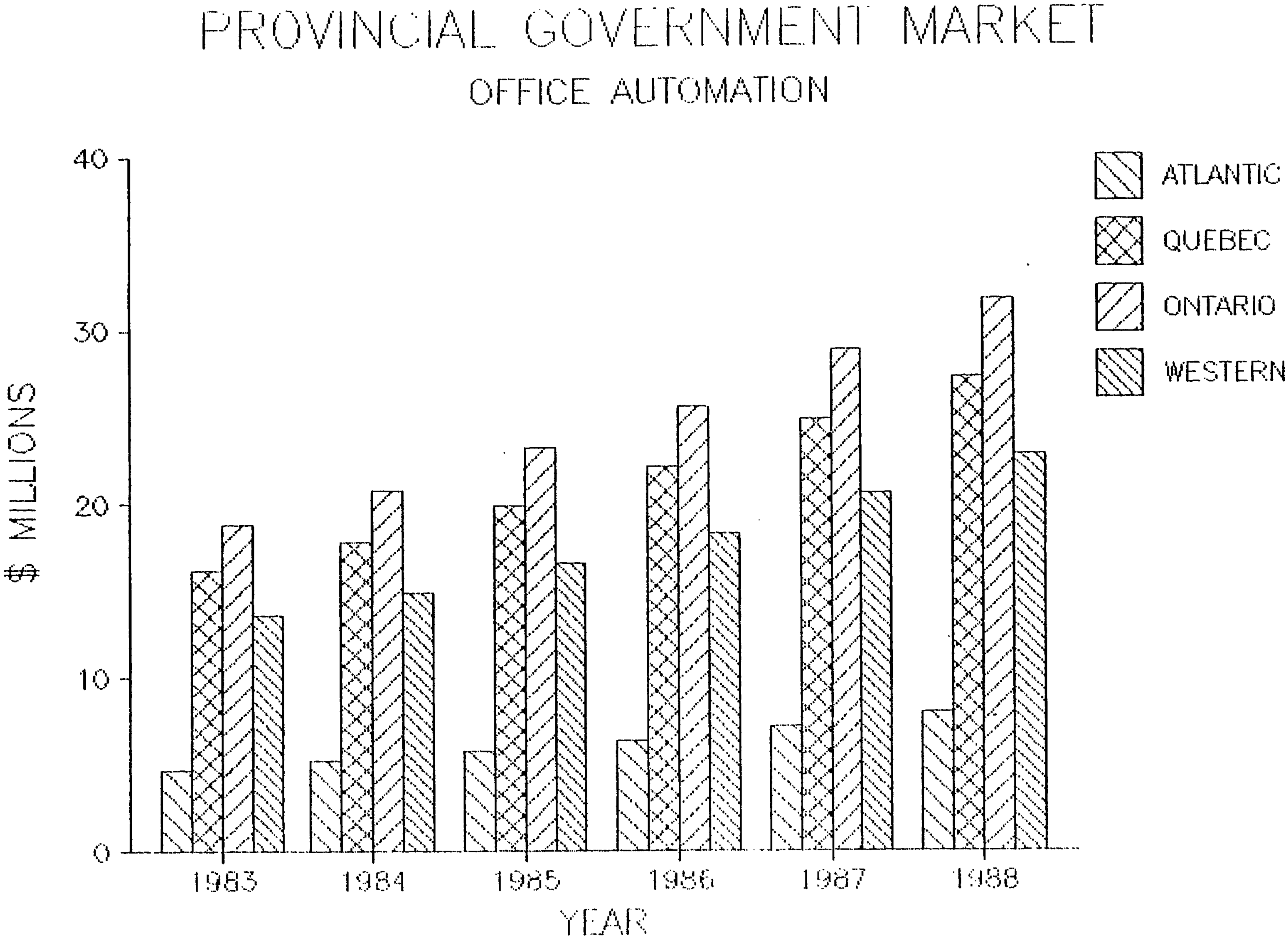
The LAN market is expected to grow from $.3 million in 1983 to an estimated $3.5 million in 1988. Local area networks have been installed in a number of test situations including the OCS field trials, and the House of Commons Office Automation System.

The storage peripherals market was estimated at $16 million in 1983, growing to $21 million in 1988. This is based on capital expenditures only and does not include leased equipment. The Input/Output market includes OCR, FAX and laser printers. It was $2.3 million in 1983, forecast to grow to $3.8 million in 1988. Again, this does not include rented and leased equipment. The most significant trend in input/output devices used by the federal government, is the replacement of existing FAX machines with newer digital facsimile terminals.

The software market was estimated at $9.0 million in 1983, and $12 million in 1988. This includes all packaged software acquired for use on micros and mainframes. However, it does not include custom software. The general trend is towards less custom software, especially for the smaller applications, and more "off the shelf". A number of departments are now maintaining listings of library of software and end users. Hence software can be tried prior to purchase to enable end users to their share experience with various types of software.

The Provincial Government market presented in Table 2-24, shows an overall growth from $53.3 million in 1983 to $89.8 million in 1988. Ontario has 35 percent of the provincial OCS market, with total expenditures of $18.8 million in 1983 and $31.7 million in 1988. Quebec has an OCS market of $16.2 million in 1983, and $27.3 million in 1988. The four provinces of Manitoba, Saskatchewan, Alberta and British Columbia were estimated to have a combined expenditure on OCS equipment and services at $13.6 million in 1983 and $22.8 million in 1988. Finally, the Atlantic provinces have 8.8 percent of the total provincial market. In 1983 the combined market for the Atlantic provinces was estimated at $4.7 million, and is expected to grow to $8.0 million in 1988. Figure 2-40 illustrates the respective OCS market growth in the provincial governments.

FIGURE 2-40



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2.9.2 United States Government

The market for office automation equipment and services in the United States government is detailed in Table 2-25. The data for this analysis has been primarily obtained from computer runs off the Federal Procurement Data System (all contract awards over $10,000) and contact with United States officials.

The total market in 1983 for the catagories analyzed per Table 2-24 was $674.8 million growing to $2.5 billion in 1988. The workstation market was $23.7 million in 1983, growing to $50 million in 1988. This includes all types of workstations, but does not include terminals and workstations procured as part of a mainframe, minicomputer or overall computer systems procurement, even though this category is defined as "Office Information Systems". Most procurement to date has been primarily word processing and financial systems, with little "office automation" as defined in this report. Overall, the United States government market appears to be at the Early/Limited stage of automation, with microcomputer based workstations beginning to appear in departments, particularly those needing spreadsheet analysis.

The PABX market was $133.9 million in 1983, growing to $338.5 million in 1988. This category includes all telephone and telegraph equipment, except rentals and leasing. The Input/ Output market was $156.2 million in 1983 growing to $977.9 million in 1988. This includes printers, OCR and FAX, as well

TABLE 2-25

OFFICE AUTOMATION MARKET
UNITED STATES GOVERNMENT
(In Millions of 1983 Dollars)

	1983	1984	1985	1986	1987	1988
	$	$	$	$	$	$
Workstations	23.7	28.3	33.7	39.2	44.6	50.0
PABX	133.9	167.9	210.5	253.2	295.8	338.5
Input/Output	156.2	262.6	441.4	620.3	799.1	977.9
Storage Peripherals	288.3	376.3	491.1	605.8	720.6	835.4
Software	72.7	98.1	132.5	178.9	241.5	326.0
TOTAL	674.8	933.2	1,309.2	1,697.4	2,101.6	2,527.8

as some computer communications input/output peripherals, such as modems and multiplexers. The storage peripherals market was $288.3 million in 1983 rising to $835.4 million in 1988. While this market is currently larger than the input/output peripherals market, it is growing at a somewhat slower pace. As a result, it declines in overall market share in 1988, to about 46 percent of the total peripherals market, from its 64 percent market share in 1983. The software market includes all types (applications, operating systems, diagnostics) of software. It does not include software purchased as part of an overall mainframe or other computer system contract. The total market as detailed in Table 2-25 was $72.7 million in 1983, growing to $326.0 million in 1988.

APPENDIX 2-A

PRODUCT DEFINITION
MULTIFUNCTIONAL WORKSTATION
&
SOME BACKGROUND INFORMATION
ON THE COMPUTER AND MICROCOMPUTER MARKETS

Product Definition - Multifunctional Workstations

The definition of a multifunctional workstation varies with the different reports and perceptions of a variety of analysts. There is no concensus on a definition. This is due to the convergence of the computer, communications and office equipment technologies and the proliferation of different products utilizing these rapidly changing technologies.

International Resource Development Limited (IRD) defines management workstations as follows: "Management workstations are multifunctional units which provide all of the automated office requirements of professionals and executives. Executives are defined as decision makers, while professionals are those who provide ideas for the organization." IRD uses the Xerox Star as the typical example of a management workstation. They view the Wangwriter and IBM Display Writer as administrative workstations, and hence do not include them in any management workstation figures.

A.D. Little defines a multifunctional workstation as follows: "They are standalone or clustered operator-oriented products. Multifunctional workstations can be linked to one another by means of local communication networks, as well as to other systems by means of telecommunications facilities. They are equipped with software which can combine office automation and information processing functions in the same process. Eventually they will handle images and voice media as well as data, text, and graphics. They will also serve as powerful desktop computers." As with IRD, A.D. Little sites the Xerox Star System as the example of this class of product.

Officesmiths Limited does not provide a definition for a multifunctional workstation, but states, "the multifunctional workstation will replace data terminals, word processors, and standalone personal computers -- which will either become obsolete or move downward in the white collar hierarchy".

Datamation recently published an article which best describes the confusion over workstations and provides an excellent definition. Dr. Michael Hammer stated, "The term 'workstation' itself, of course, is both posturing and misleading. It vagueness allows everyone to use it without fear of contradiction or FTC suit... A workstation, then is the preferred locus of execution for personal applications, which support the individual in his or her work and is of direct and personal benefit to the individual. The nature of these applications and consequently of the functionality derived from a workstation, will depend on the individual's position and the work that he or she performs. A secretarial workstation will emphasize document processing; a financial analyst's workstation will offer spreadsheet processing; and a management workstation will provide database access and decision support. These various types of workstations will inevitably have different features and characteristics in terms of both software and hardware."

Dr. Hammer further discusses the importance of the departmental information system, which is "the heart of the organization's system architecture". While each workstation will be application oriented and suited to the individual, they must also be interlinked within the office for the sharing of such information as sales performance data, production scheduling, and so on. The departmental information system will also provide other functions such as filing, printing, and communications. Its software components will include database management and decision support tools.

"Workstations are rapidly becoming indistinguishable commodities. With the more popular software packages available on many different workstations, there is little to differentiate them and tie them to any one model." The key to the workstation is the application software, the hardware's speed and power, and finally, the ability to communicate both within the departmental system and to external information sources. Again, the emphasis is on a desktop tool capable of performing a number of different tasks which directly assist the individual in performing his or her job more effectively.

Some Background Information On The Computer and Microcomputer Markets

The 1984 Canadian Computer Census provides information on the number of installed computers by industry, size, geographic location, and manufacturer. The problem with the census as a reference point for industry sector analysis is that it includes computers of all sizes, used in a wide array of applications. A further problem is that the microcomputer installation figures are very poor. However, for interest we have included Table A-1 which shows the distribution of computers by sector, and Figure A-1 which illustrates the sector breakdown for systems with rentals of less than $1,000 per month.

Evans Research estimated the 1984 Canadian market for microcomputers to be 240,000 units, of which 63,000 were expected to be acquired by large corporations. (See Table A-2.) Again, there are problems with this data. Evans reports a degree of uncertainty given that these are many microcomputers being procured by other than the DP departments interviewed.

In the United States there is some breakdown by industry, but again, there are many inherent problems with the data. Datamation had a recent article on DP budgets broken down by industry sector. Table A-3 and Figure A-2 present this data.

TABLE A-1

DISTRIBUTION OF COMPUTERS

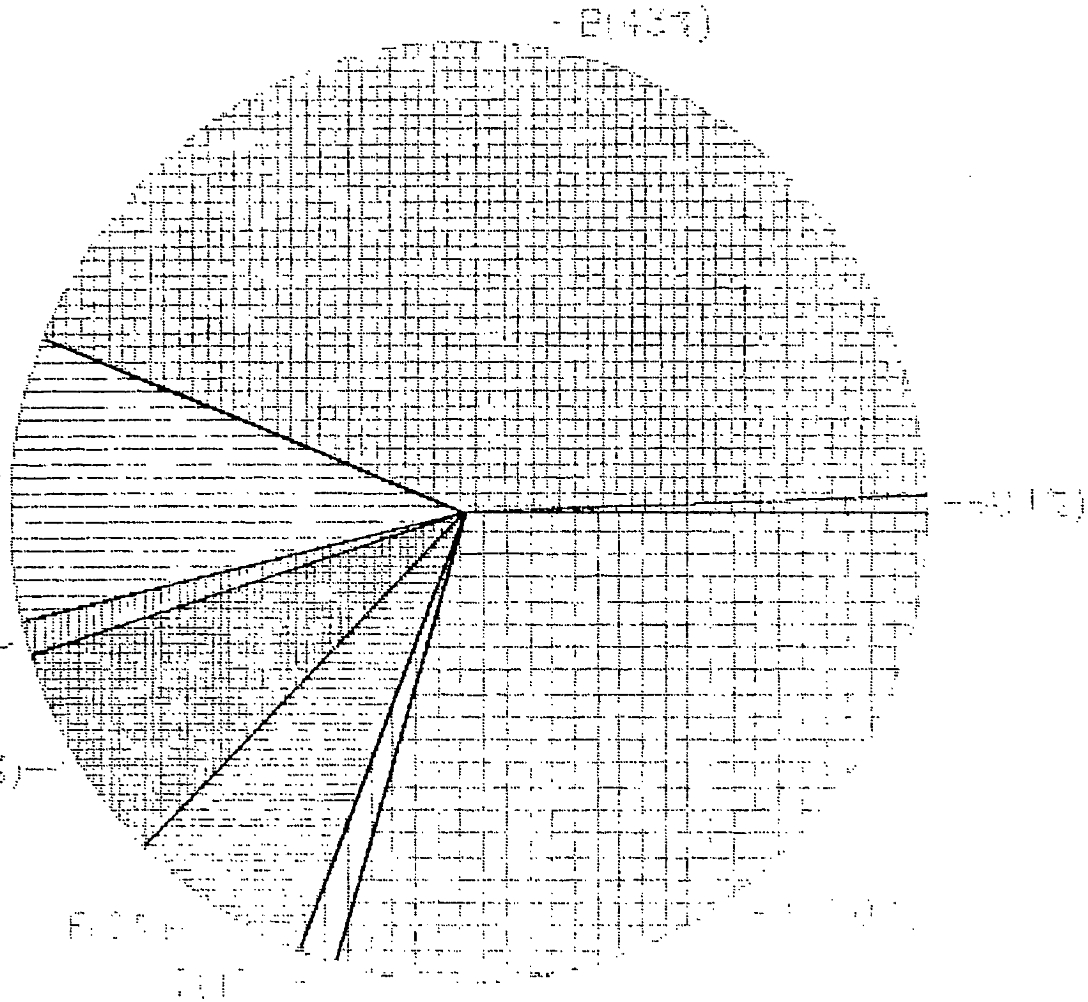
BY INDUSTRY SECTOR

INDUSTRY SECTOR	# UNITS	% INSTALLED SUBTOTAL	% OF TOTAL INSTALLATION
Medical	317	3.1	1.9
Education	2741	27.2	16.5
Government	1853	18.4	11.1
Manufacturing	2466	24.4	14.8
Resource	1005	10.0	6.0
Insurance & Financial	867	8.6	5.2
Transportation & Communication	834	8.3	5.0
Subtotal	10083	100	60.5
Total	16643		

Source: 1984 Canadian Computer Census

FIGURE A - 1

DISTRIBUTION OF COMPUTERS



A - Medical
B - Education
C - Government
D - Resource
E - Manufacturing
F - Insurance & Financial
G - Transportation & Communication
H - All Other

TABLE .A- 2.

MICROCOMPUTERS TO BE ACQUIRED IN 1984 BY FINANCIAL POST TOP COMPANIES

SECTOR	# UNITS	% ACQUIRED SUBTOTAL	% ACQUIRED TOTAL
Manufacturing/ Processing	2876	29.9	4.6
Light Manufacturing	400	4.2	0.6
Banks/Finance	1778	18.5	2.8
Insurance	1505	15.7	2.4
Transportation/ Untility	1545	16.1	2.4
Retail/Wholesale	1159	12.1	1.8
Services/Media	342	3.6	.5
Total	9605	100.1	15.1

Total microcomputers to be acquired by large firms estimated at 63,000 units.

Source: Evans Research Corporation. 1984 Buyers' Intention Survey of Financial Post Top Companies in Canada.

TABLE A - 3

PERCENT CHANGES IN DP BUDGET ALLOCATIONS, 1983 TO 1984, BY INDUSTRY

	MEDICAL 1983	MEDICAL 1984	EDUCATIONAL 1983	EDUCATIONAL 1984	GOVERNMENTAL 1983	GOVERNMENTAL 1984	BANKS 1983	BANKS 1984	FINANCIAL SERVICE 1983	FINANCIAL SERVICE 1984
MAINFRAMES	13.1	12.1	11.8	10.8	15.1	13.5	12.5	13.6	9	7.6
MINICOMPUTERS	9.8	8.2	11.9	11	7	7.9	4.1	4.4	11.5	7.4
STORAGE	4.7	4	3	2	3.2	2.9	3.7	3.9	2.8	2.8
TERMINALS	4	3.8	3.9	4.3	6.6	5.9	3.5	4	3.8	3.5
DESKTOP SYSTEMS	.4	.4	1.7	1.6	1.5	1.6	.1	7	2	2.8
PERSONAL COMPUTERS	3	1.8	6	5.5	2.4	3.1	1	1.4	6.7	7.4
SUB-TOTAL	35	30.3	38.3	35.2	35.8	34.9	24.9	34.3	35.8	31.5
CONSULTANTS	1.5	1.3	.7	1	1	.7	3.7	3.8	1.4	1.3
OUTSIDE SERVICES	12.8	10.5	4.1	2.5	7.2	5.7	2.6	2.6	6.2	5.1
DATA COMMUNICATIONS	1.7	1.5	1.6	2.1	3.3	3.2	4.8	5.4	3.5	3.8
APPLICATIONS SOFTWARE	4.3	4.6	3.4	4.3	4.3	4.6	3.4	4.8	2.9	4.2
SYSTEMS SOFTWARE	1.7	2.5	3	3.5	2.7	2.5	1.9	2	2.9	2.8
SUPPLIES	4.8	4.4	8.3	8.2	4.8	4.8	6.5	7.1	6.4	7.5
PERSONNEL	30.6	27.2	29.1	26.7	30.7	30.8	27.8	29	23.5	25.1
SUB-TOTAL	57.4	52	50.2	48.3	54	52.3	50.7	54.7	46.8	49.8
TOTAL	92.4	82.3	88.5	83.5	89.8	87.2	75.6	89	82.6	81.3

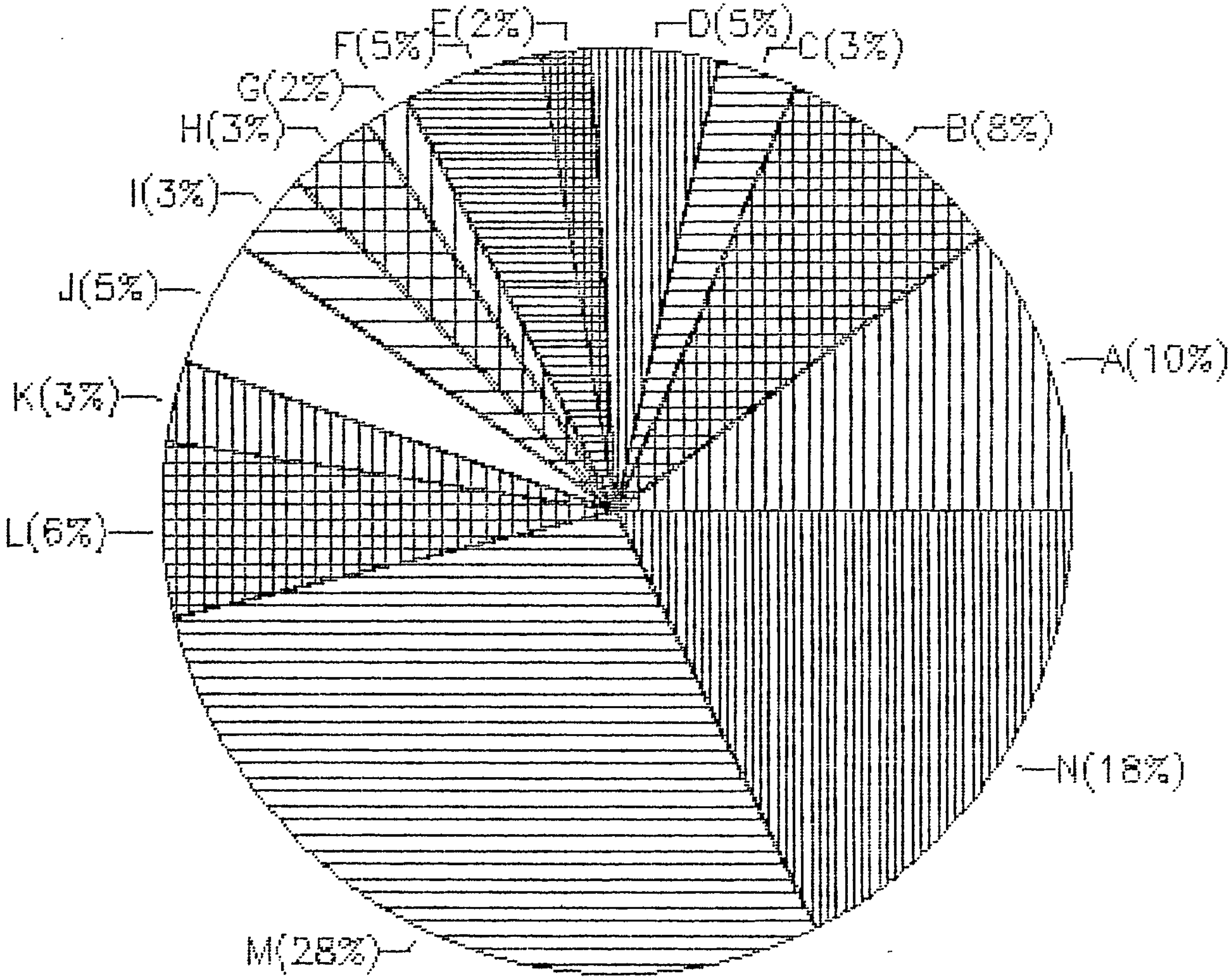
	DURABLES 1983	DURABLES 1984	CONSUMER 1983	CONSUMER 1984	OTHER SERVICES 1983	OTHER SERVICES 1984	UTILITIES 1983	UTILITIES 1984	OVERALL 1983	OVERALL 1984
MAINFRAMES	11.3	9.4	12.8	11.7	5.9	6.2	18.2	15.2	11.1	10.1
MINICOMPUTERS	9.6	8.4	7.9	7.2	9.4	7.2	4.5	4.2	9.4	8.4
STORAGE	3.5	3.9	2.5	2.5	2.4	2.5	2.1	3.1	3	2.9
TERMINALS	5.1	4.5	3.6	3	5.6	4.7	6	7.7	4.7	4.5
DESKTOP SYSTEMS	1.4	1.4	2.4	1.9	2.3	2.4	.1	.2	2	1.7
PERSONAL COMPUTERS	3.2	3.4	2.4	2.7	9.9	9.1	7	1.8	4.9	4.9
SUB-TOTAL	34.1	31	31.6	29	35.5	32.1	37.9	32.2	35.1	32.5
CONSULTANTS	2	1.6	1.2	.8	1.4	.9	1.1	.8	1.8	1.6
OUTSIDE SERVICES	2.9	2.3	3.3	2	4.4	3.5	1.1	1.4	4.3	3.3
DATA COMMUNICATIONS	3.1	2.9	3.4	3	2.8	3.1	1.7	3	2.7	2.9
APPLICATIONS SOFTWARE	4.8	5	4.9	4.2	6.1	5.1	5.4	4.1	4.3	4.6
SYSTEMS SOFTWARE	2.9	3.1	2.2	2.1	2.9	2.7	3.5	3.3	2.6	2.8
SUPPLIES	6.5	6	7.4	7.7	5.8	6.4	7.2	7.6	6.2	6.1
PERSONNEL	29	28	32.1	31.4	27.9	27.3	28.2	27.3	29.4	28.4
SUB-TOTAL	51.2	48.9	54.5	51.2	51.3	49	48.2	47.5	51.3	49.7
TOTAL	85.3	79.9	86.1	80.2	86.8	81.1	86.1	79.7	86.4	82.2

SOURCE: DATAMATION, THE DP BUDGET SURVEY: PCS MAKES WAVES, APRIL 15,1984

FIGURE A - 2

D.P. BUDGET ALLOCATIONS IN 1984

OVERALL RESULTS (U.S.A)



A=MAINFRAMES
B=MINICOMPUTERS
C=STORAGE
D=TERMINALS
E=DESKTOP SYSTEMS
F=PERSONAL COMPUTERS
G=CONSULTANTS
H=OUTSIDE SERVICES
I=DATA COMMUNICATIONS
J=APPLICATIONS SOFTWARE
K=SYSTEMS SOFTWARE
L=SUPPLIES
M=PERSONNEL
N=MISCELLANEOUS

CHAPTER 3 -- TECHNOLOGY EVALUATION AND FORECAST

CHAPTER 3

TABLE OF CONTENTS

FIGURES

TABLES

3.0 Technology Evaluation and Forecast

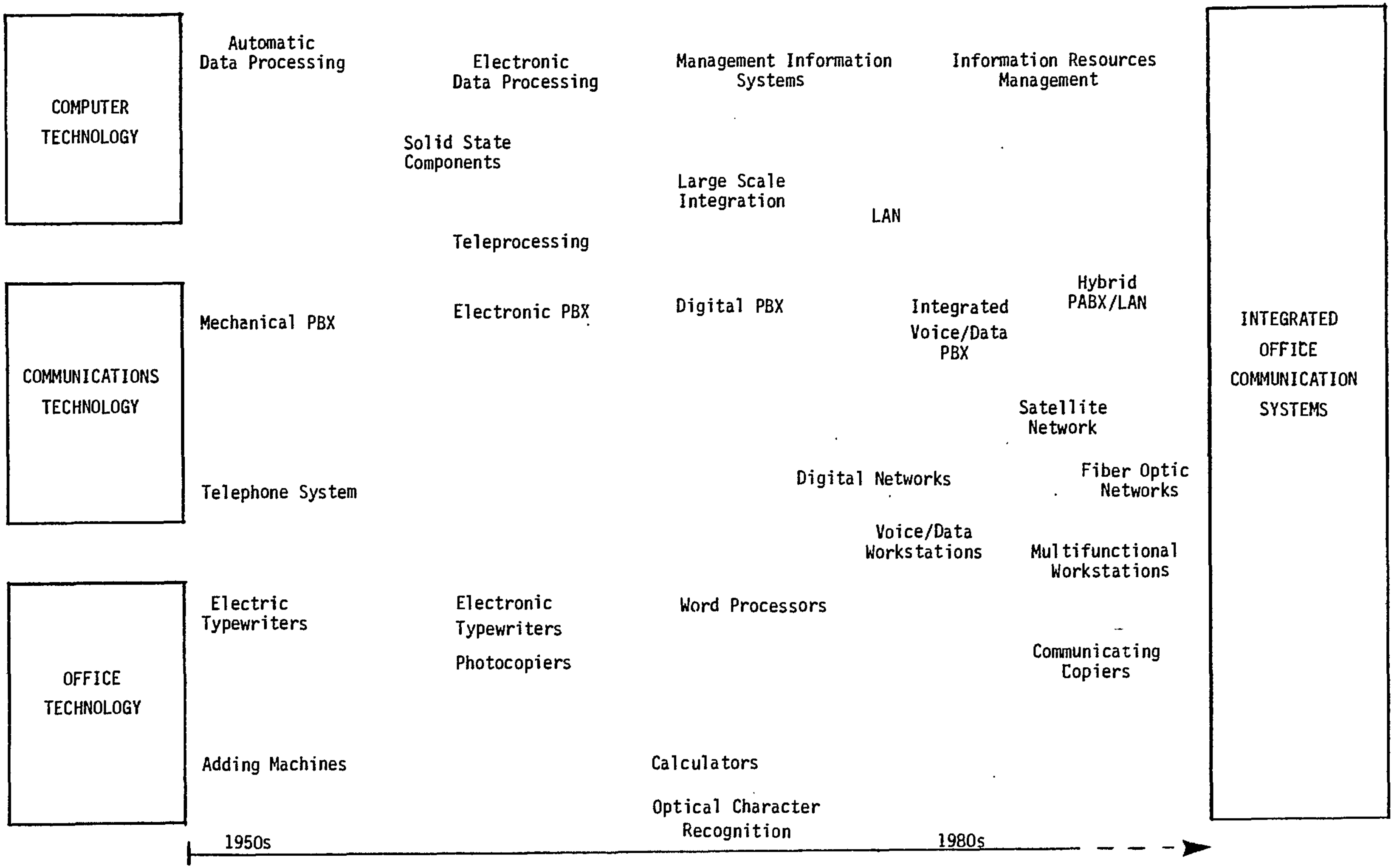
3.1 Introduction

Office communications systems (OCS) have evolved out of the three discrete areas of communications technology, office technology and computer technology. Figure 3-1 illustrates the evolution of integrated office communications systems technologies. One definition of an integrated office system is: A set of electronically connected components which integrate communications and information systems, allow distributed data processing, document generation, personal computing and decision support; and which satisfies the information access and processing needs of all office workers from executives to support staff.

Office communications systems technology has been advancing rapidly over the past several years. A great deal of advanced hardware and software is available. One of the most important issues now is how to integrate office systems in a multi-vendor world -- connectability and compatibility problems. Corporations know they must install OCS systems over the next two to five years in order to remain competitive. They also know that solutions must be found on how to connect multi-vendor equipment, how to have document interchange capabilities, and how to install and manage communications and information resource systems. Organizations are also very concerned with the cost of installation, maintenance, technical obsolesence and return on their investment.

Corporations are struggling to assess the trends in integration, how new products and system offerings will

FIGURE 3-1: MAJOR INNDVATION IN THE EVOLUTION OF INTEGRATED OFFICE COMMUNICATION SYSTEMS



evolve, and how other people are solving their integration problems. At the same time, vendors are trying to assess corporate requirements in order to most efficiently spend their research and development money to provide the required technical solutions. While living in a world of uncertainty, some clear technology trends are apparent, leading to conclusions on the overall evolution of office systems.

Technology trends were analyzed in specific sectors based on their relevance to Canadian industry. As per the Terms of Reference, the focus is on trends within the subject areas listed below. Emphasis was placed on communication technologies, especially PABX and LAN technology, selected Input/Output technologies and software.

Computer Hardware:

- Large Scale Integration
- Microprocessor Technology
- Semiconductor Memories

Mass Storage Devices:

- Magnetic Storage Devices
- Optical Disk Technology

Input Technologies:

- Optical Character Recognition
- Voice Input
- Mouse, Tablet, Joystick, Touch screen

Output Technologies:

- Video Display Technologies
- Printing Devices
- OCR/Facsimile Integration

Communications Technology:

- PABX
- LAN
- Digital and Satellite Networks

Software:

- Operating Systems
- Storage Management Software
- Application and End User Software
- Artificial Intelligence and Expert Systems

In addition to interviews with industry and other experts and an analysis of available reports, a Technology Panel was used to provide expert input to this chapter of the report. The names of the members of the Technology Panel and the Agenda, are outlined in Appendix 3A. We wish to express our appreciation to all panel members for their contribution, and in particular to Dr. Roger Kaye and Dr. Stewart Lee. The statements made in this Chapter do not necessarily reflect the views of all members of the Technology Panel.

In addition to the data contained in this report, other information is available in the Office Communications System data bank, described in Chapter 1. This data bank contains material extracted from published reports, trade magazines and other sources.

3.2 Computer Hardware

In accordance with the Terms of Reference, technology trends in computer hardware were considered in the following areas: very large scale integration (VLSI), microprocessors, and semiconductor memories. All of these will impact on the cost, efficiency and capabilities of future office communications systems.

3.2.1 Very Large Scale Integration (VLSI)

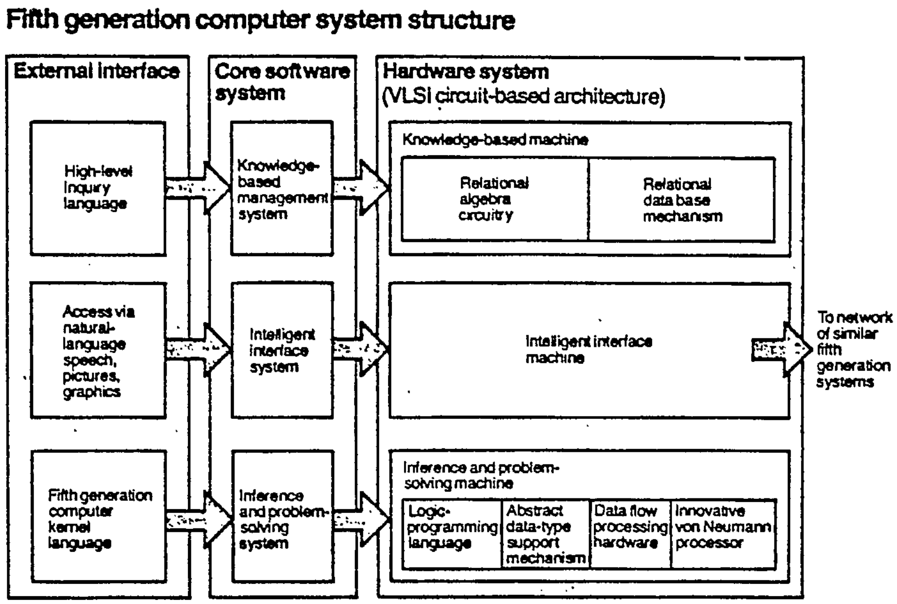
Recently the trend has been towards large scale integration (LSI) and very large scale integration (VLSI) of components. Simply, this technology comprises an electronic circuit consisting of hundreds of thousands of active, interconnected transistors placed on a small piece of semiconductor material, usually silicon. LSI and VLSI technology has had, and will have, a tremendous impact on all chip based products. These individual chips perform faster, can be mass produced, and can cost less than board-level counterparts.

One result of LSI and VLSI technology is the new "super" microcomputers that are currently on the market. These super micros have become powerful enough, because of LSI and VLSI technology, to compete in the minicomputer territory. The chips used by super micros have minimum 16 bit components and functionality, and the race is towards full 32 bit capabilities. Progress can also be measured by the fact that a 256kb memory in 1981 needed 128 chips, in 1983 it needed only thirty-two 64k chips, and now the count is down to eight using

256k parts. "Yet the current super computers are only at the threshold of what computer designers think can be achieved; the next generation of advanced super computers will make today's machines look like hand held calculators."[3-1]

New computer systems now being developed are expected to incorporate chips with 10 million plus transistors -- one hundred times more transistors per chip than are currently available. The chips will probably be gallium arsenide based, instead of silicon. These chips will be able to operate five times faster than equivalent silicon chips. Because of the increased capabilities, these will be used particularly for artificial intelligence based systems. "A fifth generation computer would act as a highly intelligent assistant, understanding what is wanted and bringing expertise and extensive information resources to bear on a problem posed to it."[3-2] Figure 3-2 illustrates what a fifth generation computer system may look like.

FIGURE 3 - 2



The progress in LSI and VLSI technology has resulted in a controversy over whether the traditional mainframe will become extinct. One side of the argument is that the trend in VLSI technology and storage technology will result in the inter-connection of intelligent workstations (powerful microcomputers in their own right) via a LAN, eliminating the mainframe. This may be valid since VLSI technology will enable opto-electronic chips to be developed, to handle the interfaces to fiber optic LANs, as well as other electronic optical processing functions. The other side of the argument is that LSI and VLSI technology will be used to improve mainframes. The VSLI technology will increase computational and information processing capabilities, and reduce mainframe hardware size and cost.

It is doubtful that there is any real issue. As individuals become familiar with their workstation and its capabilities, their information requirements are expected to increase almost exponentially. Therefore, the increasing number of workstations, plus the demand for more information almost guarantees that the mainframe will remain. In addition, a typical LAN will incorporate mini-computers (where power will also be expanded by VLSI) to provide specialized services to the workstations.

Research and development in LSI and VLSI technology is being carried out extensively in Japan and the United States. Japan has a three stage program designed to achieve working systems based on new semiconductor (VLSI) technology. Areas targeted for the project include super lattice structures, three dimensional integrated circuits, and radiation resistant integrated circuits.

Both Japan and the United States are also working on improving and increasing the automation of VLSI production methods. Methods being used to improve LSI and VLSI production include the following: Increasingly sophisticated computer-aided design, so that custom VLSI chips can be rapidly defined; the use of semicustom chips with limited modifications as required by the end user; the use of robotics to provide a flexible automated manufacturing process; and the development of expert systems to aid in the design, development and manufacturing process.

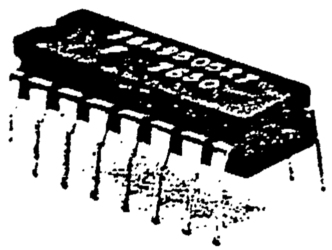
The rate of LSI and VLSI chip development will accelerate over the next ten years. Many standards will be implemented in silicon, especially in the communications area -- witness the Mitel SX 2000 switch. Protocol conversion, data compression, and communications security chips will become more frequent. VLSI chips are expected to have a major impact in LAN development and LAN interfaces. Also expected is the development of special chips for use in voice input systems, image processing and file searching. As this technology advances it will have a major impact on the future of integrated office communications systems.

The Technology Panel discussed the lack of VLSI capabilities in Canada. "Canada will always be reaching to offshore technology."[3-3] Currently the only firms producing special chips in quantity are Mitel and Bell Northern Research, and the chips are not available for general use by industry. It was felt that VLSI technical centers would be required if Canada was to have a strong OCS industry.

3.2.2 Microprocessor Technology

A microprocessor is the semiconductor central processing unit (CPU) and one of the principal components of the microcomputer. It is comprised of thousands of transistors, diodes, capacitors and resistors on a single chip, or occasionally distributed over several discrete chips. In general a microprocessor consists of the arithmetic logic unit (ALU) and the control logic unit. A microcomputer has input-output circuits, read-only memory (ROM) , random access memory (RAM) and clock circuits. Figure 3-3 is a picture of a typical chip.

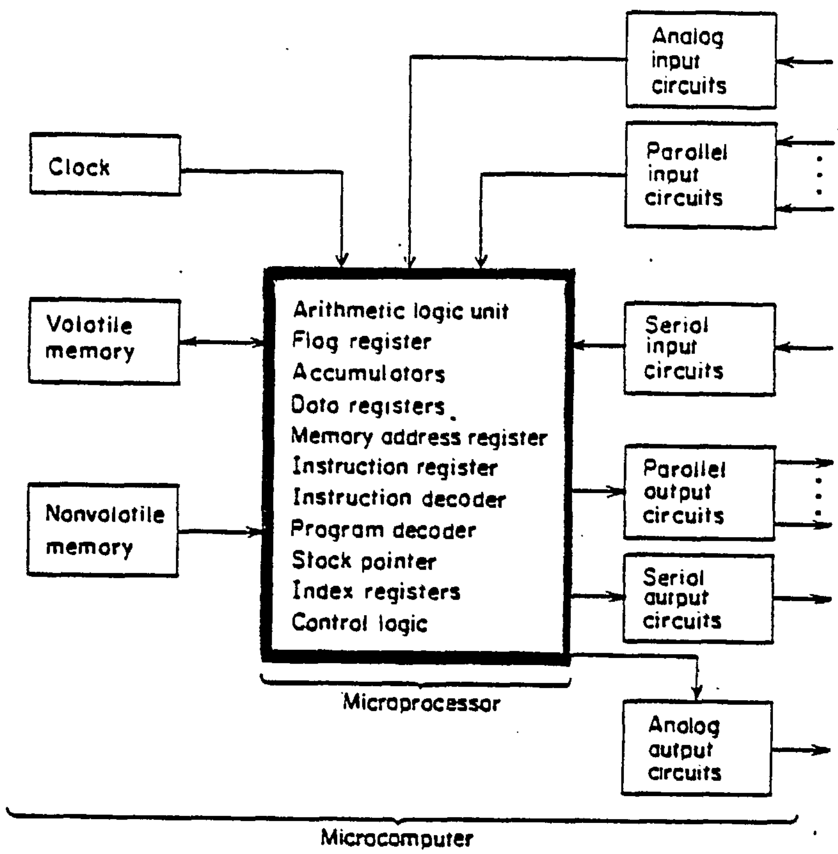
Figure 3-3: A Typical Chip Used in a Microcomputer



A simplified block diagram is presented in Figure 3-4. This illustrates how important the microprocessor is as the central device in a microcomputer. Note that some microcomputer chips contain fewer circuits than illustrated, while others contain more. Many special purpose chips have I/O interfaces that relate to a specific class of applications.

Figure 3-4

Simplified Block Diagram Showing the Microprocesor As The Major Component In A Microcomputer



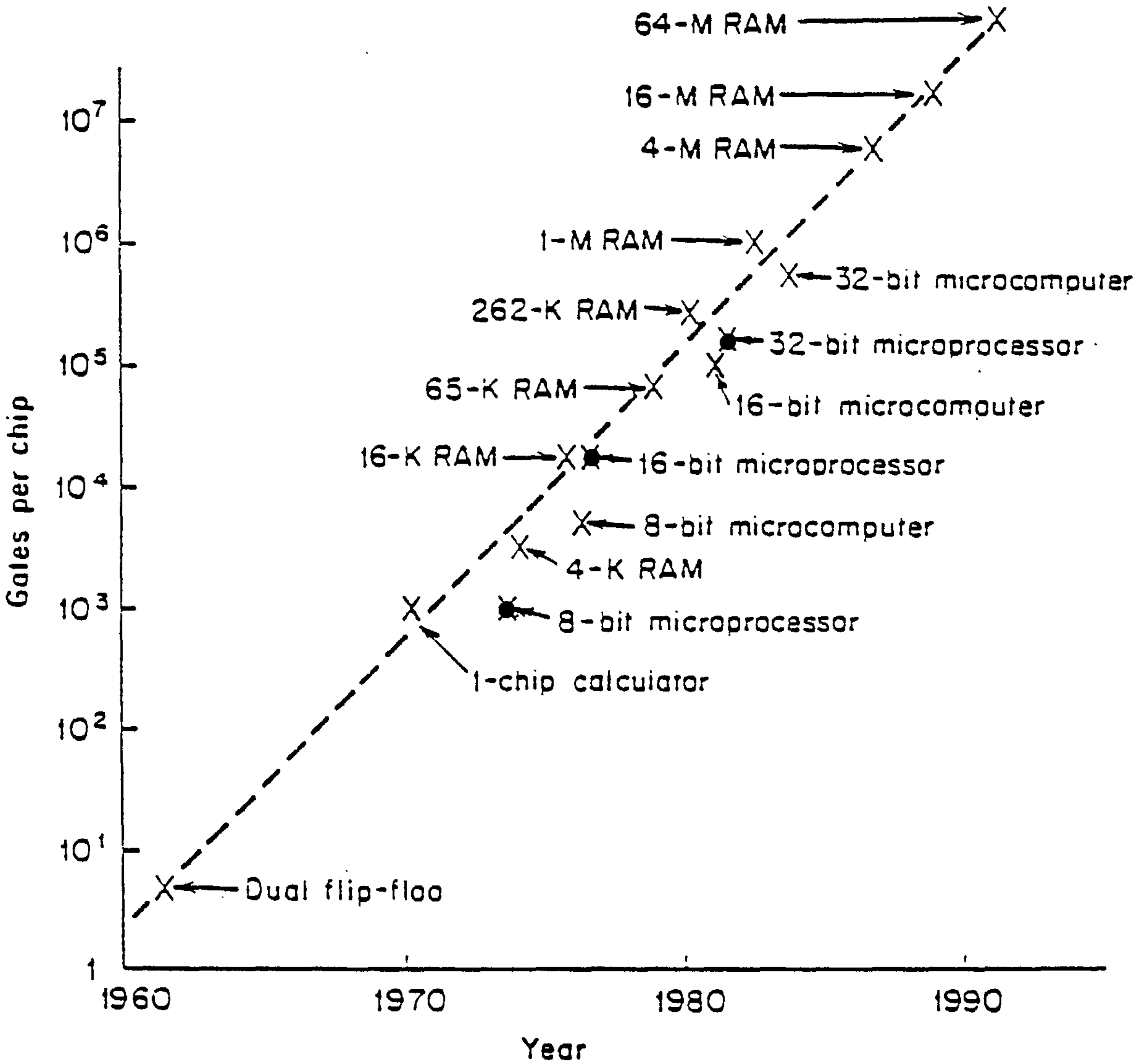
The most important trend in microprocesors is the maximum number of components, e.g. transistors, that can be placed on a chip. Over the past twenty years, integrated circuit (IC) chip density has doubled every year, and this general trend is expected to continue to 1990. This trend is illustrated in Figure 3-5. The current trend is to 32 bit chips, and ultimately 64 bit chips by the late 1980s.

The greatest impact on microprocessor technology itself has been VLSI. It is this technology that has enabled the microprocessor to handle more information faster in a smaller space and at an economical cost. Another major factor influencing microcomputers is gate arrays where random logic can be consolidated into a single integrated circuit. Also, the manner in which the information is processed is undergoing radical changes. Currently, most microcomputers employ straight sequential processing, but advances are being made in "pipelining" the information flow. With "pipelining", multiple steps - one from each of several operations - are performed simultaneously. The data output triggers the next logical operational step. Finally, another possible future trend is towards reduced instruction set computer architecture, (RISC), where every instruction has a high utility compared with current devices.

As well as the technology trend, such as placing and integrating more components on a chip, there are market factors influencing the type of microprocessors used in office systems. The most popular microcomputers (e.g. the IBM PC) influence the type and volume of microprocessors used. Based on seventy microcomputer manufacturers and their product offerings, the most popular microprocessors are the Zilog Z80, and the Intel

FIGURE 3-5

CHIP TECHNOLOGY TRENDS



8088 (Figure 3-6). With the intense competition for the office market, the future trend will be towards a limited number of microcomputer "survivors", and a small number of chip manufacturers providing microprocessors for office applications. There is also evidence that a strategic capability in office technology will require access to custom or semicustom semiconductor design. Hence the firms with flexible manufacturing systems, able to produce the complex chips required, and market them to the key OCS players, will likely be the IC chip suppliers of the future.

3.2.3 Semiconductor Memories

Interest in semiconductor memory has been generated by the system designers' need for memories that are faster, easier to use, require less power and are larger. The solution is to produce a new chip that is both very dense and easy to use. All chips, memories included, are being enhanced by new materials and fabrication processes.

Semiconductor memories can be subdivided into two main caregories: Random Access Memory (RAM), and Read Only Memory (ROM). Essentially, RAMs are used for temporary program and data storage, since the data is lost when the power is removed. The ROMs are used for control, start-up routines and permanent storage of fixed programs, since once ROM chips are programmed they retain the information. Both of these two main categories are further subdivided by memory type and application. These are summarized in Table 3-1.

FIGURE 3-6: POPULARITY OF MICROPROCESSORS FROM MAJOR MICROCOMPUTER VENDORS (1984)

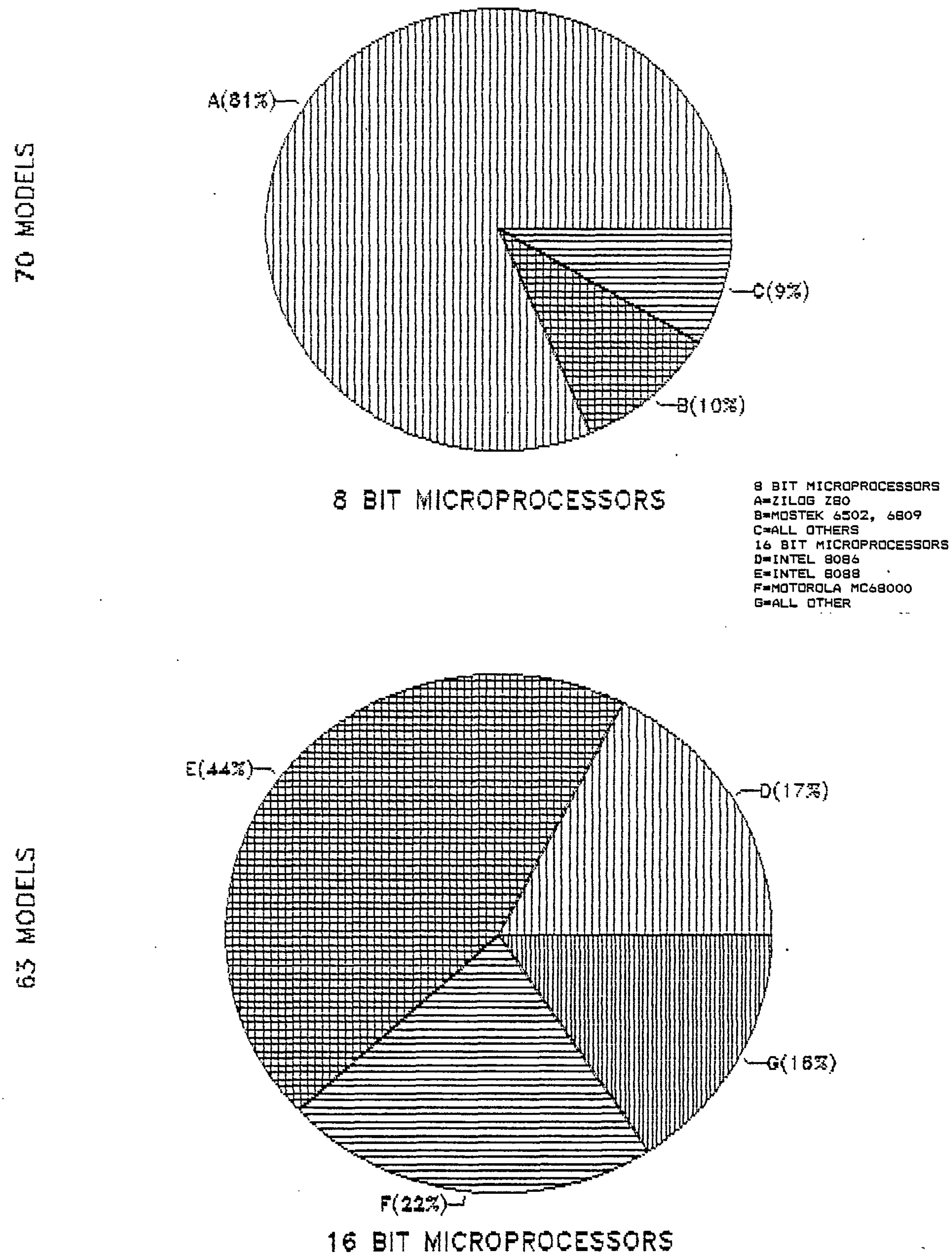


TABLE 3-1

Memory Type and Application

Memory type		Primary applications
Random-access memories (RAMs)	Dynamic RAM	Main data-storage memory for mainframes, minicomputers, and microcomputers
	Static RAM	Microcomputers requiring a small amount of read/write data storage; high-speed versions for minicomputer cache memory; low-power versions for portable equipment
	Pseudostatic RAM	Data storage for medium-sized microcomputer systems
Nonvolatile RAM		Fail-safe systems; consumer and industrial applications requiring fast reading and writing plus nonvolatility
Read-only memory types (ROMs)	Mask-programmable (ROM)	Microcomputer program storage; character set storage for displays and printers
	Fuse-programmable (PROM)	Control microprogram storage for minicomputers; automobile and military applications
	Ultraviolet-light erasable (EPROM)	Same as for mask-programmable ROM, except reprogrammability facilitates program debugging during software development
	Electrically erasable (EEPROM)	ROM and EPROM applications requiring occasional program or data updating

The two fundamental types of RAMs are "dynamic" and "static". The main advantage to static RAMs is they do not require being refreshed, that is, the data constantly being read, amplified, and then re-written back into memory.

The inexpensiveness of the dynamic RAM has permitted it to become the most highly integrated of all memory chips. In 1983 a 256kb dynamic RAM, which stores 262,144 bits, was introduced. In 1985 it is expected that the first megabit RAM (1,048,576 bit storage) will be introduced, and by the end of the decade a 4 megabit chip. A further technology advance in the dynamic RAM is the fusion of the one transistor and one charge storing capacitor into a single unit.

Static RAMs require four transistors and two voltage adjusting resistors or transistors per cell -- this means a 64kb static RAM integrates about 400,000 components. Research is being conducted to reduce the number of transistors required.

The third type of RAM is the pseudostatic RAM which uses VLSI technology. VLSI processing methods allow decision-making circuits to be put onto the same chip as the memory array. They allow the array to be very large thus keeping a high ratio of storage cells to control circuits. To date, a 64kb pseudostatic RAM chip has been introduced by Intel, and they plan to market a 256kb chip.

The ROM type chips can be subdivided into mask-programmable (ROM), fuse-programmable (PROM), ultraviolet-light erasable (EPROM) and electrically erasable (EEPROM).

Mask ROMs are the only kind of ROMs that are programmed during manufacturing. The greatest advance in this type of ROM is that one cell (one transistor) can store two binary bits. Current ROMs store 256kb.

Fuse PROMS (programmable ROMs) are programmed via minute electrical fuses in each storage cell of the memory. PROMs cannot be rewritten once programmed. New PROMs combine the transistor and fuse into one unit, and the fuse is constructed vertically to save space. PROMs have just reached the 64kb storage level.

Ultra-violet erasable PROMs (EPROMs) are programmed by trapping an electrical charge with a cell. The change in electrical properties is detected during reading (ON/OFF).

EPROMs can be erased by the user. Current EPROMs store 128kb, but 256kb have been introduced.

Electrically erasable PROMs (EEPROMs) are very similar to EPROMs, but can be erased and reprogrammed with electrical pulses instead of ultra-violet light. Present EEPROM cells use two to four transistors, but the next generation will have only 1 transistor per cell. Current EEPROMs store 16kb, and some have a 64kb capacity.

Non volatile "shadow" RAMs are the latest trend in memory devices. This chip is a hybrid between a static RAM and the EEPROM, and is considered a near perfect memory chip. These devices are very complex requiring about nine components per cell. Currently, the largest nonvolatile RAMs store only 1 kb, although 4kb units are in development.

The trend is towards these very complex hybrid chips, with increasing storage capacity. The greatest barrier is that merging features complicate a memory's cell structure and inflate chip size. This results in a larger chip, lower volume, and hence a more costly chip. A possible solution is a hybrid of a pseudostatic RAM which utilizes VLSI and an EEPROM. This hybrid may be the solution to size problems - a semiconductor memory can be built with only five components per cell.

3.3 Mass Storage Devices

In accordance with the Terms of Reference, this section focusses on the following technologies:

Magnetic Storage Technology
- Micro-floppy Diskettes
- Winchester Technology Disks

Optical Disk Technology

Solid State Disks

Of these three technologies, storage systems utilizing magnetic technology account for over ninety percent of the storage systems used today. Optical and solid state (bubble or semiconductor memories) are still at an early stage of development and are just emerging on the commercial scene.

There are a number of considerations associated with technology trends in mass storage devices. They are:

1) The cost of the storage system.

2) The amount of information to be stored, and the time the information is required to be kept.

3) The type of information.

4) Searching and retrieval methods, (i.e. ease of access to the information).

5) Data security (i.e. access control and maintenance of data integrity).

6) Management and maintenance of the mass storage system.

7) Environmental considerations, e.g. climate control.

All of these issues are important both to personal storage systems that are used in conjunction with the multifunctional workstation, and to the departmental storage system (e.g. the electronic filing cabinet or the overall corporate data base).

3.3.1 Magnetic Storage Technology

3.3.1.1 Floppy Diskettes

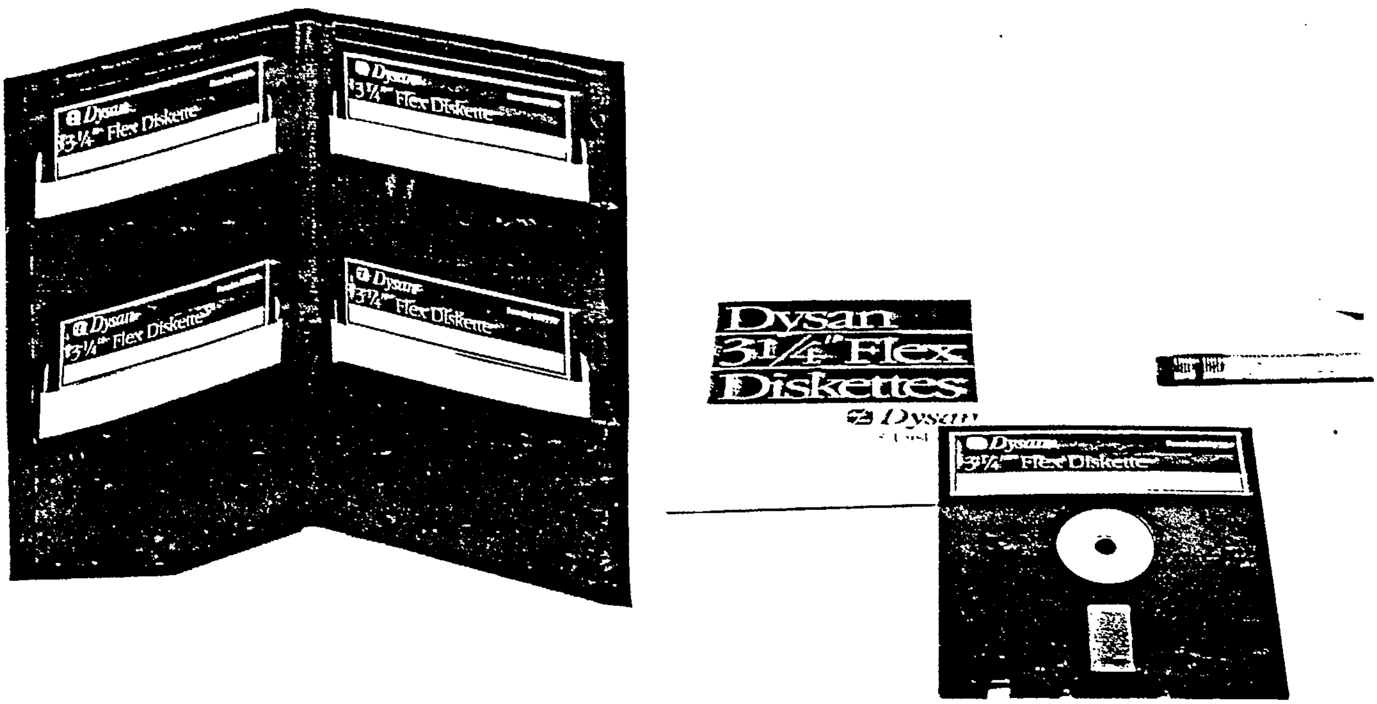
In the early 1970s, IBM developed floppy diskettes as a program loading device for large mainframe computers. The explosive growth in the personal computer market, combined with the relatively low cost of floppy diskettes and drives, has led to the widespread use of this storage technology. The first floppies produced were 8" diskettes with a 40 track per inch bit density. These diskettes had relatively modest storage capacities of 400 kilobytes.

The general trend in magnetic disk technology is towards providing the end user with greater storage space, and higher reliability at a lower cost. In 1976 Shugart Associates produced the first 5.25" floppy. This size is very popular with many of the personal computer users on the market today. By doubling the density of these 5.25" disks, and then producing them double sided, these disks offer the capacity of the 8" disks, with the convenience of the smaller size. Many floppies on the market now have storage capacities of up to 1.6 megabytes per 8" disk and 500 kilobytes per 5.25" disk. In 1985 it is expected that Eastman Kodak will introduce a 5.25" floppy disk with a 3 Mbyte capacity.

It is generally theorized that the ideal size for a floppy diskette is one that would fit into a shirt pocket -- hence the microdisk or microfloppy. In 1983 Sony announced the 3.5" flexible diskette with just under half a megabyte of storage capacity. Since then other manufacturers have announced their version of the microdisk. Dysan is offering the 3.25" flex diskette (Figure 3-7); Hitachi and Matsushita the 3" microfloppy;

FIGURE 3-7

Example of a 3.25" Microdisk From Dysan



and IBM is promoting the 3.9" diskette. While problems have existed in establishing an industry standard, it is expected that the 3.5" floppy will be the standard. Both Apple and Hewlett Packard are offering disk drives on their microcomputers utilizing the 3.5" microfloppy.

Research and development is continuing on increasing storage capacity, reliability, and media portability. One development which may impact on future floppy diskette technology is vertical magnetic recording. Vertical magnetic recording or Perpendicular Magnetic Recording (PMR) techniques can significantly increase the storage capacity of floppy diskettes. Toshiba Corp. of Japan has developed a prototype drive which handles 3 megabytes of data with a 3.5" drive. Vertimag Systems of Minneapolis is developing a drive that will store 6.6 megabytes of data on a single 5.25" disk. Major problems with vertical magnetic recording include high energy requirements and slow response speed. Also the disks are expected to cost $20 each or more.

The minifloppies (5.25") and the microfloppies (3.5") are expected to have a significant role in office automation. They will be a major factor where media portability is important. They are a relatively inexpensive and easy method of carrying files from one place to another.

3.3.1.2 Winchester Technology

Winchester technology in effect creates a "clean room" environment for the disk and head assembly. Winchester disks are a type of disk drive where the pack (rotating magnetic storage medium) is contained in a airtight environment, thus keeping out contaminants, e.g. dust. Winchester disk drives can range from the small system, e.g. 5.25" with 10 megabyte capacity to the large IBM 3380 with a total capacity of 2.52 gigabytes per drive.

The trend in Winchester disk drives is towards smaller, inexpensive systems, with increasing storage capacities. For example, one of the most popular mass produced drives is the 5.25" Winchester with a storage capacity of 20 megabytes. Prototypes also exist for a 5.25" Winchester, with 100 megabytes of storage capacity. IBM is working on a 3.5" 20 megabyte "micro Winchester" drive and similar R&D is being carried out by Toshiba, Mitsubishi, and JVC. Microcomputer Memories, CA, has produced a 3.5" 12 Mbyte drive which is currently undergoing evaluation testing. Other firms involved in the sub 5.25" Winchester disk drive market include SyQuest Technology, California, and Rodine, Scotland.

Technical innovations associated with the Winchester technology are:

a) Very compact. Some Winchester disks for personal computers take up little more room than that of a floppy disk drive.

b) Increased rotational velocity (ten times faster than floppies) because the read/write heads are not in direct physical contact with the magnetic medium.

c) Higher data transfer rates because of the increased velocity.

d) Greater packing density; bit densities have increased to 10,000 to 12,000 bpi compared to 5,000 to 6,000 bpi previously.

e) Direct Memory Access (DMA). DMA controls data transfer at rates in the megabyte per second range. The DMA operates at full memory read/write speed, eliminating the need for the microprocessor to do data handling.

f) There is reduced weight, size, and power consumption with these compact Winchesters.
Plus Winchesters are highly reliable, with a low failure rate.

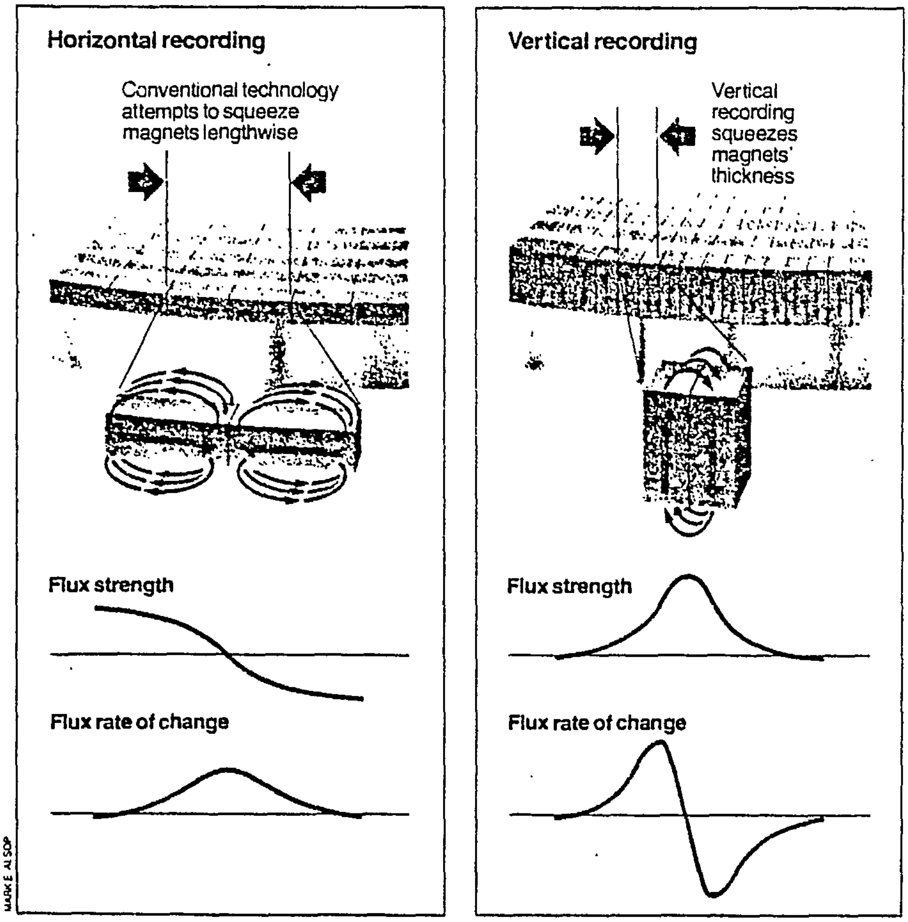
g) Finally, new Winchester disks on the market include features such as a tape unit, providing an easy and efficient data backup method.

Research and development is being conducted on thin-film read/write heads and media, and on vertical magnetic recording technology for application to Winchester systems. Thin-film heads utilize a semiconductor manufacturing technique which minimizes the width of the head's read/write gap. Thin film media involves semiconductor or wet process plating techniques used to deposit a thin metallic layer on the supporting disk material, thus permitting greater flux densities.

Controversy exists as to whether vertical magnetic recording technology will have a major impact on magnetic storage systems. Figure 3-8 illustrates the principles in horizontal and vertical recording techniques. The Technology Panel felt that

FIGURE 3-8

THE PRINCIPLES OF HORIZONTAL AND VERTICAL RECORDING TECHNIQUES



Vertical recording increases magnetic domain densities, and hence storage capacities. Also, data bits are easier to detect, being represented by polarity reversals, rather than peaks, in the electrical signal generated by the magnetic domains.

Source: High Technology, January, 1983, page 52.

vertical magnetic recording would not be a major factor because of the difficulties with the medium, including access problems, speed and energy requirements. Other commercialization barriers include a head interface problem and difficulty in producing the smooth substrates required for a durable vertical magnetic medium. The advantages to vertical magnetic recording include greater density and storage capacity. Industry experts are predicting linear densities in the order of 30,000 - 50,000 fpci; some even predicting as high as 100,000 fpci. By the late 1980s this could lead to an increase in storage capacity 100 times greater than the first Winchester drives.

3.3.2 Optical Disk Technology

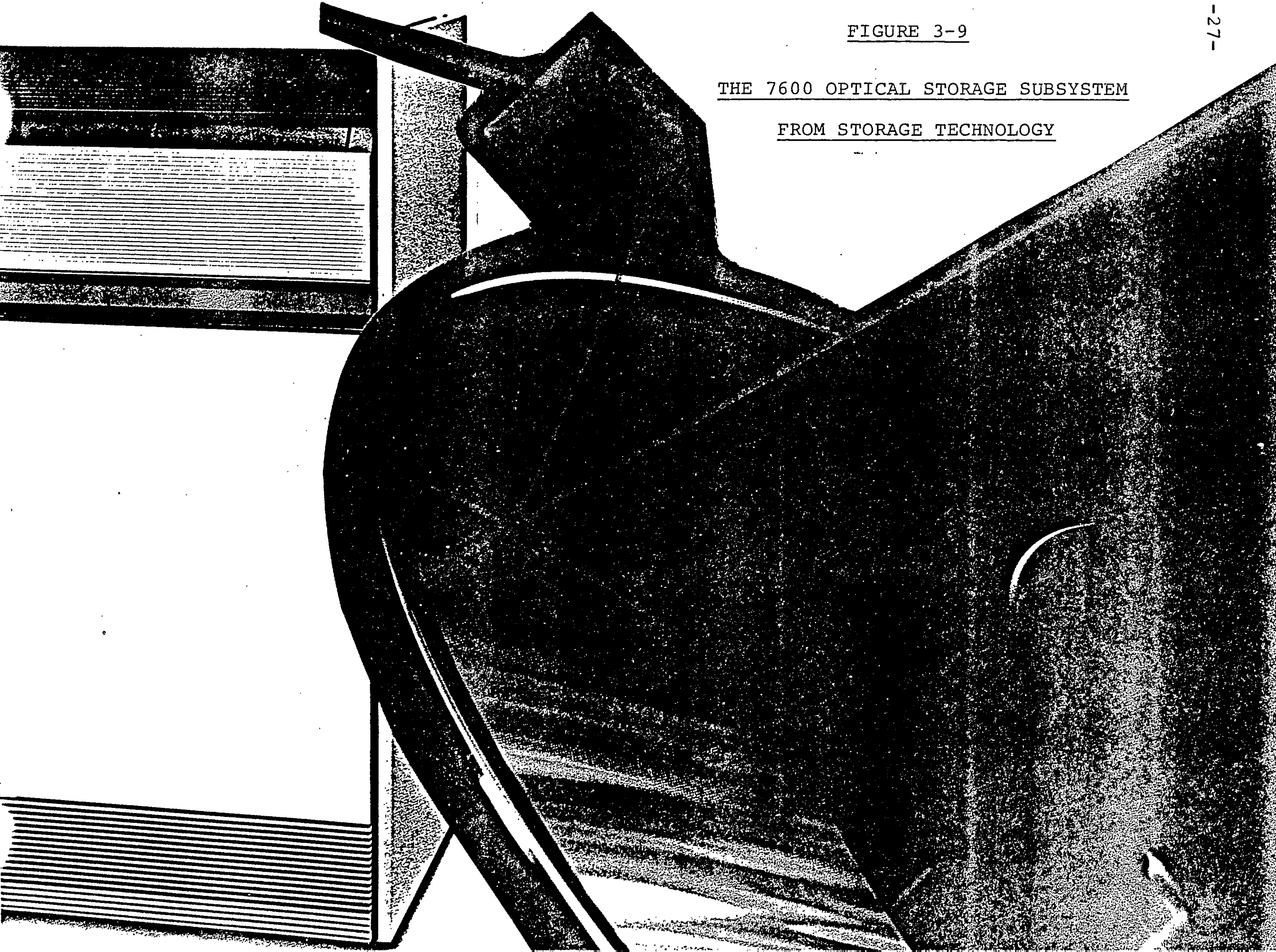
Many industry observers look to optical disk technology as being the zenith of bulk mass storage devices of the future. Although present optical storage devices are relatively scarce, with fewer than 1,000 installations worldwide, and accounting for less than 1% of the market, over 30 companies are developing optical disk drives. More than 50 companies, including Xerox/Optimer, Control Data, RCA, Toshiba, Hitachi, and Matsushita are working on the development of optical media. Industry observers believe that worldwide expenditures aimed at the development of optical systems R&D will reach $15 billion during 1985 and will double over the next four years.[3-4]

Optical storage technologies utilize a finely focused laser beam, to write data on the surface of an optical medium disk. During the writing process the laser is continuously being turned on and off in a sequence corresponding to the digital data being transferred to the disk. The high focus laser beam is able to create a tiny bubble, or hole, or some other change to the surface of the disk. During the reading cycle a low intensity laser beam is left on continuously. Light is reflected back from the disk's surface to a photo detector device which determines whether the surface has been altered. With this technology, bit and track densities can be greatly increased over the densities of conventional magnetic media. It is expected that the storage capacities of these devices will be in the range of 1 to 10 billion bytes. Late in 1983, Storage Technology Corp. introduced the first high performance optical memory system capable of storing 4 billion bytes on one side of a single 14" disk. Figure 3-9 shows the original 7600 Optical Storage System from Storage Technology Corporation, and an illustration of the technology. (Note: Storage Technology has had financial difficulties and is, for all intents and purposes, out of business.)

FIGURE 3-9

THE 7600 OPTICAL STORAGE SUBSYSTEM

FROM STORAGE TECHNOLOGY



In office automation, optical disk technology still plays a relatively small role. Its predominant role in the future will be in the archiving of corporate information. e.g. financial records, accounting, and legal documents. A major characteristic is that once information has been placed on the disk it can not be erased. The non-erasibility is a major advantage where archival records or records providing audit trails of business activity are required. On the other hand, it renders the medium less suitable for the recording of transient data which has typified many of the uses of magnetic media. Further, it is still very expensive compared to traditional magnetic mass storage devices.

Some erasable optical disks have been developed under laboratory conditions, but they are not yet commercially available. Magneto-optic technology is being developed with the aim of producing an erasable optical disk. Magnetic optical disks will be removable and reusable, but will have slightly less storage capacity than the current optical disks. Optical disks have slower access times than high performance magnetic drives. Typical access times for magnetic drives are in the order of 10 - 30 milliseconds compared to 100 - 500 milliseconds for optical drives. In cases where mainframe or minicomputer systems have numerous terminals to service, fast access disk drives are very important. However, even with the limitations of optical disks and magneto-optic disks, these drives will make an ideal form of tertiary on-line storage. With this storage medium a tremendous amount of archival information can be readily accessed in a few hundred milliseconds. Previously, a user would have to wait for tape mounts or some other form of off-line storage media to be retrieved for on-line use.

There are numerous other applications which will immediately feel the impact of optical technology. For example, local area networks will certainly be enhanced with the expanded storage capacities which optical drives can provide. High resolution graphics together with digital voice handling will be further enhanced as greater on-line storage becomes available through the use of optical technology.

Large scale public data bases will utilize this technology. Currently, on-line data is provided by facilities such as Dialog and the Source. Searches are costly and typically run $50 - $200 per hour depending on the database being used. With optical disks, information retrieval will be highly distributed with users being able to buy the contents of these databases on optical disk, for use on their own system. This will greatly reduce the cost of information, thus making it accessable to a wider variety of users.

3.3.3 Solid State Disks

The last storage technology to be covered is the solid state disk or semiconductor disk,which is not, in fact, a disk at all, but consists of semiconductor chips mounted on a board. A semiconductor disk is a large memory designed to emulate a disk drive in the sense that data is arranged and accessed sequentially in the equivalent of tracks and sectors as in the case of a disk, rather than completely at random as in the case of random access memory (RAM). The operating system reads and writes to the semiconductor disk as though it were a normal rotating device, but faster.

Bubble memory is a type of memory in which "bits" can be stored as bubbles in a thin magnetic film formed on a crystalline substrate. Researchers at Carnegie - Mellon University have now been able to put semiconductor devices on bubble memory material. Bubble memories are regarded as one of the most promising new ways to store information. The advantages of bubble memory are: 100% solid state, hence no moving parts; suitability to hostile environments; non-volatile, therefore not requiring continuous power; and very low maintenance requirements. The disadvantages are their cost, limited availabililty, and slower data access rates. National Semiconductor, Rockwell International and Texas Instruments have dropped out of the bubble memory race because of the heavy research and development cost, high manufacturing cost, and lack of demand. Intel, the only U.S. firm with a bubble memory program, together with Carnegie-Mellon, have concentrated on increasing the density of the bubbles on the garnet chip, and eliminating the support chips that surround each bubble device. The garnet is bombarded with hydrogen, helium, and neon ions which results in a special pattern increasing the bubble capacity by 16 times. Finally, the Carnegie-Mellon and Intel group used lasers to attach the silicon wafer to the garnet. The result of this technological advancement is bubble memories that are faster and smaller.

Magnetic bubble memories are primarily competing with floppy disks, microdisks, cartridges and small tape devices. They will occupy a specialized niche where data portability and reliability are extremely important. Because they are smaller, operate for years, and are stable in hostile environments, they will be attractive for use in portable computers, computers in on-board mobile environments (e.g. police vehicles), the military and other such applications.

3.4 Input Technologies

3.4.1 Introduction

Developments in input technologies have resulted from increasing concern over rising data entry costs, increasing demand for timely information, and the shift towards distributed data entry. In addition, it is increasingly the case that professional office workers enter their own data in the course of their other activities rather than having specialized operators do it for them. (For instance, currency brokers may enter transactions directly, rather than pass them in paper form to data entry operators.) The trend towards end user input, resulting in an increasing demand for creative, easier, faster and more accurate input mechanisms. Advances have been made in input areas such as: optical character recognition (OCR), voice input recognition, mouse, touch screen, joysticks, and tablets. While the standard keyboard is expected to remain the predominant input device, these other technologies are expected to find increasing applications.

3.4.2 Optical Character Recognition Technology (OCR)

Optical character recognition technology has not achieved any major technological breakthrough since its invention over twenty years ago. However, there are trends emerging which will make OCR an important element in office automation. Its main feature is its ability to quickly and accurately input typed material, which can then be sorted, edited, or electronically mailed. In organizations with a high paper burden it can significantly increase productivity. (For example, a law firm finds it can handle twice the volume of paper using an OCR, with the same number of clerical personnel.) Large financial organizations, among others, are installing OCRs in their mail rooms, and then delivering mail electronically to their employees. OCR's major weakness is its inability to process documents with both text and graphics. However developments are under way to correct this by combining OCR and facsimile technologies. The most significant trend in OCRs has been the reduction in size and price of OCR machines, mainly resulting from the use of microprocessors. New generations of OCR machines place recognition logic in computer logic rather than being hardwired, thus providing a greater degree of flexibility. Perhaps the most significant future development in OCR technology is the use of artificial intelligence to enhance optical character recognition systems. Currently at the leading edge of this technology is Kurzweil Computer Products of Cambridge, Mass. The Kurzweil Data Entry Machine (KDEM) is capable of learning to read virtually any typewritten font as it encounters it. This capability, called Omnifont, is accomplished by having an operator train the machine to recognize typesets it has not seen before. As it learns new typesets, the machine records these patterns to disk, so that it never has to be retrained on any given set. However, machines of this type are very expensive, ranging from $60,000 to $100,000 each. Also, by today's standards they are very slow, with the fastest Omnifont available today reading about 30 - 50 characters per second, compared to 75 - 100 characters per second for most of the OCRs currently available. Even with these current restrictions, though, future projections for Omnifont machines look promising.

Extensive research and development is also taking place in OCR machines for the automatic reading and digitizing of images from handwritten documents and drawings. Similar barriers exist in this area as for speech recognition. There are a tremendous number of variables and the computer must have some artificial intelligence to be able to recognize and decipher all the different letters in unfamiliar handwriting. The use of artificial intelligence systems may speed up development of commercially available machines.

3.4.3 Voice Input

Voice recognition and the use of voice as a means of information input has been the subject of research and development for the past twenty years. The reasons for the interest in voice input are that:

a) it is easier for non-computer personnel to enter data;

b) it can be faster and less tiring to enter data;

c) it frees the user's hands to perform other tasks.

d) it can be used over telephone lines

These features, in the OCS environment, are expected to result in labour cost savings and increased productivity.

The general types of voice input systems are classified as speaker-dependent and speaker-independent. These can further be subdivided into the areas of isolated words, connected speech, or continuous speech.

Limited vocabulary speech recognition is already available. Verbex Communications Systems has developed a connected speech, voice data entry terminal, with a standard vocabulary of 120 words, and an option of up to 360 words. Figure 3-10 is an illustration of the current status of voice input systems.

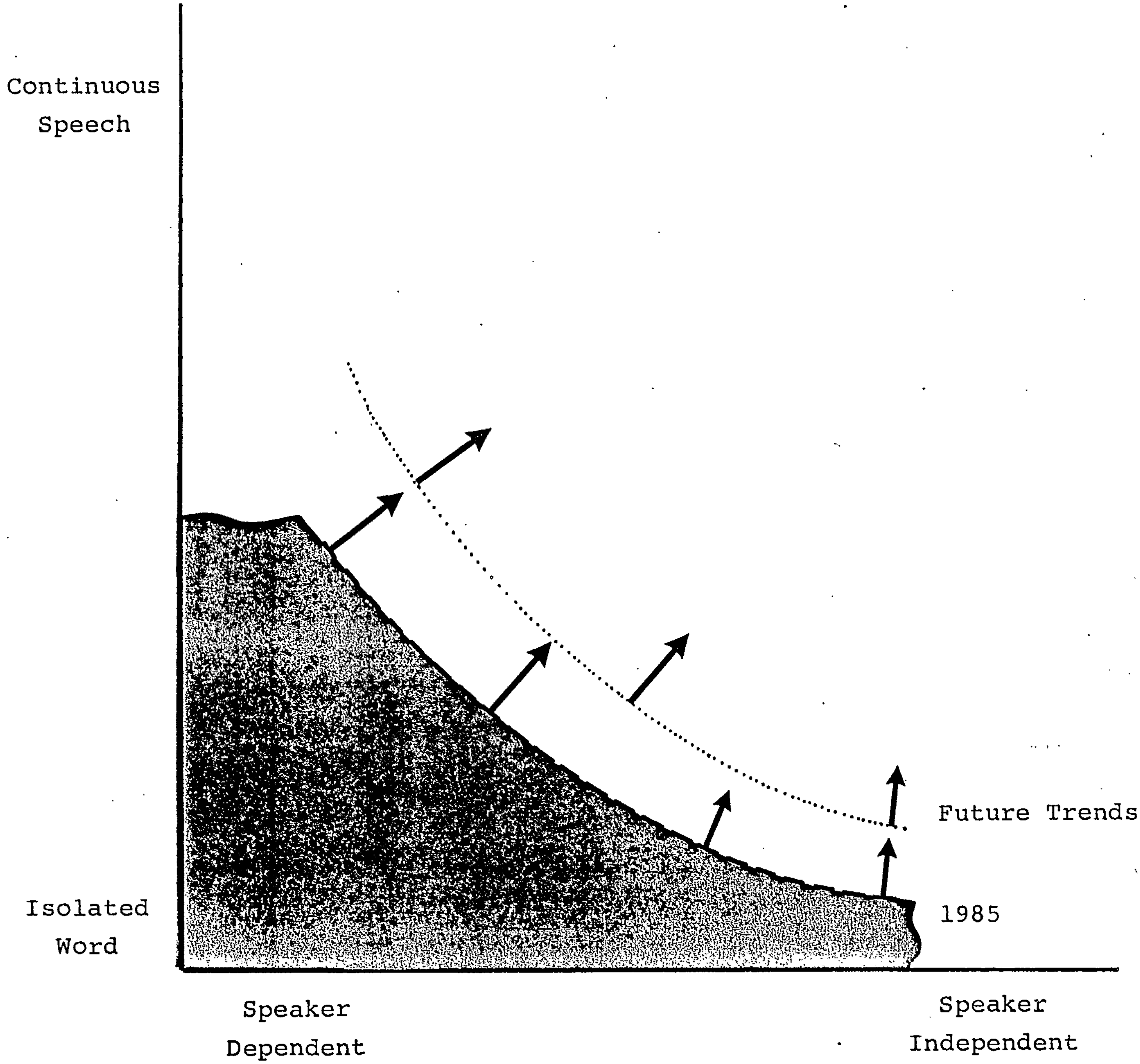
There are numerous problems with voice input systems. Voice must first be converted from analog to digital. It must then be compressed (or selection of the relevant data must occur). Then the boundaries of the word must be determined, then detection of the patterns within the word, pattern classification and finally association of pattern sequence to the vocabulary stored in the computer. Considerable processing capability and storage is required. Voice input systems are susceptible to background noise and generally have a lower accuracy rate than other input systems. They are usually speaker dependent and have a limited vocabulary because of the tremendous variations within the language. Finally, they are very costly and difficult systems to develop.

It is doubtful that voice input technology will have an impact on office communications systems in the 1980s. Industry contacts have mixed reactions to voice input technology. One argument is that voice input will be necessary to persuade management and executives to utilize office automation systems -- the reason being managers' perceived fear of the keyboard. Plus it would be faster to dictate a document directly to the computer. A contrary argument is that by the time voice input becomes a cost effective mechanism for the entry of information, many managers (especially younger ones) will be used to using a keyboard. Finally, there is consid-

FIGURE 3-10

CURRENT STATUS OF

VOICE INPUT SYSTEMS, 1985



erable background noise in office environments, particularly in today's open offices.

The major potential applications for voice input technologies in the office are:

- voice messaging
- natural interface for command entry at workstations
- document annotation
- non-terminal access to host computer via the telephone
- speech to text

The most promising application is voice messaging. In this application computers are used to digitize and store voice messages and route them through the telephone system.

With the trends in VLSI and artificial intelligence, some of the applications for voice input may become reality. Advances in VLSI microchip technology promise to provide better and more cost effective solutions to the problems associated with providing continuous speech, speaker independent, voice recognition systems. For example, the TMS-320 signal processing integrated circuit, introduced by Texas Instruments, is considered to be a speech chip breakthrough. Dr. Robert Morris of Carleton University commented on this chip as follows:

> "...I consider this chip a real break-through because it can handle voice analysis and speech synthesis in just one-fifth of its capacity, and can be used for recognition, speaker verific-ation and some crude image-processing."

Developments in artificial intelligence will also enhance voice recognition technology. Artificial Intelligence technology should assist the computer in emulating the human capability of recognizing words on a speaker independent basis.

Among world leaders in voice technology are the Japanese. NEC is the leading Japanese company in this area and has already developed a speaker-dependent word processing machine capable of recognizing an unlimited Japanese vocabulary. A speaker-independent model is also being developed but it will be limited to recognizing 128 words.

In Canada, research is being carried out on the development of a continuous speech recognizer by Bell Northern Research, in association with a team from INRS-Telecommunication of the University of Quebec.

3.4.4 Miscellaneous Input Technology

Recently, there has been great interest in such developments as the mouse, touch screens, joysticks and tablets. Currently, over 98% of all computer systens use the traditional keyboard for cursor movement and data entry.

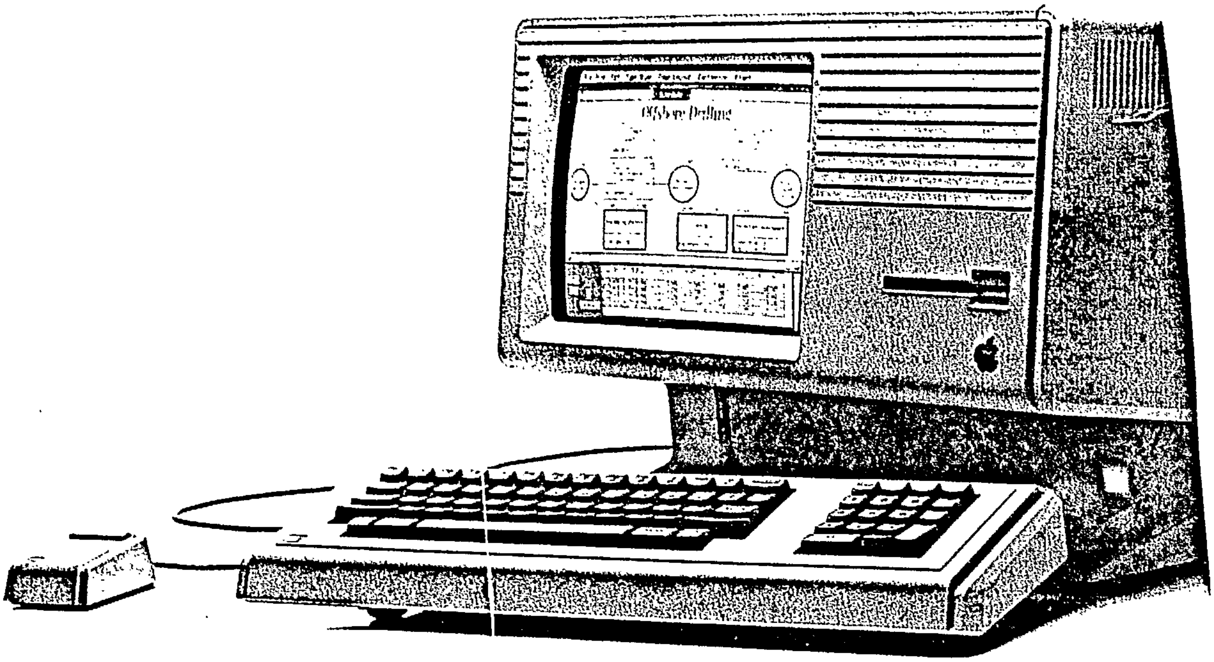
Therefore, there has been little motivation to design software packages which incorporate the alternative input devices. As software increases in complexity and the demand for user friendliness increases, the use of such devices will be more desirable, thus providing more incentive for the development of these technologies. Trends will depend largely on the applications which users find beneficial. The advances in these devices will be market driven and it is likely that future derivations of these products will only be improved variants of present offerings.

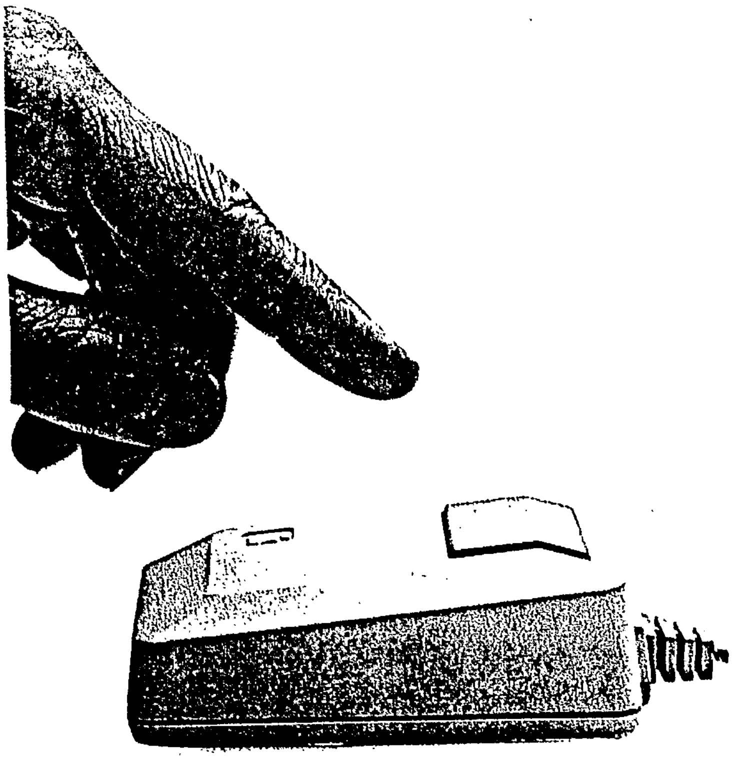
The mouse, shown in Figure 3-11, is a small device that is moved on a horizontal surface to direct the cursor movements. Five basic technologies are used in sensing mouse motion. They are: mechanical, mechanical analog, opto-mechanical, optical, and hybrid (involving a sound transducer and a strain gauge). The most common technique is based on the production of two pulse trains representing movement in the quadrature, or X and Y, directions. The mouse is a good auxiliary device to the keyboard where precise cursor movement is required and is expected to remain popular for this application. Touch screens are being offered by a number of vendors, including Hewlett Packard and AT&T. The touch screens are easier to use than a joystick or a mouse, but offer far less precision. The user chooses the appropiate menu selection or command by simply touching the screen in the right place with either his finger or a pen. Touch screens have a wider appeal than the mouse or the joystick in business applications where the reduced precision is acceptable.

The joystick is predominately used with computer games. Like the mouse, the joystick directs the cursor to be

FIGURE 3-11

THE MOUSE USED WITH THE APPLE COMPUTER





moved through a two dimensional plane (X-Y axis). It offers less precise movement than the mouse, but its main advantage is that it does not require as much working space. While the joystick can be used in office applications it has not made any significant inroads in this market.

Tablets have gained wide usage in graphics applications. A system is composed of a touch pad and pen. Images drawn on the pad are converted to digital code and displayed on the computer screen. Penpad from Pencept, in Waltham, MA, is a "smart graphics tablet". It combines the capabilities of the keyboard, mouse, touch screen or touch pad and a graphics tablet. The tablet is also expected to play an important role where graphics are required at the workstation, and where ease of command (e.g. move, delete) is required.

3.5 Output Technologies

This section focuses on major technical developments and trends in the area of output technologies. Of prime interest are the developments in display technologies, printing devices and OCR/facsimile integration.

3.5.1 Display Technologies

CRTs (Cathode Ray Tube) currently dominate most office applications requiring display units. This trend is expected to continue past 1988. Occupational health and safety factors have been a past influence on technology trends in CRTs. Unions in the United States and Canada have been very critical of the use of VDTs in the workplace and have attempted to regulate them. Manufacturers have been combatting this by stressing erogonomic design and high emission standards and these problems have been largely eliminated, from a technical viewpoint.

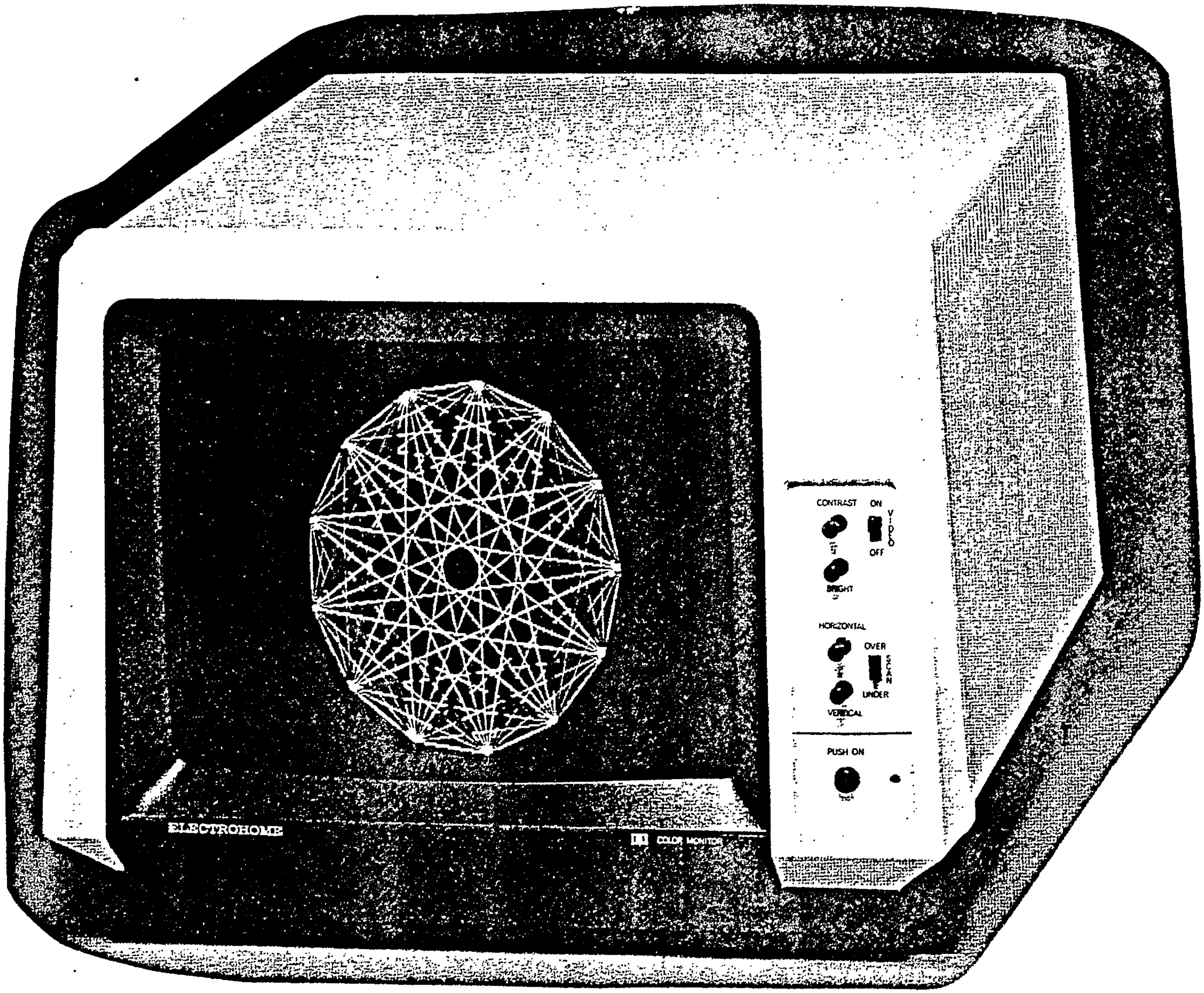
Advances in CRTs include higher resolution screens, increased colour resolution in colour monitors, and improved screen features. A high resolution colour video monitor is presented in Figure 3-12. High resolution colour monitors are just beginning to reach their intended applications in such areas as business graphics and CAD/CAM. The momentum generated from this demand should insure their continued success.

It is expected that recent trends in the reduction of the size of computer systems, keyboards, disk drives and printers will carry over to the use of video displays. Already there is an increasing demand for small, compact portable computer systems. This has sparked an increased interest in the

FIGURE 3-12

TYPICAL HIGH RESOLUTION

COLOUR VIDEO MONITOR



development of flat panel display technology. Flat panel displays are not expected to replace the CRT in the workplace, but are expected to be found in new and complementary applications.

At the present time Japan is the leader in the three technologies competing for dominance of the flat panel display market. The technologies are: liquid crystal display (LCD), electroluminescent display (EL), and plasma gas discharge. LCD technology uses a scanning laser beam which writes thermally on a high resolution liquid crystal light cell. EL displays employ solid chemicals that emit light when an electric field is applied accross them. Plasma gas discharge displays use a neon gas contained in a thin glass envelope coated with a thin dielectric material. Light is emitted when electricity is applied. The strengths and weaknesses of these technologies are presented in Table 3-2.

LCDs currently dominate the market for flat displays. They cost less and they consume less power than the other two display technologies. Consequently, the market for LCDs has been closely linked to the portable computer market and is expected to grow with it. Problems associated with the LCDs of today include their lack of colour and limited screen size. Larger screen sizes of up to 25 x 80 characters, are now coming on the market and the introduction of colour LCDs is expected within three years. EL displays are the major competition to LCDs. While they are more portable and have greater resolution, they are restricted to amber only and are more expensive than LCDs.However, once production processes are improved they may become more competitively priced. For example, Phosphor Products of England, has recently developed an electroluminescent panel,

TABLE 3-2

THE STRENGTHS AND WEAKNESSES OF THE TECHNOLOGIES

COMPETING WITH CONVENTIONAL CRTs

	STRENGTHS	WEAKNESSES
Liquid Crystal Display	- low power requirements - long battery life - lap size - 16 lines of text (HP) - colour potential	- poorer resolution - limited viewing angle - contrast problems - smaller character
Electroluminescent	- flatter & more portable - amber thought to be easier on the eyes - greater resolution - 25 lines of text	- high production cost - restricted to amber only - lack of colour potential - more expensive than LCD's
Plasma Gas	- high resolution - wide performance range - good graphics	- very expensive

which is being sold by Cherry Display Products for less than $300 each (purchased in bulk quantities). This panel offers 80 characters by 25 lines, has a brightness of 15-20 foot Lamberts and a 10:1 contrast ratio. Plasma gas displays are very expensive by comparison, but may become more competitive in the future.

Industry observers expect the market for flat panel displays to reach $4.2 to $4.5 billion by 1992. Conflicting reports estimate that LCDs will have anywhere from 35% to 75% of the market, and the remaining market will be almost equally divided between electroluminescent displays and plasma gas displays. Most sources agree that LCDs face a declining market share from the current 90%+ share they now have.

Current products available now include:

Hewlett Packard's portable personal computer with an electroluminescent display;

GRID's portable computer (Compass) with an electroluminescent display;

The Data General portable, flip up, full size liquid crystal display;

Epson, with a liquid crystal display.

3.5.2 Printing Technologies

Traditionally, the backbone of hard copy output has been the impact type printing device. Impact technologies are well established. The use of LSI and other improvements in printer electronics have served to reduce cost, improve reliability and speed and allow the incorporation of smart features such as self-testing, diagnostics and fault isolation. The result is faster, better quality and easier to use printers that are available at a fraction of the cost of their previous electromechanical counterparts. The influx of microcomputers and word processors into office environments has stimulated demand. This demand has been met using such impact technologies as dot matrix and daisy wheel printing.

Impact printing technologies are competing with developments in non-impact technologies for future applications, especially in situations where high quality and speed are an essential requirement. Recent developments in non-impact technologies include laser, electrostatic and thermal, ion deposition and ink jet technologies. Of these technologies, laser and ion deposition look very promising. Electrostatic and thermal technologies are limited because of the need for specially treated paper, while ink jet tends to be limited in printing speed.

The major trend in laser printers is towards low cost desk top models. The introduction of smaller laser printers is mainly due to the use of semiconductor laser technology. Canon has been credited with this breakthrough; its LBP-CX laser printer engine will serve as the basis for many of the product offerings available from a variety of suppliers. Canon provides the LBP-CX for about $1,000 in OEM quantities. Already Canon is providing a desk top laser printer capable of eight pages per minute for about $3,000 to $5,000 U.S.

The new desk top laser printers generally offer:

- Medium resolution printing - 250 to 300 dots per inch (dpi), versus 50 to 200 dpi for low resolution dot matix printers.

- A printing speed of eight pages a minute, regardless of page content.

- Quiet operation.

- Graphics capability.

Future variants of present laser printers with higher resolutions of 700 - 800 dpi should be available within a couple of years. However technical problems surround the development of colour laser printers , therefore inkjet and thermal transfer technologies are currently better suited for colour applications.

Ion deposition technology has mainly been developed by Delphax, a Canadian based company (see Chapter 4). Delphax uses an ionography technology in their high speed non-impact printer, providing direct competition to many of the desktop laser printers currently available.

Although all non-impact technologies are currently more costly than their impact counterparts, future cost reductions are expected. Therefore desk top laser printers will soon enter into close competition with daisy wheel printers for the production of letter quality documents.

3.5.3 OCR/Facsimile Integration

Future trends are towards the convergence of the separate technologies for OCR, facsimile, graphics, copying/printing and micrographics. Integration of OCR and facsimile will not only enhance the functions of each device but will also be able to provide the features essential to the input/output requirements of the integrated office. The new generation (Group 4) facsimile devices will be computer controlled, will operate over digital networks, will have store and forward capabilities, and will be able to print teletex. The market for this new generation of terminals will diversify according to traffic volume requirements. There will be many small and medium-sized terminals handling relatively small volumes (e.g. 250 pages/month - 2,000 pages/month). The incorporation of laser technology will allow these machines the capability of providing very high quality document reproduction.

Researchers are continuing to work on the merging of facsimile technology with low-end OCR page readers. The major problems include recognition of multiple type written fonts, transmission protocols, resolution, compression ratios and an economically priced system. Advanced research is directed towards the incorporation of artificial intelligence into an integrated OCR/facsimile machine.

3.6 Communication Technology

3.6.1 Overview

This section primarily deals with the voice/data PABX (with special emphasis on the PABX-LAN hybrid); the local area network (LAN); and communication networks, (specifically digital and satellite communications). The first two topics are concerned with communication systems within the office environment, while the last topic involves inter-office communications.

The controversy over digital versus analog is essentially dead -- digital has won. More and more voice, data, image, video, and text is being translated into digital bits (zeros and ones), transmitted, switched and processed as undifferentiated digital bit streams. The trend towards digital has been occurring over the past two decades. The first digital PBXs were delivered in 1975. In 1985 no analog PABXs are being manufactured for systems over 200 telephone lines. With the reduced communications costs provided by digital networks this trend is resulting in a substantial increase in the demand for the transmission of information. As a result, it is hastening the transformation of the office information system of the 70's into the office communications system of the 80's.

One central issue to the office of the future is the integration of voice and data. It has been estimated that 80% to 90% of all business communications is voice.[3-5] True integrated systems will have to be equally capable of handling both data and voice transmission, as well as voice/data processing. The benefits of an integrated system will include such value added features as: voice messaging, voice annotation, text-to-voice, voice-to-text, and integrated transmission. "Integration is a benefit or a value, not a feature."[3-6]

The technology associated with digital voice transmission has been well established. Pulse code modulation is one of the prime voice digitizing techniques utilized by many digital PABX manufacturers. This technique has been employed for over twenty years in the T-1 digital transmission facility incorporated in the major telephone networks of North America. The other main voice digitizing technique used by digital PABX manufacturers is delta modulation. Because of its incompatability with T-1 transmission, the potential growth of delta modulation may be severely limited.

On a broader scale, there is a clear trend towards more and more digital equipment and facilities in the standard telephone networks. Industry observers believe that with the exception of long distance it will be practically all digital by 1990. Switching will be handled almost entirely by stored program computers.

In terms of office automation applications, the introduction of digital voice technology will have its major impact in the 1980s with the wide spread use of digital voice messaging systems. Digital voice messaging systems will be introduced as subsystems of voice/data PABXs. In fact, vendors are now starting to offer voice messaging systems as an added feature to their existing digital PABX products.

3.6.2 Voice/Data PABX

The Private Branch Exchange (PBX) has been around since the telephone was first introduced into the office. Figure 3-13 summarizes the evolution of PBXs in terms of functional and technical trends. The first stage PBX is characterized by relatively primitive mechanical technology and switchboard control. The second stage PBX is characterized by automatic dial and call processing, electronic switching, stored program control, and the trend from analog to digital switching. The third phase of PBX development is characterized by voice/data integration, non-blocking features, distributed architecture, and increased capacity. This third generation is the integrated Private Automatic Branch Exchange (PABX).

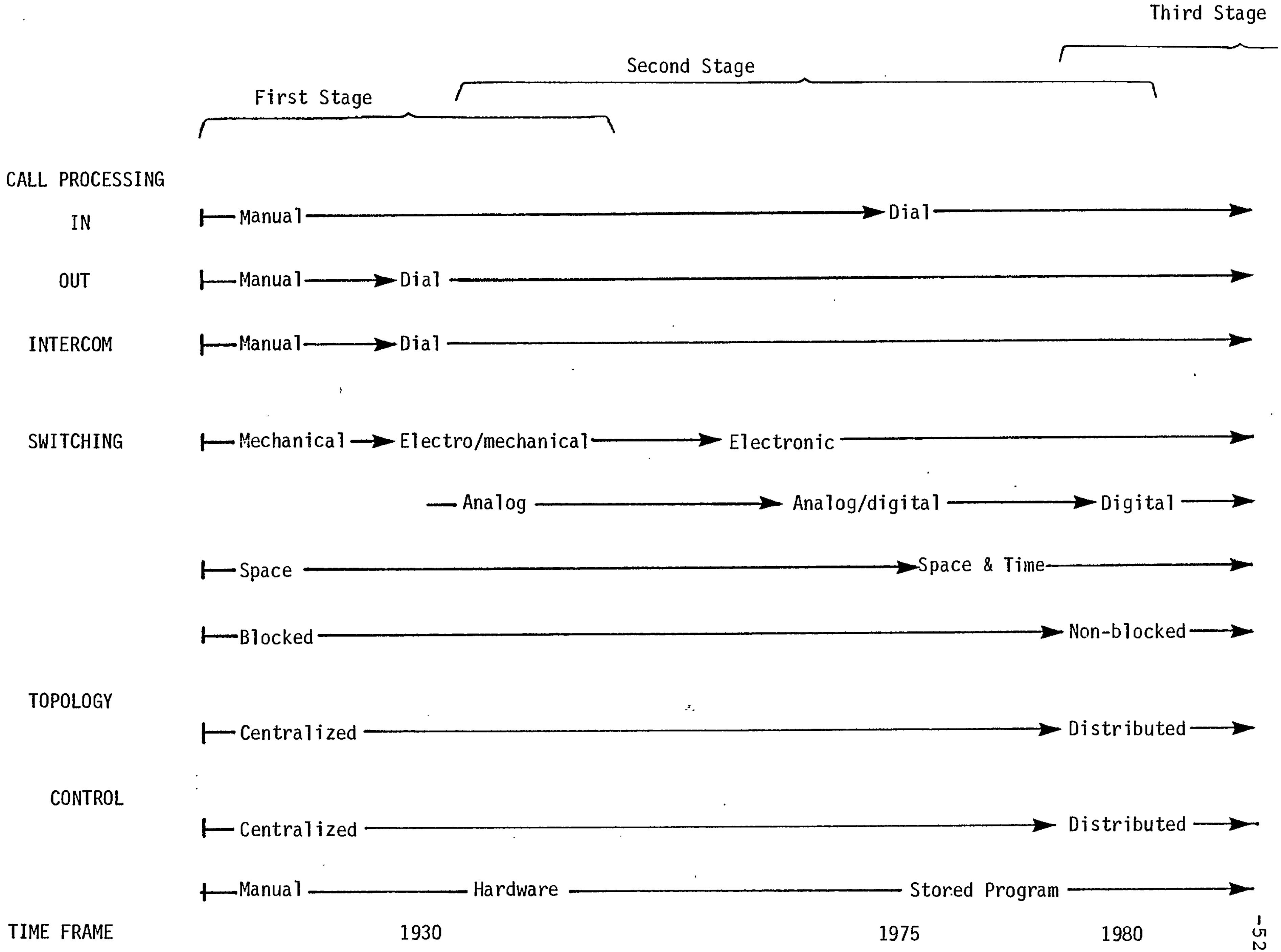
The voice/data PABX will be an integral component of the office communications system of the future. The PABX is not, at present, in direct competition with the local area network (LAN), but will be part of the overall integrated communications system, which will include both LAN and PABX. Relevant features of the voice/data PABX are outlined in the following list:

1) The voice/data PABX is ideal for low volume, low cost and terminal oriented connections.

2) It is the most efficient and cost effective method of voice transmission.

3) Today's off-the-shelf voice/data PABXs have data transmission capabilities of 19.2 kb/sec asynchronous and 56 kbits/sec synchronous.

FIGURE 3-13: A SUMMARY OF THE FUNCTIONAL AND TECHNOLOGICAL TRENDS OF PBXs



4) PABXs use existing twisted pair wire as the transmission media.

5) It is easy to add telephones, workstations and other peripherals to the system as the demand for workstations grow. Figure 3-14 illustrates a typical system configuration with the PABX as the central switching device.

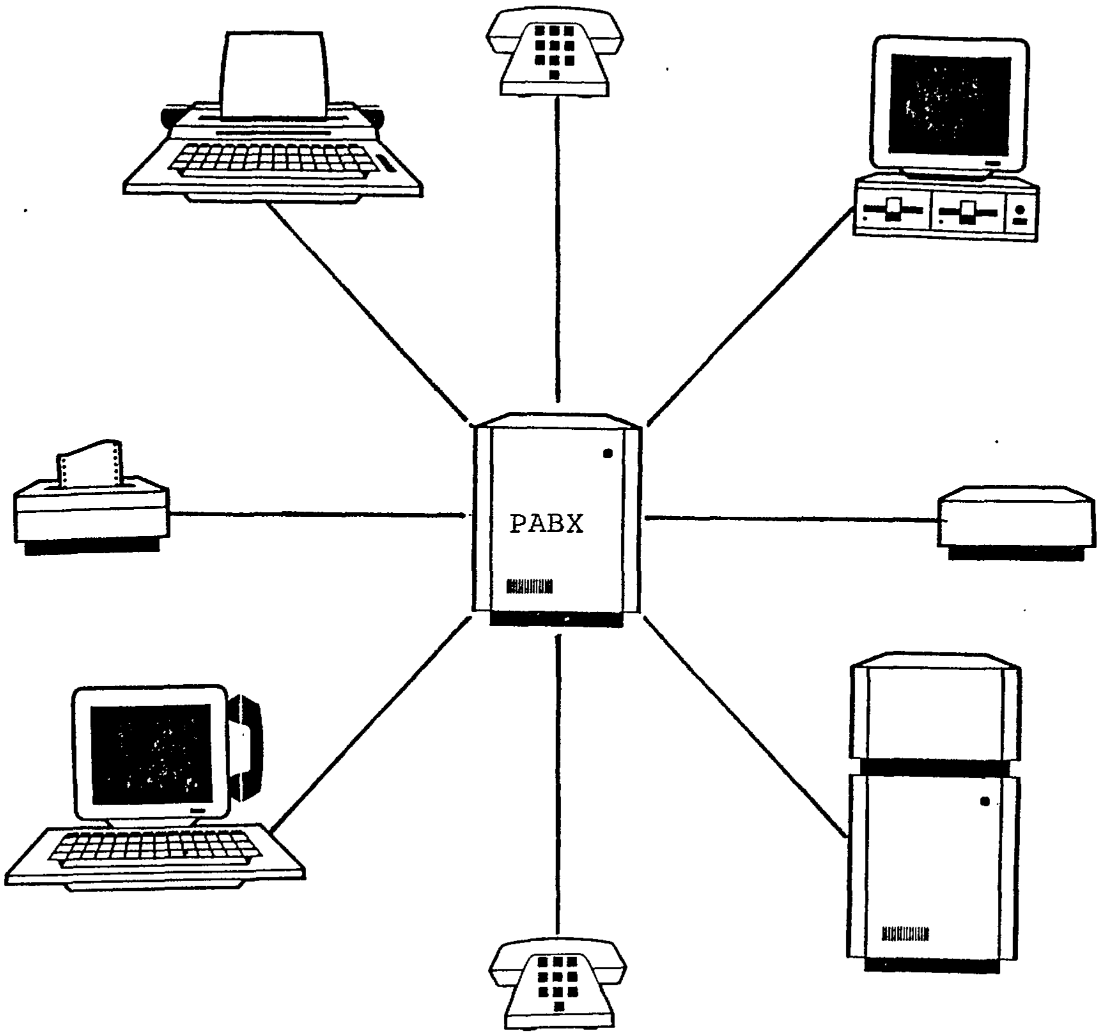
6) PABXs employ circuit switching techniques. Therefore, communication between point A and point B is independent of any other point on the system.

There are two primary issues concerning the voice/data PABX. They are: the PABX-LAN hybrid, and the bandwidth or data tramission rate requirements. These were discussed in detail by the Technology Panel. The hybrid PABX-LAN is expected to combine circuit switching and packet switching technology in a tightly coupled user transparent, dual bus architecture. This will enable the voice/data PABX to act as a bridge or gateway between LAN systems, external communication systems, or both. The hybrid is required to have transparency so that the user is not aware, nor cares, which bus is being used. This type of hybrid is also necessary for the transmission of integrated voice/data information (e.g. a voice annotated document).

A few manufacturers have already announced this type of product. They include CXC Corporation of California Inc., Ztel Inc. in Massachusetts, and Microtel Ltd. in Canada. In all

FIGURE 3-14

REPRESENTATIVE VOICE/DATA PABX CONFIGURATION



three cases they report that equal access to circuit switching or packet switching is available. Industry observers expect that within the next two to three years all major PABX manufacturers will be offering a type of PABX-LAN hybrid. However, considerable development work is still required on the design and architecture of such hybrid systems in order to achieve the desired integration.

A major issue raised by the Technology Panel was how to deliver adequate bandwidth over a twisted pair. One problem is that PABX manufacturers and other experts are not sure what bandwidth will be required at the desk. Generally, PABX twisted pair wire can handle a maximum bandwidth up to 2.5 Mbps. At the present time, most applications do not require and cannot use this bandwidth. However, even this may not be adequate when fully integrated workstations combining voice, data, text, graphics, and image are developed, and integrated into large systems with a mainframe and distributed minicomputers. Today's standard voice/data PABXs provide synchronous transmission rates of 56 kbits/sec. PABX manufacturers expect eventually to be able to provide 4 to 5 Mbps on a twisted pair wire or other transmission media such as optical fibre. As indicated before, while customers are now asking for higher capabilities at the desk, they are not using the available 56 Kbs facilities. This is because virtually no computing devices are available which require this transmission rate at the present time. Customers are putting in the higher rates in the assumption of future usage, not because of present applications.

The PACX is not, at present, in direct competition with the PABX but that situation may well change. "Currently it is more cost effective to have a PABX dedicated to voice switching, and another data switch (like Gandalfs' PACX), dedicated to switching data."[3-7] The PACX is not in competition with the LAN, but instead, the PACX-LAN combination offers a method for connecting a variety of hosts (microcomputers and mainframes) in a very efficient cost effective manner. The LAN is used for high speed, high volume, inter-computer connections, and the PACX for low volume, primarily terminal to host connections.

The end users applications and requirments determine the applicability of a PABX, PACX, LAN, or combination of systems in any given situation. Current research and development will ultimately provide the necessary interfaces and gateways between these systems. As discussed earlier, it is expected that the PABX will perform the primary gateway function.

3.6.3 Local Area Network (LAN) Technology

3.6.3.1 Introduction

The Local Area Network is essentially a by-product of the computer industry. Originally, the development of local area networks was in response to the need for interconnecting mainframe computers, computer terminals, high speed printers, and computer peripherals. Today, with the trend to integrated office systems, these networks are being expanded to include such office devices as word processors, personal computers, minicomputers, intelligent copiers and digital facsimile machines.

The Local Area Network is one of the more contentious topics currently surrounding the development of integrated office communications systems. To a large extent, this controversy stems from the fact there are over 200 vendors, all offering some form of solution to the office networking problem. The problem is further compounded by the lack of established industry standards for OCS applications. Potential LAN buyers are therefore faced with a staggering number of options and must face major uncertainties with regard to the trend in future LAN offerings.

Protocols are the most important technological issue in LAN systems. The next most important issues are: the access method, network topology and transmission medium used. Various network characteristics are outlined in Tables 3-3 and 3-4. Each of the technological issues are discussed in the following sub-sections.

TABLE 3-3

LAN CHARACTERISTICS

	Twisted pair wire	Baseband coaxial cable	Broadband coaxial cable	Fiber optic cable
Topologies supported	Ring, star, bus, tree	Bus, tree, and (rarely) ring	Bus, tree	Ring, star, tree
Maximum number of nodes per network	Generally, up to 255	Generally, up to 1024	Up to about 25,000	In experimental test, up to 65,000
Maximum geographical scope	25 km	10 kilometers **	80 kilometers	10 kilometers
Maximum distance between adjacent nodes *	4 km	10 kilometers **	—	2 kilometers
Type of signal	Single-channel, unidirectional; analog or digital, depending on type of modulation used; half- or full-duplex	Single-channel, bidirectional, digital, half-duplex	Multi-channel, unidirectional, RF analog, half-duplex (full-duplex can be achieved by using two channels)	One single-channel, unidirectional, half-duplex, signal-encoded lightbeam per fiber; multiple fibers per cable; full-duplex can be achieved by using two fibers
Maximum bandwidth *	Generally, up to 10M bps	Generally, up to 10M bps	Up to 400 MHz (aggregate total)	Up to 50M bps in 10 kilometer range; up to 140M bps in 6 to 8 kilometer range; up to 5G bps in experimental tests
Major advantages	Low cost May be existing plant; no rewiring needed	Low cost Simple to install and tap	Supports voice, data, and video applications simultaneously Better immunity to noise and interference than baseband More flexible topology (branching tree) Rugged, durable equipment; needs no conduit Tolerates 100% bandwidth loading uses off-the-shelf industry-standard CATV components	Supports voice, data, and video applications simultaneously Immunity to noise, cross-talk, and electrical interference Very high bandwidth Highly secure Low signal loss Low weight/diameter; can be installed in small spaces Durable under adverse temperature, chemical, and radiation conditions
Major disadvantages	High error rates at higher speeds Limited bandwidth Low immunity to noise and crosstalk Difficult to maintain/troubleshoot Lacks physical ruggedness; requires conduits, trenches, or ducts	Low noise immunity (can be improved by the use of filters, special cable, and other means) Bandwidth can carry only about 40% load to remain stable Limited distance and topology Conduit required for hostile environments Not highly secure	High cost More difficult to install and tap than baseband RF modems required at each user station; modems are expensive and limit the user device's transmission rate	Very high cost, but declining Requires skilled installation and maintenance personnel Experimental technology; limited commercial availability Taps not perfected Currently limited to point-to-point connections

* Note that it is not normally possible to obtain the maximum band width listed, at the same time as the maximum distance between nodes.

** Maximum for most systems. Ethernet, for example, is 1 to 2 kilometers.

TABLE 3-4

LAN - TOPOLOGY DETAILS

Topology	Performance Considerations	Constraint Considerations
Linear bus and Single Branching Tree	Delay—in token bus networks, waiting time is a fixed function dependent on number of nodes in network, in contention bus networks, delay is a variable dependent on current traffic; delay distortion ("jitter") is possible Throughput—in token bus networks, throughput decreases with each node added, in contention networks, throughput is best in light, bursty traffic conditions, and decreases in high-volume, steady-traffic environments Reliability—failure of one station will not affect the rest of the network, break in cable may affect only part ul the network Robustness—relationship between stations is peer-to-peer, network is difficult to monitor, in contention networks the difference between noise and collisions may be difficult to distinguish	Circuit speed—varies up to 50M bps Distance—generally unlimited by topology Maximum number of nodes—user stations may be added or deleted without reconfiguring the networks, in token bus networks, addition of each station directly affects performance Error rate—bit errors are lowest when fiber optic cable is transmission medium, low when coax cable is used, higher with twisted pair wire Cost—generally, lower cost per user station than star networks and higher than ring networks
Ring	Delay—waiting time is fixed function dependent on number of nodes in network Throughput—decreases with each added node Reliability—if one station fails, whole network fails unless bypass circuitry has been implemented in each interface or node, if loop is severed the whole network fails, unless redundancy features have been implemented; potentially low reliability can be compensated for by high quality engineering design Robustness—Nodes are easy to understand, construct, and maintain, may require custom-designed, device-dependent interface; communications control overhead is generally high; if network fails, recovery may be difficult, and may require complex logic and processing	Circuit speed—varies up to 10M bps Distance—limitations are imposed both on total distance, and distance between nodes Maximum number of nodes—may be a fixed parameter dependent on command station capacity, addition of each station directly affects performance Error rate—twisted pair wire is vulnerable to transient errors; fiber optics has very low error rate Cost—generally, lower cost per station than other topologies
Star	Delay—in heavy traffic conditions, requests for service may be blocked at the switch in a PBX Throughput—dependent on internal bus capacity of central node Reliability—failure of one station does not affect the rest of the network, if central node fails, the whole network fails Robustness—Ready availability of network monitoring and control software high overhead for communications control corresponds well to applications in hierarchical (master/slave) networks	Circuit speed—varies considerably depending on medium Distance—limitations are imposed on distance between central node and any user station Maximum number of nodes—expansion limitations are dependent on capacity of central node, difficult to reconfigure Error rate—twisted pair wire is vulnerable to transient errors Cost—high initial cost, but low incremental costs thereafter

*Schematic symbols—
— Transmission medium
○ User station
● Connection device (network interface unit, RF modem, transceiver, etc.)
□ Command station (central host, PBX switch etc.) or cable head-end

3.6.3.2 Protocols

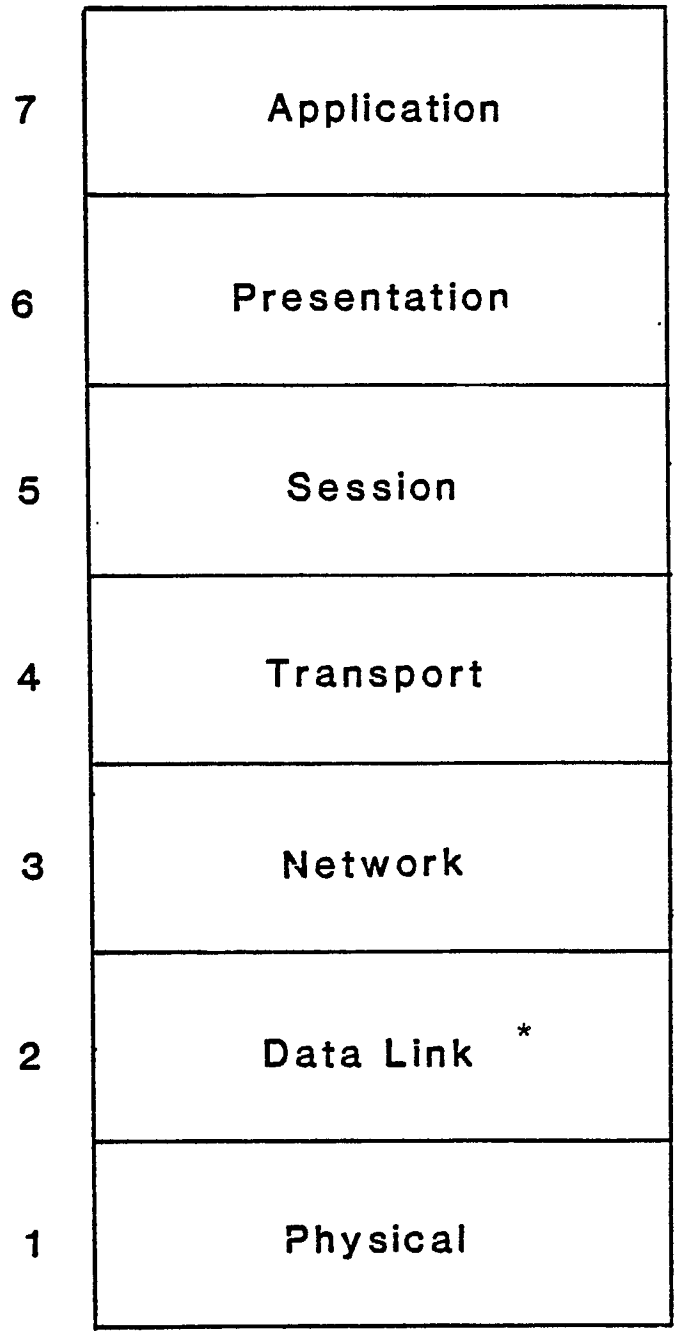
Protocols are currently the limiting factors to LAN performance. The protocol is essentially the "hand shake" between interconnected hosts. To send a packet of information, approximately 1000 to 1500 instructions are needed and it takes anywhere from 2 to 5 milliseconds. The effect of this is to reduce the possible transfer rate of data between two stations to a small percentage of the basic network transmission rate when the latter is in the region of above 1 Mbps or even lower if short packets must be sent.

All protocols are modelled on the seven layer ISO standards (Figure 3-15). These standards are still evolving and will be influenced by the type of research that is being conducted over the next two or three years. Only three out of the seven sub-layers are considered "solid"; and these are the lower level protocols. The OSI standards therefore provide a general framework only; especially as applied to LANS.

Most commercial LAN product offerings have over protective protocols built in. Part of the reason for this is the outgrowth of LAN technology from large (e.g. nation-wide) packet networks, and the development of the OSI standards from the same roots. Currently the LAN continuously checks and acknowledges the data integrity of the packets being sent. This is the root cause of the slowness of these protocols, because of the computing overhead it imposes. Research is being directed to developing protocols which could take advantage of the inherently low error rate of a LAN by using simpler and less time consuming procedures. A current target is to reduce the computing overhead per packet to about 100 microseconds. This would permit effective transfer rates much closer to the 10 - 30 Mbps basic transfer rate of high performance LANs.

FIGURE 3-15

THE SEVEN LAYER ISO MODEL



*Note: The IEEE 802 standards for LANs, interpose an additional layer, called the Medium Access Control Layer, between the Data Link and Physical layers.

Other research on protocols includes the development of protocol engines in which LAN protocols are handled by a microprocessor separate from the CPU and dedicated to this activity. Finally, work is being conducted on the use of protocols in a multivendor environment and on the bridge between the LAN and PABX.

3.6.3.3 <u>Access Method</u>

The network access method refers to the way a station gains access to the shared transmission medium and is part of the transmission protocols. While there are numerous different protocols utilized by various vendors, the most common ones are carrier sense multiple access with collision detection (CSMA/CD), token passing and the slotted ring.

Ethernet, by Xerox, is a baseband coaxial cable network utilizing bus topology with a CSMA/CD access method. With the Ethernet network there is no central control of the network. When a network station has something to transmit, it simply listens to the traffic along the network to determine if the network is active or not. Transmission will originate if the network is sensed to be inactive by the station. All stations have access to the network and attempts by two stations to use the network simultaneously, will result in a collision. If a collision occurs the message being transmitted will be destroyed. Because of this, CSMA/CD networks implement a collision recovery scheme involving retransmission of the message using random time out intervals. In the case of Ethernet each station generates a random number, the station with the smallest random number is given the right of way. Because collisions are resolved statistically, access to the network in a given time frame can never be guaranteed. Therefore, this process is not suitable for real time applications such as process control monitoring, or situations which serve critically time dependent applications.

Industry contacts have indicated that one of the prime considerations impacting on the use of Ethernet and other CSMA/CD networks in office environments is their inadequacy in handling voice transmission. Voice transmission is accomplished by converting the continuous stream of analog voice into digitized voice. The digitized voice is then placed into packets, consisting of approximately 1/5 of a second of voice data. The problem with CSMA/CD networks is that voice transmission will be chopped if packets are delayed in transmission due to other network activity. The technical problems associated with transmitting voice over CSMA/CD networks can be partially alleviated with additional hardware being added to each station along the network. The use of information buffers, echo supressors and intelligence, can replace inter-word gaps caused by delays in transmitting packets, with inter-word gaps resulting in recognizable but broken voice communications. But, voice transmission over CSMA/CD networks still does not seem practical for two prime reasons. First, the additional cost of the required hardware impacts on the economies of the network, and secondly, even with the additional hardware, the voice quality is significantly lower than that of the currently available digital PABXs.

Ethernet is basically a viable network with limited evolutionary possibilities. The bus is fixed and works well with a small number of stations. However, voice transmission is a problem and 10 megabytes is about the maximum feasible transmission rate.

Token passing systems utilize the concept of a token which represents permission to transmit on the network. The token is continually being passed from station to station along the network. The station which possesses the token has the right to transmit. If the station with the token has nothing to transmit, it simply passes the token to the next station. With the token passing protocol, access to the network can be guaranteed within a fixed maximum time interval. One of the disadvantages with this system is the difficulty in making network alterations. When a new station is added to the network, other stations must be updated with the address of the new station, otherwise the new station would never receive the token. Another problem is the situation where a station malfunctions and is unable to pass the token to the next station. Recovering from this condition requires either additional complexity at each station or the designation of a central control station with additional capabilities. Also, with a token ring system the more stations on the system, the longer it takes for the token to be passed around, and the potential exists for system degradation. There are numerous networks available using the token passing protocol. The one introduced by Datapoint in 1977 is the most common, with over 5,000 networks installed.

Slotted ring systems are based on a number of "slots" or fixed packets being sent around the network. These packets may be empty or full. Therefore, to transmit, a station grabs an empty slot. Stations receive the information when they receive a full slot with their address on it. Slotted ring is satisfactory for terminal connections, provided a short packet of information is sent. Fixed packet sizes on this system are in the 16 to 32 bit range.

The token passing LAN seems, at the present time, likely to represent the preferred technology for future integrated office communications systems, although CSMA/CD and the slotted ring have advantages in specific applications. Industry analysts believe that the LAN for the IBM PC will be a token passing ring, although IBM's interim solution is an CSMA/CD LAN (See section 3.6.3.5).

3.6.3.4 Transmission Media

The transmission medium is the medium over which the packets are sent. The four common types used are twisted pair, baseband coaxial, broadband coaxial, and fiber optics.

A controversial topic surrounding the LAN is the baseband versus broadband debate. Baseband networks are relatively inexpensive and simple compared to the more costly and complex broadband networks. Amongst some of the major advantages of baseband systems are: high transmission rates up to 10 Mbs, bidirectionality, easy installation and relocation. However, baseband systems are limited to single channel transmission and have insufficient bandwidth for communication intensive applications. Another serious limiting factor is distance. Broadband systems, on the other hand, can support voice, data, and video transmission simultaneously in different channels and can be used over a larger geographic area than baseband networks. Their disadvantages are high cost, network complexity, lower network integrity, and greater difficulty in network changes and relocations.

The utilization of baseband versus broadband in the networks of the future will depend largely on the end users application. In cases where companies desire video transmission, inter-office facsimile and other devices requiring a variety of transmission rates and communication protocols, broadband systems will clearly be superior. However, many industry analysts feel that the majority of office automation functions such as word processing, document handling and desktop computing can be easily handled with baseband networks. Most industry observers were of the opinion that bandwidth was not a serious issue in the office automation environment. They felt that the demand for greater bandwidth would grow at the same pace as the trend towards greater distributed data processing and companies would adjust accordingly. Contacts felt that by the time the bandwidth requirements of the integrated office became extensive, they would be economically satisfied through the use of fiber optic based local area networks.

Fiber optics will play an increasingly important role in the development of local area networks. Present fiber optic systems provide an unidirectional transmission path which restricts network topology to a ring, star or tree configuration. Current fiber optic technology provides a higher bandwidth than other media and can handle voice/data and video transmissions. There are several advantages associated with the use of fiber optic cable over the more traditional coaxial and twisted pair media. Fiber optic cable is lighter and smaller than coaxial and thus easier to handle. Also the glass fiber is immune to many environmental hazards such as electromagnetic interference. An added advantage is that fiber optic networks are not easy to tap into, thus providing a higher degree of network security.

Fiber optic cable is clearly becoming the transmission medium of the future, both for office and inter-office applications, although it will be a long time before it displaces the huge installed base of twisted pair wire. The primary disadvantage with fiber optic cable used to be the high cost. Now it is possible to obtain fiber optic cable at one fifth the cost of coaxial cable. Duplex fiber optic cable can be purchased at $2.50/meter (Canadian). However, it is still much more expensive than twisted pair. Another problem is the difficulty of interconnection. It is not an easy matter to splice, repair or connect fiber optic cable.

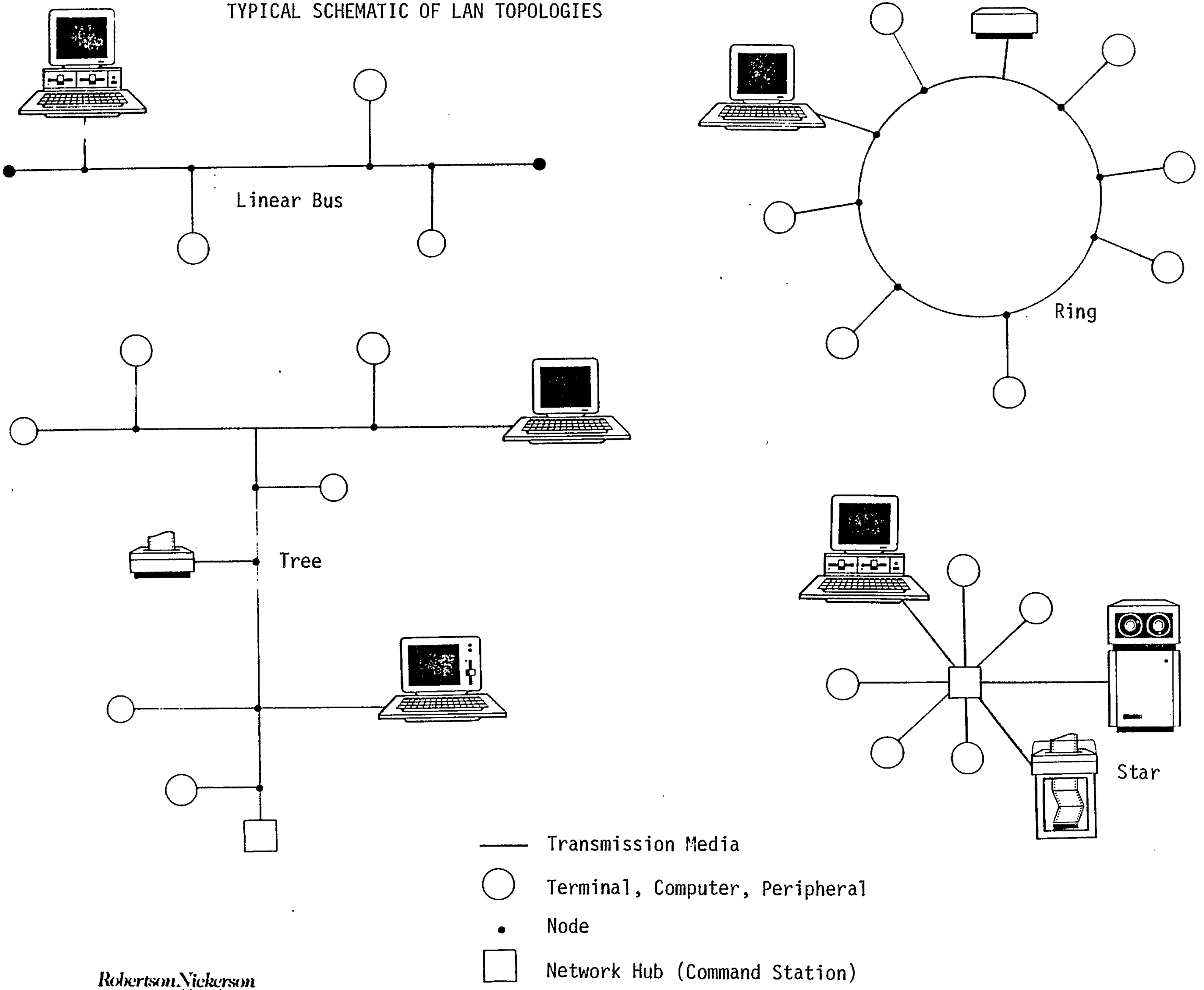
3.6.3.5 LAN Topology

The topology used is dictated by the number of nodes per network, the geographic scope, reliability required, and type of traffic. The linear bus, ring, star and tree configurations are all technologically well established. Each have strengths and weaknesses that must be evaluated for each specific appplication. (See Figure 3-16)

Sytek Inc. of Mountain View California, has been chosen by IBM to provide the networking system for the IBM PC. IBM has been financing Sytek and industry observers speculate that IBM may take an ownership position. The LAN for the IBM PC is expected to be a token passing ring system. In the meantime, IBM introduced the PC Cluster Program in 1984 enabling PCs and PCjrs to be used together in a clustered multiuser configuration, sharing a fixed disk and exchanging messages and data. IBM has also introduced the IBM PC Network allowing the sharing of information and resources amongst PCs, XT's and ATs. The PC Network is a fixed frequency broadband network with a 2 Mbps

FIGURE 3-16

TYPICAL SCHEMATIC OF LAN TOPOLOGIES



-89-

transmission rate using CSMA/CD access protocol and a standard 75 ohm coaxial cable.

3.6.3.6 Proprietary Versus Standard Network Design

The debate between proprietary and standard network design is trending to network standardization. Several attempts in the past have been made at establishing standards. However, the 802 Committee of the Institute of Electrical and Electronic Engineers (IEEE) has decided that no one set of standards can be devised to suit everyone. Therefore, the Committee has established a set of three standards dealing with different network attributes.

(1)	802-3 CSMA/CD	a system based on the Ethernet design
(2)	802-4	a token passing bus network
(3)	802-5	a token passing ring network

Some companies such as Xerox have published the standards they use in order to encourage other companies to follow them.Observers also feel the impact of the IBM LAN may be similar to the effect the IBM PC had on the microcomputer industry, of almost establishing de facto industry standards overnight. With these trends, proprietary networks only allowing equipment from a particular vendor to access the network, will face stiff competition as network standardization is further achieved.

From a Canadian perspective, one of the largest broadband networks in North America is being constructed for the House of Commons in Ottawa. The network offers communication capabilities to about 350 - 400 word processors, 1,000 computer terminals, and numerous T.V. sets. The network provides data transmission rates of 1 Mbps and has 4 out of 104 channels reserved for data transmission. It also has over 30 video channels offering cable T.V. and House of Commons proceedings, in both French and English. Also, an electronic news clipping service provides users with up-to-date information on matters from all over the country. The network combines products from many different vendors, with the major suppliers being Sytek, of California, the supplier of the LAN and interface units; and General Instrument, supplier of CATV cable equipment. The major consultant was Mitre Corp. of Bedford, Massachusetts.

3.6.4 Communication Networks

3.6.4.1 Digital Networks

There are digital network connections to all major cities in Canada and the U.S. Other networks allow connections to Europe and other countries. In Canada, the Datapac and Dataroute networks of Telecom Canada are the most commonly used digital systems. However, the development of networks capable of all digital point to point connection is still relatively slow. Most of the installed telecommunications plant and switching within cities is still analog. "It is the last five miles that causes the greatest problems in data transmission."[3-8]

Since 1975, Telecom Canada, amongst others, has been committed to the establishment of digital networks. In addition to Datapac and Dataroute their major digital network services are: the Stratoroute 2000 which is a satellite link between major cities; Digital Channel Service which provides private line digital circuits between major cities, at data rates up to 56 kb/sec; and Megaroute which is a high speed (T-1 rate or 1.544 Mb/sec) digital line connection.

In the short term the subscriber connections to digital networks will be operated over copper wire. However, over the next ten years the trend will be towards the installation of fiber optics. Telecom Canada is already installing fiber optic cable between switching centers and planning to install fiber optics coast to coast. The Province of Saskatchewan has an extensive inter-city fiber optics communications network. New York Telephone is installing fiber optics between major buildings in New York. Clearly the trend is towards new communications network investment, particularly on high density routes, directed at the establishment of fiber optic digital communication networks throughout North America.

The key to the development of world-wide digital networks is the use of the international standard ISDN (Integrated Services Digital Network). The ISDN principle is that digital building blocks are the solution to providing services to all types of users. For example, a "B" channel operates at 64 kbps, full duplex, and can be used for voice or data communication, A "D" channel operates at 16 kbps, full duplex, and can be used for low speed data transmission and network signalling.

The development of a standard digital network combined with fiber optic technology is one of the most significant telecommunications trends. This network is essential for the efficient functioning of PABX-LAN systems and integrated voice/data communications between offices and organizations. The digital network will satisfy the demand for low cost, very high speed, low error rate communications.

3.6.4.2 Satellite Communications

A current trend in office communications is the use of private line satellite channels by corporations and government agencies. Until recently, receiving data from a satellite required large and expensive satellite earth stations. The high cost associated with these stations made it uneconomic for many companies to own and operate their own private stations. In these cases, satellite services were often leased from a common carrier capable of providing the same services to numerous customers and spreading the cost amongst several users. Recently, with advancing technology, cheaper and smaller earth stations are being produced which now make it cost effective for a company to have a station on its own premises. The low cost of earth stations has been a key factor in the recent interest in satellite communications.

One of the major impediments to using satellites as a communications link in OCS systems is the high delay time in voice communication. "Satellites are wonderful for broadcast, not very good for dialog."[3-9] Many industry observers feel that satellite technology used for office communications has only about twenty years of life left. In the long term, the satellite link is expected to be replaced by fiber optic digital networks. Within the next twenty years Canada will have fiber optic cable stretching from coast to coast. Satellite connections will still be cost effective in remote areas, such as the Arctic, and in industries such as oil and gas and mining where fibre optic connections are impractical. In addition advances in satellite recovery techniques (e.g. the space shuttle) may also reduce satellite communications costs to the point where private data circuits are competitive with fibre optic networks, in medium to low density traffic areas.

3.7 Software Technologies

The main thrust towards integrated office communications systems will come largely through developments made in software technology. In fact, it is widely believed that software will be the single most important component of true integrated office communications systems.

The assessment of major trends in software development will focus on these four areas: operating systems, storage management, application and end user software and expert systems or artificial intelligence. The emphasis is only on trends expected to have a significant impact on office communications systems over the forecast period.

3.7.1 Operating Systems

Operating system software performs the management tasks required to coordinate all system resources, including processor, memory and input/output. The primary function of operating system software is to provide efficient resource sharing and to make the computer system easier for the end user to operate. In addition, it has traditionally provided the essential logical to physical interface between the computer user and the machine. This latter role will diminish in importance with the advent of specialized software packages, some of which will be based on artificial intelligence designed to provide a better interface between the human user and the operating system itself. Operating systems, when used as a direct human interface, tend to be oriented to the programmer or expert user, rather than to the type of user representative of most office workers.

The primary difference between mainframe and microcomputer operating systems is the management of the computer resources. Compared to the mainframe, microcomputer systems manage a limited array of resources, including smaller amounts of memory, a comparatively limited input/output and a slower microprocessor with limited instruction services. Operating systems for mainframes also provide such added features as multi-tasking batch processing and are able to support a larger number of concurrent users. It is only with the advent of 16 bit and 32 bit microprocessors that larger amounts of RAM have become directly addressable for a multi-user, multi-tasking microcomputer operating system.

Compatibility and portability between operating systems have only recently become a major concern. Mainframe software systems are usually specific to the particular type of mainframe or designed or modified for the specific customer, and software compatibility/portability has not been important. However, with microcomputers, it is essential to have compatibility between operating systems so that application software can be run on more than one type of machine. Compatibility between mainframe and microcomputer systems is now becoming very important, as more and more microcomputers enter the office environment and office workers press for access to the mainframe. Currently the end user must know two different command structures -- one for the micro and one for the mainframe.

The most important trend in operating systems is the development of "hooks", or published interfaces to the operating system which will enable a variety of application software to be written to run on any operating system. This will allow the end user to run a wide variety of integrated application software with considerably greater ease and "user friendliness" than today.

With respect to operating systems for large mainframes and upper-end minicomputers, the major trend is toward providing users with a greater address space. For example, the MVS operating system (which dominates the IBM mainframe market) has been substantially upgraded through the introduction of a new version, MVS/XA. One key difference between versions is that MVS/XA has increased the allowable space to 2048 million characters from 16 million for MVS. This extra memory space is considered vital as many organizations are planning to expand their data networks, connecting new terminals and microcomputers to their mainframe.

In microcomputer operating systems, the trend is towards a multi-user, multi-tasking, real time operating system, with sophisticated data security measures including password access and error trapping. Currently, the most popular operating systems are: Digital Research's CP/M and Microsofts' MS-DOS (PC DOS). These are single user, single tasking operating systems. While these operating systems are expected to remain popular in the short term because of the large installed base, they are facing increasing competition from UNIX based operating systems.

UNIX was developed by Bell Laboratories. It is a multi-user, multi-tasking, operating system with advanced capabilities including re-entrant code, separate memory space for instructions and data, time outs, interprocessing monitoring, and multiplexed input/output for high-speed data transmission between peripherals. The most serious weakness with UNIX is the lack of security. There is no method for locking files. Other weaknesses include: the system crashing if more than one user accesses the same file at the same time;

it is a development rather than execution operating system; it is unsuitable as an interface to inexpert users; lacks user friendliness and it is expensive. Nevertheless, it is being adopted as the basis for an increasing number of office systems in which a separate package is installed to act as the user interface.

A trend of major importance is towards operating systems designed to work in a distributed environment of cooperating computers, connected by networks. Many of these are of a proprietary nature, for instance the Xerox Star. Later versions of UNIX have inter-computer communications protocols built into the kernel of the operating systems. Any machine running under the operating system can then exchange files and other information with any other machine running the same operating system. Such features will become essential if network environments are to be made viable.

3.7.2 Storage Management Systems

A major trend currently emerging is the microcomputer to mainframe connection. Managers will be able to quickly and easily obtain data from the corporate database and download to application software on the micro for processing. Previously, this kind of microcomputer application faced two major barriers. Firstly, the corporate world is primarily made up of IBM and IBM compatible mainframes, with these machines accounting for nearly three-quarters of corporate installations. The systems are usually accessed only via IBM 3270 series terminal protocol. However, now many available microcomputers are capable of emulating a 3270 terminal. In addition, emulation is available for many other mainframes such as Digital's VAX. Terminal emulation, however, is of limited ability for transferring data because it lacks error-control capability. It will increasingly be replaced by file transfer protocols which guarantee error-free data.

Secondly, mainframes require users to be experienced in the use of a fairly complex database management system or rely on assistance from data processing experts. Even if a user could learn the DBMS and was able to obtain the relevant data he/she required, transferral to the micro for processing would almost certainly not allow the data to be utilized by the micro's applications software package. Today we are seeing the introduction of integrated software links which have software components residing both on the mainframe and micro. Users are able to obtain information from mainframes for direct processing by the micro without having to bother with complex mainframe query languages or file transfer commands (see Figure 3-17).

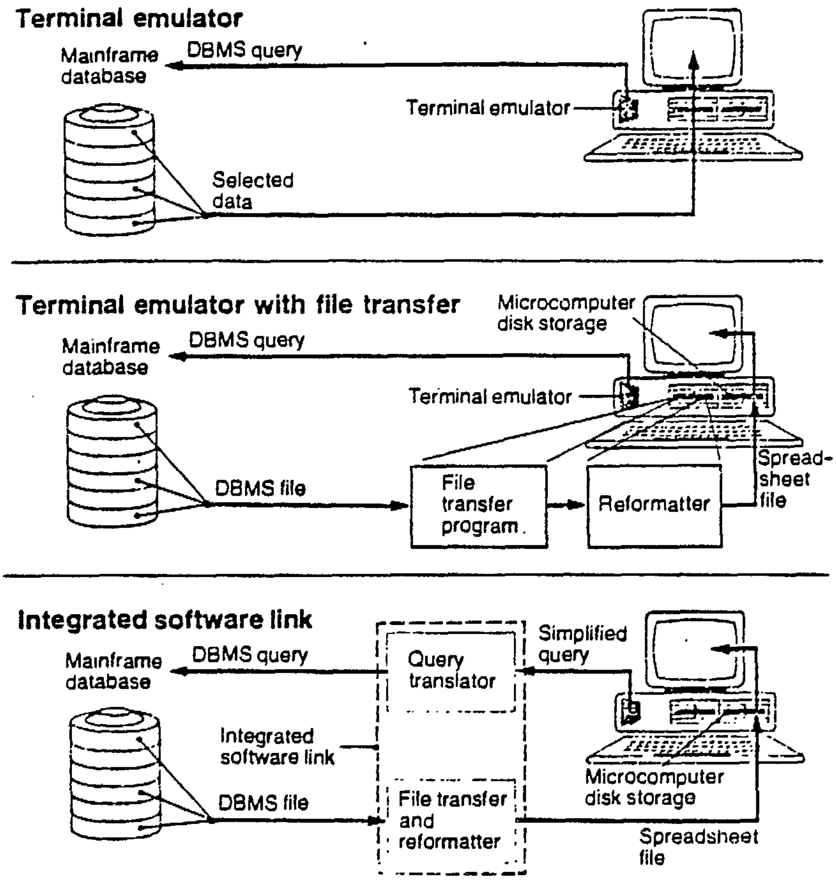
In an ideal application, a user's most frequently used data should reside and be maintained directly on the microcomputer. Industry analysts believe that 10-20% of corporate personnel will soon have storage peripherals (e.g. 20 Mbyte Winchester disk drive) at the desk. Complex issues exist over access privelages, security controls, information integrity, and the responsibility to maintain and upgrade data files. These issues must be resolved before an individual will be able to access the mainframe, combine corporate with local data, process it, and store it in the appropriate location.

3.7.3 Application and End User Software

The major trend in software use is the purchasing of pre-packaged software for both mainframe and microcomputer applications. According to International Data Corporation,

FIGURE 3-17

INTEGRATED SOFTWARE LINKS



U.S. Corporations purchased 50% more software packages last year than in the previous year. The trend within "off-the-shelf" application software is towards integrated software packages, especially for use on microcomputers.

Integrated office automation packages are seen as having the highest growth potential of any office automation related software. These packages will provide users with a wide set of functions, including word processing, database management, spreadsheets, graphics, and communications. A study by Creative Strategies [3-10] projects that by 1988, these integrated packages will be capable of providing over half of the basic office automation functions and will account for nearly one quarter of all microcomputer packaged office communications systems software.

In integrated office communications systems, major software trends include systems which are capable of providing users with some or all of the following applications:

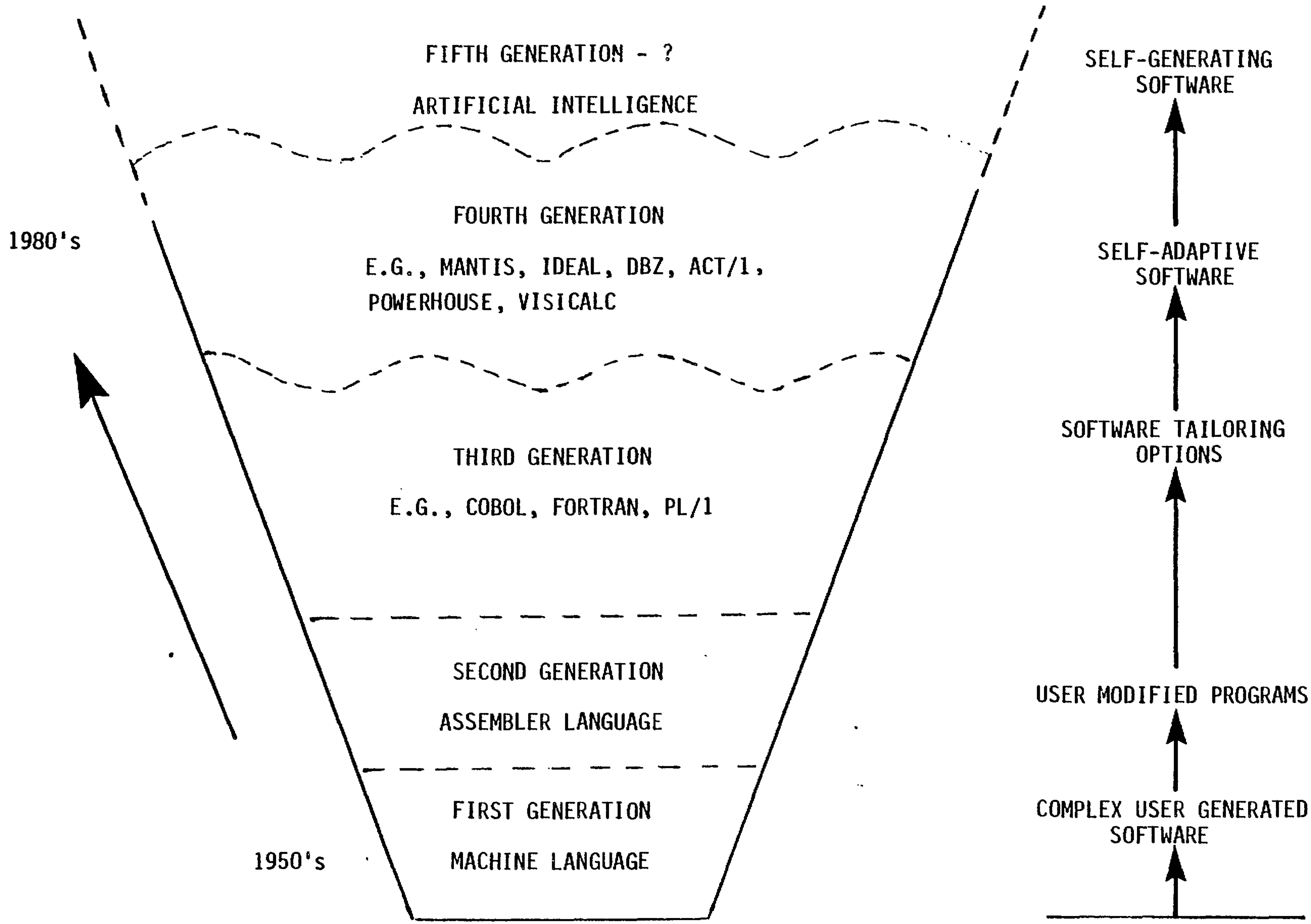
Decision support: spreadsheets, business graphics, project management, statistics

Administrative Support: word processing, document filing, electronic mail

Personal management: calendaring, scheduling, tickler files, personal databases

End user program development: programming aids such as easy to use DBMS (e.g. DBII, Knowledgeman and 4th Generation Languages) (See Figure 3-18)

FIGURE 3-18 SOFTWARE TECHNOLOGY TRENDS



The overall trend in application and end user software will include easier user interfaces, unified access to many different application programs, improved responsiveness, duality of menu commands or keyboard commands, and easier data interchange between programs. There will be a trend to integrate voice, data, text, graphics, and time resulting in a number of enhanced features, e.g. a link between agenda and clock to result in timely reminders of meetings.

Currently there is difficulty in defining how a document with text, graphics, and image should be integrated. In this aspect of integration there "is the wider acceptance of protocols for document structure and content as exemplified by the IBM DIA/DCA or Xerox Interpress system. A non-proprietary system is being defined by ISO/TC97/SC18."[3-11] The objective of an integrated multifunctional workstation is to provide the features which allow an office worker to do all their work at the one station. This requires unified access and interaction between applications and also requires universal editing features.

The Technology Panel felt that further advanced integration was one of the most important trends. Operating systems would employ "hooks", resulting in the easier use of application software. As well, natural language command systems would allow easier user access to both private and public databases and finally, significant improvements in system security would be required as offices move towards full integration.

3.7.4 Artificial Intelligence and Expert Systems

Artificial intelligence is not expected to be used to any great extent in office automation applications throughout the 1980s.[3-12] Currently, much of the research and development being carried out on such systems is aimed at medical diagnostics, oil and mineral exploration, computer assisted learning, and military applications.

Amongst the first applications of artificial intelligence to the automated office have been data retrieval and analysis. For example, high level database query languages, such as "Intellect" (developed by Artificial Intellignce Corp. of Waltham, Massachusetts) allows users to probe large databases using natural language commands. Intellect translates these requests into the set of instructions required by the computer, thus simplifying the data retrieval process. However, analysts expect that five to ten years of development will be required before these types of systems become generally available for the office.

Expert systems (systems that attempt to replicate some human reasoning and decision making processes) are now being developed for office automation. For example, an expert system for the development of policy procedure manuals would not only identify conflicting policies and other problems within a document but be able to offer solutions. Other applications include pattern analysis in historical data (e.g. trend analysis in demographic information).

Expert systems and the use of artificial intelligence are still in their infancy. However, there is no doubt they will begin to have a major impact on office automation beginning in the early 1990's, primarily in the area of decision support systems.

FOOTNOTES

CHAPTER 3

3-1 "The Race to Build a Super Computer, Newsweek July 1983

3-2 "Land of the Rising 5th Generation Computer", High Technology, June 1983

3-3 Dr. Stewart Lee, University of Toronto, Technology Panel

3-4 a) Canadian Datasystems, "Optical Memories To Get The Light", April 1984

b) High Technology, "Optical Memories Eye Computer Markets", February 1984

c) Datamation, "Optical Disks Forseen", June 1, 1984

d) Communications of the ACM, "Laser Optical Disk: The Coming Revolution in On-Line Storage"

3-5 Howard Anderson - "Which Way to the Electric Desk?" Office Technology, 1985 Conference

3-6 James Mackie, Vice President of Office Technology, Mitel, October 1985

3-7 Infotel Systems, B. C.

3-8 Bob Hudyma, Icable Inc., Technology Panel

3-9 Dr. Stewart Lee, University of Toronto, Technology Panel

FOOTNOTES

CHAPTER 3
(Continued)

3-10 Creative Strategies International, Office Automation Markets, 1983

3-11 Marcel Wein, NRC, Technology Panel

3-12 Technology Panel

APPENDIX 3A

TECHNOLOGY PANEL AND AGENDA

TECHNOLOGY PANEL MEMBERS

Professor A. Roger Kaye
Department of Systems and Computer Engineering
Carleton University

Mr. Clarence Bell
Vice President, Marketing
Rolm Canada

Professor Stewart Lee
Department of Computer Science
University of Toronto

Mr. Robert Hudyma
Icable Manufacturing

Dr. Marcelli Wein
Computer Graphics
National Research Council

Mr. Peter MacKinnon
Canadian Artificial Intelligence Products

Mr. Ike Goodfellow
Director of Data Processing Operations
IBM of Canada Limited

TECHNOLOGY PANEL AGENDA

9:00 - 9:20	INTRODUCTION
9:20 - 10:35	PABXs
10:35 - 10:50	COFFEE BREAK
10:50 - 12:00	LAN INCLUDING LAN/PABX?
12:00 - 1:15	LUNCH
1:15 - 2:45	SOFTWARE
2:45 - 3:00	COFFEE BREAK
3:00 - 4:00	TRENDS AND ISSUES

APPENDIX 3B

DEFINITIONS

OFFICE COMMUNICATIONS SYSTEMS

TERMS AND DEFINITIONS

TERM	DEFINITION
ARTIFICIAL INTELLIGENCE	The development or capability of a machine to perform functions that are normally concerned with human intelligence such as, learning, adapting, reasoning, self correction, automatic improvements.
ASCII	American Standard Code for Information Interchange. ASCII and EBCDIC are the most widely used codes for alphameric information.
ASYNCHRONOUS - DATA	Data is sent a character at a time without any prior arrangement as to how many characters will be sent per unit time, but the rate at which a character's bits are sent is predetermined. Each character is preceeded by a start bit and followed by one or two stop bits. Asynchronous is a low-speed form of communications, operating in the range of 60 to 19,600 bits per second.
AUTOMATION	A general term meaning the augmentation of human labour with machines.
BANDWIDTH	The range of frequencies that a communications channel is carrying. For example a voice-grade telephone line carries frequencies between 300 and 3000 hertz, giving a bandwidth of 2700 Hz.
BASEBAND	Refers to the use of frequencies between 0 and some upper limit as opposed to bands that lie entirely in higher frequency ranges.
BAUD	A unit of signalling speed equal to the number of discrete conditions or signal events per second. A measurement of signalling speed over a communications line.
BAUD RATE	The number of signal elements sent in one second over a communications line. The baud rate indicates how fast signals are being sent, whereas bits per second (bps) indicates the rate at which information is being transferred.
BIT	The smallest unit of information; an acronym for binary digit (i.e. 0, 1).

TERM	DEFINITION
BITS per second (bps)	The number of bits transmitted per second over a communications line.
BROADBAND	A term used to describe a bandwidth greater than a voice-grade line. Used for extremely high-speed data communications. Broadband is synonymous with wide-band. For LANs, it implies the use of carrier-frequencies to establish channels.
BUSINESS COMPUTING	The application of computers to solve business information needs.
BYTE	A group of some fixed number of bits (usually eight) that comprise a character, a machine instruction, or some other logical unit of information.
CAD/CAM	Acronym for computer-aided design and computer aided manufacturing. Specifications are inputted into the computer, graphically displayed, modified and then sent to the manufacturing center.
CARD READER	A machine that reads the holes in punched cards and passes the data to a computer as input.
CHARACTER	Specifically a letter, digit, or other graphic symbol. Generally a byte.
CRT	Cathode Ray Tube - An electronic vacuum tube, i.e. TV tube, that can be used to display graphics, images, text. In vernacular, any video display terminal associated with a computer.
CYBERNETICS	The quasi science of applying principles of human thought and brain processes to computers.
CPU	Central Processing Unit: The unit of a computer that includes the circuits controlling the interpretation and execution of instructions. Generally viewed as the brain of the computer.
CENTREX	Central office telephone equipment serving subscribers at one location on a PABX basis. Allows services such as direct inward dialing, direct distance dialing and console switchboard.

TERM	DEFINITION
COAXIAL CABLE	A tubular cable in which one conductor is a sleeve that completely encircles the other, which is a wire.
COMPATIBILITY	The ability of hardware or software or both components to work together.
DAISYWHEEL	A type of print mechanism in which a wheel with character images spins in front of the paper, and when the character to be printed is in the proper position a hammer drives the slug against the paper.
DASD	Direct-Access Storage Device. A DASD is any storage device that can immediately read or write anywhere on its recording surface -- every place is addressable.
DATA BASE	A file containing information on a particular subject or subjects.
DATA BASE MANAGEMENT SYSTEM	DBMS. A complex software system for controlling, reading and updating data bases.
DATA CAPTURE	The method for acquiring data for input to a computer.
DATA ENTRY	A function such as keypunching to capture data in a form suitable to be fed into a computer.
DATA PROCESSING	The collection, arrangement, and refinement of data into a usable form, or to achieve a particular result through the use of computers.
DATA SECURITY	Refers to the protection of data from theft, environmental damage, incorrect data alteration, as well as controlling access to the information by authorized personnel only.
DEMODULATE	To convert encoded analog signals received from a communications line into digital bits for input into a machine. This forms the basis for most data communications (opposite process is called modulation).

TERM	DEFINITION
DENSITY	The amount of information stored per physical unit of area or space on a magnetic storage medium.
DIGITAL	The use of binary numbers to symbolize characters or values.
DOT MATRIX PRINTER	A type of printer that uses dot matrix character formation to produce copy. The print mechanism consists of a vertical row of wires aimed at the paper. As the print head moves across the paper, high-speed solenoids drive the wires against an inked ribbon to make the dots.
DIGITAL CIRCUIT	A communications channel that carries data in a digital rather than analog form.
ELECTRONIC MAIL	The use of computerized message switching to send information from one person to another or from one organization to another.
EMULATE	Making one device behave like another. For example, using software to make an IBM PC look like an IBM 3270 CRT terminal to the mainframe.
ENCRYPTION	The enciphering of information for purposes of security and secrecy.
ENCRYPTION KEY	A group of bytes of data, themselves unintelligible, that hold the information required to encipher or decipher data according to some prearranged method.
EPROM	Erasable Programmable Read Only Memory. A type of memory chip on which a program can be written electronically and which will not lose its contents even if power is removed, but which can be erased when required.
FACSIMILE	FAX. A technology for scanning visual documents and photographs, reducing images to digital form, transmitting them over a communications facility and then reconstructing them.

TERM	DEFINITION
FIRMWARE	A program that is permanently recorded in a PROM and therefore essentially a piece of hardware that does software functions. Also called microcode.
FLOPPY DISK	A low cost portable rotary storage medium (magnetic) frequently associated with small computers.
FIBER OPTICS	A technology for transmiting information via light waves through a filament of glass.
GALLIUM ARSENIDE	A crystalline material used to make extremely high grade semiconductors. Superior to silicon, but are very rare and expensive.
GATEWAY	A connection between two separate data communications networks, enabling the exchange of information.
GRAPHICS	The production of lines, angles, curves and other non-alphanumeric information by a computer on a video display terminal, printer or plotter.
HARD DISK	A small, high-capacity disk storage device for use with a microcomputer, i.e.: Winchester disk.
HARDWARE	Physical equipment used in data processing; the actual equipment.
HIERARCHICAL STORAGE MANAGEMENT	A time-and-usage sensitive method of managing large amounts of data, in which the selection of a storage medium for a particular file depends on how soon and frequently the information is needed. The storage media are prioritized, so that DASD is at the highest level, mass storage is at the next level, and tape at the lowest. Hierarchical storage management is an automatic process under software control in most systems.
HIGH LEVEL PROGRAMMING LANGUAGE	A human-oriented language in which computer programs are written. For example, COBOL is considered high level, while assembler is low level (machine language).

TERM	DEFINITION
HOOK	A hook is a published interface to an operating system which will enable a variety of application software to be written to run on the operating system.
HOST COMPUTER	The computer that is in control of a communications network or of another computer.
IEEE	Institute of Electrical and Electronic Engineers.
IMPACT PRINTER	A line printer that prints by striking the paper, i.e. dot matrix printer, daisy wheel printer.
INFORMATION SYSTEM	Any coordinated combination of computer hardware, software and data that work together for a specific set of goals.
INTEGRAL MODEM	A modem built directly into a communicating machine, as contrasted with an external modem.
INTEGRATED CIRCUIT	A large number of related electrical conductors, transistors, and other electronic components, microscopically placed on a semiconductor substance. Abbreviated IC; often called a chip.
INTELLIGENT DEVICE	A machine whose internal functions are directed by a program. Intelligent devices are usually terminals or peripherals attached to a larger computer. They receive directions from the computers, but they do not rely on the computer to control their internal operations.
INTERACTIVE COMPUTING	An operating environment in which a computer and a human at a terminal conduct a dialogue. The human can enter programs and data, edit and execute programs, etc., usually seeing the results immediately.
I/O	Input/Output. A general term that encompasses the input/output activity and the device that accomplishes it.

TERM	DEFINITION
ISO	International Standards Organization.
JOYSTICK	A manual control most often seen in connection with computer game. The joystick is a lever that can be moved any direction from the vertical. It sends a byte to the computer, the numeric value of which indicates the position.
KERNEL	1) A software product that must be modified by the buyer before it can be used on a specific machine. 2) Sometimes used in the sense of nucleus; the central portion of a computer operating system.
KEYBOARD	Input device similar to a typewriter keyboard.
LANGUAGE PROCESSOR	A utility that translates human written source programs into a form that can be executed on a computer.
LARGE-SCALE INTEGRATION	Semiconductor chip technology. The placing of thousands of microscopic circuits, transistors, resistors... on a tiny piece of semiconductor material (i.e. silicon). Refinement of this technology includes VLSI (very large scale integration, and ULSI (ultra large scale integration).
LASER MEMORY	High density data storage where bits are burned into a smooth surface as tiny pits by a high powered laser beam. They are read by a low powered laser that scans the surface, detecting bit patterns via reflectivity. The surface is not erasable or reusable but can contain billions of characters on a small surface (i.e. video disk), therefore, it is excellent for archival purposes.
LASER PRINTER	An extremely fast electrostatic printer. As the paper travels through the printer,it passes a laser that forms character images in dot matrix patterns as dots of static electricity. A metallic dust then blows across the paper, sticking to the static dots and falling off uncharged areas. A heat process melts the powder, fusing it to the paper to form inked printing.

TERM	DEFINITION
LAYERED ARCHITECTURE	A concept applied to the design and control of very large data-communications networks. All components of the network fit at one level or another within a pyramidal control structure; the higher the layer, the broader its span of control.
LAYERED PROTOCOL	The rules for passing communications among levels in a hierarchial network using layered architecture.
LDM	Limited Distance Modem. A low-cost device used to send and receive data signals over short-haul line (i.e. less than 5 miles).
LED	Light Emitting Diode. A solid-state device that glows as electricity passes through it. Often used for indicator lamps.
LIGHT PEN	A device used for marking a position on a light screen. When the tip of the light pen is placed near the surface of the screen, a signal is emitted that is picked up by the control electronics of the CRT, translated into an XY address, and then passed to the computer.
LINE DRIVER	An alternative term for limited distance modem.
LISP	A high-level programming language that is especially suited for symbolic manipulation and analysis.
LOCAL AREA NETWORK	LAN, an in-house data-communications system that allows a number of information processing devices to be linked up with each other on a local basis.
MACHINE LANGUAGE	The binary code read by the control section of a central processor.
MANAGEMENT INFORMATION SYSTEM	A co-ordinated system of hardware, software, and data whose purpose is to provide business information for management review and decision making.

TERM	DEFINITION
MASS STORAGE SYSTEM	A peripheral designed to store vast amounts of information and to provide access to the information automatically and quickly.
MASTER UNIT	When two intelligent devices are connected it sometimes becomes necessary to designate one as the master unit and the other the subordinate or slave unit.
MB	Megabyte, one million bytes.
MEMORY	In general, memory is the ability and device which enables a machine to store information, subject to recall.
MICR	Magnetic Ink Character Recognition. The ability of a machine to read human-legible alphanumerics by detecting the shapes of their magnetic fields. MICR is used mainly on bank cheques.
MODEM	A device placed between a communicating machine and a telephone line to permit the transmission of digital pulses.
MULTIPLEXER	A device that combines several separate communications signals into one and sends them out on a single line.
MULTISYSTEM NETWORK	A data-communications network with two or more host computers, with facilities which allow a terminal to be able to select the computer that it wants to communicate with.
MULTI TASKING	The concurrent execution of two or more tasks by a computer.
MULTI USER	Generally refers to the ability of a computer to support several interactive terminals at the same time, with the appearance that each user has exclusive use of the computer system.
NETWORK	A group of communicating devices e.g., terminals and computers.

TERM	DEFINITION
MODE	In a data-communications network, a device that performs control functions, thus influences the operation of the network.
NON VOLATILE	A memory or data storage device that retains its information content when the electrical power is removed.
OFFICE AUTOMATION	An office exists to meet certain functional needs of an organization, therefore the goal of office automation must be to improve these basic business functions. Office automation is the technology utilized to realize the improvement of office functions and tasks, it can typically include workstations, communications networks, departmental computer systems.
OFFICE INFORMATION SYSTEM	An office information system is a set of electrically connected components which are able to meet the information requirements of all the workers in an office(s).
OFFICE COMMUNICATIONS SYSTEM	A co-ordinated system of hardware, software and data whose purpose is to provide business information (data, text, graphics, image and voice) to be exchanged electronically among office workers.
OPERATING SYSTEM	The master control program that governs the operation of a computer system. It is always present and active while the computer is running. Depending on the size and complexity of the system, it can control the following: . Job entry control - means for other programs to be started . Input/output services . Convenience services, e.g. timers . Data Management, e.g. storing, retrieving, indexing . Supervision, i.e. controlling memory
OPTICAL CHARACTER RECOGNITION	OCR. The visual recognition of letters, digits, and other symbols legible to both a machine and human. In OCR, a printed document is passed through a scanner that translates the shapes of symbols into binary codes, that are then passed as input data to the computer.

TERM	DEFINITION
OPTICAL MEMORY	See laser memory.
PABX	Private Automatic Branch Exchange. A microprocessor based telephone switching system which provides for the transmission of calls to and from the public telephone network.
PBX	Private Branch Exchange. A manual or automatic telephone switching system.
PERIPHERAL	A generic term encompassing the input/output and data storage systems attached to the computer, and generally located adjacent to it.
PERSONAL BUSINESS COMPUTER	A professional quality microcomputer suitable for handling most of an individual's computing needs in a business sytem.
PIXEL	Acronym for picture element. Several pixels are combined to form a character image or graphic.
PLUG COMPATIBLE	Two competing pieces of equipment can be exchanged, without having to make changes to accomodate their differences.
PORT	A communications connection on a computer or remote controller, suitable for attaching a single line.
PORTABILITY	Refers to the ease of transferring a program from one computer type to another.
PROM	Programmable Read Only Memory. A memory whose contents are not lost when power is removed, and which can only be read.
PROTOCOL	The rules and formats for conducting communications on a large network. The protocol controls the way messages are addressed and routed, relationships between modes, hierarchy policy and the exchange of control information.

TERM	DEFINITION
QUAD DENSITY	A data recording format on a floppy that can accomodate four times as much information.
RAM	Random Access Memory. A common term for the semiconductor memory of a computer.
RANDOM ACCESS	The ability to read or write at a particular location in memory or a file without passing sequentially through preceeding locations.
ROM	Read only memory. A semiconductor memory chip whose contents can be read, but only written on by special means.
READ/WRITE HEAD	A device that both records and reads data on a moving magnetic surface, e.g. tape or disk.
REAL TIME	A method of data processing in which data is acted upon immediately instead of being accumulated and processed in batches.
RS-232	A standard of the Electronic Industries Association describing the most commonly used interfaces between communicating data processing equipment and modem.
SEMICONDUCTOR	A material whose resistance to the flow of electricity can be varied by the presence of an adjacent electrical field, magnetism, or light. The most common material used is silicon.
SEMICONDUCTOR DISK	A large memory designed to emulate a disk drive.
SNA	Systems Network Architecture. A product offering of hardware and software by the IBM Corporation for integraded data-communications/data processing systems.
SOFTWARE	A generic term for computer programs.

TERM	DEFINITION
SYNCHRONOUS	A data communications term describing the way signals between machines are timed. In synchronous communications, a pre-arranged number of bits are expected to be sent across the line in large frames in groups at a specified rate e.g. 4800 bps.
SYSTEMS INTEGRATION	The combining of products from a number of vendors, both hardware and software, to provide a turnkey system tailored to a particular kind of business or application.
TELECOMMUNICATIONS	Voice and/or data communications using communication networks.
TELEPROCESSING	The combination of telecommunications and data processing.
ULSI	Ultra Large Scale Integration. An evolution of large scale integration LSI.
VDT	Video Display Terminal, often called a CRT.
VIRTUAL	Giving appearance of being without actually being; an important concept in data processing systems, where virtual techniques trick the computer system or program into believing there are more resources available than there actually are.
VIRTUAL MACHINE	A portion of a computer system or time, that belongs to an operating system and functions as an entirely complete system though it is not. Under the virtual machine concept, two or more wholly independent operating systems share a computer concurrently.
VIRTUAL STORAGE	A method for assigning a program a larger address space than is actually available.
VLSI	Very large-scale integration. See large scale integtarion (LSI).
VOICEPRINTING	Computerized analysis of human speech to detect unique characteristic (similar in concept to fingerprinting).

TERM	DEFINITION
VOICE RECOGNITION	Input of data or commands to a computer system via speech.
VOICE SYNTHESIZER	A computer output device that emulates a human voice.
VOLATILE MEMORY	Memory that loses its contents when the power is removed.
WAFER	A large, flat crystal of semiconductor material on which many chips are manufactured. After the circuiting has been applied, the wafer is cut into individual chips.
WINCHESTER DISK	A disk drive where the pack (rotating data storage medium) is contained within an air tight housing.
Z80	A microprocessor chip mainufactured by Zilog, Inc., used frequently in microcomputers.

Reference: The New American Computer Dictionary
Data Communications Dictionary
Dr. Roger Kaye, Carleton University