A Profile of the Microelectronics Industry in Canada

Prepared for:
Bureau of Business and Economic Development
Department of Regional Economic Expansion
Ottawa, Ontario, K1A 0M4

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March 17, 1981

Mr. R. Bourgeois
Director
Bureau for Business and Economic
Development
Department of Regional Economic Expansion
Sixth Floor
Place du Centre
Hull, Quebec
K1A OM4

Dear Mr. Bourgeois

It is with pleasure that we submit our report to you on a "Profile of the Microelectronics Industry in Canada". As you are aware we surveyed a limited sample of 20 companies, but they included some of the larger and successful firms engaged in the manufacture of high technology products in Canada. The overall market growth of the microelectronics high technology industry in Canada ranges from 30% to 40% per year. In the companies surveyed, growth rates ranged from 15% to 200% per year with an average of 53%.

Our general conclusions support the thesis that Canada can continue to participate (and indeed expand its total market share) in this high technology field and develop businesses with a high percentage of export sales. We also believe that opportunities exist for the location of companies, employed in the manufacture of microelectronics products, in the designated and slow-growth regions of Canada.

We enjoyed working with you and your colleagues and we were very pleased to have the opportunity to work on this project for the Department. In our

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opinion it will be possible to see some tangible results realised from data that has been produced, leading eventually to capital investment and the creation of jobs in the disadvantaged regions.

Yours truly,

W.A. Hoy
Vice President
DPA Consulting Ltd.

WAH/sb

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Acknowledgements

Recognition is given to the several experts & specialists contacted and to the 20 companies who generously gave their time to contribute to the input of this study. A list of the companies and personnel is given in Appendix 1. Chart 1 was produced by computer graphics, courtesy Phoenix Graphics Ltd., Ottawa. The electronic circuitry on the cover was supplied through the kindness of CAD/CAM Graphic Systems Ltd. of Ottawa.

EXECUTIVE SUMMARY

In this study of the microelectronics industry in Canada two major sources of information were used: data from Statistics Canada, and an interview survey of 20 companies using or making microelectronic products.

The overall market growth of this high technology field ranges from 30% to 40% a year. In the companies surveyed, growth rates ranged from 15% to 200% per year with an average of 53%. The younger companies were noted to have the larger growth rates.

The microelectronics industry is one of considerable growth potential with a strong entrepreneurial base offering good prospects for Canadian development in major urban centres, a number of which are covered by DREE's programmes. Highlights and findings of the study follow.

1. Business Office Administration equipment (typewriters, word processors, micro-computers and terminals) has the second highest imports by value of the major microelectronic groups. It is also the second lowest in domestic shipments. This group represents a key potential growth area for Canada, and import substitution should definitely be considered in the Department's strategic planning and identification of "prospect" industries.

2. Another group that should be considered seriously is the home electronics market. World-wide sales are estimated at $200 billion by 1995 and the potential market for Canadian firms, both domestic and exports, is simply enormous.

3. During the course of the interviews that were conducted, a number of examples of imported high technology machinery and equipment were identified. Two companies in the survey

had numerically controlled machine tools for metal working that cost up to $150,000 each and were considering buying others. These machine tools are made in the U.S.A.. Also considerable potential has been identified for the growth of computer aided manufacturing (CAM) in welding, turning and milling and the application of robots. It is in areas such as these that DREE should now focus some effort, i.e., in-depth market definition and identification of market demands. This should be followed, once the promising microelectronic product has been identified, by a pre-feasibility study to attract the necessary Canadian manufacturing interest.

4. Chips and integrated circuits are presently made in Canada, but they are generally of the specialty kind. Standard chips are imported. There is a tendency to dismiss the standard type chip manufacturing as uneconomic for Canadian firms considering the competition from Asian countries, and that therefore Canada's effort and energy should be concentrated in the specialty market that requires individual components and requires Canadian ingenuity and specialization. It would be difficult for Canada to break into the manufacture of standard designed chips, but at the same time it appears unfortunate if this massive market of the present, and even more of the future, were to be foregone without a serious effort to gain entry.

5. A strong case can be made that supports Canadian involvement in the High Technology field. The often held view that automation through microelectronic controlled machinery will result in redundancy may well be true, but the converse of this argument is that if Canada does not advance as quickly as possible with the development of microelectronics, then a competitive advantage will be lost and a certain loss of jobs will take place.

6. By and large, companies in the microelectronics field like to congregate in the same region, or locate near an area where there is a critical mass of knowledgeable people and other companies. Ottawa is a prime example and it is considered by many in the industry that the Ottawa Valley sub-region has the largest concentration of such companies in Canada. What attracts these companies to Ottawa? Clearly, the already established NRC, Northern-Telecom - the giant Bell subsidiary - and two universities in an essentially white-collar town, has a considerable bearing on the matter. Key factors that were identified were human resources and industry symbiosis. In considering alternative locations, therefore, clearly a sizeable urban area, or ready access to an urban area, is an important factor. Aside from the considerations of lifestyles and social needs of educated people, high technology companies cannot find the skilled manpower they require to function efficiently in small or remote towns. Thus, DREE, in its strategic planning for the microelectronics industry, should not focus on a number of potential sites (the scatter-shot approach), but carefully select a chosen few. We would suggest that Montreal, or immediate environs, Quebec City, Halifax, Winnipeg and perhaps Saskatoon should be chosen sites. All are sizeable urban areas, all have universities and an excellent supporting infrastructure.

It is recognized that by recommending a select few cities, other locations that are deserving of consideration will be missed out. It should be noted that smaller cities in slow growth regions will be able to sustain one, two or more firms in the micro-electronic field. Nevertheless, it should be also borne in mind that if the Department wishes to create an environment where there is a critical mass of skills and people and an atmosphere where the appropriate inter-company osmosis and expansion can take place, then every effort should be made to focus and concentrate on a well chosen and select few cities that meet the main locational criteria.

In certain of the microelectronic firms access to international air travel is also important, especially to the U.S.A.. Only two of the 5 cities named have frequent and regular flights to the U.S.A. (Montreal and Winnipeg), although all of them, of course, have access by freight transfer.

7. Research and access to research facilities is an important criterion in the spontaneous growth of companies in microelectronics. Thus, the spawning of ideas from Universities is important. During the course of field work it was identified that Universities were the original source of new ideas, leading to the establishment of small companies, but which materialize into larger ones. The best example of these are those industries that cluster around the large research orientated universities in California and Boston. Universities provide important seeds for new entrepreneurial ideas and, in the right climate and given appropriate support, can lead to flourishing spin-offs in the form of microelectronic manufacturing facilities. Saskatchewan's Sedco has recognized this potential, as Sedco's biggest single project to date is the multi-million dollar research centre under construction in Saskatoon. The centre will house university research facilities, several private research organizations and companies such as Northern Telecom Ltd.. DREE development officers could capitalize on the potential available in university towns by working closely with identified opportunities and be prepared to offer package deals to encourage and realize new facilities in this critically important sphere.

8. Section 6 identifies a number of companies that plan to increase their production capacities over the course of the next 2 years. There would appear to be some immediate opportunities for DREE to develop. For large, well established companies we would suggest that, after DREE has undertaken sufficient homework, an approach

be made to the Board of Directors of these firms by a very senior member of the Department to stimulate and gain the necessary initial interest.

In interviews with companies included in this survey, the question was asked whether the company planned to expand within the next 2 years. In section 6, there are some case examples of companies that replied in the affirmative. However, it should be noted that large, established companies tend to do their strategic planning in 5 to 7 year time-frames. In the context of the large capital investment spending on new plant facilities (that can involve today anywhere from $50 million to well over $1 billion) a time horizon of 5 years for these companies is just around the corner. In the first two years the market gap is identified and detailed analysis is undertaken to identify the likely portion of that market that can be secured in the competitive market place. Financial justification and detailed feasibility analyses then take place and the engineering specifications are prepared. Construction for large facilities take 18 months to 2 years.

Our point here is that this internal process is going on continually within large corporations and that therefore DREE should not just consider the relatively near term prospects and the realization of new jobs in 2 year time-frames. While this is attractive and should be pursued, it would also be wise policy for the Department to identify viable sector or product areas and initiate discussions with the appropriate manufacturing corporations at an early stage and ensure all the options are known to the company and included in their planning process.

10. In some instances key components of the finished product are imported from the U.S.A. These components have U.S. manufacturers' patents and cannot be made in Canada if there are restrictive licensing arrangements. One President of a Canadian company stated that every effort should be made to contact the U.S. multinational companies directly, present a proposal package and endeavour to attract them to Canada. The lowering of tariffs under the Tokyo GATT round has made it possible for American firms to locate in Canada, with a world product mandate from their parent company, and export to mainland U.S.A., Europe and Latin America profitably. Digital and IBM are two such examples where this inter-company product rationalization has already taken place.

11. From discussions that have been carried out with the senior management of several firms during the development of this profile, it was clear several lessons could be learned. The common thread that comes through is that some of these companies would perhaps have behaved differently had they been more aware of DREE's programmes. The companies surveyed represented a very small percentage of the manufacturing sector, which would indicate that were DREE more aggressive and pro-active in its marketing of the Department's programmes, much interest might be stimulated and many more developments could take place in disadvantaged areas.

12. The overall impression was that senior management of the large and small microelectronics firms would be responsive to a dialogue with the Department on site selection issues.

A PROFILE OF THE MICROELECTRONICS INDUSTRY IN CANADA

SECTION 1. INTRODUCTION

It is generally acknowledged that the microelectronics industry is one of the fastest growing sectors of the economy, not only in Canada but in most of the industrially advanced countries of the world. Growth rates of companies in this high technology activity of microelectronics were found to be in the range of 30% to 40% a year with some reporting successive annual increases of 100%. In one particular sector of this high technology field Canada has achieved a position of world leadership, producing components and systems in telecommunications that are used around the world.

This study is designed to develop a profile of the high technology field of microelectronics and explore the potential for new applications and innovations for Canada, particularly in areas of slower economic growth. The study does not investigate in detail marketing opportunities for specific products but rather attempts to identify product areas that warrant further detailed examination for location in the slow growth regions.

The study will include:

a) an exploration of the scope of application of microelectronics to existing manufacturing and processing;

b) the possibility of new microelectronic products and the estimated extent of this market;

c) an estimate of potential for Canadian manufacture of the microelectronic components to satisfy the applications referred to in points (a) and (b);

d) the likelihood of regional application of the new growth in microelectronics as defined in the above points (a), (b) and (c) and will contain a list of companies in DREE designated areas which might likely have an opportunity to participate in this growth.

METHODOLOGY

The study was comprised of three parts:

- the gathering of information from the literature and from experts and those in key positions in the field;
- the conduct of a survey by interviewing people in senior positions in 20 companies in the microelectronics business;
- the analysis of the data obtained and the compilation of a report.

Interviews with experts and specialists in the field included those in the federal Departments of Industry, Trade and Commerce, and Communications, and the Ontario government Task Force on Microelectronics, certain associations, and other knowledgeable professionals. A list of these contacts is provided in Appendix 1.

In the survey of companies using or making microelectronics, twenty organizations were contacted in Ottawa, Montreal, Toronto, Hamilton and Burlington. The names of the companies and the personnel contacted are also included in Appendix 1.

Following this Introduction, the following section will cover a definition of terms, and an outline of the market structure and just what is included, for the purposes of this study, in the microelectronics sector of the economy. Section three of the report will describe the present market for electronics and microelectronics in Canada. Following this, section four will explore prospects for the future. Section five will discuss the potential for new products arising from the literature and company interviews. The next section will look at the impact of microelectronics on the economy and society over the near term future. This will be followed by a section on why high technology companies locate where they do; and notations on what companies in the group surveyed might have plans to locate in designated areas. Finally, conclusions will be drawn in section 7.

SECTION 2. DEFINITIONS & MARKET STRUCTURE

Definitions

The term microelectronics arose from the developments of miniaturization in electronic circuitry. Instead of wires, vacuum tubes, resistors, capacitors, and such components, the development of the printed circuit and semi-conductors permits the making of a complete electronic circuit - including these components - on a thin wafer of silicon ¼ inch square (or diameter) and smaller.

A Semi-Conductor is made from silicon with certain impurities added. Its function is to replace the transistor - which replaced the vacuum tube. It permits miniaturization of electronic circuitry to microscopic size. By printing the circuit on a wafer of silicon, a number of semi-conductors can be provided.

A Chip is a printed circuit on a wafer of silicon which has been made so small it is called a "chip". It consists of layers of insulation, conductor, resistance so that the functions of resistance, capacitance, and transistors are provided in a flat and tiny configuration. The circuit is designed originally in a convenient, readable, workable size on a computer view screen and reduced by a photographic process to the ultimate microscopic dimension. Chips range in price from a few cents each to a hundred dollars or more according to whether the unit is a standard one, made by the tens of thousands, or a one-off special design of some complexity.

A Printed Circuit Board (known also as a PCB) is an electronic circuit printed on a non-conducting material using a conducting metal for "ink". This system replaces the former method of using metal wires. Holes are provided at points along the lines where the components - resistors, capacitors, transistors, integrated circuits and other components - are later placed and soldered in. A PCB can be designed by computer graphics and manufactured by completely automated equipment. Sizes range from a rectangle a few inches per side to boards a foot or two per side. Prices also vary according to size and complexity - from about $3 to several thousand.

An Integrated Circuit is a chip or a series of chips in a plastic or insulated cover with metal connectors sticking out like a centipedes legs. A common size is ¼ inch wide by ½ inch long, and 1/8 inch thick with protruding "legs". They come in a variety of sizes up to say 1 inch by 3 inches and 1/8 inch thick with the ever present "legs". Prices range from about 50 cents each for simple standard ones to several hundred dollars for specials.

A Hybrid Integrated Circuit is an electronic circuit printed on a ceramic base with several layers of film to serve as insulation, resistance, and conducting but containing no silicon layer to perform the semi-conductor function. These components are added to the unit as required. Sizes commonly vary from an inch or less in width and length, to several inches. Usually the unit is provided with connection "legs" to facilitate its application. Prices range from about $2 to several thousand depending on the volume manufactured and the degree of complexity.

A Thick Film circuit is one deposited on a ceramic base where resistors are also deposited on the base, and transistors (in miniaturized chip form) added to the surface. Connection legs are provided, extending off the sides. Sizes and prices are similar to integrated circuits.

Into these devices - and assemblies of them as described above, can be incorporated programs, memories, time measurement and time delays. Output can be in terms of signalling switches to go on and off - and at specific times - and to give out information that has been stored, or the device can be used to act as a memory to monitor and store information such as temperatures, dimensions, or discrete events and to respond with feed-back if so instructed.

The potential applications of such devices can be seen to be almost endless. For purposes of this study the applications have been classified into three major groups:

I) The basic components - chips, integrated circuits, PCB's
II) Microelectronics in manufacturing and processing, i.e. to help make other products
III) Microelectronics in products or services.

Within these 3 major groupings the following products are manufactured:

I. The basic microelectronic components.

These include the chips, the integrated circuits, including silicon, hybrid and thick film, and printed circuit boards and related components and devices.

II. Microelectronics in manufacturing and processing.

This includes the use of instruments and controls, either incorporated in machines and processes or as separate units, as an inherent part of the production process. Robots are included in this group as well as the activity known as CAD/CAM.

CAD/CAM is a frequently used acronym for Computer Aided Design/Computer Aided Manufacturing. CAD includes computer graphics, computerized drafting, and the use of the computer in calculating stresses and forces in structural design, and even in designing electronic circuitry for chips and PCB's. CAM includes robots, computerized materials handling, numerically controlled machine tools, and a very wide variety of microelectronic applications through sensing and feed-back devices. Applications are not only in manufacturing but in chemical processing, smelting and refining, agriculture and all aspects of the resource extraction industries.

III. Microelectronics in products and services.

This group includes consumer products - radio, TV, appliances - and applications in communications, office machines, microcomputers, electronic funds transfer and information handling. It also includes equipment used in scientific, medical, education and other specialized fields. Some products in this group might overlap into the manufacturing and processing group above.

Two sources of information on the size and/or nature of the present market in the microelectronic industry have been used in this report. One is the data compiled by Statistics Canada and the other is from the interviews with people in the microelectronics business.

Statistics Canada do not have a specific microelectronics classification. They do have one on Electrical and one on Electronics. Since the Electrical classification includes heavy equipment, cable, pole line hardware, turbines and so forth, this classification will not be used here. The Electronic classification, however, includes nearly all the product classes in which microelectronics figure prominently, so this will be used to provide the statistical data for the industry.

An appreciation of the extent of coverage and structure of the Electronics group will be gained from an examination of the content of this classification. See Table 1, which follows. [1)]

The next section will discuss the present and future market characteristics for the microelectronics industry.

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1) 1979 Annual Report "Electrical and Electronic Industry - Abstract of Industry and Trade Statistics" Department of Industry, Trade and Commerce, Ottawa See pages 24 - 26.

TABLE 1

Classifications Included in the Electronics Industry.

Electronic Sector

S.I.C. 334 - HHLD. Radio & TV

Phonographs, coin-operated, esc. pts.
Tape players, recorders exc. pts
TV receiving sets, color, under 19"
TV receiving sets, color, 19"
TV receiving sets, color, over 19"
TV receiving sets, nes under 19"
TV receiving sets, nes 19"
TV receiving sets, nes over 19"
Radio receiving sets, automobile
Radio receiving sets, nex exc. pts
Phonograph record players, dom exc pts
Comb. radio-phonograph sets exc pts
Receiving antennae & mounting exc pts

S.I.C. 335 - Communications Equipment

Telephone appar equip & parts
Telegraph appar equip & parts
Sonar echo sound & rel dev & pts
Radar equip & rel dev & pts nes
Radio transmitting receiving units
Radio, TV, broad Transm equip nes
Commercial communication equip nes
Navigation instrs appar & pts
RR & transit signal systems & pts nes
Alarm & signal systems & ptc nes

S.I.C. 335 - Electronic Components

Sound amplifiers
Television picture tubes
Electronic receiving tubes
Pts of electronic tubes nes
Integrated circuits
Semi-conductors, transistor type
Semi-conductors nes
Parts of semi-conductors
Capacitors, electronic & parts
Resistors, electronic & parts
Crystals, mounted & holders
Transformers, electronic type & pts
Inductors & coils electronic & pts
Power supply units & pts, pks electro
Microphone & parts
Speakers, electronic communication & pts
Tuners
Printed Circuit boards
TV, radio & phono sets chassis
Pts of phono record players nes
Pts of tape players & recorders nes
Electronic equip components nes

S.I.C. 318 - Office Machines

Acc bookkepp. mach & pts nes
Adding machines & parts
Address, mail handl machs & pts
Calculating machs & parts
Card punch, sort & tab machs & pts
Electronic computers & pts
Cash register
Pts & attach for cash registers
Coin handl & rel machs & pts
Dictating & transcr mach & pts
Duplicating machines & parts
Typewriters, electronic, word proc
Typewriters, electric
Typewriters, portable
Pts attach & access for typewriters
Office machs equip & pts nes

S.I.C. 3911 - Instruments & Related Products

Elec prop meas instrs & pts
Oscilloscope, oscillograph & access
Elec prop record instrs & pts
Signal gen & test oscillators
Elec & electro meas test instrs pts
Thermometers
Thermostats
Gas meters & parts
Flow level meas & control instrs pts
Motion, rotation meas control instrs
Meteorological instrs appar & pts
Thermal meas & control insts nes
Humidity meas & control instrs
Pressure meas & control instrs
PH meas & gas analysis instrs
Comb meas & multi function instr
Meas & control instrs nes
Parts of meas & control instr nes
Spectrophotometer colorimeter & pts
Geophysical mineral pros equip pts
Nuclear radiation meas equip & pts
Photocopy & similar machs & pts
Microfilm equip & parts
Blue & white print proc equip & pts

SECTION 3. PRESENT MARKET AND FUTURE PROSPECTS

The present "Apparent Domestic Market" for microelectronic products as described in the IT&C report, [1] was 5.5 billion dollars in 1979. Although this does not pick up all the applications of microelectronics, it does represent the major part of it.

In Table 2 which follows, it is interesting to note the relationship between the domestic production (shipments) and exports and imports for the four categories listed. The "Apparent Domestic Market" is determined as the Shipments plus Imports less Exports. For convenience this can be expressed algebraically as:

$$ADM = S + I - E$$

Ideally the domestic market should be fully supplied by Shipments, that is by production in Canada. And Exports should be high and Imports low. What really is happening is often the opposite. In all categories but one in Table 2, the imports are larger than the domestic production.

Opportunities for some of these imports to be replaced by made-in-Canada goods would seem to exist. However, in many cases the low costs made possible by high volume in the country of origin and low import barriers make it difficult to compete. The relationships between the domestic shipments, exports and imports is shown in the graphical representation of Chart 1.

The foregoing discussion is based on one of the two available sources of information - statistical data published by Statistics Canada. The other source of information, interviews with people in, or connected to, the microelectronics industry provides a somewhat different perspective. In 15 of the companies interviewed, exports averaged 47% of their output, with imports relatively low. Perhaps this is characteristic of the particular

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1) Ibid, p.90

TABLE 2

Domestic Market, Foreign Trade and Employment for the Electronic Industry

- 1979 -

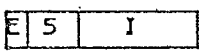
Industry Grouping	Ship-ments	Imports	Re Exports	Imports Less Re-Expo	Exports	Apparent Domestic Market	Imports % A.D.M.	Exports % Ships	Trade Balance Balance	Trade Balance Commercials		Ships % A.D.M.
	- million dollars -											
Electronic Industry	3513.5	3873.6	255.4	3618.2	1619.4	5512.3	65.5	46.1	-1998.8	-36.3	-1.0	63.7
334 Radio & TV	238.0	543.8	2.8	541.0	104.4	674.6	80.2	43.9	- 436.6	64.7	+6.7	35.3
335 Comms & component	1925.2	1410.7	67.6	1343.1	749.7	2518.6	53.3	38.9	- 593.4	-23.6	+1.0	76.4
318 Office Machs	639.9	1343.1	168.4	1174.7	641.6	1173.0	100.1	100.3	- 533.1	-45.4	-4.5	54.6
3911 Instruments	710.4	576.0	16.6	559.4	123.7	1146.1	48.8	17.4	- 435.7	-38.0	-0.6	62.0

CHART 1

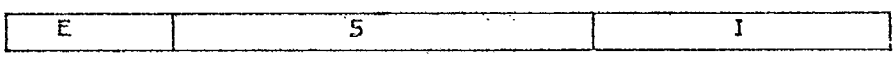
THE ELECTRONIC INDUSTRY

SHOWING THE RELATIONSHIP OF EXPORTS (E) SHIPMENTS (S) AND IMPORTS (I).

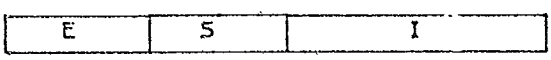
RADIO & T.V.



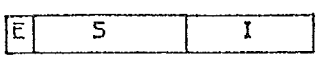
COMMUNICATIONS & COMPONENTS



OFFICE MACHINES & COMPUTERS



INSTRUMENTS



REFERENCE: "ELECTRICAL & ELECTRONIC INDUSTRY - ABSTRACT OF INDUSTRY & TRADE STATISTICS" 1979 ANNUAL REPORT DEPARTMENT OF INDUSTRY TRADE & COMMERCE

companies visited and is related to their expertise. Linear Technology, for example, in selecting their product specialty decided to concentrate on one special type of microelectronic chip and be the best in the world in that product. Now their exports comprise about 90% of their total business - and they export some to Japan, the acknowledged leader in the making of high quality chips.

Another factor to be kept in mind in looking at the statistical performance of the electronic industry is the service end of the business. As can be seen in Table 1, it includes no category for software and services to the microelectronic industry. Software and system development is a large portion of the microelectronic/computer/ information handling activity. For example, the programming and service requirements for computer accounting and office automation is a major part of an installation, and this market will certainly increase. The closest Statistics Canada classification for this is Computer Service Industry (SIC 853). This has two sections and is shown here for 1978 in Table 3. [1)]

As with other Statistics Canada classifications, the input for these figures comes from the larger companies and misses what, in this business, is a large part of the market - the individual and the smaller company.

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1) Ibid

TABLE 3

1978

COMPUTER SERVICE INDUSTRY - S.I.C. 853
INDUSTRIE DES SERVICES INFORMATIQUES - C.A.E. 853

	Computer Service Suppliers Fournisseurs de services informatiques	Hardware Suppliers Fournisseurs de machines	Total
Number of establishments Nombre d'établissements	698	32	730
Employment Emploi	13,148	8,855	22,003
Revenue Type: ($'000) Sorte d'exploitations:			
-Processing Services Services de traitements des données	313,762	x	-
-Input Preparation Préparation de l'entrée	36,823	y	-
-Software & Systems Services Services de logiciel & de systèmes	112,150	23,330	135,480
-Other Computer Services Autres services informatiques	28,531	68,691	97,222
-ADP Hardware Sales & Rentals Location de machines T.E.D.	36,259	748,094	779,353
-Unidentified & Other Non-identifier & autres	9,261	39,701	48,962
-Total Revenue Total d'exploitations	531,786	879,816	1,411,602

X- included in unidentified & other...inclus dans non-identifier & autres.
Y- included in other computer services...inclus dans autres services info.
A- Sources of Operating Revenue of Companies & institutions Engaged in Providing Computer Services to the Public as a Secondary Activity...
Sources des recettes d'exploitation des entreprises & institutions fournissant des services informatiques au public a titre d'activité secondaire.
Source: Stat/Canada - Cat. 63-222.

What are the future prospects for this market? An interesting forecast is found in the publication "U.S. Industrial Outlook 1980".

Growth trends of all manufacturing industries in the U.S. in 1979-80 ranked Electronic Computing Equipment tenth, following industries such as Aircraft Engines and Parts, Automatic Environmental Control, Process Control Instruments and Industrial Heating Equipment. [1] However, the forecast for growth in the 5 year period 1979 - 1984 ranked Electronic Computing Equipment number one, with a compound annual rate of change of 11.7%, the highest of all industries. In the same comparison Electronic Components moved up from 50th to fourth place in real growth rates, and Consumer Electronics from 141st to 10th. It is more than likely that "as the U.S. goes, so goes Canada" in this particular respect.

It seems that every other day one reads in the newspaper or a trade journal of similar high growth figures in various aspects of the microelectronics business. [2]

In the companies surveyed for this report the annual growth rate reported by 14 companies averaged out at 53% with a range of 15% to 200%.

There is ample evidence that the microelectronics industry will see substantial growth in the decade ahead, and provide Canadians with many domestic and export opportunities.

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1) "U.S. Industrial Outlook 1980", U.S. Dept of Commerce, Washington, D.C., Jan 1980

2) See, in this connection, Financial Post Special Supplement, Jan 24, 1981

The balance of the section will look at the present and future market prospects in terms of the three major classifications that have been identified, with references to statistical data and the information gleaned from the interviews.

I Chips

Chips, integrated circuits, printed circuit boards are the essence and the beginnings of microelectronics applications.

Statistics are available on the imports and exports of semi-conductors, which would include chips, hybrids, and integrated circuits.[1] These show, for 1979, imports valued at $216 million and exports at $34 million. No data is given on shipments but this can be estimated. Most of the chips and integrated circuits that are of a standard variety are imported into Canada in fairly large volume. Only the specials with proprietary designs are made here. If it is assumed that the amount of chips made here would be ¼ of the amount imported, then the "Apparent Domestic Market" would be an estimated $50 million for shipments plus $216 million of imports less $34 million of exports, or $232 million.

In Canada, a number of firms are manufacturing both silicon and ceramic based chips but in all cases they are special designs made to their own or customers' specifications.

Manuacturers of chips and the related basic micro-electronic products are found in Bromont, Que., (IBM, Mitel) in Ottawa, (Northern Telecom, Mitel, Epitek, etc.) Brockville (Computer Assembly Systems) and Burlington, Ont. (Linear Technology).

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1) Ibid, p. 37

Most people interviewed on the subject of manufacturing chips in Canada agreed that it was not practical or economic to compete with the standard chips produced by the Americans and Japanese. Canadian production, they felt, should concentrate on the special purpose products and those designed and made by a company for its own use.

II Microelectronics in Manufacturing and Processing

There is no single Statistics Canada classification that would indicate the extent of the market in the use of microelectronics in manufacturing and processing. Computers and microprocessors are used in a wide variety of industrial activities. The use of robots and CAD/CAM activities have already been mentioned. The cost of labour and the cost of energy have made microelectronics applications much more attractive to cost conscious industries.

Robots are a particularly interesting development, fast rising in popularity. A recent study estimates the North American market to be $79 million in 1979. This in itself is not as significant as the rate at which it is growing. In 1977 the market was estimated to have been $26 million and in 1985 it is forecasted to be $438 million.[1] General Motors in the United States is reported to have 270 robots and there are presently more than 3000 in the USA.[2] Robots range in price from $7500 to $150,000 and can, according to one survey interviewee, be made in any location that is cost effective.

The field of CAD/CAM, computer aided drafting and computer aided manufacturing, is also a large and growing market for microelectronics. Application areas are outlined in a

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1) Engineering Journal, Dec 1980, p. 26

2) Time Magazine, Dec 8, 1980, p. 52

report on this subject by the "CAD/CAM Technology Advancement Council" of the Department of Industry, Trade and Commerce, and shown in Table 4. [1)]

In BARRON's of Dec 22, 1980, a report on CAD/CAM estimated the market (U.S.) at $430 million a year, growing at 40% per annum. This would mean a market of $2.3 billion by 1985.

Computer aided design (CAD) is also a fast growing technology. This activity requires a heavy investment in software, and offers two sources of business income:

- development of the hardware and software as a package for lease or sale;
- sale of services on a company's own CAD hardware and software.

Software in the field of design and graphics to accompany the design function is expensive to produce at today's level of sophistication. Elaborate programs have been developed over time that cost a million dollars. Programs for special purposes can be developed for a reasonable investment, and give a high return on investment.

Phoenix Graphics of Ottawa, interviewed in the survey, is selling equipment and services in computerized design and drafting. Designs once made can be instantly re-scaled from inches and feet to metric or changed in overall size, individual sections picked out and enlarged and so forth.

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1) From "Strategy for Survival", CAD/CAM Technology Advancement Council, Department of Industry, Trade and Commerce, Ottawa, September 1980.

TABLE 4

SUMMARY OF CAD/CAM APPLICATION AREAS

Computer Aided Design	- Production design and analysis including graphic design, functional analysis, stress strain analysis, heat and material balances, simulation and modelling, data reduction and analysis and cost estimating of the proposed product or system to determine fitness of purpose and economically optimized production.
Customer Order Handling	- Record keeping, tracking and reporting on the status of individual customer orders, particularly when part of an integrated on-line system.
Production, Material & Inventory Control	- Scheduling and information handling pertaining to material requirements planning, inventory control, facilities planning and order scheduling, particularly when related to an integrated on-line system.
Automated Production	- Numerical and computer control of machine tools, lathes, milling, boring machines, pattern and fabric cutting, welding, brazing, plating, flow soldering, casting, flame cutting, spray painting and automated assembly (all of these exist and are under further development).
Automated Material Handling	- Integrated materials handling using computer operated conveyors, robotic units, etc.
Automated Testing	- Automated inspection of machined parts, testing of electronic components, circuits and products, automated material inspection and grading using sensor based computer systems, pattern recognition.
Automated Packaging	- Computer implemented coordination of material and information in packaging, bottling, labelling and weighing systems.
Automated Warehousing	- Computer implemented order picking and material handling for both work in progress inventory and finished goods inventory. Automated label reading, routing of packages, parcels, baggage in shipping, sorting and distribution centers.

Notes: - CAD/CAM technology will yield its greatest economic and productivity gains when all or most of the above application areas are married or joined together to form an integrated system. Hence there is a strong development trend in this direction.

Computer Assembly Systems of Brockville are using a computerized design program to set up printed circuit boards, and integrated circuits - which are then manufactured in a fully automated process. Other companies in Canada are doing this as well.

Computer aided manufacturing (CAM) like its partner CAD, has a very large future for the application of microelectronics. A number of these have already been mentioned.

Two companies in the survey, Canadair and CAE Electronics, had numerically controlled machine tools for metal working that cost up to $150,000 (made in USA) and were contemplating adding others. Both of these companies also had computerized drafting (made in USA) and one had computer controlled wire wrapping machines. Neither company had, or were presently considering, robots.

Considerable potential was reported for the growth of the CAM activity in welding, turning and milling.

Almost all companies in the survey had computers in their shop for information handling - scheduling, reporting, inventory and parts control.

Instrumentation of processes, once mostly electrical, are now being converted to electronic with digital readouts replacing the old dials with indicating pointers. Microprocessors are also being used not only to record the process data but are programmed to signal the process at critical points to adjust automatically and correct variations from the norm. This is a very large market and such systems and devices for process monitoring control can be manufactured for use domestically and in the export market. One company visited, CAE Electronics, did have such a business in Canada (with some exports) to the extent of $100 million per year.

Nearly all of these high technology companies mentioned their use of microelectronics in testing equipment. The Instrument classification in Statistics Canada (SIC 3911) shows good opportunity for manufacture of instruments in Canada. Linear Technology had developed their own testing equipment to such a degree that they were considering making it in volume and marketing it to other high technology companies. Because of the nature and variety of test equipment, the possibility of new and innovative technology has interesting prospects for development of this activity in Canada.

In addition to the use of microelectronics in manufacturing there is a large potential application in the processing industry - pulp and paper, petrochemical, oil refining, resource extraction, smelting and agriculture to name a few.

Canadian International Paper described the computer application to a computer controlled continuous paper making process at a cost of $500,000.00. This included the systems engineering, the computers, microprocessors, the sensing devices and feed-back controls. This contract was let to a Canadian company, and another of similar size let to a U.S. company. They expect to spend another $1.5 million over the next five years for similar projects of process control. Table 4A shows market potential for the above.

III Microelectronics in Products and Services

The products and services to which microelectronics are applied, range over a very wide spectrum, but for purposes of this report have been grouped into:

Consumer goods
- radios, TV's, appliances
- home computers
- computer games
- home energy control and security devices

TABLE 4-A

TABLE 4-A MANUFACTURING AND PROCESSING	Software - retail	Hardware	Capital Investment	Competition	Market Readiness	Export Potential	Made in Canada Potential	Good Potential for Regional Development
CAD - Computer Aided Design	x		h	h	m	l	l	
		x	m	h	m	m	m	
CAM - Computer Aided Manufacturing								
- Numerically Controlled Machine Tools		x	h	h	h	h	m	
- Robots		x	m	m	h	h	h	x
- Welding, Machining, etc		x	m	m	h	h	h	x
Computers in material control, data analysis	x		l	h	h	m	m	
		x	h	h	h	m	m	x
Automated materials handling & warehousing		x	m	h	h	m	m	
Process control (chemicals, refineries smelters)		x[1]	h	m	h	h	h	x
	x		m	m	h	h	h	x
System design & implementation	x							
		x	m	m	h	h	h	x

1) Includes instrumentation

Education
- instructional programs
- information retrieval
- computers for students

Communications
- telecommunications
- interactive TV
- electronic mail

Business and office administration
- electronic funds transfer
- office automation
- word processors
- information handling
- accounting and reporting

Laboratory, scientific and medical
- instrumentation
- computer controlled devices

Consumer Goods

At one time electric motors began to invade the home and now each North American home has quite a number of them - furnace, refrigerator, clocks, hand tools and so on. Now is the beginning of a period when electronics in the home will dramatically increase. The accompanying chart shows the rate of increase in microelectronics expressed as "bits of memory and logic" in the home over the period 1930-1990. [1)]

The use of microelectronics in consumer goods is in the very early stages. Computer games, home or hobby computers, are increasing rapidly in popularity. The production of radios and television sets, once an active industry in

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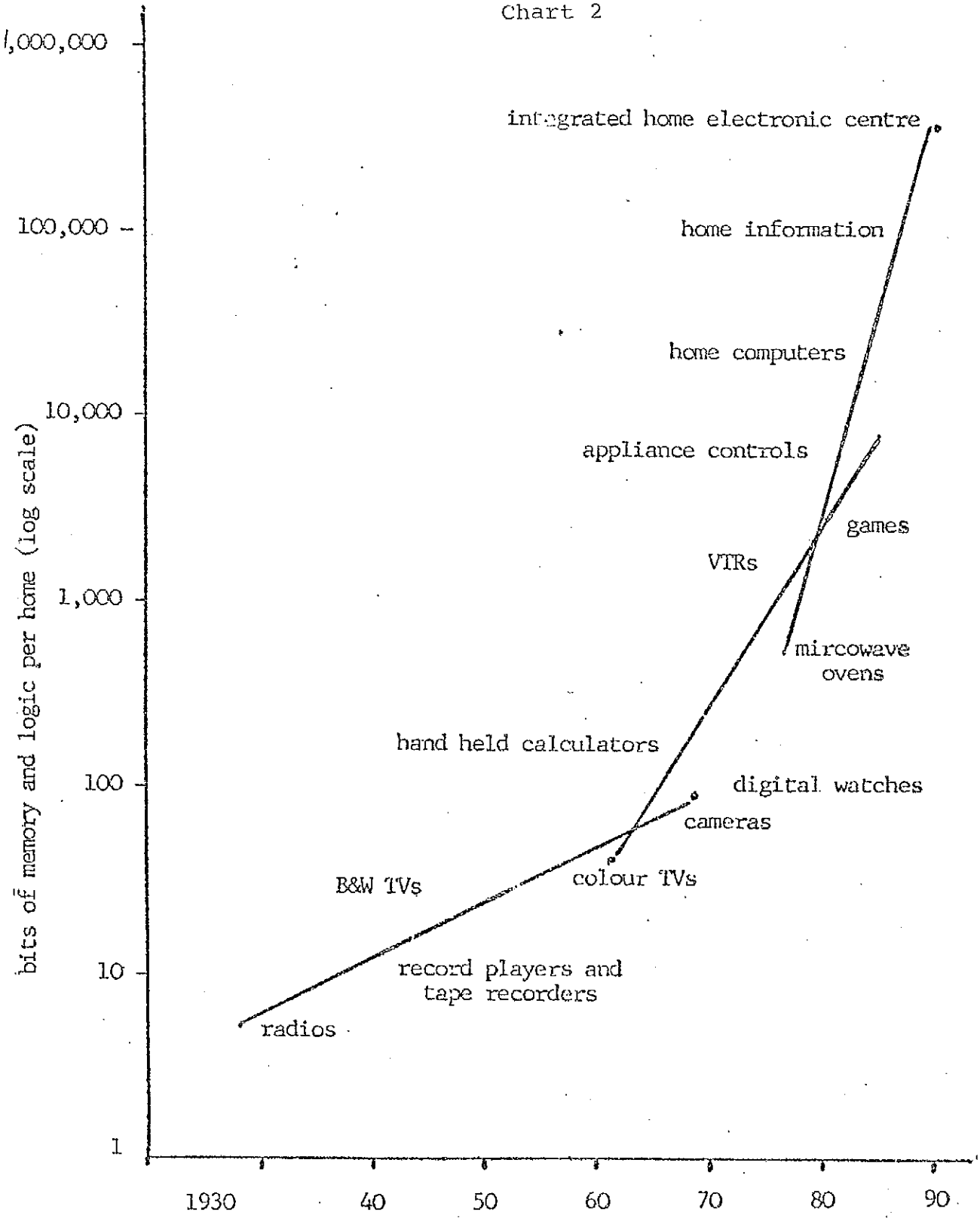
1) The Economist, London, June 16, 1979

Chart 2



Intelligent electronics in the average American home

Canada, has become so automated and standardized that almost all North American production has moved to Asian countries. Only about 1/3 of the apparent domestic market for radios and TV's is presently satisfied by domestic output. (See Chart I).

Home computers, or micro-computers, is a fast growing market. Presently a home computer with disc drive and display costs about $2,000, and represents about 15% of a worker's salary. In 10 years this could be down to 1% of a worker's salary and an affordable item for the home. Since it will communicate, educate, entertain and control, the sales potential is quite high. It is predicted that the market for home electronics in 1995, because of the interaction of the micro-computer with the many activities of the home, will be $200 billion - a five fold jump from 1979. [1)]

With the cost of energy steadily increasing, the home computer, or special microprocessor, will be used to program the heating, lighting and energy consumption in the home. And it will pay to do this.

With the advent of Telidon - Canada's entry into the interactive TV information centre - the microelectronics of the home will increase significantly. Telidon may eventually be the nerve centre of the home.

Some of these aspects of microelectronics in consumer goods are shown in the following Table 5 which gives some empirical judgements on market significance.

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1) Computer Data, January 1981, Page 17; and Interface Age, December 1980, Page 68

TABLE 5

TABLE 5

CONSUMER GOODS

	Software - retail	Hardware	Capital Investment	Competition	Market Readiness	Export Potential	Made in Canada Potential	Good Potential for Regional Development
Electronic Games	x		l	h	h	h	h	
		x	h	h	h	h	m	
Home Computers (hobby and personal finance)		x	h	h	h	m	m	
Energy and appliance program devices for the home		x	m	m	h	h	h	x
Digital Tuning Radios		x	h	h	m	l	l	
Home Security Devices		x	m	l	m	m	h	x
Medical diagnosis programs diet etc. for Telidon	x		l	l	l	h	h	
Programs for home computers	x		l	m	h	h	h	
Information/communication utility (e.g. The Source)	x	x	h	l	l	m	h	

h = high

m = medium

l = low

Education

The present level of sales of computers and microelectronics to the educational system is relatively low. This suggests that a large future market exists but also suggests that the supply of computer-familiar (to say nothing of computer-trained) young people will be far short of needs and will be one of the great constraints of the future growth of the microelectronics business in Canada. The current status of the computer in the schools in the United States is discussed by Walter Koetke in the January 1981 issue of Kiloband Microcomputing. There is no evidence that Canadian schools are this far advanced. The size of the U.S. market is indicated in both software and hardware.

> "Seymour Papert's current work that provides individual microcomputers for each member of a third grade class will no longer appear to be a unique, idealized experiment. I suggest that students at most grade levels will have easy access to computing facilities. The existence of computer laboratories that can provide one computer for each member of a class is no longer unusual at the secondary school level and rather common at the college level. Spokesmen for Pittsburgh's Carnegie-Mellon University have vowed that by 1985 every freshman enrolled in the university will be issued a microcomputer as part of the university's orientation package. Certainly many other institutions will follow the lead of Carnegie-Mellon.
>
> Dr. Papert has observed that purchasing microcomputers to be issued to each first grader would add very little to the present expense of educating a child for 12 years. When you consider the educational potential of this expense, you might easily assert that the initial first grade cost increase would result in actual savings over 12 years. Microcomputers will be in the hands of perhaps the majority of college students, will be readily available to most secondary students and will be accessible by many elementary students.
>
> Dr. Molnar of the National Science Foundation made a statement that might be paraphrased as 'Any teacher who still thinks he or she might be replaced by a computer, should be.'

> One generally conservative source places 1980 school expenditures for computer hardware and software in excess of $90 million. Roughly 30 percent, or $27 million, represents the software portion of this expense. The same source projects that educators will spend nearly $800 million for computer hardware and software in 1985. Approximately 60 percent of that amount, or $480 million, will be spent on software (in the U.S.)"

Canadians might well look to the needs of their schools and plan to provide made-in-Canada micro-computers, with the attendant software for them. The potential is large, but will the Canadian school systems buy from the domestic producers?

An assessment of the educational market follows, (Table 6), using the same rating system as that for consumer goods.

Communications

Canada - particularly through Northern Telecom & Mitel Corporation - has done well at producing and exporting telephone equipment and technology to the U.S. and other countries of the world. Both Gandalf and Mitel, two Canadian companies interviewed, supplying the Communications industry, exported over 50% of their output, and were growing at 100% per year.

The communications sector of the electronic industry (see Table 7) ships two to three times as much as the other three sectors in the Electronic Industry classification. Exports are also the highest in dollar value but ratio of exports to shipments is low compared to some of the companies interviewed. Mitel report that 95% of their business is outside of Canada - either manufactured here and exported or manufactured outside of Canada. Canadair, Computer Assembly Systems, and Linear Technology all export over 90% of their output.

Growth rates in the surveyed companies were, on average, much above the Statistics Canada figures for the Electronic Industry. Companies such as Mitel, Gendalf, CAE Electronics, Computer Assembly Systems all were growing at over 80% per year.

New technology in the application of microelectronics to the communications industry will be of two kinds. Both will be important:

- one is the upgrading of the quality of the existing products and lowering the costs;
- the other is the development of entirely new products and systems.

Future growth will be related to the converting of electromechanical switching to electronic, then to digital. This function will be a heavy user of chips and large integrated circuits.

The advent of Telidon suggests opportunities for support and supplemental hardware plus an infinite appetite for information and software.

Other products will be developed in the industry as suggested below, (Table 7).

TABLE 6

EDUCATION MARKET	Software - retail	Hardware	Capital Investment	Competition	Market Readiness	Export Potential	Made in Canada Potential	Good Potential for Regional Development
Microcomputers		x	h	h	l	l	m	x
Educational programs	x		m	l	l	l	h	
Laboratory test Equipment		x	m	m	m	h	h	x

If every other secondary and post secondary school in Canada put in a laboratory of 25 micro-computers for every 500 students, over a three year period, the annual sales of computers would be $75 million. This adds up to a substantial market, and could well be a conservative estimate.[1)]

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1) See calculations of estimate: Appendix 4.

TABLE 7

TABLE 7 COMMUNICATIONS	Software - retail	Hardware	Capital Investment	Competition	Market Readiness	Export Potential	Made in Canada Potential	Good Potential for Regional Development
Supply to the Telephone Industry		x	h	h	h	h	h	x
Components -								
- Integrated Circuits		x	h	h	h	h	h	x
- Modems		x	m	h	h	h	h	x
Telidon Support		x	m	m	l	l	h	x
	x		m	l	l	l	h	x
Military		x	h	m	m	-	x	

Although some of the younger companies in the telecommunications field are growing at rates of 30% to 100% per year, the industry (SIC-335 Communications & Components) in total is not. The present level of domestic production of $2 billion per year has been growing over the past 10 years at rates between -1% and +38% with +12% being the average. The domestic and export market in 1985 then will be about $3.4 billion in telecommunications equipment and components. Considering the Apparent Domestic Market, this will grow, by the same reasoning, to $5.8 billion by 1985, at the average 10 year rate of 11.5%.

Business & Office Administration

In the Statistics Canada category of Office Machines (SIC 318) many (as will be gathered from Table 1) are mechanical/electrical and not electronic, nor micro-electronic. This however is changing. For example a whole new generation of electronic typewriters is now on the way.

Imports supply a major portion of the domestic market (see Chart 1). The ratio of imports to shipments is higher than for any of the other three classifications in the Electronics Industry. The apparent domestic market is however the second highest next to Communications. This shows a good potential for Canadian products. It is notable that Fortin Electronics of Winnipeg - a small local company - is building and marketing their own word processor, and electronic business office equipment.

The automatic office with electronic word processing, computerized accounting and filing, computerized management information systems and communication, has been talked about for some time. It is, however, in the early stages. Most people interviewed indicated it had good growth prospects, but none expected a rapid adoption of it. In fact, only a few companies reported using word processors and none were found to be using the communications package. Many companies used computers for accounting, record keeping, and inventory control.

The potential for microcomputers in the small business field in Canada has been estimated by William Hutchison as follows:[1)]

> "There are 56,000 firms with sales under $10 million in this country and only 10% have computers."

Based on an estimate by R.W. Hough for the Department of Communications, the market for electronic equipment in the office - typewriters, word processors, microcomputers and terminals - over the next few years will be about one billion dollars annual sales. Unless Canadian manufacturers enter this market in a substantial way, the greater part of this business will go to foreign producers.

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1) Financial Post, Special Report, Jan 24, 1981

The market potential, in essence, is as follows:

TABLE 8

BUSINESS AND OFFICE ADMINISTRATION	Software - retail	Hardware	Capital Investment	Competition	Market Readiness	Export Potential	Made in Canada Potential	Good Potential for Regional Development
Word Processors		x	h	h	m	l	m	x
Microcomputers for the business office		x	h	h	h	m	m	x
Accounting, filing management information systems	x		l	m	h	m	h	
Photocopying		x	x	x	x	l	l	

Laboratory, Scientific and Medical

This category of application of microelectronics to laboratory, scientific and medical, has good potential for innovation, specialization and Canadian manufacture.

The present apparent domestic market for Instruments in Canada (SIC 3911) is shown in Table 2, at $1.1 billion in 1979. During the previous 2 years it grew at over 20% per year. At the same time exports in this category increased at an average of 38% in that period. The application of microelectronics in this category thus has considerable promise.

Some product types are addressed in Table 9 below.

TABLE 9

LABORATORY, SCIENTIFIC AND MEDICAL	Software - retail	Hardware	Capital Investment	Competition	Market Readiness	Export Potential	Made in Canada Potential	Good Potential for Regional Development
Testing devices for laboratory and industry		x	m	l	h	h	h	x
Measuring instruments for temperature moisture, etc.		x	m	h	m	m	h	x
Medical diagnostic systems	x	x	m	m	h	h	h	x
Medical treatment equipment		x	m	m	h	h	h	x

In the classification of Instruments the figures in Table 2 show a negative trade balance for 1979 but 62% of the apparent domestic market is being met by domestic production. Again, on a relative basis this represents a fairly good Canadian contribution to the total market.

The application of microelectronics to military needs has not been given a separate grouping in this study. It is intended that these products will be included throughout the other classifications such as manufacturing, communications, scientific and medical.

With some appreciation of the size and scope of present & future markets for microelectronics, the next section will explore new products and applications in the various categories.

SECTION 4. NEW PRODUCTS, APPLICATIONS, AND MANUFACTURING OPPORTUNITIES

During discussions with the surveyed companies, a number of suggestions were received relating to new products and applications in the microelectronics field.

In the area of chips and integrated circuits, it was generally felt that only special chips should be made in Canada and the standard ones - the nuts and bolts of the business - should be imported. Innovative designs and specialty products are the more appropriate direction for Canadian manufacturers to go.

However, two people felt that standard chips should be produced in Canada to provide a made-in-Canada product, and to have the facility available when shortages, or other reasons, cause chips to be unavailable or in short supply from other countries.

Two or three suggested that there is a potential market for chip testing devices and related services. The resources of universities, technical colleges and research centres could be explored for available technology in this field.

The potential for new products and microelectronic applications in the manufacturing and process sector appears to be very high.

In manufacturing, the development of CAD/CAM is evidence of this interest in applying microelectronic devices and systems to the improvement of productivity and the conservation of energy.

In computer aided design two approaches can be considered for applying microelectronics:

- the development of computer-graphic products: hardware and software; and,

- the offering of design services, using sophisticated equipment.

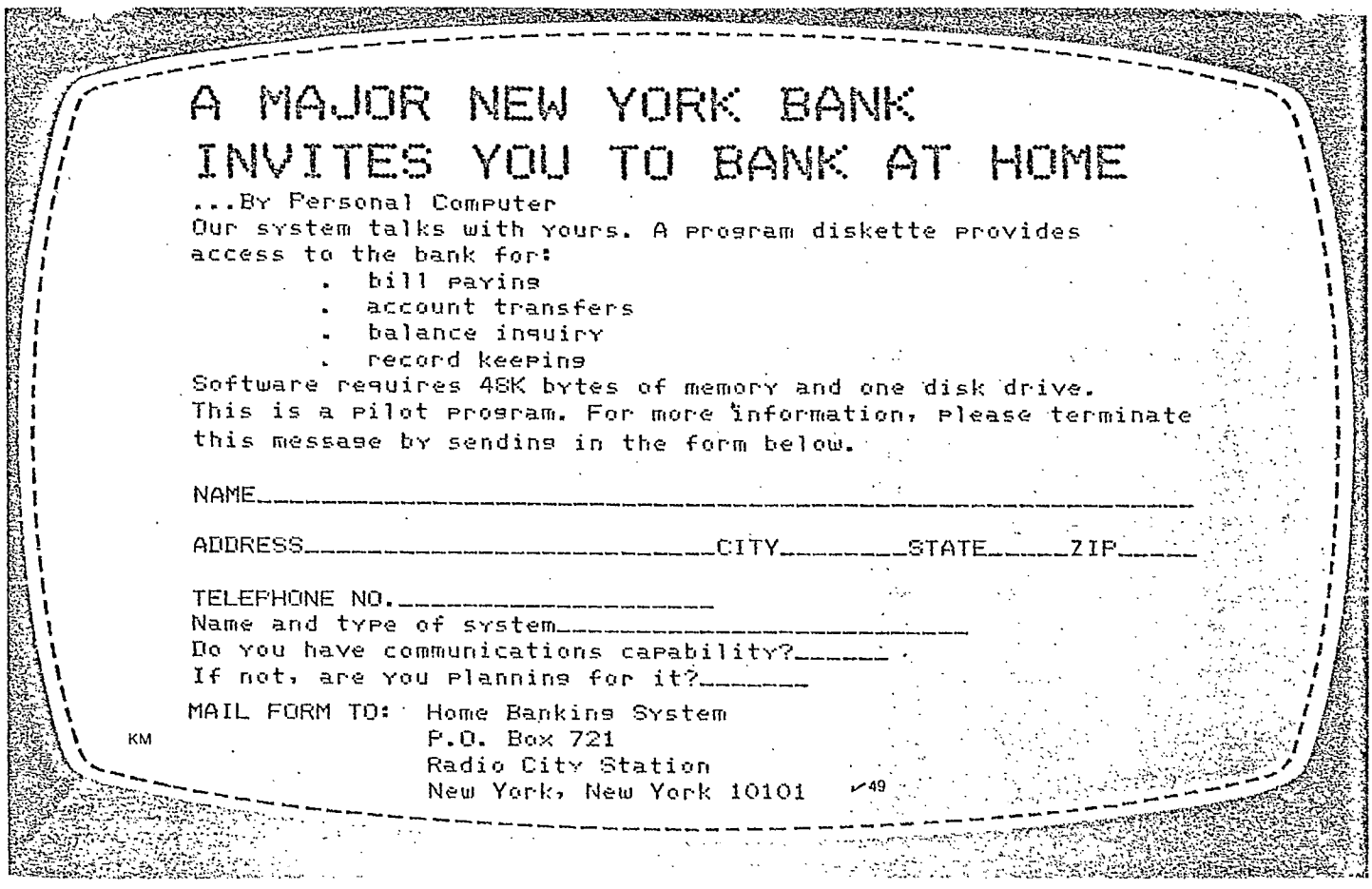
Opportunities to start such activities could be sought by locating interested individuals - or companies - and providing the necessary financial support and seed money. One chief engineer suggested that a CAD service be set up and operated out of a university.

In computer assisted manufacturing, the development of better ways of making things, moving things, and controlling things, provide many opportunities for applying micro-electronics. Again, the opportunities are often realized through the identification, encouragement and support of individuals who have ideas to be developed. As the president of Digital Equipment observed, someone should make a tour of Canada, visiting universities, technical colleges, industrial laboratories, and research centres, seeking out the people with ideas, or even locating prototypes that are ready for further development.

Robots were found, both in the literature and in the interviews, to be products of considerable potential. It is possible that with sufficient backing a better mouse trap can be designed and built by Canadians and marketed within and outside Canada. It would be worth-while to bring together the microelectronics specialists and machine tool builders towards a joint enterprise. A pick-and-place robot for a price of $10,000 was the concept of one microelectronics company executive - CAD-CAM Graphics. Export potential for such a product would seem to be quite good. Once the $10,000 robot was proven, then more elaborate ones could be developed and a Canadian expertise developed.

The potential of using micro-computers to monitor and control manufacturing and processing operations has considerable potential. This has application in power stations, chemical plants, and industrial processes. The example of the $500,000 contract for a systems engineering firm to automate a chemical process is one that suggests the potential growth of this type of technical services business. Such companies could locate anywhere - close to good air transportation - and offer professional services across Canada, and internationally. Again, it is a matter of finding the necessary people as a nucleus for an organization. Universities and technical colleges would seem to be good foci for such activities.

Potential application of microelectronics in the consumer goods and communications markets is also very high. It is in the communications sector that Canadian companies have been so innovative and so successful. The growth area still to be developed here is in expanded communications in the home with the advent of Telidon and the personal computer. The home computer and terminal market is somewhat competitive, a fast-growing one, but one that has potential for innovative products. Note the advertisement appearing in the January 1981 issue of MICRO-COMPUTING on banking from your home. It is not a dream of the future. It is here now, and needs a home computer terminal!



A MAJOR NEW YORK BANK
INVITES YOU TO BANK AT HOME

...By Personal Computer
Our system talks with yours. A program diskette provides access to the bank for:

- bill paying
- account transfers
- balance inquiry
- record keeping

Software requires 48K bytes of memory and one disk drive. This is a pilot program. For more information, please terminate this message by sending in the form below.

NAME_____

ADDRESS_____CITY_____STATE_____ZIP_____

TELEPHONE NO._____
Name and type of system_____
Do you have communications capability?_____.
If not, are you planning for it?_____

MAIL FORM TO: Home Banking System
KM P.O. Box 721
Radio City Station
New York, New York 10101 ✓49

The development of a hand-held alpha-numeric key-pad, to save buying a full typewriter-style keyboard, would be a useful product to manufacture to prepare for the advent of Telidon.

Computer games in software form can be marketed from any location by mail-order - or telephone. Customers would be those with home computers throughout North America. Games in French or bilingual programs would be an appropriate product for Canadians. Other software products would include programs for accounting, financial management, diet regimes, health care, fitness, etc.

The development of home management devices for energy programming, environment control and security are rapidly

gaining in popularity and could be manufactured in Canada and exported as well.

The field of education is a promising future market for the application of microelectronics. Both hardware and software products have large potential for innovative development. Boards of education are gradually buying micro-computers for student use. As in many applications of computers to the economy and society, software programming is behind the technology. Much has to be done in the development of education programs to catch up with the potential of the hardware. There are microelectronic applications in the laboratory as well as the classroom.

The chief staff engineer of Westinghouse Canada mentioned the possibility of developing microelectronics testing devices for school laboratories - particularly technical schools and community colleges. Presently the electrical meters and devices cost about $7,000 per work-station (ie. per student in the laboratory). The application of microelectronics to this, providing one micro-computer unit with video screen per student work-station, with teacher inter-connection and memory storage, could be produced for perhaps $1,500 per student.

In the field of business and office administration new applications will more likely be in the development and installation of integrated systems, than in the development of new equipment. The copier, the word-processor and computer terminal have all been developed to a point where they are well advanced but very few offices have been able to adopt the full set of inter-acting equipment. Small business has an almost desperate need for people to apply accounting and business information procedures to computer equipment.

Innovation, specialization and new applications of microelectronics in laboratory, scientific and medical

equipment has high potential for Canadian enterprise.

Someone described an electronic litmus paper. Carleton University has a limited company, "Contech E.T.C. Ltd", which was created to promote ideas germinated in the University, and to seek out manufacturers. Linear Technology reported (as mentioned previously) the development of an innovative testing device for integrated circuits that they would consider marketing. Another contact described a microelectronic device under development to sell for $300 that is for medical treatment, that permits reduction of inflammation and can be self-administered. Such developments lend themselves to Canadian ingenuity and specialization, where mass markets, mass production and heavy capitalization are not controlling factors. Explorations for products to be manufactured could be made by trips to the field - universities, research centres, company laboratories and medical centres.

Finally, the potential development and application of "new products" in software, both to make the chips work, and to provide people interaction, has great potential for Canadians. This has been mentioned in several categories, including:

- computer games;
- personal programs (diet, financial, etc.);
- education;
- business systems; and
- CAD/CAM.

Software and programming represents a new industry, created by the computer, and will eventually be a large employer. Some programming is best done in the heart of the marketplace, but much can be done, through modern methods of communication, in homes, or in remote places of the country.

SECTION 5. IMPACT OF MICROELECTRONICS ON THE ECONOMY AND SOCIETY

There is a certain uneasiness regarding the prospect of job displacement with the adoption of microelectronic devices throughout our economy. The automation of the office, the use of robots, the simplification and automation of manufacturing, all pose threats to job security, and the possibility of large lay-offs. Such examples of new methods of processing financial transactions as quoted by Colin Norman in "Microelectronics at Work" give justification to this concern.

> "The British insurance company, Friends Provident, is already developing its own internal services by transacting insurance through a nationwide network of display terminals, which also provide for the composition and printing of policy documents and the automatic handling of premium payments. This 'instant policy' system has, they claim, virtually eliminated all paper work from what was a notoriously paper-bound process. It used to take a minimum of three weeks to produce even a straightforward policy from the cutomer's proposal form, whereas with the new system a policy can be issued in three minutes. The Services Manager of Friends Provident anticipates staff savings of 40 percent, which will pay for the cost of installing the system.
>
> A similar transformation in the United States has taken place in the letter-of-credit department of Citibank's Wall Street office. Richard Matteis, a Citibank vice president, describes how the company automated the handling of letters of credit using a variety of computer-controlled equipment and record storage: "Where it once took days, 30-odd separate processing steps, 14 people, and a variety of forms, tickets, and file folders to process a single letter of credit, it now requires one individual less than a day to receive, issue, and mail out a letter of credit - all via a terminal that is fully online to a minicomputer-based system."[1)]

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1) Colin Norman, "Microelectronics at Work: Productivity and Jobs in the World Economy", Worldwatch Paper 39, October 1980, Worldwatch Institute, Washington, D.C., Page 37.

Whether the microelectronics revolution will change the trends of history is a moot question. Over the last 100 years no single technological change has caused a serious or sudden deflection in the overall productivity rate of the economy. It is the contention of the work of a group of British researchers that the microelectronic revolution may be in reality another technological evolution, and the jobs lost by one improvement will be picked up by another.[1] One point was clear, that if Britain (, and the same would hold for Canada) did not advance as quickly as possible with the introduction and development of microelectronics, she would lose the competitive advantage and then jobs could certainly be lost. It is apparent then, that the economic battles of high technology must be fought, and fought on an international scale.

Social changes of some significance will take place in all aspects of our lives, as a result of the adoption of microelectronic devices. In the office, the introduction of word processors, and the next generation of office equipment - voice activated machines - plus the adoption of computer communication will cause basic changes in work styles. Many professional and management personnel will work at home, communicating voice and text to the office, or to specific individuals wherever they may be. The easy access to data banks for research and management information will change work styles significantly, and improve the quality of performance and output.

Electronic mail and electronic funds transfer will also affect life styles at work and at home.

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1) Sleigh, Boarwright, Irwin, Stanyon, "The Manpower Implications of Microelectronic Technology", Her Majesty's Stationer's Office, 1979, London.

The school will undergo major changes with significant increases in productivity through the use of student computer terminals and the development of new methods of assimilating knowledge - and perhaps experience.

The introduction of the computer powered information (and entertainment) centre in the home will give society problems of information overload and raise the need to devise new ways to manage personal time.

Telephone, radio and television reduced the isolation of farmers and those living in small remote communities. The introduction of the new microelectronic devices will create the sense of larger community by enlarging their networks through facilitating communication and the flow of information. Such increased networking power will give those in isolated communities economic earning potential that never existed before. This could have some significant impact on economic growth in smaller centres and communities of Canada

SECTION 6. LOCATION OF MICROELECTRONIC COMPANIES

This chapter will note the companies known to be in the microelectronic business, that are in designated low growth areas, what the criteria of location are, and how the companies responded to enquiries about locating in such designated areas.

a) Companies in Designated Areas

Three sources of information were used to prepare a list of companies in the microelectronics business that are in designated areas: one was the 20 companies included in our survey; another was the membership list of the Canadian Advanced Technology Association in Ottawa; and a third was the companies included in the Statistics Canada publication (43-206) on "Communication Equipment Manufacturers - 1978". From these sources were extracted the names of companies in designated areas, and this is shown as a list in Appendix 3. It is necessary to note that the list does not necessarily include all companies in these areas, but it does include most of the larger ones.

b) Criteria for Location

During the course of the survey, company representatives were asked what their criteria would be for selecting a location suitable to their type of business.

The highest score was given for the availability of human resources. This had several aspects to it. In the first place it was important to locate where professional and specialist talent can be attracted, ie. recruited, and kept. Factors in this were, attractive housing, and to be in or near a community of professional contemporaries such as a university or along with other and similar companies. The concept of locating in an area where there is a critical mass of knowledgeable people and organizations seemed to be of interest to a number of companies.

The second important criterion was that of transportation. Most people required good air connections for both goods and people. Some felt that easy access to US/Canada customs was important. One company, for example, occasionally drove from Ottawa to Ogdensburg to expedite or rush shipments to the US. Several Ottawa companies expressed strong feelings about the poor air connections out of this centre. To spend a day in Denver, for example, took 3 days of time.

Ranking third in the criteria of location was the proximity to a good university or technical college. One company was contracting out their research to university staff. Others used the technical resources of the university for consultation and recruitment of technical staff.

It was considered important to several companies that they be located within their market area, or in close proximity to their major customers.

Four interviewees said that the location of the company was in reality based on the fact that the founder lived in that community.

Cost of operations, and government incentives were also mentioned by several companies as determinants in company location.

In a study of high technology companies in the municipality of Ottawa-Carleton,[1] they were asked about the positive and negative characteristics of operating in this area. The highest ranking positive response was, proximity to the federal government; secondly, the high number of high-tech firms in the area; and the highest ranking negative response was lack of adequate air service.

The full list of advantages and disadvantages of locating a high technology company in the Ottawa area as seen by the respondents of this Ontario government survey are shown in Table 11 that follows.

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1) "Micro-Electronics 80 - A Survey of High Technology Companies in the Regional Municipality of Ottawa-Carleton" Ministry of Industry & Tourism, Toronto October 1980

TABLE 11

Advantages and Disadvantages of Locating a High-Technology Company in the Ottawa Area

Perceived Positive Characteristics of Region for High Tech Industry

(Responses ranked by frequency of occurence)

1. Proximity to federal government
2. High number of high tech firms in area
3. Locally available labour pool
4. Presence of government research facilities
5. Lifestyle
6. Local educational facilities
7. Established supply/distribution networks and support industries
8. Geographical location of region
9. Region's reputation as high tech area
10. Low expenses in region
11. Good regional industrial climate

Perceived Negative Regional Characteristics for High Tech Industry

(Responses ranked by frequency of occurence)

1. Lack of airline connections/poor airport facilities
2. Manpower shortage
3. Negative effects of federal government presence
4. Lack of support industries or services in region
5. Competition for manpower between high tech firms
6. Regional supply problems
7. Regional shipping or freight problems
8. "Silicon Valley Syndrome" gathering momentum.

c) Response to Enquiries on Locating in Designated Areas

A number of companies in our survey were approached and asked directly whether firstly they were planning to expand or build a new plant in the next 18 months to 2 years, and secondly, if the answer was in the affirmative, whether they would consider locating in a designated slow growth region of Canada, given the financial assistance that is available through the Department of Regional Economic Expansion.

The response to these two questions was in some instances very encouraging. Regardless of the responses, however, and these are itemized later, some very illuminating facts became apparent in discussing RDIA and other DREE programmes, and it is these issues that DREE should seriously address if it is to become more successful in persuading firms to locate in designated areas. Some of these issues are listed below:

1. An obvious fact that became apparent is the general lack of knowledge about the RDIA programmes, despite the publicity efforts of the Department.

2. Because DREE reacts to requests from the private sector, it follows that firms that know little about the incentives available will not in fact become more informed. The corollary to this is that DREE is not aware of a company's expansion and planning intentions, and so cannot take advantage, by an early approach, of a firm's desire to expand capacity by "leading" them to a designated area.

3. A part solution to this would be for DREE to become much more pro-active. There are firms in southern Ontario, Ottawa and even designated areas that would react positively to a high-level, well informed approach, offering a package of inducements and information. We believe that a more aggressive, direct approach is essential if DREE is to improve its successes substantially. Without a pro-active role, the Department does receive requests for incentive assistance from both small and large firms; but by taking a pro-active role it will be possible to anticipate and "lead" companies in their decision making process. The alternative is that the individual company makes decisions at the Board level without the benefit of all financial options available.

4. Dissemination of information regarding DREE programmes more actively would also avoid the negative kind of response to Federal Government programmes. One frank and blunt President of a surprisingly large Canadian corporation, for example, responded to the suggestion of using DREE incentives by saying, "One life-time grant for a life time of misery". Unfair though this remark may be, it shows a surprising ignorance of the programmes and benefits available. In this instance it was compounded by the fact, on closer examination, that the company in question had never received a grant. A good deal of these unfortunate, misleading impressions could be overcome by a more active and market oriented DREE approach by a select few of knowledgeable, capable, industrial development officers.

5. Lack of knowledge of DREE incentive programmes was further exposed in that some companies, who had already received initial incentive grants, failed to apply for an expansion grant when they decided to expand, or they made a prior commitment and were thus excluded. The answer to this would probably be that if they were going to expand anyway, then it must have been sufficiently profitable that additional grants were not necessary. However, the company frequently did not apply because they were not "aware" of the possibility of further assistance and, given such financial aid, their expansion could well have been bigger.

Below are listed a number of companies that indicated they were considering expanding or establishing a new manufacturing facility over the course of the next 2 years. It should be noted that some of the companies were more secretive or less forthcoming than others. Also, given the nature of this study, the information obtained is obviously not in-depth. This is partly counter-balanced by the fact that the information was secured from very senior levels of the companies approached.

1. MITEL Without doubt MITEL offers one of the most immediate opportunities - at least as identified within the confines of this relatively limited investigation and study. A fairly lengthy conversation was held with the President of MITEL (Mr. Mike Cowpland). There is no need to dwell on the success of MITEL and its products as the story is well known. In terms of plant space in Canada the picture is roughly as follows:

	Present	To be Commissioned July 1981
Kanata, Ontario	200,000 sq ft	230,000 sq ft
Bromont, Quebec	25,000 sq ft	48,000 sq ft

MITEL has also opened plants in Ireland, England and Puerto Rico and recently anounced the opening of 250,000 sq ft of plant space in Wales employing 300 people, with an expected growth to 1300 by 1985. MITEL creates job intensive facilities in a high technology industry at reasonably high wage/salary levels.

The immediately important aspect from DREE's point of view is that MITEL informed the consultants that, in order to meet pressing demand, there is a need for an additional 1,000,000 square feet by 1982, which in corporate planning terms is just around the corner. As it is so close at hand MITEL are probably open to any reasonable suggestion just now. There are some qualifications, however. One is that the incremental space be within commuting distance of senior management. This limits the options to say Hull and eastern Quebec. (Renfrew is considered not to have a sufficient pool of skilled resources available). At one stage the President indicated he might consider Montreal, but he seemed much more interested in Cornwall, which is only an hour from Ottawa. Cornwall has another attraction; there is a fair amount of empty warehouse/factory space, which could perhaps be readily converted to MITEL's use and save valuable construction time. Also it is on the U.S. border. MITEL exports 85% of its production - much of it to the USA.

The problem of course is that Cornwall is not designated. The options open to DREE therefore would be to say investigate whether it is worthwhile putting a separate package together for MITEL say under an existing shared cost Subsidiary Agreement with Ontario, or formulating a special deal under G.D.A. That is one option. The other possibilities may be easier from DREE's point of view under the existing RDIA framework. For example Hull or environs is a natural selection, although MITEL would only qualify for ACC and no incentives on salaries and wages. In our opinion if DREE mounts a well prepared and careful approach to MITEL it may be possible to persuade the senior management to locate in the Montreal region. Access to Dorval airport would be important, but the approach should be at a high level on both sides and DREE should go in with an attractive package. There is no doubt MITEL are on the look-out for an opportunity and, by their admission, it is increasingly difficult to find sufficient quality manpower in the Ottawa region. If the company is not approached and DREE is not pro-active, then the decision will be taken without DREE input. While the decision has not been taken, the new facility is thus footloose and the Department could perhaps exert some key influence as to the location chosen. MITEL also indicated that grants are important to them insofar as it can aid significantly in their ROI calculations to offset any disadvantages there may be.

2. CANADAIR LTD Canadair Ltd is located in Montreal and has a plant in the Eastern Townships. While the company was relatively secretive as to its intentions, the Senior Vice-President Operations made it quite clear that several million dollars would be spent on expanded or new facilities within the next year or two. Again, this is a case where, if DREE is to have some bearing and influence on where this activity is to take place, then the Department must take a pro-active stance and make the initial, concerted approach.

3. Epitek Electronics Epitek of Kanata provides an interesting example of a company that considered a DREE incentive grant to locate a plant in Renfrew, but withdrew its application, and indeed expanded in Kanata. Employment is presently 115 and expected to grow to 200 in 2 years. There are several reasons why Epitek did not ultimately locate in Renfrew. There was concern about creating a separate facility to the main plant, where there was a continuous process from the beginning to the final product; the company already had land in Kanata, and there was concern about the availability of sufficient skills on the labour market.

Despite this situation, Epitek would still consider locating a new plant in a designated area, but it would be one that manufactured new products and not include existing products made.

4. NCR Canada Ltd NCR, manufacturer of business machines, has expanded its facility at Waterloo this year by 40,000 sq ft. This expansion will meet the company's requirements until 1984 apparently. The Manager of Corporate Planning stated quite emphatically that there would have been a possibility of locating elsewhere had they been aware of the RDIA programmes and the location of the designated areas. NCR also indicated that although their immediate space requirements are satisfied, they would seriously consider a designated region for new developments in the future, but that they would need to know the scope of assistance available now to incorporate such detail into their long range planning. NCR also stated that a brochure alone is insufficient and that a communication from DREE spelling out the forms of assistance would be much more helpful.

In other words NCR again represents a case of a company that is unaware of help that could be available. Examples such as these would strongly suggest that were DREE to assume a more active development role, then there could be more opportunity realized than is presently the situation.

5. Computer Assembly Systems, Brockville Discussions held with the President, Mr. Hugh Watt, revealed that CAS is presently considering buying a new plant of 10,000 rising to 25,000 sq ft, employing 30 to 40 initially, rising to 100 to 150 jobs. The present employment in the company is 150 with plants in Brockville and Toronto, where integrated circuits and printed circuit boards are manufactured. Access to suitable personnel in Brockville is already a problem and 20% of the employees in the plant there commute from Prescott 24 kilometres away.

CAS wish to remain in the general vicinity of the St. Lawrence Valley. Properly packaged, it may be possible to persuade the company to say locate in Hull or its environs.

6. Linear Technology Discussions were held with Dr. W.A. Pieczonka, President of Linear Technology of Burlington. This company provides yet another interesting case example of a high technology firm (manufacturing chips), that is in the process of tripling its space from 12,000 sq. ft. to 38,000 sq. ft. but would seriously have considered any other option. The additional plant capacity will commission this year, and the company apparently "wrestled" with the problem last year as to precisely where to expand. Burlington was finally chosen because it was perceived there were initial cost savings. Present employment is 70 people.

The interesting information is the outlook for this firm and, if properly handled, it presents some opportunity for DREE. The President of the firm said he expects the demand for their products to double every 2 years for the next 10 years. The firm will be looking to expand again by 1983. A key factor for Linear Technology is access to an international airport and, in our discussions, the firm indicated it would therefore be willing to consider Montreal or Winnipeg. Much of Linear Technology's supplies use air transport and exports too. Of the firm's production 96% is exported to the U.S.A., Western Europe and the Far East. Airport access to the U.S. is particularly important. Of the supplies that are imported from the U.S., Linear Technology is endeavouring to cultivate know-how in Canada to create domestic production. The company indicated it would be "very interested" in suggestions for assistance in its new round of plant capacity expansion.

7. Honeywell Limited Honeywell, which manufactures computers and business machines, will be undergoing a further expansion in 2 to 3 years time, according to the President, Mr. Bruce. The starting point would be 100 jobs. Present expansions are underway at Toronto and Montreal. The company would now like to expand its operations into the West - Saskatchewan or Alberta.

We believe that it should be possible to influence a firm such as Honeywell to locate in a region chosen by DREE, providing sufficient inducements are offered. Given the intelligence that Honeywell plans to expand in the West, then the groundwork to direct and influence their locational decision should be mounted soon.

8. Westinghouse Canada Limited, Hamilton In the absence of the President, Frank Tyaack, the consultants spoke with Mr. Carmen, Vice-President Marketing and Strategic Resources. DPA firmly believes that again there is considerable scope for DREE given the right initiatives. Of all the firms we spoke to, Westinghouse is probably the largest multi-national, and yet their intentions over the course of the next 4 years represent a considerable opportunity for DREE.

After a recent period of rationalization in Canada, the company is expanding and in fact will commission 5 new plants in 1981, one of which is the $30 million facility at Renfrew, which has received DREE support. In its rationalization programme, Westinghouse divested itself of certain manufactures and now focuses on three major industrial categories:

- Utilities - power systems
- The Industrial Sector
- The Construction Sector.

Annual sales are presently in the order of $500 million, but the really significant fact is that the company expects to achieve sales of $1 billion by 1985. To secure this level of sales will require major increases in plant capacity by the company and should present excellent prospects for DREE. An approach to Westinghouse should be made at the highest level of management in the Department and in the company. The senior management of the firm is amenable and anxious to be kept informed. The company signified that the U.S. parent is well aware of their Canadian intentions. Also, Westinghouse has substantial exports from Canada.

9. International Systcoms A discussion was held with Mr. Lionel Hurtubise, President of International Systcoms Montreal, manufacturer of mobile communication systems.

This is another company that adopted a very positive approach to DREE and its programmes. The company presently employs 350 people and has facilities in Edmonton, Brockville, Bromont (where some electronic assembly takes place) and the Head Office in Montreal. The company indicated quite categorically that they would consider a plant in Winnipeg, in particular to be near Manitoba Telephone. This is a case example of a relatively small but successful firm that could be guided by appropriate DREE inputs carried out in a professional manner.

10. IBM IBM has no immediate plans for further expansion after having expanded their facilities "dramatically" in Toronto and Bromont. IBM received DREE incentives for their Bromont facility (the grants were repaid), where the first plant employed 200 initially, but now employs 1,200 after four major additions. 2,000 people are employed in the Don Mills area. This employment relates strictly to manufacturing and development and does not include their computer service network.

In addition, the company has a research laboratory in Toronto, employing 400 (having recently added 100 new jobs), which ranks it among the top 10 private commercial laboratories in Canada. Further benefits this company brings to Canada are the exports, as they are increasing at a dramatic rate every year. Exports from IBM amounted to $167 million in 1975. In 1980, they reached $382 million, or more than double. In 1979, IBM purchased $271 million of components from Canadian suppliers.

While the company indicated that it was not immediately considering a new manufacturing site, they also stated that they are continually looking at other possibilities and have an open mind towards slow growth regions.

At first blush there would not appear to be a major opportunity for DREE. However, companies of this size and successful annual growth have constantly to review and plan to meet increasing sales. To some extent too, companies of this nature are relatively footloose, in that they are not constrained by the cost of transportation in the high value products with which they deal. Access to a stable and available work force is important, however. Given a little more intelligence of IBM's likely intentions and requirements to meet forecast demand (both for the export market and domestically), it should be possible, and the attempt would be worthwhile, to exert very useful guidance towards the company' in the selection of its next major manufacturing location.

11. Digital Equipment World-wide, Digital Equipment is a massive firm employing some 57,000 people. There are 1,600 employees in Canada with one plant in Kanata, employing 800 people manufacturing backframes for computers. The Kanata facility provides 95% of the firm's requirements

world-wide, so that exports are considerable. In Canada major distribution offices are in Halifax, Montreal, Toronto and Calgary. Since moving from Carleton Place in 1972 in Phase I, Phase II followed in 1977 and Phase III in 1980. The company is now about to start Phase IV at Kanata. Total plant space is presently 300,000 sq. ft. The company will require additional space within the next 2 years and would certainly be interested in considering a designated region either in the West or the East, as they now feel they have reached their limit of size with the Kanata facility.

This company provides an example of one where DREE could package a carefully designed proposal, with supporting documentation, to locate its future plant space requirements in a location which meets DREE designs as well as certain economic criteria from the company point of view.

SECTION 7. CONCLUSIONS

There are three strong messages that arise from this study of the microelectronics industry:

1. The microelectronics industry is growing at the remarkable rate of 30-35% per year and is expected to continue at this rate of growth for the forseeable future.

2. Canadians can participate in this high-technology growth and develop businesses with a high percentage of export sales.

3. Opportunities exist for location of microelectronics high technology companies in designated slow-growth areas.

The high technology microelectronic industry has a high dependence for leadership on high technology people. This was a characteristic of the companies in the survey, and has a strong influence on where companies locate. A small company whose head was the technical leader in the organization could locate anywhere. A larger company, dependent on a supply of highly trained personnel, preferred to locate near a critical mass of knowledgeable resources - a university and/or other high technology companies.

There appeared to be growth opportunities for Canadians in manufacturing specialist items:

- robots;
- testing equipment;
- computer controlled energy devices; and
- instruments, laboratory and medical electronic equipment.

In addition to manufacturing, Canadians can participate in the microelectronic industry by providing software and services:

- developing and installing industrial process control systems;
- writing programs for the retail market, ie. games and personal programs; and,
- programming and/or servicing office communication and accounting systems.

There are numerous opportunities for the microelectronics industry to be located in designated areas. It would appear though that DREE would need to take a more pro-active approach towards companies to create the necessary interest and motivation.

There is good possibility of the developing, manufacturing and marketing of microelectronic products and systems in centres where universities and technical colleges provide high technology personnel and a research base. Universities provide good germinating ground for ideas, which with appropriate encouragement and support, can be developed into regional businesses.

In conclusion, this profile of the microelectronics industry has shown unusual growth potential; one that Canadians can pursue to economic advantage, and one which lends itself to business development in slower growth areas of Canada.

APPENDIX 1

A PROFILE OF THE

MICROELECTRONICS INDUSTRY IN CANADA

A Profile of the Microelectronics Industry in Canada

List of Companies & Persons Interviewed

Companies	Persons interviewed
Canadian International Paper Company, Gatineau	Maurice Bellmare Engineering Dept
Comshare Ltd, Ottawa	Rick Crutchlow Ottawa Manager
Gandalf Data Communications Ltd Ottawa	Colin D. Patterson President
Hewlett-Packard (Canada) Ltd	George Jones Marketing Manager
Northern Telecom Ltd, Ottawa	Lloyd Taylor, Vice-President, Semi Conductor Components
Mitel Corporation, Kanata	Mike Cowpland, President Ralph Bennett Vice-President Semi-Conductor Mfg
CAE Electronics Ltd, Montreal	Ross Hague, Director Govt Relations Robt Duthie, Manufacturing Manager John Prieur, Manager Purchasing
Canadair Ltd, Montreal	Andreas Throner Senior Vice-President Operations
International Systcoms Ltd Montreal	Lionel Hurtubise President R.J. Dargent Vice-President, Engineering
Digital Equipment of Canada Ltd, Kanata	Denzil Doyle, President
Phoenix Graphics Ltd, Ottawa	Murray Shantz, President

APPENDIX 1, (cont'd)

Leigh Instruments Ltd, Ottawa	Glyn F. Jones, Corporate Director of Engineering
Epitek Electronics Ltd, Kanata	Morley Miller, President James Gardner, Vice-President
Westinghouse Canada Ltd, Hamilton	J.K. Carman, Vice-President Marketing & Strategic Resources G.J. Hoolboom, Director of Staff Engineering
NCR Canada Ltd, Mississauga	E. Ray Nafziger, Manager Corporate Planning John Bennett, Manager Production Mgt John Rietsna, Manager Corp Systems Support Florence Israel, Manager Market Research
IBM Canada Ltd, Toronto	Grant Murray, Vice-President also President of Business Equipment Manufacturers Association
Honeywell Ltd, Toronto	J.H. Brace, President Bruce Barry, Manager Components Division (also Ken Lynch, Ernie Douglas)
Linear Technology Inc Burlington Ont	W.A. Pieczonka, President H.D. Barber, Vice-President Operations
Computer Assembly Systems Ltd Brockville	Hugh Watt, President David Suell, Vice-President
CAD/CAM Graphics, Ottawa	Tom Milo, President

Associations and Experts

Gordon Thompson	Scientist, Bell Northern Research, Kanata
Gordon Hutchison	Publisher, "The Electronics Communicator", Ottawa
Robert Long	Executive Director Canadian Advanced Technology Association Ottawa

APPENDIX 1, (cont'd)

Jacques Lyrette, Ottawa	Office of the Future, Dept of Communications
Keith Revill	Province of Ontario Task Force on Microelectronics

(and other e.g., in Dept of Industry, Trade and Commerce)

APPENDIX 2

MEMBERSHIP LIST - CATA

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APPENDIX 2

MEMBERSHIP LIST

AS OF

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Cableshare Limited P.O. Box 5880 20 Enterprise Drive London, Ontario N6A 4L6	Mr. H. Woods Manager, Advanced Technology Group
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Computer Methods (Canada) Ltd. Suite 906 2300 Yonge Street Toronto, Ontario M4S 2B1	Mr. Allen S. Berg President
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Harrison, Williams & Associates Ltd. 1085 Cahill Drive West Ottawa, Ontario K1V 9J1	Mr. David J. Harrison Vice President
HiTech Canada Limited Suite 103, 68 Highway 7 Ottawa, Ontario K2H 8P5	Mr. Steve Sandler President
Huntec (70) Limited 25 Howden Road Scarborough, Ontario M1R 5A6	Mr. R.W. Hutchins President
William G. Hutchison & Co. Ltd. P.O. Box 5819, Station A Toronto, Ontario M5W 1P2	Mr. W.G. Hutchison President
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APPENDIX 3

COMPANIES IN ELECTRONICS

IN DESIGNATED AREAS

Companies in Electronics in Designated Areas

Employment code		
	0 - 50 employees	(A)
	51 - 100 employees	(B)
	100 - 500	(C)
	over 500	(D)

Nfld	Northern Telecom Ltd, St John's	A
N.S.	Northern Telecom Ltd, Amherst	C
	Hermes Electronics Ltd, Dartmouth	C
	Nautical Electronic Laboratories Tantallon	B
PEI	Northern Telecom Ltd, West Royalty	A
	Imapro Inc, Charlottetown	
N.B.	Northern Telecom Ltd	B
Que.	AES Data Ltd, Montreal	
	Amplitrol Electronics Ltd, Candiac	B
	CAE Electronics Ltd, St. Laurent	D
	Canadian Marconi Company, Montreal	D
	Central Dynamics Ltd, Pointe-Claire	C
	Centre Electro-Technique Inc, Ste-Foy	B
	Circo Craft Co Inc, Montreal	B
	Codalex Ltd, Montreal	B
	Comterm Ltd, Pointe Claire	
	Electro-Vox Inc, Montreal	A
	Electroline Television Equip Ltd, Montreal	A
	Farinon Canada Ltd, Dorval	C
	Gandalf Data Communication Ltd, Hull	
	General Signal of Canada Ltd, Montreal	A
	Hylogic Limited, Dollard Des Ormeaux	A
	IBM Canada, Bromont	D
	International Systcoms Ltd, St. Laurent	C
	International Technical Prod (Canada) Ltd Pointe Claire	B
	Lab-Volt (Quebec) Ltd, Ste-Foy	B
	Matrix Electronic Systems Ltd, Montreal	
	Mitel Semiconductor Inc, Bromont	B
	Multi-Vox Ltd, Montreal	A

	National Semiconductors Ltd, Montreal	C
	Neeco Industries Ltd, Montreal	D
	Northern Telecom Ltd, (Digital Transmission Div) Montreal	D
	Northern Telecom Ltd, (Analog & Radio St Laurent)	D
	Northern Telecom Ltd (Switching Div Combined Report) Montreal	D
	Omicron Data Systems Ltd, Pointe Claire	
	Positron Industries Inc, Montreal	A
	Pylon Electronic Development Co Ltd, Lachine	B
	Sanyo Canada Ltd, Montreal	
	S. Baum Tooling Company Ltd, Montreal	A
	Shelbern Electronics Ltd, Town of Mount Royal	
	Siemens Electric Ltd, Pointe Claire	A
	Spar Aerospace Ltd, Ste-Anne-De-Bellevue	D
	Sytrolec Controls Ltd, Montreal	A
	Televox Systems Inc, Quebec	A
	Transcom Electronics Manufacturing Ltd, St Jerome	A
	Universal Telecommunication System Ltd Pointe Claire	A
Man.	Industrial Research & Development, Winnipeg	
	Interdiscom Systems Ltd, Winnipeg	
	Fortin Electronics, Winnipeg	
	K-Cycle Engines Canada Ltd, Winnipeg	
	Cook Electric Co of Canada Ltd, Winnipeg	A
	GTE Lenkhurt Electric (Canada) Ltd Winnipeg	C
	ITT Industries of Canada Ltd, Winnipeg	A
	Quality Communication Products Ltd Morden	B
Sask	SED Systems Inc, Saskatoon	
	GTE Lenkhurt Electric (Canada) Ltd Saskatoon	C
	ITT Industries of Canada Ltd, Regina	A
	Northern Telecom Ltd, Regina	B

APPENDIX 4

CALCULATION OF ESTIMATE OF EDUCATION COMPUTER MARKET

Appendix 4

Calculation of Estimate of Education Computer Market

1. Secondary Schools

Secondary Schools in Canada 1979-1980	1,695	(without Quebec)
Combined Elementary and Secondary 79-80	1,765	(without Quebec)
Quebec Secondary Schools 1979-1980	650	
Quebec Combined School 1979-1980	200	
	4,310	

Student Population, grades 7 - 13, Including Quebec: 2,300,000.

THEREFORE, average school size: 530 students.

Allowing for a laboratory of 25 micro-computer units, at $3,000.00 per unit (hardware and programs), for every 500 students, the market becomes:

$$\frac{2,300,000}{500} \text{ students} \times (25 \text{ @ } \$3,000) = \$345 \text{ million.}$$

Consider that only ½ the schools in Canada do this, then potential sales would be ½ of $345 million = $175,000,000.00.

2. Universities

Post secondary school enrolment is approximately 600,000 students, undergraduate and graduate. If a laboratory of 25 micro-computer units were provided for every 500 students at $3,000 per unit then the sales potential would be:

$$\frac{600,000}{500} \times (25 \times \$3,000) = \$90 \text{ million}$$

Universities would likely move into this field faster than secondary schools, so estimate the market over the next 3 years as 2/3 of this = $60,000,000.00.

Total market in secondary schools, plus post secondary schools, over the next 3 years:

$175m + $60m = $235 million

or approximately $75,000,000 per year.

In terms of $3,000 units, this is 25,000 micro-computers.

APPENDIX 5

ESTIMATE OF MICROELECTRONIC

OFFICE EQUIPMENT MARKET TO 1985

Appendix 5

Estimate of Microelectronic Office Equipment Market to 1985

An estimate of the number of electronic office machines that would be in use by 1985 has been made by R.W. Hough and Associates in a report to the Department of Communications, entitled: "Office Automation Equipment - The Present Base and Future Prospects to 1985".

The market for some of these is as follows, with our estimates of dollar costs and subsequent dollar volumes.

	Preliminary forecasts for number of units added 1978-1985	Per Year (rounded)	@	Millions $
Office typewriters	160,000	23,000	$ 2,500	58
Word Processors	55,000	8,000	16,000	128
Computers	132,000	19,000	35,000	665
Data Terminals	150,000	21,000	2,500	53
				$ 904