DISCUSSION PAPER

ENSURING CANADA'S COMPETITIVE FUTURE

STEP: SUPPORT FOR TECHNOLOGY ENHANCED PRODUCTIVITY

THE HONOURABLE EDWARD LUMLEY

Government of Canada | Gouvernement du Canada
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Canada

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1982

INVESTMENT IN NEW TECHNOLOGY
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PURPOSE

1. This paper analyses the industrial development and manpower implications of the "Electronics Revolution". It outlines the need for and nature of possible government initiatives to encourage an appropriate response across all industry sectors to the challenges and opportunities created by this "revolution" and it sets out mechanisms to encourage appropriate planning for labour adjustments as new technologies are being introduced on the shop floor.

BACKGROUND

2. The development and application of new electronic technologies are forcing the industrialized world into a fast-breaking process of adaptation and change. The two dimensions of this process of adjustment affecting Industry and Labour are:

(a) Industrial Implications

These involve
- the use of electronics throughout all industrial sectors to enhance the productivity of industrial and office processes, and
- the creation of new economic opportunities to produce electronic goods and related services.

(b) Labour Adjustment

The introduction of electronics on the shop floor and in the office will affect the number and required skills of people now working, while rapid growth of electronics applications will create new job opportunities in electronics manufacturing and service industries.

3. Trends in the evolution of advanced industrial process technologies and areas of new industrial opportunity in manufacturing and services have been evident for a number of years as have the problems of labour adjustment. Government efforts to capture industrial potential began with the Enterprise Development Program, the Defense Industry Productivity Program and tax support for both R&D and capital investment in production equipment. These measures provide general support for all industries rather than favouring the manufacture and use of electronic equipment.

4. A more directed effort to come to grips with a portion of these issues was the Computer Communications Task Force begun by DOC in 1972. The Electronics Industry Consultative Task Force which reported to government in 1978 concentrated on specific industry related problems. It was recognized that if a concerted push to encourage the manufacture and use of electronics was desired more focussed instruments would be necessary. This thinking led in that year to the establishment of the Special Electronics Fund (SEF) as the principal instrument to encourage the electronics revolution in Canada.

5. With respect to manpower issues, the federal government, through the Canada Employment and Immigration Commission (CEIC), has launched a number of labour adjustment programs. These measures provide support for counselling, training and mobility to meet general manpower adjustment needs including those arising from technological change. The Industrial and Labour Adjustment Program (ILAP) introduced in 1981 also provides a range of industry and labour adjustment support services.

6. In the fall of 1980, MSED organized a task force, comprising representatives from ITC, DOC, CEIC, MOSST and other interested departments, to review the implications of the electronics revolution. This review lead to the preparation of a Memorandum to Cabinet entitled "Microelectronics and Information Technology". The purpose of the MSED paper was to set out broad policy guidelines for structuring program proposals to deal with the industrial, labour and social impacts of new electronics technologies.

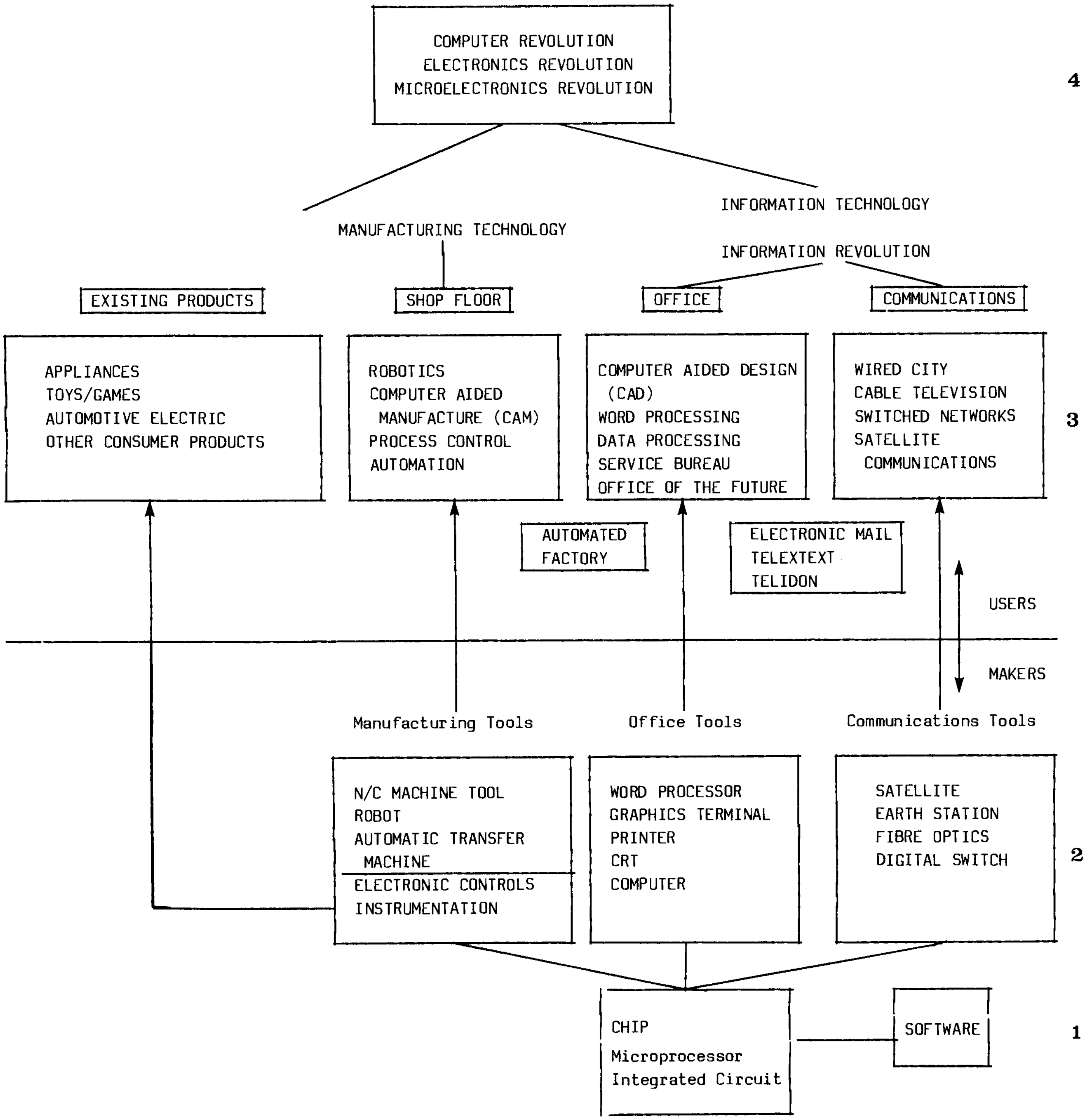
7. This paper is complementary to the MSED activity. It concentrates narrowly on the need for additional industrial and labour policy initiatives based on an examination of the adequacy of existing programs.

FACTORS

8. Developments in electronics are important to Canada because, by lowering the cost and increasing the versatility of computing power, they are inducing a rapid upgrading of the capabilities of practically all known technologies and the effectiveness of the labour forces that use them. The power of these technologies is such that their use is creating new standards of industry performance and competitiveness. They are inducing changes in the way that work is performed and in the conduct of international trade and commerce.

9. The diagram below portrays the breadth of the application of electronics and attempts to capture the essential elements of its impact on industry and society.

A LEXICON OF THE REVOLUTION



10. Starting from the bottom line (line 1) the "chip"* is identified as the base technology. When combined with software (human intelligence) the chip may be built-in to a range of products or systems as set out in line 2. The three boxes on this line are in effect different types of tools which, when used (line 3) in consumer products, in manufacturing processing on the shop floor, in the office (and home) and in the communications sector are leading to revolutionary changes (line 4).

11. The diagram is divided horizontally to emphasize the important distinction between the need for all of industry to adapt or adjust to the use of microelectronics and the need to exploit new manufacturing opportunities arising from the introduction of microelectronic dependent products. The top half of the diagram illustrates the areas of major industrial adjustment (users): the lower half encompasses the main categories of new manufacturing opportunity (makers).

12. As this diagram makes clear, electronic technologies are now affecting the economy in five principal ways:

- they are being incorporated in existing consumer and industrial products. In the process, they are modifying these products; in some cases they are leading to the introduction of new products, and they are establishing new international standards for products quality and price;

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* In this paper, "chip" is used interchangeably with "Integrated Circuit". The chip, a tiny fragment of silicon, can contain the equivalent of 100,000 transistors and enables computing power to be spread cheaply through the factory, the office, and the home.

- they are being used on the shop floor to change the way that products are made through the use of more sophisticated, intelligent production machinery ranging from simple "add on" control devices to robots and full scale, automated factories using computer aided manufacturing (CAM) and computer aided design (CAD) techniques. Used in this way these technologies represent the next step in the long historical continuum of change towards greater automation and higher productivity across all industrial and manufacturing sectors;

- they are being applied in offices to facilitate the performance of many administrative and management functions through the use of new products that will lead to the "Office of the Future". These products, essentially adaptations of known computer and communications technologies, promise to have a dramatic impact on office productivity and will supplement the efforts of firms to improve competitiveness through investment in new production equipment;

- they are leading to the development and introduction of new communications technologies, systems and services that facilitate the movement and manipulation of information and data for business purposes. Access to these new technologies and the sophisticated communications infrastructures required to support them are essential if companies are to reap the full benefit of investment in shop floor and office automation;

- the industries supplying the equipment and related software and services going into shop floor, office and communications applications are beginning to constitute a powerful force for growth, jobs and exports. They may well comprise the largest industrial sector in the world economy by 1990 outside of agriculture.

13. These challenges and opportunities are discussed from a Canadian perspective in more detail below. Readers familiar with the subject may wish to skip the following and proceed to the "Policy Implications" section on page 21.

I USERS

14. All Canadian industries are potential users of electronics technology. As shown in Figure I, they must come to grips with it in four principal ways:

- in the products they make
- in the way they make their products
- in the office
- in communications

A) Existing and New Products

15. Electronics is permitting the development of entirely new products and is improving the performance and quality of existing products, while reducing the costs of both their production and operation. The first sectors to have been affected have been those whose products produce information, and thus are particularly susceptible to electronics-based improvements. Some of these products were electronic themselves, such as radio and TV; others were electrical or mechnical, such as watches, calculators and industrial controls. In each case electronic advances have eclipsed the old technology. In some, they have led to a new product. This experience suggests that when electronics is adapted to a traditional product, its penetration is rapid and thorough. The impact these changes have had on national strengths and on individual companies, some of which were large and well financed, is well known. Switzerland provides one of the best examples. In the space of a few short years, the mechanical watch industry has died and has been reborn a different industry, making electronic time pieces.

16. There are signs that the same thing is beginning to happen to other non-information products. One example is the automobile where electronics is being used to improve performance and serviceability, monitor and control emissions, and provide attractive features for the driver. Advanced electronic controls in major appliances provide another example in that they improve the convenience of operation of the appliance while at the same time improving its reliability.

17. Canadian industry's response to these challenges has not been encouraging; firms have experienced difficulty adjusting or have missed opportunities. For

example, the consumer electronics sector has suffered a severe shakeout; production of calculators has ceased in Canada; the auto parts industry generally has failed to secure much of the new electronic parts business; and the industrial controls sector is reliant on parent firms and licences for new product technology.

18. Other sectors do not appear to be better positioned to respond effectively. Overall there is a low level of indigenous design, development and engineering and a reliance on foreign sources for new products. As a result, domestic firms may well lag in the introduction of electronics and may have a harder time adjusting than foreign competitors, even in areas where Canada currently is strong. This could lead to a loss of domestic and export sales as conventional Canadian products are surpassed by better quality products from offshore.

B) Production Processes - The Shop Floor

19. The use of electronics in the production process is spreading, as producers come to realize that it offers a way to obtain sustained productivity growth. The introduction of electronic dependent manufacturing and industrial process techniques is only at an early stage of development but it appears to hold the promise of being the next major step along a continuum towards greater automation. Powerful, low cost miniaturized computers, combined with the latest techniques in electro-mechanics, electro-optics, hydraulics and new materials, result in machines and processes which will change our entire approach to manufacturing. Costs can be reduced by increasing the output per man hour, reducing required production skill levels, performing operations which cannot now be performed in medium volumes, removing or reducing the effect of hazardous environments, and improving product consistency to reduce wastage.

20. Electronics developments will have an impact on both continuous "production line" and "batch" operations. In the former area, a good example is the auto industry. A study quoted in The Economist indicated that heavily automated Japanese plants produced roughly 65 cars per worker annually, while North American factories produced only 45. The impact in terms of market success is indirect, but part of the cost competitiveness and

consistent quality of Japanese cars must be attributed to investment in electronics-based automation.

21. The production of goods in small quantities or batches, which comprises the vast majority of production and is particularly relevant to the Canadian environment, has been resistant in the past to automation because the requisite specialized production tools have lacked the flexibility to handle differing products. Thus the choice faced by firms in the past was between a costly array of equipment used only part time or less efficient general purpose machinery. Computer aided manufacturing (CAM) technology promises to improve this situation by enabling specialized equipment to be adapted quickly to use on changing designs or models with little loss in efficiency.

22. The introduction of robots, which do jobs never before performed by machines, further underlines that automation is no longer associated with single function machines which require high volume manufacturing to be cost effective. These new intelligent automated machines are characterized by their flexibility and are truly multi-function units. Not only can they perform a variety of production operations, but they can economically produce at medium volume. Their flexibility also allows them to be "plugged-in" to many manufacturing operations which are now labour intensive.

23. A further development is that electronics technology is improving productivity in the design and engineering phase (computer aided design or CAD). CAD and CAM can be linked together to produce a more efficient, responsive product development and manufacturing system. Running along in parallel with these advances in electronic usage directly in the production process, are continuing developments in the application of computers to other aspects of the entire production process; shipping, receiving, material management, inventory control, production scheduling, inspection, quality control, etc.

24. Large companies, particularly those in continuous process activities or with high volume production runs, are taking advantage of the new technology in order to achieve productivity gains. Not only have they the resources to devote staff to keeping up with the technology, but they often have diverse operations on which to test a variety of approaches. In other

countries, Japan, Germany, and the USA being examples, they have the support of government in the development of experimental systems.

25. Small and medium sized companies find it difficult to foresee or forecast the extent of CAD/CAM applications in related industries or, more significantly, the degree to which such applications may be efficiently utilized in their own operations. Many of these are not aware of the industry trends as a whole and do not recognize the impact of breakthroughs achieved in their equipment suppliers' technology. Further, they lack the in-house technological skills and sophistication to implement these new applications. Hence, although a dramatic "revolution" is taking place, many potential users are unaware of it or have difficulties in exploiting it.

26. Canadian industry is, to a large extent, in this latter category. Its competitive position is being attacked by capital intensive, high volume production from other developed countries on the one side, and by labour intensive production from low wage developing countries on the other. The latest techniques in production automation give Canadian industry the chance to compete, if the opportunity is grasped rapidly enough. On the other hand, failure to embrace new production techniques while others are investing heavily will lead to an inability to keep up with world standards of competitiveness and a loss of domestic and export market share.

C) The Office

27. Since the turn of the century, there has been enormous growth in the service sector. Yet productivity improvement has been low because there has been a low level of capital investment per worker. Few new machines have been introduced to extend a worker's capabilities. Electronics technology in the form of "The Office Of The Future" promises to have a particularly dramatic effect on service sector productivity because it improves man's ability to work with information, and the product and process of an office is information.

28. The use of electronics to handle data (computer processing) has been in use for roughly 35 years, and has resulted in improved efficiencies and effectiveness in the treatment of that kind of information. Electronic

machines (word processors, facsimile, intelligent copiers) are just starting to be applied to the less structured but simple clerical and secretarial functions. One can expect that the more complex officer and managerial functions also can be improved through capital investment in information machinery. Management support systems that integrate the modern capabilities of data sources, mathematical models and computers into potent management tools are beginning to appear. There is no question these developments will enhance the competitiveness of firms. The volume and complexity of information that must be collected, analyzed and disseminated by a modern corporation has grown to such an extent that it is only through the innovative application of electronic technology that it can be controlled and directed. The applications extend beyond the internal office functions of firms and institution. These developments will raise the productivity and competitiveness standards of marketed services such as architecture, data processing, consulting engineering, law, insurance, finance, and business consulting services. For example, United Airlines claims an 8% improvment in salesmen's productivity through the implementation of electronic management techniques.

29. In contrast to the use of electronics in product design and on the shop floor, Canadian industry has adapted quite positively to these developments in office technologies. Domestic firms have been early and extensive users of computers for data processing and are showing the same positive approach towards the new information processing equipment. Manufacturers of office electronics generally feel that Canada's sophistication and adaptation to the equipment is equal to that of the world leading U.S. Particularly good examples are Canadian banking and insurance companies which have extended their global reach at least partly on the basis of a strong ability to process information using the latest techniques. This positive attitude appears to extend to the use of new office machines and is shared by smaller, less sophisticated firms for whom the equipment is becoming feasible.

30. As in the case of manufacturing equipment, smaller firms are at some disadvantage compared to larger firms when applying electronics in the office. Larger firms can employ special purpose equipment or custom designed systems and can try out the latest solutions in a small way without imperilling their administrative operations.

Small firms must make do with general purpose solutions and must wait for others to prove out the most advanced techniques. As technology progresses, this form of discrimination will disappear.

D) Communications

31. The communications sector really is one of the service industries discussed above. It is treated separately because of its central role in the extended use of electronic equipment. The developments of products on the shop floor and in offices will lead to enormous increases in the amount of information used in the conduct of business. To gain full benefit of the advances in these areas, there must be an equally well developed communications capability to tie it all together.

32. Canada's strengths in this area are impressive. The service suppliers - telephone companies, CNCP Telecommunications, Telesat Canada - understand and can assist users with the application of the technology. The existing communications network is extensive, modern and compatible with the new technologies. As well, Canada is a world leader in the development of communications equipment and systems. The first domestic satellite, early implementation of digital switching and transmission and technological leadership in fibre optics and two-way television are examples of this capability.

33. In spite of this strength and history of successful and continuous innovation, it should not be thought that the future is without challenge. The blurring of the boundary between computing and communicating is unsettling traditional supply relationships. The trend in the United States to deregulation is resulting in changes in telecommunications economies, particularly for the increasingly important international data traffic.

34. The challenge to Canada is to maintain the strength of its telecommunications infrastructure, stay at the leading edge of technology and ensure that the cost and quality of telecommunications services remain competitive. Very important regulatory concerns, such as degree of competition in telecommunications and customer ownership of terminal equipment, will have to be dealt with in such a way to ensure that Canadian industry

continues to have not only the telecommunication services it needs but the supply industry it deserves.

II MAKERS

35. Electronics is a highly internationalized, $200 billion a year business. If recent growth performance continues through the 1980's, it will quadruple in size by 1990. No serious limitations to this continued growth are foreseen. The products of the industry are pervading every aspect of human endeavour. Growth is fueled by technological innovation. At the basic level, this innovation is occurring at the core of electronic technology, the integrated circuit. Emanating from these advances in semiconductor technology are a wide variety of electronic and non electronic products that are finding favour and meeting real needs of industry and consumers.

36. The Canadian electronics industry is tiny in this global context. Yet it has the same opportunities as industries in other countries to develop the technology, service existing markets and pioneer new markets. In some cases, the technological capability already exists in Canada and opportunities are just waiting to be grasped. In other cases new markets have opened or are emerging and no competitiors have yet dominated them. Occasionally, suppliers can create new markets through the introduction of innovative products.

37. The direct benefits to Canada of taking advantage of these opportunities by investing in the technology and its marketing are employment growth in high skill occupations, increased economic activity and improvements in the trade balance for fabricated end products. But the presence of a healthy sophisticated electronics industry has indirect benefits beyond these employment and growth factors.

38. Potential users are better off with a competent supply industry capable of meeting the bulk of their needs. In order for the technology to be applied intelligently, a close relationship must develop between the supplier and user. The software that makes the computer perform the application can only be developed by those having a detailed understanding of the capabilities of the computer and the structure of the job to which it is being applied. In addition, many of the applications are so novel that neither the supplier nor the user

clearly understands their implications. It is only through joint design and engineering that many of these applications will be properly satisfied. Equally, because of the complexity of the requirements and the sophistication of the electronic solution, there can often be a long debugging and modification period before a new system is working to the satisfaction of both the supplier and the customer.

39. Nonetheless, simply because of the breadth of opportunity in electronics, the domestic electronics manufacturers will not supply the full range of products. Canada will have to specialize in those areas where we have strength, where prospects are good, and where the benefits of this user/maker synergy are most promising. The sectors that meet one or more of these criteria are discussed below. These include telecommunications, office automation, integrated circuits, industrial process equipment and software and services. Exclusion of any sector, sub-sector or product area does not imply that, with the right combination of circumstances, Canadian capability could not be built up in these excluded areas.

A) Telecommunications

40. Telecommunications equipment manufacturing is the Canadian electronics industry's strongest performer. Both demand and output of telecommunications equipment have grown rapidly in Canada. Over the past ten years the Canadian market has grown at an average annual rate of 6.3% reaching almost $1.9 billion in 1978.

41. The telecommunications industry in Canada, as elsewhere, is undergoing some fundamental changes which promise to alter considerably the present structure of both the carriers and equipment manufacturers. These changes are primarily technology led based upon developments in microelectronics and concurrent advances in satellite communications, fibre optics, digital transmission and switching. These innovations are bringing about a merging of computer and communications technologies and creating possibilities for new communications services.

42. The emergence of these new technologies, which are part of the broader revolution in the electronics industry, are eroding the traditional monopoly boundaries

of thé telphone companies and weakening the barriers to new entrants to the telecommunications manufacturing industry. Technological expertise in switching, transmission and telecommunications R&D is now within the province not only of the incumbent telecommunications manufacturers but also the computer industry, the aerospace industry, and the office machine industry. Common design concepts and components have also reduced the significance of the technical integrity factor as a defence of carrier ownership and control of the total end-to-end system. All of this is resulting in strong pressures for increased competition in the supply of telecommunications equipment.

43. Increased competition should open up new domestic market opportunities to small innovative Canadian firms, hitherto restricted to serving "niches" in the market not occupied by the large vertically integrated firms. It will also make the Canadian market more accessible to imports and to foreign based multinationals with varying degrees of assembly and manufacture in Canada. In this more competitive environment, the Canadian industry, especially Northern Telecom, will have to adopt a defensive strategy to retain its position in the domestic market and an offensive strategy in penetrating the export markets which will be the key to growth. Both strategies will depend upon developing and maintaining a leading position in a few key products which promise strong domestic and export market demand.

44. There are three products which offer particular promise for continued growth of the Canadian industry: fibre optics, switching, and mobile radio systems. Fibre optics will provide the link that will enable the impending convergence of computers and telecommunications. The potential market for replacing the present paired copper wires presently used in the telephone system by fibre optics is enormous. Canadian capabilities to meet this domestic demand are rapidly developing and these can be built upon to provide for a strong export growth. The substantial potential domestic market is a key factor influencing developing Canadian capabilities in mobile radio systems.

45. In addition, opportunities will arise in the terminal equipment area, as a result of the trend towards subscriber ownership of telephone terminal equipment. The opening up of this market will permit entrepreneurs

to offer innovative solutions to the telephone needs of business and residential users. Many of these innovations will be based upon the power of the microprocessor. The success that these companies could be expected to attain will put additonal pressures on the traditional manufacturers of telephone terminal equipment.

B) Office Automation

46. In the broad area of office products, Canada (along with most other countries) is heavily dependent on major U.S. based multinationals. However, indigenous technology and supply capability is beginning to develop at the leading edge of the market, the so-called office of the future, which combines electronic office equipment with advanced telecommunications equipment to provide products that promise significant improvements in office efficiency. The developments include advanced versions of the now familiar word processor, intelligent laser copier/printers, automated personal calendars, interactive graphics, electronic private automatic branch exchanges (PABX) and many others. Today these machines exist largely as stand-alone products. But when the operations of each machine are connected with those of other machines through the communications network, the offices of the future emerges with expected synergistic effects on productivity. By concentrating in this area, which has not yet been sewn up by the traditional international suppliers and which capitalizes on the Canadian strength in telecommunications, Canadian firms have the potential to become major factors in the production of electronic office equipment.

47. Existing Canadian capability, beyond the telecommunications capability to the office function, lies in word processing equipment. AES Data and Micom, both of Montreal have been innovators in the development of word processors. They have obtained a dominant share of the Canadian market and a strong presence in export markets. Both firms are well aware of the need to extend their capability beyond word processing into other aspects of office automation and, indeed, into complete office systems.

48. It is widely accepted that the key to success in the office of the future market will be the ability of suppliers to offer solutions to office productivity problems, that is, full systems including hardware, software and communications services. In the U.S., this

means the advantage is with the giants IBM, Xerox and AT&T. If a Canadian supply base is to be established, these capabilities, which now exist separately in the carriers and the manufacturers must also be harnessed into a similar systems capability.

49. The OCS program of DOC, supported by ITC, is an initial, but very important step in achieving this systems capability in Canada. To provide a focus within which industry can organize itself the government is providing modest support in three prime areas: technological support, product development assistance, and directed procurements. A three phase program encompassing these elements is planned. The program of work includes development of the functional specifications of an advanced office systems, field trials in government departments, support for product development by companies, and the engineering to integrate the products into a complete prototype system.

50. The program should result in the development of a Canadian industrial infrastructure with a competitive capability to keep up with market and technological developments. The government, as a consumer of office of the future systems, also will benefit from its experience with the developmental work and the field tests.

51. The activities of DOC in the development and promotion of Telidon will also be integrated into the Canadian office automation capability. While Telidon was originally envisaged as an interactive home information service, it is becoming increasingly clear that the initial and perhaps primary market will be as the basis for interactive business information systems. As such, this will place Telidon in competition with other more traditional data base or information system services available to business. As a result of the missionary work of DOC in promoting Telidon as a viable information retrieval system, an important industrial production capability has grown up. This includes Norpak, Electrohome, AEL Microtel and potentially NABU.

C) Integrated Circuits

52. A third area of interest and possible opportunity for the Canadian electronics industry is in the basic technology that underpins all major areas of electronics applications, the integrated circuit or microelectronic

chip. In the past, there has been a tendency to downplay the opportunities for Canada in the production of microelectronics because of the cost of entry, the size of existing foreign suppliers and the failure in the mid-1970's of the one major attempt by Canada to get into the business. This pessimism may be unfounded. Northern Telecom has successfully resurrected its microelectronics facility, concentrating in custom applications in telecommunications. Mitel is having success with a similar venture in Quebec.

53. Part of microelectronics technology is evolving towards the production of "semi-custom" chips, chips of a standard design which can be modified or specialized to meet particular needs. This permits longer, cheaper runs of the partially fabricated chip. Subsequently, this chip can be completed for custom applications using only a limited amount of capital equipment. Mitel Corporation has announced that it is willing to license its technology and sell the semi-custom chips to other processors. These developments suggest that even a small country like Canada can find a role to play in the basic technology of the electronics revolution. The difference is that the development, production and marketing of custom and semi-custom integrated circuits are much less expensive than undertaking those activities for standard circuits, where the cost of entry is high and the competition is fierce.

54. The importance for Canada of maintaining a presence in the integrated circuit business is that it provides the opportunity to design equipment in parallel with integrated circuit developments and in turn influence circuit developments in line with end user needs. This relationship between circuit developer and circuit user or equipment manufacturer is increasing in importance as integrated circuits become more complex. The support and assistance of the chip manufacturer are becoming an essential part of the product design activity. In addition to creating this important synergy between user and maker, the existence of a supply capability in microelectronics will also ensure that a supply of people with experience in microelectronics is present in Canada.

D) Industrial Process Equipment

55. Two other maker sectors are important to Canada because of their critical role in supplying equipment for use in industrial products and processes - the machine tool and industrial instrumentation/process control sectors. Canada is not strong in either sector although there are a number of specialized firms which are world competitive in their field. In the machine tool sector, government policy since the mid 1960's has been that usage of advanced production equipment is a priority. Accordingly the machinery tariff program has permitted duty remission on the importation of machinery that is unavailable from Canadian production if the importer undertakes to pass on the tax saving to Canadian customers. For many reasons the supply capability for modern production machines is sparse. In the absence of machine tools manufacturers, the instrumentation and process control sector suffers. It has a smaller domestic market to build upon, and it misses the technology development benefits of co-operation with tool makers.

56. With the recent world trend towards programmable automation made possible through microelectronics, another maker sector holds promise to become an important new opportunity for Canadian Industry - advanced industrial robotics. The potential for productivity gain through the application of such technology in manufacturing operations is now widely accepted, but its successful application will rely heavily on supportive expertise from a responsive supplier. This technology of sensor based robotics is well matched to the capabilities presently being developed within the high technology sector of Canadian Industry. The opportunity to build on the advanced product requirements of a domestic market could provide the necessary base to establish a competitive position in the export market which is projected to experience very rapid growth.

E) Software and Services

57. The linkage between making and using is software. The products described above have little relevance to users unless they include the software, the instructions that tell the machine what to do. Software production has been and remains a highly labour intensive activity. In spite of continuing advancements in computer languages

and programming aids, the productivity of software writers has failed to keep pace with productivity improvements in equipment making. Accordingly, software is becoming an increasingly large element of the cost of electronic systems.

58. Of equal concern to the cost of the software is the supply of skilled programmers and software writers. Some concern has been expressed that a worldwide shortage of these skills will retard the application of modern electronic technology in both the office and the factory. Canada has many strengths in software as exemplified by its advanced usage capabilities in the office and in communications. Its strength in factory type applications is lower. Whether the people shortage will develop in Canada and to what extent remains unclear. This will depend upon the ability of our universities and technical colleges to turn out increasing numbers of programmers and the facilities available for, and the willingness of, hardware engineers and technicians already at work in industry to make the transition to software work.

59. The shortage of skilled software developers may accelerate the trend for users to purchase standard software packages rather than continuing to develop or contract to develop custom, tailor made software. While a standard software package may not perfectly meet the user need, the cost difference between standard and custom software can be ten to one or more. The installation time can be considerably shorter.

60. If the trend indeed is to purchase packages, the opportunity for Canada lies in the development of an independent software industry. It is estimated that 140 firms in Canada, predominantly Canadian controlled, derive their principal valued-added revenues from software and special purpose data processing systems. The software supplier typically performs one or more of the following services:

- the development of custom software for unique customer needs;
- the procurement, integration and installation of a computer system for turn-key contracts;

- the supply of proprietary software packages (i.e., cost control, hospital administration, leasing, on line banking, etc.);

- the training of the customer's computer users.

61. In effect, the independent software house has become a management service much like a CA firm, law firm or investment counsellor, helping others with their information management needs.

62. The software supply industry will grow rapidly over the next five years. There are a number of factors contributing to this growth potential and the competitiveness of Canadian firms. Fewer users can justify creating their own software capability. New hardware technologies (micro computers, distributed processing, etc.), are heavily dependent on user oriented packaged software. Unlike the hardware sector, the market for software is not characterized by the existence of strong, potentially dominant competitive forces.

63. The development and marketing of software packages can become an important element of the growing service industry rising up around the increasing use of computers. Other elements of this industry include telecommunications services, data processing services, facilities management services, design services, data bank services and a variety of consulting services. The existence of these service providers will be essential to the prosperity of the domestic electronic industry and to the Canadian users of electronics in their products and processes.

64. Further study of opportunities in software and services both in terms of developing a competitive industry and in terms of responding to the skill shortage is being undertaken. The problems and prospects of the software industry will be dealt with in depth in a subsequent paper, including the related activity areas of computer services, information networks and commercial data base supply.

POLICY IMPLICATIONS

65. The messages that arise out of all this change are simple.

For Users	Industry must begin to use the technology in its products and processes at a rate at least comparable with practices in competitive countries.
For Makers	The Canadian electronics and machinery sectors must invest heavily in modern production equipment and development if they are to offer the products and related services that will be demanded by the market and required on the shop floor, in the office and in new communications facilities.
For Labour	Because of the rapid changes in the nature of office and production jobs brought on by the technology, certain skills and occupations will become redundant while others will be created, resulting in a greater need for planning by the private sector to achieve effective utilization of the existing labour force.
For Government	The consequences of industry's failure to adjust are stark. They include reduced competitiveness and loss of market share leading to increased trade deficits, greater unemployment, increased labour unrest and lost opportunities for economic growth. Ultimately, it will lead to a reduced quality of life and standard of living for Canadians.

66. Canadian expenditures on industrial R & D are low by international standards and, with exceptions in the resource sectors and some high technology areas where government initiatives have created market space for domestic suppliers, Canadian industry has tended to be a technological follower rather than leader. A number of characteristics of Canadian industry are often referred to in trying to explain this lack of innovative effort. The branch plant nature of much of Canadian industry may also doom companies to reliance on mature technologies doled out to subsidiary companies at the whim of foreign firms that control the rate of technological progress within global corporations.

67. Throughout the 1970's these structural characteristics contributed to the discomfort felt in many sectors (notably secondary manufacturing, shipbuilding, textiles, automotive assembly) as the movement to freer trade exposed Canadian industry more fully to the rigours of international competition. The "electronics revolution" is now accelerating the pace of innovation, it is extending competitive challenges more pervasively throughout the economy and it is making the consequences of a failure to adapt more abrupt and binding.

68. Despite the clarity and compelling nature of these consequences there continue to be strong, countervailing forces at work that discourage users from embracing new industrial and manufacturing process equipment, that constrain industry from exploiting new manufacturing opportunities and that reflect efforts to properly anticipate and plan for labour adjustments on the shop floor. To begin with, all of the old constraints to industrial innovation remain. In addition, the specialized nature of investments in electronics result in several requirements that are currently difficult to meet in a Canadian context.

69. Investment in electronics is a unique capital investment problem. Even simple applications often represent a radical departure from the technologies a businessman or company has been using. Consequently, they do not understand the technology, they do not know how to use it effectively and they are often skeptical of the need to change. The tendency is to wait to see the new equipment profitably used elsewhere before taking the plunge themselves.

70. This problem is exacerbated by the heavy demands that these investments make on the analytical planning and engineering capabilities of individual firms. In particular, the process of adapting these technologies to meet the needs of individual users generally involves the development of application software, an expensive process that requires skilled engineers and technicians. These are areas where much of Canadian industry is weak. Small and medium size firms, truncated subsidiaries of MNE's and firms outside the industrial heartland can find it difficult to marshall this type of capability in house. The knowledge is highly specialized, the need is irregular and few companies can afford to carry it. Consequently, they are more reliant on outside advice but

in Canada, these sources of expertise may not be readily available. Traditional equipment suppliers may lack both knowledge and objectivity, consulting firms are new to the game, and university and other institutional sources of knowledge are only now beginning to be established.

71. If the majority of potential industrial users are not now familiar with electronics technologies and actively planning for their introduction, certainly little thought has been given to addressing the question of planning for accompanying labour adjustments. Planning for labour adjustments must be tailored to the unique characteristics of individual plants, to the specific nature of the new technologies being used and to the skill mix, structure and even personalities of the plant workers. The general labour sensitivity to this issue adds another dimension to this problem. Management often is reluctant to let labour know of their investment intentions because of uncertainty about labour's reaction, thus hampering effective planning. Constraints also arise on the labour supply side. These involve the adequacy of institutional and in-service training programs to turn out sufficient people with new skills. Thus, general nervousness and uncertainty about how to deal with potential labour issues arising from the use of these technologies may either deflect decisions to invest or result in less than optimal use of advanced equipment.

72. Canadian "makers" of these technologies and products in the electronics and machinery sectors are familiar with the implications of the electronics revolution for both Canadian society and for themselves. However, foreign competitors in the scramble for electronic markets are usually broadly based, long established world scale producers often strongly supported by their governments (see Appendix A). If Canada is to maintain a significant position in these markets, it must remain competitive in price and product sophistication with foreign firms. To do this the Canadian electronics industry must be prepared to plan, finance and manage ambitious programs of rapid growth that involve significant and steady investment in research and development and in new, modern plant and equipment. The foreign-controlled firms in Canada, who are generally the larger companies, often have difficulty convincing their parents that they should be permitted to

make these investments in Canada. The Canadian owned segment of the industry is hampered by the small size of individual companies and their inability to finance the scale of investment required.

73. Summarizing the above:

- potential Canadian users of technology are constrained from investing rapidly enough because of inadequate information about the technology;

- there is inadequate pre-planning at the individual plant level to deal with labour adjustment needs; and

- potential Canadian makers lack the risk capital and financial resources to grasp the new product opportunities open to them.

74. If the consequences of Canada failing to keep pace with other countries are to be avoided, government must assist industry and labour to overcome these constraints.

I Current Policy Framework

75. The current federal government response to this range of specific needs is contained in the Special Electronics Fund and certain Canada Manpower programs. Other general measures such as the incentive programs and tax measures referred to earlier establish a supportive environment but do not specifically address the needs of firms and labour in responding to electronics-induced changes.

76. The SEF addresses user needs through the Microelectronics Support Program portion which comprises a proposed awareness program, six centres of advanced technology in microelectronics, and the provision of grants for small feasibility studies, and modest implementation assistance. Maker needs are met primarily through the major projects portion of the fund. In addition, contributions are available to support the design of custom and semi-custom chips. Labour training needs may be partially addressed through the educational activities of the microelectronics centres. The federal government has also established two support programs for

specific electronic technologies, Telidon and Office Communications Systems.

77. In recognition of many of the labour concerns identified above, the federal government has, through CEIC, launched a number of adjustment programs. These measures include: a comprehensive Manpower Consultative Service which assists firms to redeploy workers, institutional and industry-based retraining programs to help workers acquire new skills and a national Mobility Program to assist those who must move to find employment. In addition, the Industrial and Labour Adjustment Program (ILAP) assists specific communities where economic dislocation causes severe economic and social repercussions. The program provides for early retirement benefits, portable wage subsidies for older workers, additional job creation projects and higher training and mobility incentives.

78. Finally, the federal and some provincial governments have been considering proposals aimed at improving the flow of information to potential users of electronics, particularly with respect to CAD/CAM technology. NRC has a $23 million proposal to establish a Manufacturing Science and Production Technology Research Institute in Manitoba. ITC was allocated funds in the May 1981 Economic Development action to establish a national CAD/CAM centre to provide a clearing house for information on the technology and to facilitate coordination and communication among other centres and with the private sector. The Ontario government has announced its interest in establishing a $50 million CAD/CAM Development and Robotic's Testing Facility to assist in the development, design and installation of this equipment, and at similar cost, a Microelectronics Centre to provide chip design and consulting services, primarily to the electronics industry. New Brunswick and Alberta are also considering the establishment of centres to spur the development and application of electronic technology.

ALTERNATIVES

79. The basic choice facing government is whether or not to attempt to address the constraints to the full use of electronics in Canadian industry. Given the massive level of intervention in this process by other countries, (Annex A), the serious consequences to the economy of not

responding to the challenge and the fact that government made a decision to act two years ago in implementing the SEF, the remainder of the paper assumes that some level of government involvement is appropriate.

80. The tax system is already quite supportive of capital investment in manufacturing and processing. Efforts to make the tax system even more attractive of specific investments in electronics would have to solve formidable definitional problems (i.e., what investments would qualify), thus limiting the ability to use this mechanism to address the areas of concern. As well, assuming that definitional problems can be solved, enriching tax support measures could be expensive. To illustrate, all of Canadian industry invests be expensive. To illustrate, all of Canadian industry invests $20 billion annually in new production machinery. If only 5% of this were susceptible to improvement by electronics technology and the government shared one quarter of the cost, the outlay would be $250 million annually.

81. This narrows the alternatives to the use of funded programs. There are two options: refinance the SEF without altering the program structure, or fit the existing program elements into a more comprehensive initiative that fills in the gaps in the SEF and that more effectively addresses the question of labour adjustment on the shop floor. This latter option is nationally called Support for Technology Enhanced Productivity, or STEP. These alternatives are discussed below.

I <u>Refinance the SEF</u>

82. This option has several advantages. The cost to government would be less than the STEP proposal since it does less. It would allow time for further evaluation of the need for and structure of possible incremental program elements. Refinancing of the SEF would provide some evidence of government's concern.

83. On the other hand, it would continue to provide only a partial response to the identified range of program needs. These program gaps would diminish the potential impact of government initiatives. Of particular concern, is the fact that the scope of the

program is oriented primarily to the needs of smaller, first time users.

84. The provision of $10,000 for feasibility studies and up to 75% of implementation costs to a maximum of $100,000 for first time users of microelectronics is a very useful and highly attractive incentive but only to a limited population. It is restricted to neophytes, and it will be applied to small and simple projects. While the benefits to the individual users can be very large, the overall impact will be limited.

85. Restricting the Major Projects Fund to the electronics industry is a drawback on the markets side. While microelectronics is driving change, much of the productivity improving developments take place outside the electronics industry. As constituted, the SEF does not apply to the machinery industry, from which many of the innovations in manufacturing automation will come.

86. A further serious limitation of the SEF is the lack of coordination with the government's labour adjustment programs. While the programs of the CEIC would certainly apply to many situations where the SEF is involved, there is no way to ensure that labour issues are being addressed under the SEF as now constituted.

II <u>Introduce STEP</u>

87. This alternative involves a broadening and deepening of the elements of the SEF to allow the program to address the full spectrum of user and maker needs identified above. As well, it contains a mechanism to coordinate industry support elements with the labour adjustment elements of CEIC programs. The following paragraphs identify the shortcomings of the SEF in more detail and indicate the nature of the more comprehensive proposals envisaged for STEP.

A) <u>Users</u>

i) Industrial Education

88. Changes to the awareness program under STEP would focus on broadening the scope of the program content to include labour implications, and the involvement of labour representatives in the seminars. This should help to sensitize business and labour to the issues and encourage a dialogue. Secondly, it may be desirable to

expand beyond awareness into industrial education. The seminars will become more pertinent and effective as they become more sector specific. To do this and maintain adequate regional coverage would require a larger number of perhaps smaller seminars operating over a longer period of time and might entail greater diversity in both format and content. It may also be important to achieve greater depth than can be covered in one day awareness seminars. Three to five day seminar/tutorial/workshop sessions geared to middle and general management can provide significant degree of understanding of the benefits, costs, pitfalls of investing in the new technology and more important, the confidence to try the technological. As well as going into more depth there may be a need for some superficial efforts to raise the perceptions of the general public and Microelectronic/ Computerization Weeks have been undertaken in France and Japan while the U.K. has declared 1982 as the "Year of Information Technologies". Thus, larger outlays in respect of industrial education over several years would be required. Although the incremental cost would be small, perhaps $2.5 million, it could have tremendous leverage in precipitating decisions about the application of electronics. Only one or two modest incremental investments could produce increased benefits well in excess of the cost of the full industrial education program.

ii) Investment Information

89. The Factors and Policy Implications sections of this paper have emphasized the importance of the information gathering, analysis and planning functions. The acquisition of sufficient information to make an intelligent investment in electronics technology has been identified as the greatest user need.

90. The current SEF programs are useful for small firms and projects. However, for all but very simple applications, the process is more complex and costly.

91. With respect to cost, it is obvious that as one moves up in terms of project scale, a $10,000 feasibility study quickly loses its relevance as an incentive to investment decision-making. Basically, it will enable a potential user to determine whether or not to buy simple, add on micro-electronic sensors and controls. In larger applications, maximum benefit from the use of new

industrial equipment may require reorganization of production processes and the development of complete manufacturing systems costing millions of dollars. In the process, feasibility studies become more comprehensive, time consuming and costly. Indeed, the feasibility studies may become sufficiently expensive propositions in themselves to deter companies from thoroughly examining the merits of alternate production technologies. This in turn leads to uniformed experimentation, ad hocery and less than optimum utilization of this machinery.

92. The complexity of electronic solutions may also increase rapidly with increases in scale. Indeed a point is quickly reached where a proper feasibility study becomes only the first step in the investment decision-making continuum. Rather than prescribing a clear cut, definitive solution, the feasibility study will simply chart a course for the potential investor to follow. This initial assessment must be followed by detailed process engineering and design studies, software development and testing, plant layout changes and possibly an extended period of debugging the new equipment. Changes in industrial process may also affect production volume thus requiring additional analysis of marketing strategies and overall corporate missions.

93. Thus, managers must proceed step by step through a phased investment process that has numerous decision points. Each of these points requires the collection and evaluation of information beyond that contained in the initial feasibility study. Throughout each of these follow-up steps, even the largest companies will continue to be dependent on outside advice and expertise. More to the point, these sources of expertise must be tapped if companies are to be reasonably assured of being able to use the new technologies effectively and to secure the hoped for productivity gains.

94. In planning for the introduction of electronic technologies to the shop floor, the question of labour adjustment occupies a strategically important position. This is a concern both in terms of dealing with labour's fears of being made technologically redundant and also of ensuring the availability of appropriately trained personnel to manage and operate the new equipment. The adequacy of industry efforts to manage the process of labour adjustment at the individual plant level is also

of considerable interest to government in the general context of overall labour adjustment. If these micro level labour problems prove manageable through upgrading the skills of existing workers and through relocation efforts, the broader, longer term questions of labour dislocation may prove less onerous.

95. General support for computer related service industries is not covered in this discussion paper. However selected companies that rely heavily on CAD and particularly those involved in the provision of internationally traded services do fall within the area of economic activity which the proposals contained in this paper are designed to encourage. Thus, these firms might also be considered as potential recipients of government assistance, perhaps on an exceptional basis.

96. In light of the above, the effectiveness of government assistance would be enhanced if it is provided in a form and in a sequence that matches the steps in the entire investment sequence and that encourages adequate planning for labour adjustments at the plant level.

97. A phased program of government assistance for feasibility assessment and project implementation for larger industrial users of modern manufacturing technologies and selected service firms might include the following two elements to complement the existing $10,000 feasibility contributions and $100,000 implementation assistance:

1) larger feasibility study assistance (up to $100,000 on a 50/50 shared cost basis with individual companies)

2) a subsequent contribution of up to $1.5 million on a 50/50 shared cost basis to offset implementation costs including:

   - incremental costs for professional services associated with the project (e.g.: software development, engineering design, market research, consultants);

   - R&D and relevant technology development and testing; and

- some of the cost of in-house labour adjustment and retraining programs.

98. The most effective means of managing the labour adjustment issue at the firm level might be through the establishment of a committee consisting of representatives from management, labour and government to monitor the changes proposed and to jointly design the programs required to either retrain or relocate workers affected by the introduction of the new technologies. Specific programs to support these labour adjustments are already operated by CEIC. It is intended that these programs be used to complement the investment support measures discussed above. The manner in which the ITC and CEIC programs would be integrated is described in section C below.

99. These additional program elements should go a long way towards encouraging effective, thorough planning within corporations for the introduction of new electronic production equipment. They would strengthen or augment in-house planning and engineering capabilities. They would act as a catalyst to focus management attention on the productivity and quality control benefits of modern process equipment, provide them with an objective assessment of equipment needs, assess the benefits and costs of restructuring industrial processes and provide supplementary technical assistance during the changeover. With respect to labour, they would ensure jobs for the maximum number of existing employees through retraining and relocational assistance. This type of support would also give the government considerable leverage as it would influence multi-million dollar investment programs by encouraging the critical evaluation and planning stages.

100. In full operation, this expanded portion of the program could be expected to support in the neighbourhood of 30 feasibility studies annually, leading to perhaps 10 or 15 projects that would require additional implementation assistance. Thus the estimated incremental costs of supporting industry efforts to collect investment information and data could eventually amount to roughly $20 million annually. Such a program would be an innovation for the federal government and it might be preferable to provide a smaller amount of funding for a few years to test the validity of the program design.

iii) Microelectronics Centres

101. One source of specific investment advice and information will be the microelectronics centres established by the government. While only in the formative stage, these centres have attracted favourable comment from provincial governments and the private sector. To ensure that firms throughout Canada have access to these centres and their services, it may be desirable to further expand their number. In particular, there may be a need for three additional centres in the Atlantic Region in recognition of the lower level of business support services there and the greater needs of smaller less sophisticated companies. Provision could also be made for a centre for Saskatchewan to service the needs of the agricultural and resource sectors. These additions would mean the presence of such a centre in every province. The additional cost of these centres would be $800,000 per year for five years.

iv) Custom Circuits

102. The program of small contributions for custom and semi-custom integrated circuit design is worthwhile, but rising design costs for custom chips into the $750,000 range have made the $100,000 contribution limit an inadequate incentive. It therefore may be desirable to establish a new maximum contribution of $500,000 with government meeting 75% of the costs.

103. Up to a maximum of five custom designed chips might be supported each year with smaller, but eventually more numerous contributions being made for semi-custom chip adaptation. The estimated incremental costs of this change would be in the order of $2-3 million annually.

B) <u>Makers</u>

104. As noted above, without a continuing base of funding for the Major Projects portion of the SEF, Canada could well lose a number of attractive projects. In addition, much of the money being invested in Telidon and OCS for research, marketing standards development, etc., could be wasted, from an industrial benefits perspective, unless suppliers of this technology can gain access to a fund of this sort.

105. Because of its strict electronics orientation, the SEF currently can do little to support the supply capability in new manufacturing technology. For this reason, it would also be desirable to extend the automation, including advanced numerical control, electronically driven machine tools, computer aided design and manufacturing robotics. This would provide clear evidence of the government's intention to encourage the development of advanced technology production equipment in Canada and could be a useful tool for strengthening and restructuring parts of the machinery industry.

C) Labour

106. To complement the industrial support measures, there is a need to ensure that labour adjustment issues are adequately dealt with at the company level when planning for and implementing electronic applications. This can be achieved by requiring that appropriate labour adjustment efforts be a requirement for the receipt of government incentives to apply the new technologies. Brief reference was made to this question in preceding sections and relevant supportive manpower programs were identified. In order to place these suggestions in perspective the manner in which the question of labour adjustment would be handled, if all of the program proposals in the previous two sections were introduced, is summarized in the following points.

(a) The need for proper planning to deal with labour adjustment issues and the availability of CEIC and ITC assistance to facilitate this objective would be highlighted in the general awareness program and labour would be invited to participate in the awareness seminars.

(b) To ensure that manpower adjustment planning is started at the earliest stage in the planning cycle:

- companies seeking $10,000 grants for the conduct of feasibility studies will be encouraged to build an assessment component into the terms of reference of their studies whenever the potential number of affected workers warrants (generally these small grants will cover simple electronics applications where only a few workers will be affected thus making detailed manpower planning both impractical and perhaps unnecessary).

- support for larger feasibility studies will be conditional on inclusion of a manpower component designed to lay out the scope of potential labour adjustment needs.

(c) Subsequent contributions to assist with project implementation will be conditional on receipt of a firm's commitment to CEIC to develop and implement an adequate manpower adjustment plan. The planning should be done with the full involvement of the existing work force and should encompass both retraining and relocation aspects. The intention is that projects supported under these programs would provide a good role model for the rest of industry for dealing with labour adjustment issues.

(d) For these larger projects, government assistance towards the costs of designing and implementing an in-house manpower plan will be provided through existing CEIC programs in cases where affected workers and their employer can agree to cooperate. (This is currently a CEIC program which funds up to 50% of related costs.)

(e) If labour and management, in good faith, cannot agree to cooperate, CEIC may recommend that ITC use its implementation assistance contributions to cover up to 25% of the costs of designing an adjustment plan. CEIC would then monitor its implementation.

107. A final feature of program design intended to integrate the two elements of support would be extensive decentralization of the industry user program administration to ITC regional offices. As the manpower programs are already locally administered, this should facilitate the development of a comprehensive package of support. Such a move would also make the program more accessible to smaller firms and should increase its impact in the regions outside central Canada.

108. CEIC is of the opinion that it will require additional funds to meet the training and planning needs

for labour adjustment and that some internal administrative and design changes will be required to improve program responsiveness and delivery. However, precise definition of these needs can only be derived through experience.

D) Summary - Elements in STEP

I Users

(a) Expanded industrial education program.

(b) For first time users of microelectronics:

- contributions of up to $10,000 for feasibility studies;
- contributions of up to $100,000 (maximum 75% government share) to assist in the implementation of projects.
- simple administrative procedures.

(c) For potential users of electronics in the production process:

- contributions of up to $100,000 for larger feasibility studies (maximum 50% government share);
- up to $1.5 million in contributions (maximum 50% government share) to offset larger project implementation costs;
- more rigorous qualifying criteria.

(d) Microelectronics centres:

- up to ten regional microelectronics centres (an increase of four over the current program).

(e) Custom Chips:

- up to $500,000 contributions, 75% government share, towards the cost of custom and semi custom chip design.

II Makers

- Refinance and extend the major projects fund to support both producers of advanced electronics and industrial process equipment.

III Manpower

- Require preparation of in-house manpower plans as condition of larger feasibility and project implementation support;

- up to 50% CEIC or ITC contribution, to develop in-house manpower plans and to cover the cost of an industry/labour monitoring committee;

- draw on supplementary CEIC manpower consulting planning, training and mobility programs.

IV Administration

- Decentralization of the administration of industry support elements to ITC regional offices. Close cooperation in the regions between ITC and CEIC to allow "one stop" program delivery.

E) Impact

109. Most of the measures included in STEP involve matching contributions by the industrial recipient. Indeed in the case of major projects, it is expected that the Crown contribution will be less than 25% of total project cost. Thus in full operation in 1985/86, the $25 million government expenditure would cause approximately $100 million in industry investment. The applications/feasibility aspects of the program will have a small initial industry investment but can be expected to lead to major downstream investments, perhaps as much as $125 million. The industrial education program could lead to another $125 million in industry investment. Thus private sector investment of $350.0 million could be caused by a $40 million Crown investment.

110. This $350 million in private sector investment represents nearly 4% of current private sector investment in new machinery and equipment in the manufacturing industries. Thus, government could take credit for sponsoring a significant increment in the production capability in Canada. This increment will be at the

leading edge of technology and will represent the most competitive portion of Canadian industry resulting in significant growth in manufacturing exports and in import replacement. When fully operational, annual investments of this level could substantially reduce Canada's trade deficit in manufactured goods.

111. It is extremely difficult to arrive at any estimate of the impacts for the manpower side. The two major projects funded so far by the SEF are expected to produce one job for every $25,000 of government support. Extended to a continuing program of $25 million annually, 1,250 new jobs could be created each year. The high cost of job creation reflects the fact that many of these positions are high paying, high skill occupations requiring considerable capital investment. Clearly the user side programs will help to preserve and upgrade jobs, especially if they are operated in conjunction with manpower programs. On the other side of the ledger, the programs will create sizeable demand for the provision of related service activity, but specific employment gains in these occupational areas defy precise measurement.

FEDERAL/PROVINCIAL RELATIONS

112. Investment in high technology industries, particularly electronics, is of interest to all provinces. The electronics industry is currently concentrated in Ontario and Quebec, but there are centres of activity in other provinces. Because of the nature of the industry, particularly the diversity of products and the opportunities for specialization, many of the aspirations of these other provinces for more electronics investment can be realized.

113. Beyond greater participation in the development and production of electronic goods, all provinces are interested in the use of electronics. Just as Canada lags behind other developed countries in its application of electronic technology to the production process, there is a regional disparity in its application within Canada. These factors all tend to retard the early application of modern production technology. The measures in the SEF and the extensions proposed here represent a mechanism for closing this gap.

114. In spite of their interest, no provinces have yet implemented dedicated programs for encouraging either the

manufacture of electronics products or their use. Of the general programs in place, the best known is the Ontario BILD program. This program has a definite high technology bias, and includes proposals for a microelectronics development centre, CAD/CAM centre and a bioengineering centre. Other provinces have expressed a similar interest and a desire to cooperate with the Federal Government. The competition from the provinces to have microelectronics technology centres is an indicator of this interest.

115. When announced, the SEF was generally well received. Some of the provinces, including Nova Scotia, Quebec, Saskatchewan, Manitoba and B.C., have indicated a willingness to enter into joint Federal-Provincial projects.

INTERDEPARTMENTAL CONSIDERATIONS

116. This document has been written by DITC officials with support and contributions from CEIC. Other departments have been consulted in the development of the analysis and policy options including the departments of Labour, Communications, Finance and Regional Economic Expansion, the Ministries of State for Economic Development and Science and Technology, the Treasury Board and the Privy Council Office.

RECAPITULATION

117. The electronics "revolution" is underway. Its effects on Canadian industry and labour cannot be stopped at the border. All industrial sectors must embrace the technology in their products, on the shop floor and in the office or risk losing their market position to competitors more willing to exploit the quality and productivity gains implicit in the use of new electronic technologies. The necessary labour adjustments must be made to retain jobs in competitive firms and to take advantage of the new employment opportunities created through the manufacture and servicing of electronics products.

118. The process of adjustment by users, makers and labour all face constraints to rapid and positive adaptation. These create a range of needs, many of which could be assisted by government initiatives. Existing

programs meet these needs in a limited way but are restricted in their focus, funding levels and duration.

119. The government faces a choice between deferring action pending more definitive analysis or employing directed programs to address both the industrial and manpower adjustments required by electronics applcations. If the latter course is followed, the program alternatives involve refinancing the SEF or expanding and integrating the elements of the SEF and labour adjustment mechanisms to form a more comprehensive program of Support for Technology Enhanced Productivity (STEP).

GOVERNMENT ASSISTANCE TO THE ELECTRONICS INDUSTRY IN DEVELOPED COUNTRIES

A survey of the programs of support for the electronics sector in several of the more important electronics producing countries highlights the strategic role seen for the industry by other governments and their willingness to invest large sums to encourage the industry to attain the goals set for it. A.though this survey focuses primarily on direct government assistance to electronics, the electronics industry in developed countries benefits to differing degrees from a variety of more general industrial support mechanisms, including:

- government procurement policy
- provision of venture capital
- funding of R&D
- financial and taxation measures to promote development and use of new technologies
- tariff barriers
- use of standards to promote national interests
- government financing of training programs
- aid in developing exports
- establishment of public research institutes to conduct basic and applied research and transfer new technologies to the private sector.

Much of the information provided here is in descriptive form. Quantitative data is not easily available on the amount of assistance policies, general tax measures, nationalization schemes and regional development policies. The data that is available has been collected from a variety of sources over an extended period of time. The numerical data has often gone through one or more currency conversions at different times. Accordingly, they are correct only in general magnitude and should be quoted cautiously.

United States

Until very recently, the U.S. has not had a deliberate strategy of support for electronics; rather, financial assistance for the sector was provided in the context of government work to achieve other goals, particularly in the area of defence. However, the level of support provided was so great it became a dominant factor in the development of the U.S. industry world wide, substantially replacing normal competitive conditions and commercial criteria. The absence of such massive early support for the industry elsewhere in the world (with the partial exception of the Japanese in some consumer electronics goods) meant the non-U.S. electronics firms could not hope to compete on equal terms, and as a result U.S. companies achieved a pre-eminent position.

U.S. support for the industry has been channelled through two main routes: direct procurement, including funds for product development, and (largely military) funding of basic and applied research. It has been estimated that in the period from 1958 to 1969, the U.S. government funded directly over one-quarter of the R&D done by the semiconductor industry. Procurement of these goods has been another very substantial source of funds to support technological activity in the sector. Indeed, it is difficult to underestimate the importance of U.S. government procurement in the period of the late '50's and '60's. Until the mid-'60's, U.S. government agencies comprised the major portion of the market for many, if not most technically advanced electronic products. This thrust played a big role in creating a dynamic industrial synergy between the electronics producers pursuing new technologies and government agencies applying and expanding the use of the new technology.

The end of the Vietnam War, a decline in the space effort and the growing application of electronics in the private sector led to a decline in the relative and actual role of the U.S. government in stimulating and directing the development of the electronics industry. Nonetheless, support has continued at a level far in excess of that in other countries. The total U.S. federal R&D budget in fiscal year 1978 was $26.3 billion of which $14 billion will go to industrial firms, mainly to support development activity. An additional $270 million is available for firms to invest in R&D plants. Using industry R&D spending patterns as a proxy, it would be reasonable to assume that just under one-fifth of this funding, something over $2.5 billion, would be supplied to electronics firms. This support is in addition to tax based assistance such as write-offs of expenses and tax credits.

The terms and conditions of U.S. R&D support are also very generous. Typically, an R&D contract will provide 110% financing, covering the full costs to the firm of doing the work and adding a guaranteed 10% profit. One result of the U.S. approach is that firms can spend huge amounts of money on R&D, a very significant portion of which comes from government. In 1975, U.S. companies spent $15.1 billion of their own money on R&D and $9.1 billion of the government's. For industries which produced goods and services largely for the public sector, (of which electronics is a good example) the ratio of public to private financing is even greater. For example, in 1975 for R&D, ITT spent $263 million of the U.S. government's money and $219 of its own; Boeing, on a STOL plane competing with the DASH-7, spent $95.2 million of government money and $41 million of its own.

Even with this very heavy and generous funding for electronics there is rising concern in the U.S. that its level of assistance, particularly in the area of electronics is slowing down. The coincident establishment of substantial government-funded programs to support electronics activity in Japan and several European countries in an effort to "catch up" to the U.S. has added to this concern.

There are signs that the U.S. is reacting by increasing defence development contracts. To take the example of manufacturing technologies, government projects, largely contracted out, include the $100 million United States Air Force, Integrated Computer Aided Manufacturing project for aerospace companies; the National Aeronautics and Space Administration CAD oriented Integrated Planning for Aerospace Design program; the United States Navy Computer Aided Shipbuilding Design and Construction program and others. In the integrated circuits area, the Department of Defence is funding a $150 million program to develop circuits with processing capabilities 100 times greater than existing devices.

In addition, the Detroit Cooperative Generic Technology Center Inc. has been selected by the U.S. Department of Commerce to create and operate a research facility in the area of computer integrated manufacturing, supported by a grant of $1 million plus a $5 million grant for facilities and equipment.

Japan

Japan, like the United States, has consistently given a very large amount of government support to the electronics industry. The big difference is that from the start Japan identified electronics as one of the critical industries of the future in which it wanted to have a powerful position. To this end, it has pursued a strategy of deliberately supporting and promoting the industry, with particular emphasis on the creation of the all-important synergy amoung researchers, producers, and users. This strategy, starting in the early 1950's, has been far-sighted, sustained, consistent and very heavily financed. The broadest range of government measures has been used to assist the industry; funding for R&D and other corporate activities, loans, export assistance, heavy protection from imports, procurement preferences, use of chosen instruments, indicative planning and support of cartels, forced transfer of technology from foreign subsidiaries to Japanese companies, restrictions on foreign investment, and currency exchange restrictions.

The current program of support for the electronics industry was established with the 1971 "Temporary Law for Strengthening Selected Electronic Equipment Industries". The law set a series of technological goals, focussed on closing the gap between Japan and the United States. The budget allocated for this project was $1.4 billion over seven years with two-thirds going to computers, a fifth to industrial electronics systems and the remainder to integrated circuits, components and materials. Even this very generous program has been added to. In 1976, the Japanese government announced plans to spend roughly $1 billion over the following four years to develop Very Large Scale Integration (VLSI) aimed at computer and telecommunications applications. The core of the program is the VLSI project itself.

For this, the Ministry of International Trade and Industry supported the formation of a "VLSI Technological Research Association" comprising five Japanese electronic companies (and excluded the largest, IBM, which is foreign owned). The association had a four year, 70 billion yen ($375 million) R & D program which included a 30 billion yen ($161 million) grant from the government. Closely related to this project are a range of applications efforts including a $150 million plan for the Nippon Telegraph and Telephone Corporation, aimed at the development and production of new telecommunications devices based on VLSI components.

Further recent examples of government assistance include $80 million to be allocated over five years for advanced software development, $100 million towards development of totally unmanned factories and an additional $60 million supporting manufacturing technologies for highly automated factories.

Perhaps one of the most important features of Japan's efforts in the electronics (or indeed, any other) sector is the close working relationship between government and industry and among different companies. In addition to the usual matrix of interlocking and consultative and cooperative committees, the Ministry of International Trade and Industry (MITI) has the authority to exempt any portion of the electronics industry from the Anti-Monopoly Law. Cartels for controlling production, R&D and raw materials not only are permitted but have been strongly supported by the government. Indeed, one of the current concerns of Japanese officials in MITI is the distressing tendency toward competition within the computer industry. The cartelisation of much of the electronic industries' activity gives Japan a major advantage by eliminating duplication of effort among the companies and promoting the co-operative synergistic interrelationships which underpin the rapid advance of new technologies and their application. This feature, combined with the heavy funding available, gives Japan a very powerful program.

Another feature of Japan's efforts, particularly pertinent to Canada is the almost complete exclusion of foreign owned subsidiaries. This extends beyond a simple program of preferences for domestic firms in procurements or government assistance to a policy of actively discouraging foreign firms from establishing facilities in Japan to serve the market and continuing efforts to "freeze out" those foreign owned firms already in Japan. A good example of this is IBM Japan which over the years has been obliged to manufacture its most advanced products in Japan and simultaneously license the technology to its Japanese competitors, been excluded from government procurements, restricted in terms of the market share it may capture, and excluded from the government-industry cooperation and planning committees.

However, it should be noted that, as Japan has succeeded in achieving its internationally competitive status in high technology sectors, many of the direct support mechanisms have disappeared or declined. Direct subsidies to industry have become smaller, import quotas have been relaxed or have disappeared, government procurement preferences have been weakened and foreign investment is being permitted.

United Kingdom

Britain, since the early 60's has, as a matter of policy, provided support for the electronics industry. Initially the intent was to assist British industry in keeping up with the technology, particularly in the area of integrated circuits, and build some British-owned firms with competitive capabilities in electronics. The first big Government project was its shared (50-50) funding of R&D through the Advanced Computer Technologies Project. Towards the end of the decade, the government encouraged the formation of a national computer company (ICL) and supported it through procurement preferences and financial support for R&D and marketing. As a result, by 1980, ICL had attained 35% of the home market as well as significant sales in international markets. However, this good performance did not prevent the company from experiencing substantial losses in 1980 and 1981. Following several months of attempts by the government to find a private sector rescuer for ICL, the British Government announced a £200 million loan guarantee to prevent the company from going under.

Other activities in the information processing field include government development and marketing of Prestel, a commercial videotex system, and the promotion of software expertise in foreign markets.

However, more recently the government has indicated that pursuit of such a strategy led to a failure to invest sufficiently early and heavily, and did not do enough to promote creative interchanges between researchers, producers and users. In recognition of this, a strategy has been developed to focus extensive business and government efforts on a specialized electronics area -- microelectronics and VLSI in particular -- as an entry point and base for future development. This strategy has three thrusts: to build a world competitive capacity in standard chips, build strength in customized special chips and to encourage the development of applications by users. Most recent forecasts suggest that the total government financial commitment for all three could reach close to $1 billion over five years.

For the first two thrusts, the government has established a five year $160 million Microelectronic Industries Support Project which will provide 50% of the costs of research projects and 25% grants (up to 50% in special cases) for the costs of developing products and processes. Both can be recovered by a levy on associated developments and sales. In addition, 25% grants are available for investments in production facilities. These programs are in addition to existing programs of technological and R&D support for the electronics industry which provide roughly $11 million annually.

Complementing this matrix of technology assistance projects has been a program of heavy, direct investment in the electronics industry by the National Enterprise Board, a quasi public corporation analogous to the CDC in Canada. The most important investment by the board has been the commitment of roughly $115 million towards the start of INMOS, a new company producing standard VLSI chips. INMOS began production in the U.S. but will transfer production to the U.K. The U.K. has made this large and highly risky investment because of concern about the ability of the industry to survive in the U.K. without the synergy created by a large producer of standard VLSI's. It also was felt that the geographic proximity of a large standards producer would help on the applications side through the movement of people between the producer and users. In addition to INMOS, the NEB has invested almost as much again over the two years 1977 and 1978 in other electronics companies.

In a further effort to create the important synergy between users and producers, the British government established in July, 1978 a Microprocessor Applications Project (MAP). The experience of the government with this program is a good, if somewhat dramatic, example of the lavish government approach to electronics support in several countries. (France, Germany, Italy and Sweden all have or are developing similar scale programs.) The project initially was funded with $30 million for two years to encourage the application and use of micro processors in other sectors. In the fall of 1978, the government added several more millions to fund a three year publicity project to demonstrate to industry the microcomputer potential in automating production and services, updating products and deriving new products. Later that year, the British Prime Minister announced a massive expansion of the program with the allocation of an additional $750 million over three years to provide assistance to the producers and users of chips, aid for new factories, and for communication, educational and training programs.

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All of these incentives schemes are in addition to a range of more general programs of assistance for technological activity similar to the general programs offered in Canada. They include:

> Product and Process Development Scheme (roughly $40 million annually for shared cost assistance similar to EDP).
>
> Selective Investments Scheme. Initial allocation of roughly $230 million to provide interest relief grants on major new investments in manufacturing which would not otherwise proceed.
>
> R&D Requirements Boards (similar to EDP regional boards with a mandate to share R&D project costs 50-50).
>
> National Research Development Corporation (a public corporation similar to NRC offering cost sharing of R&D, venture capital for equity and loans to new companies to exploit new technology and working capital loans).
>
> 100% tax write-offs of capital and current technology related expenditures.
>
> Incentives in areas for expansion (a DREE type program which offers grants, loans and special tax treatment to firms. It covers scientific research also).

Procurement policy is also used to support the electronics industry. Until implementation of the GATT Procurement Agreement, the government bought all its computers from ICL. A feature of both procurement policy and the grant programs has been that the Department of Industry explicitly discriminated against foreign firms, reflecting the sentiment of Ministers in favour of domestic control of companies, particularly in an area of strategic importance such as electronics. This was emphasized by the INMOS venture. In the other electronics programs the approach is to support wherever possible British companies.

France

France's strategy with respect to electronics has had two main themes: first, an emphasis on building an internationally competitive capacity in several electronic subsectors and second, a very strong emphasis on retaining French control of the industry, indeed of all high technology industries. In the '60's and early '70's, France pursued these two objectives in the fields of computers and telecommunications. In both sectors, substantial government help in the form of financial assistance, direct investments and directed procurement was used to secure a French presence.

At least in the case of computers, France has had little success for a substantial expenditure of money. Several unsuccessful corporate restructurings were undertaken by the government in the late '60's and early '70's. Under its current "Plan Informatique" the government brought about a merger of France's two main companies, the Compagnie Internationale pour l'Informatique (CII) and Honeywell-Bull to form CII-HB, a single majority French owned firm. Support for this cost the French government over $700 million including financial commitments up to 1981.

In 1979, France laid a significant emphasis on networks and new telecommunications services -- especially such home data services as the videotex system Antiope, electronic mail and an electronic telephone directory. Through its efforts in these fields, the French Government hoped to stimulate its industry into a leading position in the future home services market.

In the field of telecommunications equipment, the French government forced the sale of two foreign owned firms (ITT and Ericsson-France) to the Thompson-CSF group. Procurement policies of the French PTT have been used as a matter of course to support the domestic industry.

France's seventh economic plan running 1976-80 identified six key pilot projects around which the transformation of the French industrial structure in the next twenty years should take place. Three of these are electronics: integrated circuits; communications, computerized information and audiovisual aids; and space technology for television and data transmission. The government provided an initial $2.7 billion to begin implementation of all six projects.

At this time the strategy to build a French presence in the integrated circuit industry, perticularly in the field of LSI and VLSI is the main focus of the government's efforts in the electronics area. As in the case of computers and telecommunications, the policy instruments are heavy financial assistance, direct investment, direction of procurement to chosen instruments, and a strong preference for French control although foreign firms will be permitted substantial minority holdings. As in the case of Britain, considerable emphasis is being placed on developing both custom and standard ICs, and tying these developments to a stimulated growth of the use of ICs in the wide variety of industries, in an effort to generate the all important synergy among producers and users.

The centrepiece of the strategy is a joint venture between Motorola and EFCIS, (a French chosen instrument currently in the custom LSI field) to build a world competitive producer of standard LSI and VLSI integrated circuits. The initial investment is $75 to $100 million, with slightly less than half coming from the government. Motorola likely will acquire its equity through the investment of its technological know-how. The next step, planning for which is already underway, is the development of a second IC manufacturing operation, backed by principal domestic users of circuits such as electrical, car and computer firms. This firm would be based on Secinmos which would also seek an American partner to provide the start-up technology. Over a five-year period, the French government has planned to spend a minimum of $25 million annually in the support of the IC industry.

In the custom LSI field, France supports three chosen instruments which receive procurement and R&D assistance. The three companies have research programs covering the next five years and costing over $250 million, the government's share of which is roughly half. These companies will be recipients of assistance under the IC industry programs but it would appear that the aid will be in addition to the existing funding of R&D projects.

This review of some of the more important measures the French government has established for electronics is not complete; France offers, as do all other industrialized countries, a range of tax-related incentives for R&D and new investments. The various specific programs noted above involve differing kinds of financial commitments from the government, so that a summing of the actual expenditures would be very difficult to do. Nonetheless, it is safe to say that the French government has committed close to a billion dollars to the electronics industry for a period of five or six years.

West Germany

Government policy toward the computer part of the electronics industry has been based on two basic principles: the 'Germanization' of computer manufacture and research aimed at developing applications for export markets. In 1967, the government set up the first five-year program to support the computer industry. From then until 1970, government funding amounted to about DM 88 million annually. A second computer plan covered the period from 1971 to 1975 and funding rose to DM 362 million a year. The main thrust of the second program was to stimulate the effective use of computers through training programs and applications support. The financing of research and support for product development in German firms absorbed 40 per cent of the budget. The government also set up a public procurement policy that gave preference to German products. Another support tool utilized has been direct financing through government shareholding in the capital of domestic firms.

The objective of Germany's third computer development program was to stimulate a broadly based data processing industry by supporting industrial R&D. The government also provided support for applications in such fields as information systems, telemedicine, education, computer-assisted design, process control and user support. This program had a four-year budget of some $150 million a year.

These stimulative measures encouraged diffusion of computers through German industry. Many were used in CAD/CAM applications. A total of $180 million was allocated for developments in CAD/CAM and automatic process control. Further CAD/CAM development is conducted through an extensive system of centres and institutes employing thousands of scientists and engineers with strong emphasis on the mechanical engineering aspects.

The government also initiated a special program to achieve a VLSI (very large scale integrated) circuit manufacturing capability. The cost of this program is thought to be $120 million a year for five years. Its *modus operandi* is the provision of joint financing for industrial research on approved projects.

As in other countries, the impact of information technology on society as a whole only recently became visible, and Germany is now attempting to develop a national policy. In September 1979, the West German Government announced a $600 million information technology program for the period from 1980 to 1983. Its aim is to improve understanding of the social impact of the technology, to increase the country's capability in skills needed to use the technology and to foster the necessary communications infrastructure.

An essential part of West Germany's overall electronics strategy has been the provision of substantial assistance to internationally competitive companies such as Siemens and Nixdorf. Initially, individual firms such as Siemens developed their technological capability by first producing under licence to an American firm, then progressively obtaining autonomy. At present, R&D activity at Siemens is heavily funded by the ministry for research and technology. The $3 billion-a-year ministry targets certain areas for research. Then private industry applies for funding and, if approved, gets funding of 50% of expenditures.

Netherlands

In 1980, the Dutch government announced that it had earmarked £18 million to support microelectronics. The Dutch plans were to involve a £5 million industrial support program which was to include awareness activities, consultancy services, and the promotion of applications through a new microelectronics centre to be set up by the government.

To support such developments, the Dutch government also announced the allocation of £2 million for research programs on microelectronics, both in existing centres of higher education and in the new microelectronics centre.

Norway

Until recently, Norway did not earmark particular sectors as promising, allowing industry on its own to determine promising activities. However, during the past year, Norway mounted a special program in support of microelectronics development at a cost of $1.8 million.

Sweden

In promoting growth sectors, Sweden aims at eliminating obstacles that hamper the rapid development of high technology industries. The Swedish Investment Bank is particularly active in financing high risk investments. It can provide new equity capital up to $72 million. Also, a state holding company AB Statsforetag has invested in perceived growth companies.

In 1979, grants to the computer and electronics sectors amounted to $59 million. The space industry received $43 million.

Switzerland

Modest funding has so far been allocated by Switzerland for such sectors as microprocessors ($3 million) and electronic watch components ($5.3 million).

Canada

Like the United States, Canada, until recently, has not implemented programs specifically aimed at the electronics industry. Accordingly much of the support that the industry has received has come under general innovation or technology support programs. The two programs that have been most utilized by the industry have been Enterprise Development Program - Innovation and the Defense Industry Productivity Program. Both programs involve contributions for product development. In the case of DIPP the products developed must have an export defence market potential. DIPP also can subsidize the acquisition of advanced production machinery by defence contractors. The Electronics Industry received $14 million under these programs in 1979, $21 million in 1980 and are expected to receive $44 million in 1981.

In 1979, the government established the Special Electronics Fund as part of the EDP, with $50 million in funding over three years to support the production and use of advanced electronics. About $20 million was set aside for user programs - awareness, technology centres, custom circuits, feasibility/applications studies. All manufacturers in Canada who have not previously incorporated microelectronics devices in their products or processers, are eligible for one time assistance under each of the feasibility and application (implementation) aspects of the program, provided the company and the project are commercially viable and that the project would not have proceeded without government assistance. The "no previous experience" criterion does not apply to projects involving the design and application of custom integrated circuits. As of September 1981, 28 feasibility studies, with a total crown contribution of $245,000, have been approved or are pending. Two implementation projects, with a crown contribution of $160,000 have also been approved. One implementation project and one custom circuit project were in process.

The amount of $30 million was set aside for major projects. Major projects funding is similar to DIPP support in that capital as well as R&D spending can be supported. Commercially viable firms undertaking large scale projects that would increase electronics production or R&D activities are eligible. To be supported a project must be of significant economic benefit to Canada and would not be undertaken without government assistance.

Two major projects have been approved to date. The first and larger of the two at $21 million is with Mitel Corp. Its purpose was to support the expansion of Mitel's semiconductor operations in Bromont and Ottawa and to ensure that this highest technology part of Mitel's business stays in Canada. Although this project has progressed more slowly than planned, due to equipment supply problems in the U.S. and construction labour difficulties in Quebec, it is meeting expectations. The integrated circuits portion of Mitel's business is increasing in importance and is providing the technological edge that is making its telecommunications products so successful.

The second major project, at $7 million, is with Sentrol. Its nominal purpose is to convert Sentrol's line of paper making inspection equipment from electromechanical and analogue to electronic and digital. More importantly, it is expected to position the company to broaden its applications capability, deepen its technological strength and become the leading process automation supplier in Canada.

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