The Information Revolution and its Implications for Canada

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

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Shirley Serafini
and
Michel Andrieu

Communications Economics Branch
Department of Communications
November 1980

Available in Canada through

Authorized Bookstore Agents
and other bookstores

or by mail from

Canadian Government Publishing Centre
Supply and Services Canada
Hull, Quebec, Canada K1A 0S9

Catalogue No. Co 22-28/1981E
ISBN 0-660-10877-1

Canada: $4.95
Other Countries: $5.95

Price subject to change without notice

Preface

The information revolution is like the proverbial double-edged sword: it cuts both ways—it holds out opportunities and threats. The authors of this report say that whatever its consequences, this revolution cannot be ignored. Its implications for Canada are both considerable and wide-ranging.

The views expressed in this report are those of the authors alone and do not necessarily represent the position of the Department of Communications or the Government of Canada. However, the publication of this report reflects the government's determination to encourage awareness of the implications of the information revolution.

As such, this report is one in a series by the Department of Communications aimed at stimulating public discussion of the issues raised by communications which the department considers to be of national importance.

The authors wish to thank Margaret R. Prentis, former Director-General, Telecommunications Economics Branch, Department of Communications, and now a member of the Anti-Dumping Tribunal, for her support and encouragement in the undertaking of this work and L.A. Shackleton and P. Robinson, both with the Information Economy Policy Group, Department of Communications, for their helpful criticisms and suggestions on previous drafts.

Table of Contents

1

Entering the information age

Since World War II, communications and computer technologies have developed so rapidly that sophisticated new networks have emerged, linking data terminals and powerful computers in a wide range of applications. The cost and size of computers have fallen dramatically, while their flexibility and capabilities have increased. The cost of communications has also declined as significant improvements in data transmission services have occurred. Recent developments in semi-conductors have extended electronic computing into a myriad of economic applications in industry, communications, data processing, office equipment and consumer goods and services. Indeed, computing services are now central to the proper functioning of governments, commerce and industry. Meanwhile, computers, information workers and information itself are more and more pushing aside the traditional inputs of non-information capital and labor into products and services.

Innovations in information technology succeed each other and are diffused throughout the economy so rapidly that fundamental structural changes have started to occur. Some experts now believe that only the term "information revolution" can capture the speed of these developments and the magnitude of the resulting structural change. Old industries and old ways of doing things are falling by the wayside. The demise of the Swiss watchmaking industry and the worldwide upheaval in the printing trades are only two of many examples illustrating the potentially disruptive effects of these new technologies. New industries producing and employing these technologies are emerging every day. Countries are adopting these

technologies at different rates, resulting in shifts in international competitive strengths. These, in turn, are already having indirect structural effects on the Canadian economy.

The social and economic impact of the information revolution could be as profound as that of the industrial revolution. Many industrialized countries recognize this overwhelming fact, as well as the need for comprehensive approaches to policy in order to deal effectively with the widespread changes expected to result from pervasive application of these new technologies.

This report describes the elements of the information revolution and its implications for Canada in an international context. Its purpose is to lay the groundwork for the formulation of policy proposals aimed at helping Canada to make the most of the information revolution. It consists of seven chapters.

Chapter 2 analyses the emergence of an information economy in Canada and other industrialized countries. The concept of an "information economy" illuminates the growing role of information-related activities in our economy and the resulting changes in the composition of the labor force.

Chapter 3 examines the information revolution precipitated by the enormous advances in micro-electronics, computer and communications technologies. Also considered will be the likely impact of these changes on production processes, as well as the new products and services to which these technologies will probably give birth in the next 10 years.

Chapter 4 describes the wide spectrum of policy concerns experienced by the governments of all industrialized countries as they confront the potential implications of the information revolution. The possible impact of the new technology on productivity and employment, the privacy of personal data stored and transmitted electronically, the implications for Canadian culture inherent in the new technology, the effect on national sovereignty caused by transborder data flows, the increased vulnerability of society—all these are issues which the information revolution raises with compelling force. It touches upon virtually every aspect of our economic, social, cultural and political life as a people.

Chapter 5 analyses the responses of other industrialized countries to the double challenges of the information revolution and the information economy. The "game plans" of the U.S., Japan, Germany, U.K., France and Sweden are all examined here, along with the central strategic issues raised and support policies adopted in each country.

This international overview sets the scene for the assessment in Chapter 6 of the Canadian situation. Can we cope with the information revolution? What are our strengths? Our weaknesses? In what key areas may government action become necessary in the short and medium terms?

The final chapter provides some of the basic elements which are needed for the formulation of a policy strategy designed to turn the information revolution to our advantage. The need for an integrated approach is stressed, as is the fundamental importance of active co-operation between the private sector, the federal government and provincial governments. Such an approach also underscores the need for a balance among the disparate economic, social, political and cultural goals of society, all of which are coming into conflict with the advent of the information revolution.

2

The new empire of the information worker

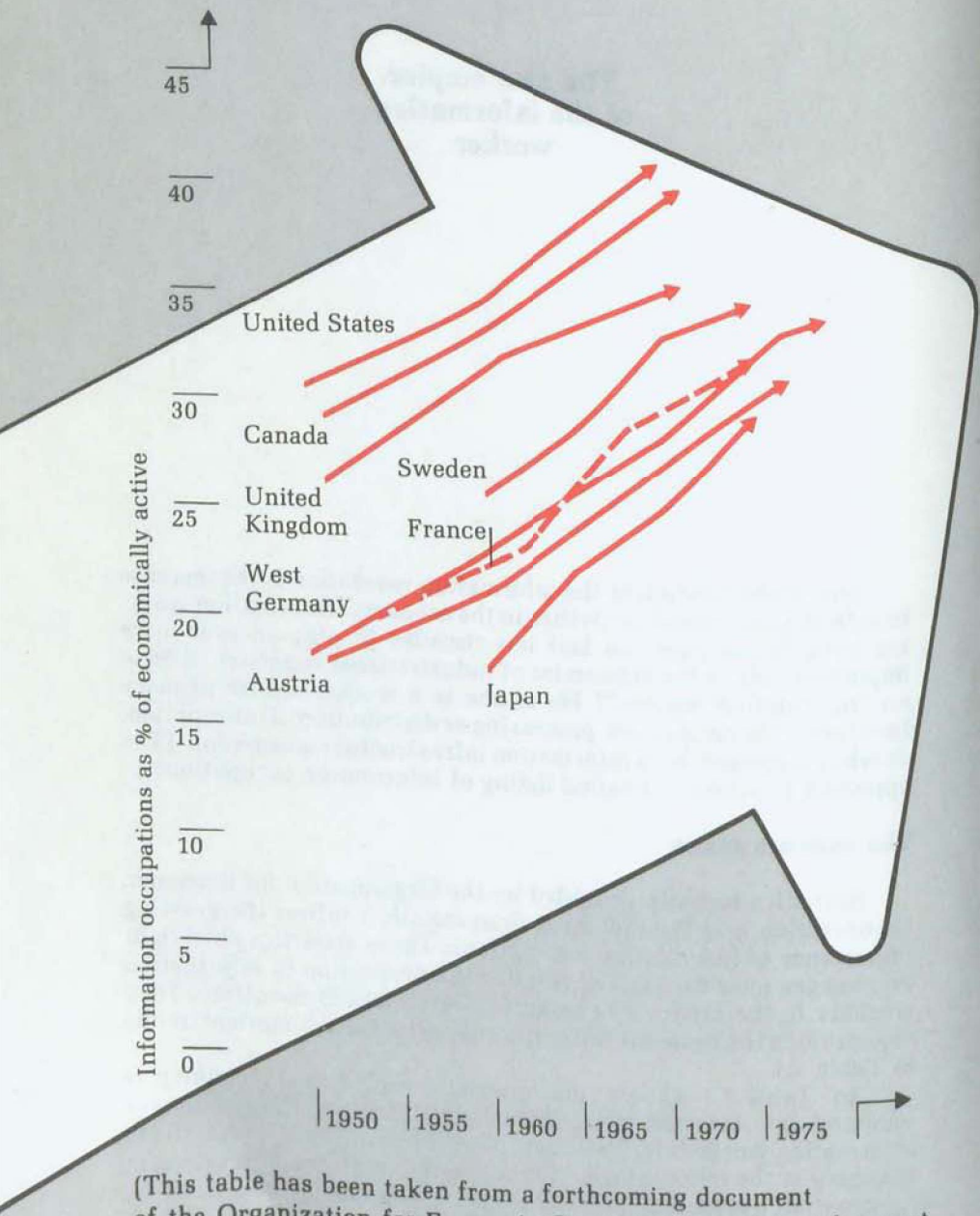
One manifestation of the information revolution is the increase in information-related activities in the economy. Information workers have begun over the last few decades to play an ever more important role in the economies of industrialized countries. Who is an "information worker"? He or she is a worker whose primary function is the production, processing or distribution of information, or who is engaged in an information infrastructure occupation. (The appendix provides a detailed listing of information occupations.)

The numbers games

Statistics recently compiled by the Organization for Economic Co-operation and Development dramatically confirm the growing importance of information occupations. These statistics shed light on changes over the last 30 years in the proportion of information workers in the labor force within selected OECD countries. They also provide the basis for the graphical portrayal of historical trends in Table 2.1 .

As Table 2.1 shows, the upward trend in every country is unmistakable, even though countries may differ in the proportions of information workers in their respective labor forces. The American economy is the most information intensive, with the proportion of information workers in the labor force rising from about 30 to 40 per cent between 1950 and 1970. Similar trends have prevailed in Canada: the proportion of information workers grew from 29 to 40 per cent between 1951 and 1971.

Table 2.1: Changes in the share of "information occupations" in the labor force over the postwar period



(This table has been taken from a forthcoming document of the Organization for Economic Co-operation and Development entitled *Report on Economic Analysis of Information Activities and the Role of Electronics and Telecommunications Technologies.*)

Equally interesting, the trends are not only upward; they are also remarkably parallel. In short, the ranking of countries in terms of "information intensity" has remained the same.[1]

No one has yet been able to explain satisfactorily why some countries appear to be more information intensive than others. But important contributing factors may be international differences in levels of economic development and output mixes, caused by the division of labor between nations. This could explain not only why the U.S. is in the leading position but also why the U.K. appears to be more information intensive than Germany—despite Germany's higher per capita income; Germany has a strong industrial base (which is not very information intensive) while the U.K. has traditionally been relatively strong in banking and financial services, both of which are highly information intensive activities. Such explanations are just tentative and superficial rationalizations of the data. Only a much more serious analysis could provide a full explanation.

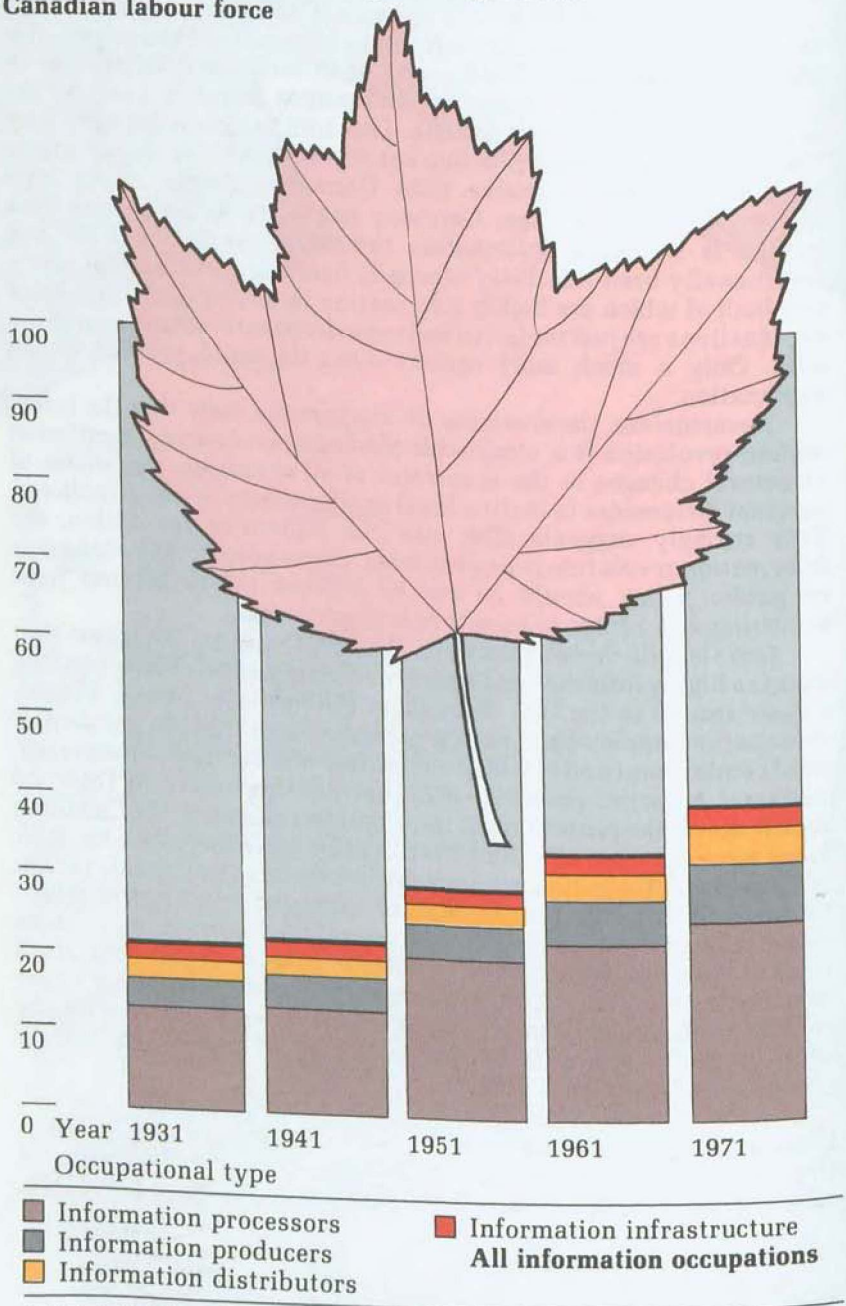
Nevertheless, these results do support the view that the information revolution is a worldwide phenomenon causing significant structural changes in the economies of all countries, regardless of national differences in institutional arrangements or public policies. This strongly suggests that, *like the industrial revolution, the information revolution is unavoidable. Consequently, the objectives of public policy should be not to prevent the revolution from occurring, but rather to turn it to our advantage.*

Can Canada do so? Certainly, the OECD statistics suggest that ours is a highly information intensive economy, consistently ranking a close second to the U.S. throughout the post-war period. Indeed, information employment now represents more than 40 per cent of total employment and is still growing. But who are these information workers? A partial answer to this question is provided in Table 2.2 which shows the proportion of information workers in the Canadian labor force between 1931 and 1971. As this table indicates, the bulk of Canadian information workers are information processors (about 63 per cent in 1971), that is, workers engaged in activities which essentially involve collecting and compiling information, such as clerical workers. Information producers (about 19 per cent of all information workers in 1971), information distributors (about 12 per cent in 1971) and information infrastructure workers (about 6 per cent) represent respectively the second, third and fourth largest groups of information workers.

Clearly, the proportion of the labor force working in every information occupation has grown continually—with the exception of information infrastructure occupations—over the period 1961-71.

[1]The term, "information intensity", is based on a vague, arbitrary definition of information activity. For this reason, the absolute levels of information intensity in the various countries should be taken with a grain of salt.

Table 2.2
Information occupations as a percentage of the Canadian labour force



Source: derived from decennial census statistics by Statistics Canada at the request of the Canadian Department of Communications.

The share of this latter group declined during that period though the absolute number of persons engaged in this occupational category actually increased from 169,000 to 207,000. The labor force as a whole just grew faster.

Indeed, the rate of job creation in information occupations was truly dramatic, as shown in Table 2.3. *Between 1931 and 1971, all information occupations experienced growth rates significantly higher than the Canadian labor force.*

The absolute growth in the number of information processors—including administrative, managerial, supervisory and clerical workers—was the greatest over the whole period. In 1931, this group numbered 513,000. By 1971, there were more than two million, composing one quarter of the labor force.

Since 1961, the second fastest growing group has been information producers. Their growth rate has continually increased over the past 40 years. This group includes scientific and technical workers, brokers, insurance agents, surveyors, architects and systems analysts. By 1971, 650,000 persons or 7.5 per cent of the labor force belonged to this category.

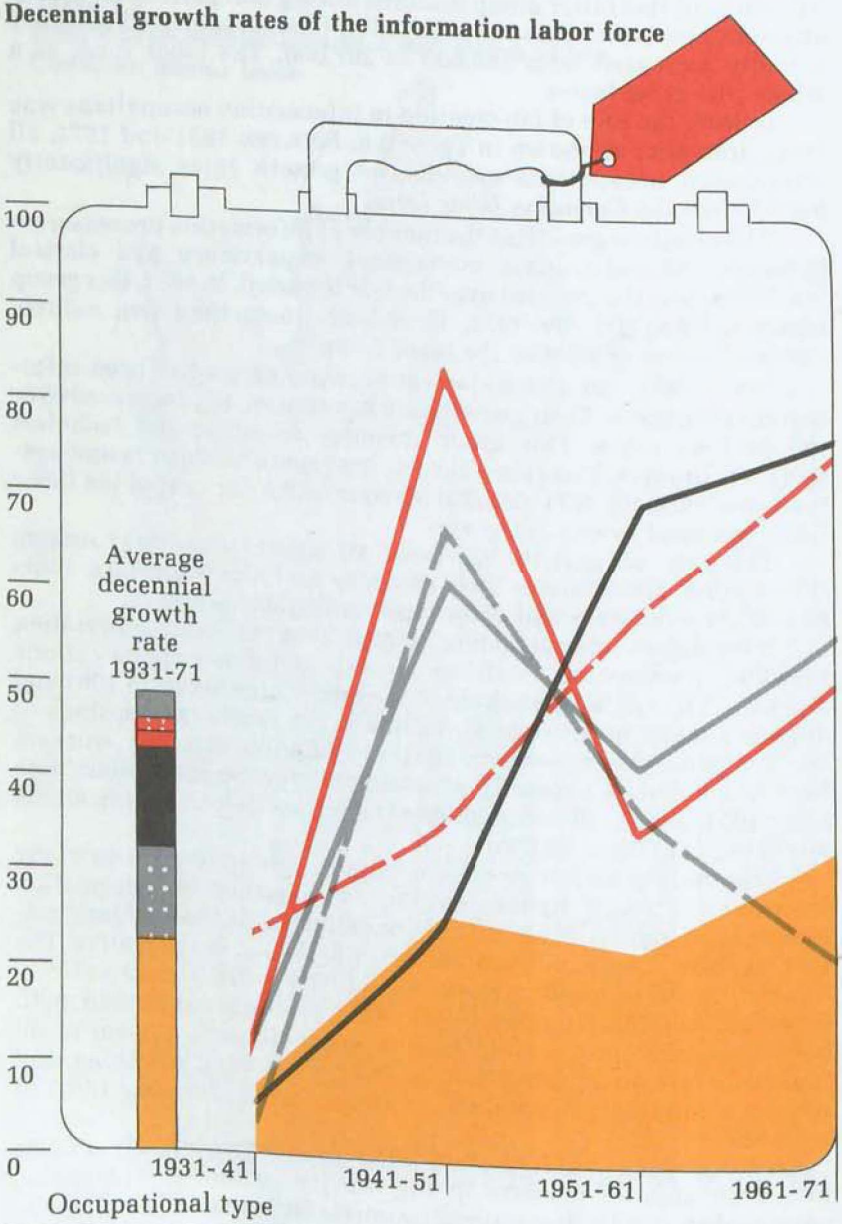
The rate of growth has been strongest since 1951 among information distributors. This category includes educators, journalists, broadcasters and other communications workers.

Information infrastructure occupations include information machine workers, as well as postal and telecommunications workers. The fall in their share of the labor force between 1961 and 1971 is a result of the relative decline in the numbers of postal and telecommunications workers. But information machine workers have accounted for a steadily increasing proportion of the labor force since 1931, and in 1971 outnumbered postal and telecommunications workers (111,000 to 96,000).

Information activities have a large economic impact in many industries. Though figures on the contribution of information activities to industrial output are unavailable, the share of information workers in each industry, shown in Table 2.4, is suggestive. The finance, insurance and real estate industries are almost entirely informational. Government and service industries rank second, with half their labor forces classified as informational. Indeed, in all industries except construction, agriculture, forestry, fishing and trapping, information occupations absorb more than one-third of workers.

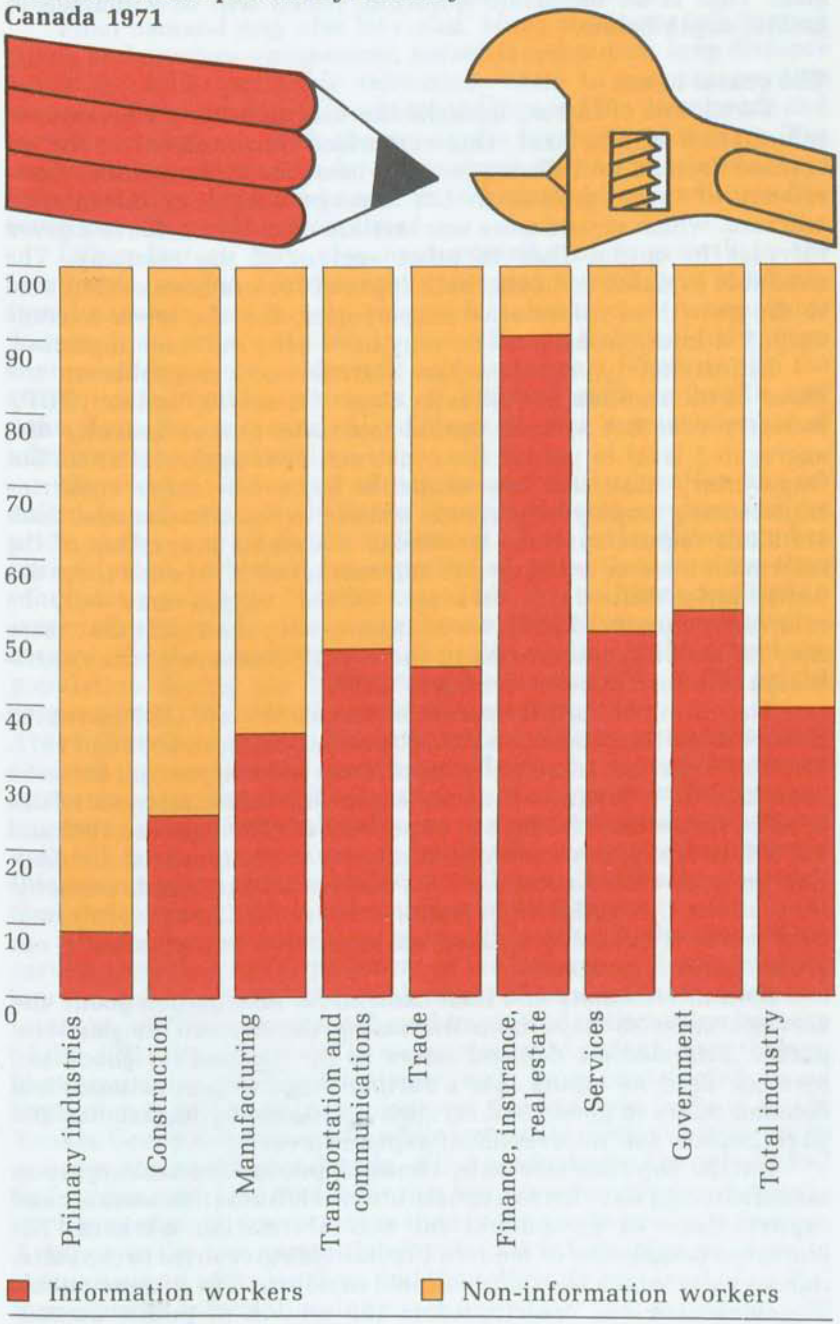
The growth in information-related activities closely relates to the substantial increase in the service sector—a widespread phenomenon in all industrialized countries and especially striking in Canada. Here, between 1961 and 1974, the service sector, with employment growing at 5.8 per cent a year, largely absorbed the increase in the labor force, which was expanding at a rate of 3.6 per cent a year. In 1971, 76 per cent of information workers belonged to the service sector, as compared to only two and 22 per cent in primary and secondary industry, respectively. Can such growth be

Table 2.3
Decennial growth rates of the information labor force



Source: derived from decennial census statistics.

Table 2.4
Information occupations by industry
Canada 1971



Source: derived from decennial census statistics.

sustained in a future dominated by the new information technologies? That is an important question, which will be examined in greater depth below.

The causal nexus

Two kinds of factors underlie the disproportionate increase in information employment. One comprises those related to the increased demand for information activities. The other includes those related to lower growth in the average output of information workers, which means more workers are needed to achieve a given increase in output than in other sectors of the economy. The available evidence indicates both types of factors have contributed to the growth of information employment. But the lower average output of information workers may have been the most important.

Unfortunately, no Canadian statistics are available on the share of information activities in Gross Domestic Product (GDP). Industry does not compile output measures at a sufficiently disaggregated level to permit the construction of such statistics. But fragmentary statistics are available for a few other countries experiencing employment trends similar to those in Canada. Such statistics require cautious treatment: a sizeable proportion of the information sector is engaged in non-market activities and these are particularly difficult to measure. Indeed, output may only be arbitrarily measured in terms of inputs, with the result that there may be serious inaccuracies in the overall measure of the contribution of information activities to GDP.

The output of the information sector as a share of GDP increased in the United Kingdom from 30 to 33 per cent between 1961 and 1972. The U.S. experienced a similar trend: from 43 to 49 per cent between 1958 and 1974. Japan is the only exception: information activities apparently declined from 36 to 35 per cent of GDP between 1965 and 1970. It is likely, in view of the similarity in occupational distribution between Canada and the U.S., that our output trends resemble those of the U.S. rather than Japan. In short, the Canadian information sector is probably making an increasing contribution to our gross domestic product.

Both intermediate and final demand for information goods and services seem to have been increasing throughout the post-war period. Intermediate demand refers to the demand for goods and services used as inputs into a further stage of production. Final demand refers to goods and services purchased by households and governments and to investment expenditures.

On the intermediate side, changed production techniques in manufacturing have led to a substitution of information workers and capital (such as computers) for non-information workers. The increased complexity of modern life has also given rise to consultative services which are informational in nature. The increasing role of government has contributed to the growth of public bureaucracies. In addition, the growth of private bureaucracies due to the

increased size of firms and government has brought about an increase in administrative and managerial personnel.

Final demand may also be rising. Many consumer information goods and services—magazines, personal computers, long distance telephone calls and cable television—seem to possess positive income elasticities. For this reason, the demand for these goods and services should rise with the per capita level of real income. The scanty empirical evidence, however, suggests that the relative share of information goods and services in household expenditures has remained fairly stable over time.

Other factors may also have contributed to growth in the information sector. For example, increased commitment to educational services has largely taken place because of demographic factors. Innovative activities in scientific and technical fields have been receiving more public and private support. There is also the trend toward public provision of services such as health and unemployment insurance. All of these require a great number of administrative personnel.

Government financing of services such as education has resulted in a discrepancy between the cost of these services and the price of the service to the individual. This price distortion has probably led to higher consumption of education services than otherwise would have been the case. This, in turn, has necessitated a larger allocation of resources to these highly information intensive sectors. On the other hand, the expected decline in the school age population during the 1980s may well precipitate a fall in the proportion of information workers in education.

A Time for Reason, the 15th annual review of the Economic Council, focuses on the causes underlying the growth in service sector employment within Canada. As we have seen, information employment is closely related to service sector employment: 76 per cent of information workers are employed in service industries. For this reason, many of the same factors will contribute to the growth of the service sector and to information employment.

The Council sees the main source of increase in the share of the service sector in total employment as the lower growth of output per worker, combined with the stable share of services in an increasing total output. This argument should be viewed with caution because of the difficulties involved in measurement of output. Nonetheless, low growth in productivity may well have contributed to an expansion in information employment. For example, in the U.S., the Yankee Group estimates that, while industrial productivity grew 90 per cent during the past decade, office productivity has only inched up four per cent. One reason for this low growth is a faster decline in the hours of work per employee than in the goods-producing sector. Another is the low capital/labor ratio for information workers in comparison to other workers and the relatively low level of capital formation in information-intensive activities. It is estimated that less than $2,500 in capital is spent to back the typical office worker,

while each factory worker has the benefit of $25,000 in machinery. A third factor is the slower rate of technological change in much of the information field.

It should be kept in mind, however, that information workers account for less than half the total employment in the service sector. Consequently, not all factors ruling service sector employment will apply equally to information employment. For example, it has been argued that the lower quality of labor has contributed to slower productivity growth in the service sector as compared to the goods producing sector. A measure of labor quality in terms of wages and salaries provides no evidence that information labor is of lower quality. In fact, the reverse may be true. In 1971, information workers composed 40 per cent of the labor force, but their earnings amounted to 50 per cent of total employment income.

Some recent studies also support this view, suggesting that labor productivity is rising in the performance of routine tasks in public administration. Between 1967 and 1973, the output per man year in such tasks within the U.S. government grew 1.6 per cent every year. Indeed, productivity increases obscured by conventional statistics may well have occurred in many information activities. If this is true, the information labor force may well have increased in response to an expansion in traditional information activities and the emergence of new information activities.

The diffusion of new information technology will likely also substantially increase the productivity of information workers. For example, the traditional ratio of one worker to a machine may change in the service sector. The Economic Council predicts "the automation of offices and business procedures may be close at hand".

The outlook for future employment in the information sector is not clear. The anticipated growth in productivity resulting from the new information technologies will mean fewer workers can produce the same amount of output. The demand for certain information services may also fall. Changing demographic trends may result in less emphasis on educational services. Shifting public perception of government may mean a reduction in the size of the public service. At the same time, increases in leisure time may stimulate consumer demand for information goods and services to fill the void. The anticipated aging of the Canadian population in the 1980s will also probably result in greater demand for social and health-related services which are information intensive. The energy shortage may heighten the trend toward a "conserver society", and the much discussed notion of substituting information for energy may become a reality in certain situations. For example, telecommunications may replace travel in many instances.

The interaction of these and other factors will determine the future course of information employment. The net result is not clear, but there is reason for concern that the growth in information employment will taper off in the near future. This development could have serious implications for the overall level of employment and mix of occupations in Canada during the coming years.

3

The technological revolution

The extraordinary evolution and diffusion of information technology since the Second World War is the second major manifestation of the information revolution. Such technology is the product of a melding between computer and communications technologies — a convergence which has created powerful systems with vast capabilities for computation, analysis and access to enormous amounts of information.

Each new generation of computers has achieved drops in cost/performance ratios of incredible magnitude. As cost has shrunk dramatically and capabilities have soared, computers have become progressively more miniaturized. Exploration of the growing potential of semiconductors has now become a major thrust of technological change in the computer industry. Although the first microprocessors made from semiconductors were built only in 1971, microcomputers are already into their third generation. The tiny size of silicon chips and their increasing storage capacity create a tremendous scope for new applications.

The number of computers in Canada has increased rapidly, from about 1,000 in 1965 to an estimated 37,000 in 1979[1]. The apparent move to small computers with a monthly rental value below $5,000 reflects the use of computers by smaller firms, as well as the trend to distributed electronic data processing. These statistics may overestimate the trend toward smaller machines in terms of computer

[1]Computer Communications Secretariat, *The Growth of Computer Communications in Canada*, p. 92-93.

power, but only because they do not take into account the drastic fall in cost of computers.

Telecommunications provides the second technological push towards an information economy. Recent major developments in this technology fall into categories such as fibre optics, satellite technology and digital transmission and switching. Canada has been a world leader in all these fields.

Digital transmission and switching permit the integration of voice and data signals and can provide better transmission quality at lower cost and with greater reliability than conventional analog transmission. Computer communications has been revolutionized because digital transmission systems use the same language as the computer and signals require no conversion as with analog transmission. In 1973, Canada became the first country in the world to have a commercially available, nation-wide, digital data system. The melding of digital transmission and packet switching technology has brought about new network service offerings such as the CNCP Infoswitch and the TCTS Datapac networks.

Fibre optic cables are composed of fine strands (or fibres) of glass through which high-frequency light waves are transmitted. Their advantage over conventional copper cables lies in their capacity: 10,000 times more information can be transmitted than through a conventional wire pair. In effect, telephony, data and broadband services can be carried over the same fibre optics cable. A second advantage is their immunity to electromagnetic interference and resulting capacity to provide better quality signals. Third, fibre optics are becoming cheaper than conventional cable as initial research and development (R and D) costs are amortized and the world price of copper rises.

Satellite technology is growing by leaps and bounds and has a significant advantage over terrestrial facilities: distance and terrain do not affect transmission costs. For this reason, satellite technology is ideally suited to Canada's geography. It is also perfect for such advanced applications as direct broadcasting. Meanwhile, satellite use is growing rapidly as the cost of the technology falls.

Contemporary information technology embodies an ingenious convergence between electronics, computing and communications technologies. Its basis is micro-electronics which is bringing the cost of processing, storing and transmitting information down to a level where they can be applied to everyday uses. No longer are computers restricted to the specialized, high value applications of the past. Now they can be linked together when necessary by satellites, fibre optics and digital channels. Such is the technological basis for the information revolution.

The potential applications of information technology are vast. They will affect all aspects of our lives and raise serious economic, social, legal and political issues. They will lead to profound changes in our production processes, as well as a host of new business and consumer services and new products. Some examples of these

applications are given below. They illustrate how the new technology may transform most facets of our economic life as a nation.

The automation of production

The introduction of information technology will likely mean sweeping changes in the production methods used by resource industries, manufacturers, the service sector and offices. Even now, electronic technology is ever more the dominant source of technical change in industry. One Canadian economist has estimated that more than half of the changes reported to have taken place in Canada in the past five years were computer-related.[2] Resource industries are prime candidates for applications of electronic control and instrumentation equipment. Electronic control of various processes has already occurred in the pulp and paper industry. Mining and oil exploration and recovery now depend increasingly on computers. Computer simulation models, such as the one developed by the computer modelling group at the University of Alberta, can play an important role in ensuring use of the most effective oil recovery techniques.

In manufacturing, the development of computer-aided design (CAD) and computer-aided manufacturing (CAM) will probably transform production processes. As described by J. Scrimgeour, a CAD/CAM expert, "the CAD/CAM automated factory includes: computer graphics for the design and drafting of the product, with the design held in computer memory rather than by drawings and blueprints, computer-generated parts lists, vendor ordering, production scheduling and inventory control. . . computer-controlled stacking cranes for automatic movement of material, assembly areas employing robotics and direct computer control of numerically controlled machine tools, inspection and automatic test equipment."[3] The prediction is that, by 1985, full on-line automation of complete manufacturing plants controlled by a central computer will be a reality. The president of General Motors recently stated that within 10 years computers will control about 90 per cent of all new machines in his manufacturing and assembly plants.[4]

The new technologies will also reach into every part of the service sector. For example, the distributive trades are even now being transformed by the use of point-of-sale terminals and automated warehouses. Merchandisers are employing optical character recognition wands to keep track of inventory. The distribution sector has accounted for a steadily growing share of Canadian computer installations in recent years. An understated estimate of

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[2]S. Peitchinis. *Effect of Technological Changes on Educational and Skill Requirements of Industry.*

[3]J. Scrimgeour. *CAD/CAM and Canada*, pp. 3-4.

[4]R. W. Decker, "Computer Aided Design and Manufacturing at GM".

this increase in the Canadian Information Processing Society's annual census shows that installations of computers valued at $1,000 a month or more in the distribution sector rose from 7.6 to 13 per cent of all computer installations between 1970 and 1978. The computer applications transforming the service sector range from computer-aided design in architecture, through electronic publishing to electronic scanners for medical diagnosis to data banks of legal precedents. Financial institutions are moving to automated methods of handling paper-based transactions. The availability of word processing equipment is already beginning to transform offices. In time, these computer communications applications will provide the infrastructure for unified electronic information systems—involving electronic textual communication within the office, and electronic mail between offices.

Central to an understanding of the implications of the new information technology is one fact: it facilitates changes in the worker/machine ratio not possible to the same extent with mechanical technology. This fact raises important questions about the capacity of the service sector to absorb labor in the future.

New services and products

The range of potential new services based on information technology is huge. Massive catalogues of offerings have been predicted over the last 10 or 15 years. Many of these will fail to materialize because of lack of market demand, economic infeasibility and, occasionally, institutional barriers. But a number of services are already achieving success in the marketplace and many others will probably become profitable realities.

At present, business services are more advanced than new home services. Q.L. Systems, Lockheed, I.P. Sharp and other companies now offer advanced specialized electronic information systems. Data communications services such as Datapac and Infoswitch are also available, as are many different airline reservation systems and electronic message systems based on computers and facsimile transmission. Electronic mail based on communicating word processors is just around the corner. CNCP has announced plans in 1981 to introduce on a commercial basis "Infotex", a network of communicating word processors. Another important development will be electronic funds transfer systems (EFTS). EFTS involves combining computer and communications technologies in electronic devices and communications networks to displace traditional paper-based payment media. During the 1980s, mini and microcomputers should make the computer dramatically more accessible. These tiny machines will give small businesses access to services such as computerized billing, accounting and inventory tracking, once only feasible for large firms and institutions.

The ordinary consumer will also benefit from the information revolution. Satellite programming services will extensively broaden the range of entertainment available to homes. A number of cable

television companies now offer home protection and fire alarm services on a trial basis. Public information retrieval services such as Telidon may allow the home viewer to access vast data bases of information on his or her television screen. With a television receiver, telephone and terminal device hooked into a switched network, electronic newspapers, teleshopping and other new services become technically possible.

Applications of information technology are also having an impact on existing capital and consumer goods. Digitally controlled machine tools and word processors are excellent examples of capital goods unimaginable without the new information technology. Such product innovations often make possible the innovations in processes by others.

Such consumer goods as pocket calculators, electronic watches and educational toys like Texas Instruments 'Speak and Spell' are also rooted in micro-electronics. The new technology is also transforming many conventional consumer products. Sewing machines, microwave ovens, automobiles and washing machines are just a few examples of products now employing microprocessors, both to replace older electro-mechanical parts and, in some cases, to perform new functions.

4

Issues raised by the information revolution

This chapter provides a summary of many of the policy issues raised by the information revolution—issues relating to national sovereignty and identity, the role of government, the vulnerability of the computerized society, the impact of these technologies on the economy and employment and such social concerns as privacy.

In presenting the issues arising from the information revolution, many tend to over-emphasize its negative aspects. The benefits derived from use of these technologies are also widely recognized. They include increased productivity, provision of new goods and services to consumers, wider availability of information, opportunities for greater job satisfaction, and elimination of dangerous jobs. These benefits explain, at least partially, why the developments are occurring. Another contributing factor is the technological imperative itself.

This perspective is fundamental when considering the issues raised by the information revolution. Policy approaches must weigh potential benefits against possible negative aspects. In addition, considerable empirical research will be necessary to ascertain the degree of seriousness of the perceived problem areas.

Erosion of national sovereignty

Since World War II, most industrialized countries have grown ever more interdependent. Exchanges of all kinds between countries have increased dramatically and helped a multiplicity of international bodies to emerge. Their main purpose has been, in turn, to solve conflicts arising from increased interdependence or to

coordinate concerted actions by countries faced by a common problem or set of problems. At the same time, the growth of electronic media, especially television, has enhanced public awareness of international developments.

National sovereignty is the ability of nationals (both in and outside government) of a particular country to exercise control over political, economic, social and cultural developments within its boundaries. In the post-war environment of interdependence, the partial erosion of national sovereignty is a fact of life. Nation states have relinquished some of their powers to plurinational or international bodies and must more than ever before consider the world environment in their policy-making process.

Another contributing factor has been the expansion of powerful multinational corporations. These companies have greatly stimulated economic growth and technical progress. They have also been able on occasion to take advantage of weak international agreements and international rivalries between countries to evade national legislation and pursue independent policies, sometimes in conflict with the interests of host countries. The role of these firms is particularly important in Canada where a large number of multinational branch plants exist as a result of heavy foreign investment over many years.

The information revolution may accelerate the erosion of national sovereignty by further increasing the dominance of multinational corporations in the world economy. The new advances in computer communications, by significantly reducing the cost of managing large and complex organizations, may tend to increase the optimal size of firms. The beneficiaries of such a development would be large firms like the multinationals. Simultaneously, the new technology may enable them to take greater advantage of the international division of labor through increased specialization of branch plants. Such a development might undermine the viability of purely national firms which could find it ever more difficult to compete. The new information technology may also help multinationals to increase control by their headquarters over corporate planning and operations by centralizing computing resources. Such a step might, indeed, become necessary to co-ordinate the activities of the more specialized branch plants.

As a result of these developments, host countries may experience a serious loss of control over domestic economic activities. The increased importance of multinationals could mean that a larger share of the Canadian economy will be run from abroad. The migration of control to headquarters could cause further reductions in the autonomy of branch plants. Countries such as Canada might evolve from a branch plant economy to a "warehouse economy". In such an economy, branch plants would have lost to headquarters, not only jobs, but also important decision-making functions in such key areas as financial control, administration, research and development, planning and marketing. On the other hand, technological

developments such as the diffusion of mini-computers could conceivably contribute to increasing the independence of branch plants. The limited available evidence, however, suggests that concentration trends tend to dominate.

In consequence, it may very well be that in the future the host economy will become more vulnerable to events abroad, particularly in the home countries of the multinationals. For instance, breakdowns in the computer services centralized at headquarters—because of strike, mechanical failure or shortages—could seriously disrupt the operation of branch plants. The migration of key decision-making functions to headquarters will also have a debilitating effect on the host country: domestic requirements for indigenous management, technical and scientific expertise will all fall, leading to a decline in the basic human and technological resource base in the host country. Finally, the migration of computer services abroad will also reduce the applicability of domestic laws because domestic jurisdiction cannot readily be exercised over data stored and processed abroad. In particular, reliance by domestic subsidiaries on headquarters-based computing services may facilitate the extraterritorial application of the laws of that country in which the headquarters are located.

The vulnerable future

The growing reliance of advanced industrialized countries on computerization and sophisticated data networks entails serious risks. Any major failure of these systems could cause massive economic and social disruptions more damaging than widespread electrical blackouts. A report, entitled *The Vulnerability of the Computerized Society*, by a Swedish government committee is, up to the present, the most comprehensive attempt to study the problem at a national level. This study concluded that the vulnerability of such a society would be unacceptably high and future developments, unless counteracted, will increase that vulnerability.

Vulnerabilities fall into two categories—those internal to the computer system or centre and those external to it.

External vulnerabilities can impinge on national sovereignty and national security. Foreign processing resulting in transborder data flows may expose information to new threats not found domestically. *Given the relative size of Canada to the United States, the particularly high level of U.S. investments in this country and the increasing flow of data across the border, Canada may be more vulnerable than many other countries.*

National security becomes a concern when defence forces use computers and, more generally, when anyone places information in data banks which may be useful to an enemy. The danger also exists that information stored abroad could be used for strategic purposes. Different sets of data, each innocuous in itself, could also be combined to produce nationally sensitive information. Furthermore, if the country where the processing takes place becomes involved in

a war, the continued availability of the system would be jeopardized. Political instability in neighboring countries might disrupt telecommunications services, preventing the successful transmission of data to and from foreign computers and terminals.

Natural disasters also constitute external threats to the availability of computer and data transmission services. These natural disasters need not affect the computer system directly; loss of hydroelectric power or damage to telecommunications facilities will have the same effect. Areas such as California where data processing is concentrated could present high risks. Use of foreign processing facilities also intensifies the threat of natural disasters because preparation for such emergencies, requirements for back-up and response to the emergency itself are all out of domestic control. Furthermore, in such cases, as limited services are resumed, the requirements of the host country will no doubt receive priority.

Criminal acts, including terrorism, also raise questions of vulnerability. Computer centres, telecommunications facilities and support services such as electricity all have a high public profile. They are, in short, attractive targets for riot, insurrection, civil war and criminal activity.

Computer systems are also vulnerable to computer crime and other incursions on computer security. The presence of trained personnel, suitable training programs and even labor legislation may affect the availability of an information system. The interconnectedness and centralization of computerized systems only intensify this vulnerability. For example, Sweden has expressed concern that 70 to 80 per cent of its computers are located in a few major urban centres. In the U.S., the National Academy of Sciences is questioning whether too many files are stored in too few locations.

Few countries have yet been able to assess the degree of vulnerability but their preoccupation with these issues is intensifying as awareness develops.

The new joblessness

The impact of the information revolution on employment and other related issues has attracted up to now the most widespread concern. As already seen, the new technology has enormous potential scope for improving productivity and automating activities which were previously labor intensive. In Europe, the issue of technical change and its effects on employment have been the subject of considerable public discussion.

Skeptics believe that, if dislocations due to automation were to be widespread, the effects would already be apparent because automation has been proceeding for 100 years. But J.M. McLean argues, "scepticism about the impact of micro-electronics cannot be supported by referring to the historical falsity of the automation scare."[1] He states that early writers on automation underestimated the time scale in which a new technology attains its full social and economic impact. Various barriers must be overcome: initial high

costs, lack of understanding and shortages of skilled manpower to operate the technology. Only then can a technology achieve its full potential. He believes that the shift to computerization is sufficiently far along to permit the effective, profitable diffusion of micro-electronics technology. A major unforeseen development has been the potential impact of automation on the service sector. Previously a "snug harbor" for those displaced from industry by technological unemployment, the office is becoming computerized and is rapidly losing favor as a long term refuge.

No doubt the information revolution will do more than destroy jobs. New industries and jobs will emerge. But workers will not easily move from old to new jobs, just because the skills they have acquired will be obsolete. Studies by the federal Department of Communications (DOC) indicate that information capital not only replaces blue collar workers, but also concurrently creates demand for new white collar workers. While computers and microprocessors displace production-line workers, they demand the services of programmers, information processors and similar people. In the service sector, word processors will eliminate a large amount of typing, while automated warehouses will force out clerks. But, at the same time, the need for software specialists and technicians will increase. Countries throughout the world are recognizing the need for retraining and education to improve worker mobility. They perceive education as an ever more necessary tool for bringing the population into the information age.

Concern about the employment effect of the new technology has been voiced in a number of countries. In the U.K., a powerful film produced by the BBC and entitled "Now the chips are down" emphasizes dramatically the potential job displacement effect of the information revolution. This film played an important role in precipitating the major British policy initiative on micro-electronics announced by then Prime Minister James Callaghan in December 1978. Mr. Callaghan indicated that the U.K. Government was launching a massive program designed to foster the creation of a viable micro-electronics industry in Britain and to encourage the vigorous application of this new technology in British industry.

Concern about the employment implication of the new technology has further intensified in the U.K. with the recent publication of a report by Jenkins and Sherman of the Association of Scientific, Technical and Management Staffs. The authors predict that, by 1990, the U.K. will have 5 million unemployed instead of the current 1.5 million.

France, like Britain, is greatly worried about the potential displacement of workers because of the information revolution. A

[1]J. M. McLean, *The Impact of the Microelectronics Industry on the Structure of the Canadian Economy*, p. 4.

major government study, *L'informatisation de la société*, analyzed this issue in great detail. It was prepared under the direction of Simon Nora and Alain Minc and commissioned by President Valèry Giscard d'Estaing at the end of 1976. The study tries to evaluate the employment risks inherent in the introduction of the new technology and to project job losses, sector by sector. Its major conclusion is that "telematics" will bring about significant increases in productivity which in the short run will lead to increased unemployment, particularly in the service sector. The restoration of full employment in the longer run will depend, according to the authors, on substantial increases in the demand for services within the non-competitive social and community service sectors.

In the United States, Professor Wassily Leontief and others have voiced anxiety about the employment effect of the new technologies. He argues that micro-electronics and related technologies "can reduce the total demand for human labor for the same reason and essentially through the same process that a few decades ago led to the replacement of draught horses by trucks, tractors and automobiles"[2]. *According to Leontief, there is no more reason to expect that workers displaced by machines will necessarily find employment building these machines, than to expect that horses displaced by mechanical vehicles could have been directly or indirectly employed in the expanding automobile industry.*

This provocative analogy should not be taken too literally. But it still raises the possibility of a future "horse scenario" in which only a minority of highly skilled individuals are required to run the economy. The rest would experience widespread unemployment or underemployment. In such circumstances, strong government intervention would become necessary to maintain an equitable distribution of income between the employed elite and the unemployed. The notion of work itself would have to be rethought. Some form of work sharing would probably be desirable to avoid a polarization of society. Unfortunately, the investment in human capital demanded by such a scheme may be unacceptably high.

The impact of the information revolution on employment is receiving growing attention in Canada. Perhaps the most thorough treatment of the subject is a report on *The Effect of Technological Changes on Educational and Skill Requirements of Industry*, prepared in 1978 by Professor Peitchinis for the Department of Industry, Trade and Commerce. The author's conclusions are based on responses by 104 firms to a mail questionnaire. He states that, although employment does not appear to have been affected in the aggregate by the new technology up to now, large scale manpower displacements demanding substantial retraining programs will probably occur in the near future.

[2]W. Leontief, "Issues of the Coming Years", p. 75.

One major finding is startling. The responding firms expect that, in the future, 60 per cent of the workers affected by technical change will require greater technical knowledge. For the recent past, the comparable figure is only 17 per cent. Of the 25,000 workers employed by the surveyed enterprises, 3,000 or 13 per cent had already been displaced by technological change. Only 600 new positions were created.

The results of this survey only give a partial picture of the effect on employment of technological change. We do not know whether the displaced workers found employment elsewhere. The author's conclusions are only tentative, anyway, because only 10 per cent of the firms surveyed responded to the questionnaire. But these findings are consistent with the concerns raised in other industrialized countries and, for this reason, deserve further investigation.

The growing fear of job dislocation caused by the new technology is leading to increasing labor unrest in many countries. Countries like Sweden and Germany possess mechanisms to help unions exert influence on management and channel this unrest into a constructive dialogue between labor and management on the orderly introduction of the new technology. In countries such as Canada, no such mechanisms exist. Labor unrest could lead to growing labor-management confrontation which in turn could become a corrosive political issue.

Obstacles to innovation and improved productivity

The new information technology offers great scope for improvements in productivity with respect to both goods and services. *Canada, with an economy largely based on foreign trade, must exploit this technology as actively as our major competitors. If we fail to take advantage of it, our products could well become uncompetitive in world markets.*

As shown in Chapter 3, production methods in resource industries, manufacturing, services and offices will all likely undergo changes with the introduction of the new information technology. *If we are to gain the enormous benefits offered by the new technologies, barriers to their diffusion must be overcome.* These include unawareness of the potential inherent in the technology, inexperience in its application, management's and the general public's generally conservative attitudes to technical change, a lack of skilled persons to develop and use the technology, and unions' opposition to changes perceived as having an adverse impact on their memberships.

An inadequate capability for producing the basic hardware may also hamper diffusion of the technology. Many have argued that the successful application of the technology requires a domestic production capability in order to attune component development to user needs, to acquire the skills needed for applications and to assure a reliable source of supply. But many countries cannot afford the initial capital or the risks attendant upon remaining at the leading

edge of information technology production. Canada will certainly have to specialize in certain areas where it has a comparative advantage. Innovations could come from many sectors, such as independent entrepreneurs, the telecommunications carriers, the cable companies, goods producers and even the government. All of these have some expertise in electronics, communications and allied technologies.

If productivity improvements are to occur, both producers of new goods and systems and the users implementing them may have to make major capital investments. Investment funds will be necessary both to upgrade production facilities and to conduct R and D. An important issue is the limited availability of capital for these uses. In the past, such industries as the software industry and film and television program production industries have had difficulty attracting venture capital because they lack bankable assets. The low level of private R and D activity in Canada is also a well documented problem. Such problems are not easily overcome. We shall need measures to encourage capital investment, measures which address both internal sources of capital, such as profits, and market sources.

New technology may also be acquired through technological transfer. Foreign direct investment, licensing arrangements, joint ventures and acquisition of foreign firms are only a few of the means available. Historically, transfer to Canada has relied heavily on foreign direct investment. But this may not always be the best way to gain access to foreign technology. Alternative approaches demand exploration.

Deindustrialization and regional disparity

The information revolution affects the location of economic activities between as well as within countries. Information goods producers and users of the new technologies are already experiencing this consequence of the information revolution.

With respect to information goods, the international trend so far has been for a small number of firms, industries or sectors in specific countries to dominate world production. Consumer electronics in Japan and computer manufacture in the U.S. now both have dominant positions in the world market. The leading computer manufacturers are, of course, multinational enterprises. The world outlook of these firms causes them to divide tasks internationally, with subsidiaries specializing in certain products. R and D laboratories are usually located on the parent's home territory and near the decision-making centre. Of the U.S. multinationals, only IBM and Honeywell do any extensive R and D work in Europe. In recent years, production has shifted to less developed countries in the Far East and to such European countries as Ireland and Spain, which pay lower wages. *The dominance of the information industries by a small number of multinationals profoundly affects trade balances and the international division of labor.*

For this reason, it is vital that Canada assess the balance between imports of information goods and domestic production in such areas as terminal and peripheral equipment and telecommunications equipment and components. We must determine whether alterations in the current commodity trade pattern are necessary, desirable or even possible. Recently, Canada's poor trade performance with respect to electronics manufacturing has received a great deal of attention. This situation indicates that we must identify and exploit opportunities for Canadian industry to develop information goods which can be sold on the world market. In particular, we must analyse the impact on Canada's competitive situation of the protection and support given by our major trading partners to their domestic manufacturers. Only then will an adequate assessment of potential export markets be possible.

Use of the new technologies has already become more important than their manufacture for international competitiveness. Microelectronic technology dramatically reduces production costs and increases economic efficiency. Countries which successfully diffuse the technology throughout industry will be able to improve their international competitive position by lowering prices of their goods more than those countries which have not embraced the technology.

Industrialized countries will have to rely on high technology products and processes to remain competitive in the future. Fierce competition from industrializing nations such as Taiwan and South Korea will render such a step necessary. This competition was first experienced in consumer goods like textiles, toys and radios. Now it affects more and more bulk materials like steel and plastics, and signs now exist that at least some of these countries are moving into the production of such goods as ships, color television and audio equipment.

Trade in information 'invisibles' is also an important issue. Software, data banks, computing services and data transmission services are having a growing impact on national economies. Transborder data flows are also becoming a serious preoccupation in many countries. A study conducted by the Canadian Computer Communications Secretariat indicated a growing transfer of information processing activities from Canada, Most of these transfers are from Canadian subsidiaries to foreign headquarters. They could provide the basis for a damaging migration of management and planning functions from Canadian subsidiaries. Equally serious is the possibility that large imports of information processing and other services arising from these transfers could aggravate balance of payments problems. This transfer of information processing will likely be accompanied by a transfer of related jobs and, therefore, intensify the effects of the information revolution on employment in Canada. This study suggests that, *by 1985, equivalent of $1.5 billion in computing will have been transferred from Canada to other countries, mainly the U.S.*[3]

[3]Computer Communications Secretariat, *op. cit.*

Finally, the impact of information technology on developing countries is a growing international concern. Adoption and rapid diffusion of micro-electronics in traditionally labor intensive industries such as textiles will probably erode the advantages of cheap labor in developing countries. The result may be significant changes in trade patterns between the industrialized and third world countries. The ultimate effect may be a further widening of the gap between rich and poor.

The domestic pattern of industrial location is also a subject of concern. The new telecommunications technologies appear to facilitate geographical decentralization of activities while simultaneously permitting centralized decision making. This pattern is already emerging in some multinational firms. If it takes place at the domestic level, regional disparities could intensify. But such a trend may be more apparent than real. Telephone surveys conducted by the Computer Communications Secretariat indicated that a number of firms had their computer replaced by services provided by a Canadian parent or affiliate over the period 1973 to 1976. Yet a survey of Canadian information processors conducted in 1977 indicates a trend toward decentralization over the next five years. In this study, decentralization was defined as a data processing alternative in which the processing activities are broken out into a series of autonomous areas of responsibility and each location completely handles its specialized applications.[4] An important contributing factor to this trend towards more decentralized data processing is the relative decline of computing costs when compared to communications costs. This evolution of costs gives an incentive to firms to decentralize their data processing activities. Moreover, this decentralization reduces the vulnerability of the system to computer failure or sabotage.

The earlier applications of computer technology generally occured in central Canada, but the concentration of computing power in one region has been continually decreasing, though the rate of change has slowed since 1975. In addition, the facilities of the major service bureaus are now accessible via telecommunications from almost any point in the country. No evidence exists that the new telecommunications and computing technologies have, as yet, tended to change the location of economic activity within Canada. Market forces, combined with the improvement in data communications, appear to result in a gradual dispersion of the computing power and general accessibility of even the largest computers. Indeed, *if the new information technology allows an increased substitution of communications for transportation, the technology may encourage rather than hinder regional economic development.*

On the other hand, though access to computing power per se may not hinder regional economic development, the new information technology may have a severe adverse impact on specific industries clustered in certain locations. Such industries may become uncompetitive or outdated because of technological change, either in

industries providing the same products or in others providing substitutes for their products. The economies of areas depending on affected industries could be seriously impaired.

Differences in provincial education systems may also affect the degree to which different regions use these new technologies.

The economic revolution

The application of the new information technology may affect the structure of industry in a variety of serious ways. *This new technology could precipitate pervasive changes in production processes, the size of firms and the relative importance of different industries in the national economy—including the emergence of new and decline of old industries.*

In considering the impact of information technology on the relative importance of different industries, examples of old industries violently affected by information technology immediately spring to mind. These include the traditional watchmaking industry and the manufacturers of electromechanical calculators. Other new industries, such as developers of software and data banks, are also coming into being. Perhaps of wider significance than the demise or formation of whole industries are changes in both the product ranges and the markets of what is usually considered a single industry. For example, traditional toy manufacturers are now producing a whole new range of electronic toys, while manufacturers of silicon chips are moving into areas such as electronic calculators and digital watches.

The implementation of the new information technology may affect the size of enterprises through impacts on economies of scale in industrial organization and in production. Many writers have already pointed out that the technology of electronic components and equipment manufacture is becoming increasingly capital intensive and expensive. As a result, only large firms can remain competitive in high technology industries. The new technology may also contribute to corporate concentration in user industries by reducing the administrative diseconomies associated with large enterprises.

For these reasons, smaller businesses may be at a disadvantage in exploiting data accessible in data banks. At least initially, they will not be able to exploit the newly available data as effectively as large businesses with professional staff in the information area. In many cases, smaller businesses will not realize how such data could benefit them. They will also lack the expertise to locate and interpret what they need.

Fortunately, other structural forces may also operate to lower the level of industry concentration. For example, the cost of computers has fallen so much that their use by small businesses is now

[4]Evans Research Corp., *The Trend to Decentralization: Part One.*

becoming economical. The technology also offers new opportunities to industry by enabling some firms to achieve efficient levels of output, even with relatively short production runs.

Both the factors tending to reduce firm size and those tending to increase it require examination.

The new technologies are raising serious questions too about the boundary between services provided on a traditional monopoly basis and those which might be left to competition. *Until quite recently, banking, mail, telecommunications and data processing were relatively distinct. Now, with the distribution of intelligence through data transmission, these functions are blurring together as the distinction between telecommunications and data processing becomes more obscured.*

The evolution of electronic payments systems and electronic mail is opening further areas of conflict. In the U.S., the Postal Service is now testing the feasibility of a public electronic mail system. Opponents argue that private enterprise should supply such systems. A.T. and T., Xerox and Satellite Business Systems all wish to set up networks which businesses could use for electronic mail. New networks, composed of individual television stations distributing their signals by satellite, are challenging the monopoly of the traditional broadcasting networks.

These developments are already forcing governments to rethink the boundaries between monopoly and competition and to reassess the role of regulation in the economy.

The decline of national culture

The new information technology—and in particular, direct broadcasting satellites—could considerably reduce the ability of nation states to control the inflow of foreign signals in the absence of corrective action by governments and appropriate international agreements. In that case, the result may be wholesale invasions of foreign culture and a decline in the relative importance of domestically produced cultural and entertainment materials, ranging from television programming to movies to books to a host of others. The advent of direct broadcasting satellites raises the issue whether broadcasters of one nation should be permitted to beam their programs into the homes of another without the prior consent of the receiving nation's government. This question has engaged widespread attention at various U.N. bodies over the past 10 years.

Despite the Canadian content policy of the Canadian Radio-television and Telecommunications Commission (CRTC) over the last few years, foreign productions already dominate Canadian airwaves. English-speaking Canadians spend only an estimated 26 per cent of their television viewing time watching programs of Canadian origin. Even on French language stations, foreign programming attracts a viewing share of more than 40 per cent. The dominance of foreign signals will intensify with the advent of direct broadcasting satellites unless domestic alternatives are developed.

Already northern communities are picking up U.S. satellite signals in the absence of Canadian alternatives.

The new technology may also threaten Canadian publishers. Until now, they have supplied not only Canadian books, but also foreign books, acting as agents for foreign publishers. This control on the inflow of foreign publications has enabled Canadian publishers to impose a high mark-up on foreign books which allegedly has been used to subsidize publication of Canadian books. This system, however, is now being threatened by U.S. wholesalers who can now use electronic networks to compete directly with Canadian publishers in supplying foreign publications to Canadian booksellers. Because U.S. wholesalers are able to meet the Canadian booksellers' requirements quickly and with substantial discounts, Canadian publishers will be seriously handicapped in their efforts to cross-subsidize Canadian publications with mark-ups on imports. As a result, Canadian authors will have a more difficult time getting their works published and fewer Canadian books may be available in future to the Canadian public.

Such applications of the new technology as computer-aided learning programs or home videotex services could also emphasize foreign (at the expense of Canadian) values and culture. Their extensive diffusion might pose an additional threat to our cultural integrity.

The threat to privacy

Electronic data transmission performs the same function as other means of transporting data, but the speed, accessibility and interactive capability of a direct communications link make for a qualitative difference in the sharing and using of data. Direct links between many terminals through a host of electronic paths, each and/or all interacting with computers in whatever configuration is desirable, represent a flexibility and diversity of unprecedented range.

The carrier can, of course, monitor his entire system for overloading, faults and service restoration with test equipment of lower cost and higher sophistication than in the past. But the corporate data owner cannot effectively control access to his system or his data. Nor can he record or prevent its manipulation from unauthorized terminals or by unauthorized persons from authorized terminals. The corporate or personal damage resulting from misuse of illegally obtained proprietary data can be severe and raises grave issues.

A number of governments have already passed legislation to protect personal information. Such legislation generally limits the use made of collected information, requires disclosure to an individual of personal data on him or her, prohibits its disclosure to unauthorized persons and sets up complaint procedures with respect to its relevance and accuracy.

The laws protecting personal information differ considerably between countries and have not been harmonized. The Council of Europe and the OECD have jointly expressed their worry that a country with weak privacy laws could become a "data haven", where firms subvert their own country's privacy laws by setting up a subsidiary in the less stringent host.

A recent OECD study suggests that only a relatively small portion of international data flows contains personal data. In most cases, these personal data are used for banking, credit control and travel applications. Domestic users also process personal data in foreign data processing facilities, but the data may only be accessed by the originating country.

Corporate information forms a more important part of international data flows. Such information may include marketing files on clients, comprising considerable sensitive information about each client's activities, background and credit rating, to mention only a few possibilities. Interestingly, the protection of corporate data has not attracted as much public attention as that of person data—despite the relative importance of the former in international data flows.

The OECD report also indicates that the new data networks provide significantly better production than more conventional networks. New networks such as the European SWIFT (Society for World Interbank Financial Telecommunication) combine sophisticated, on-line encryption systems with administrative actions to decentralize personal credit files. Both are practicable now with the new technology. Indeed, well engineered data networks and clever application of new methods can enhance the protection of personal and corporate data.

But no amount of technology can provide total security against unauthorized and illegal access to private and personal information, and its subsequent misuse. Unhappily, the balance of power between misusers of information and its protectors pivots mainly on the degree of sophistication, money and new technological applications each brings to the problem.

Civil liberties

Civil rights groups have expressed worry about the growing potential inherent in the new information technology for massive surveillance and control of individuals. Laws to protect personal information have tended to quell such fears, but the potential is still there. For instance, a threat to individual privacy could arise from the linking of computerized tax records with personal data such as EFTS credit statements. Similarly, electronic surveillance systems designed to protect property could be misused for surveillance of individuals.

Surveillance on a smaller scale is also possible in the work environment, for the new technology has a far greater accounting capability than older technologies. Word processors can monitor

typists' performance as they produce typed texts. New automated supermarket checkout counters can record cashiers' errors and monitor how fast they process shoppers.

Information concentration

Worry about the surveillance potential of the new technology is only intensified by the growing concentration of control and ownership in the information area. For example, electronic modes of communication have clearly increased the power of the press. The possible swift and widespread distribution of centrally prepared reports and articles is an ever growing reality. At the same time, the gradual disappearance of second newspapers in Canadian towns and cities implies that fewer individuals have ever greater power "to make the news". Local newsletters have been expanding to meet the desires of people for local news. However, these alternatives do not have the same reach as the major newspapers.

A similar concern has led to the concept of separating content and carriage in the operation of telecommunications networks. If carriage is characterized by strong economies of scale and scope, as it has been often claimed in the past, it makes sense in terms of efficiency to have only a restricted number of carriers, either regulated or publicly owned. But if the carriage monopolies or oligopolies also control content, the result could be an unacceptable concentration of power. *Equitable access to electronic highways is fundamental to maintaining the free flow of information so basic to a democratic society.*

Age of the electronic hermit

As the new technology enables the diffusion of more and more services to larger numbers of people, more Canadians will find themselves dealing more with machines and less in direct social contact with people. Such a development could well contribute to alienation. The human need for live, physical contact with other human beings could be frustrated. Some segments of society could also reject the information technology. A counter-culture could conceivably emerge, emphasizing unmediated interaction between individuals, as opposed to the mediated interaction which will probably prevail with the new information technology.

Electropolitics

Some potentially harmful implications of the information revolution will attract public attention and may result in an increasing role for government in the economy and society as a whole. As already noted, a number of governments have already acted to protect the privacy of personal data. A number of countries are considering or have already implemented freedom of information legislation designed to ensure public scrutiny of "big government's" activity by the general public. Not very successful action has also already been taken to protect Canadian content industries from the invasion of foreign culture.

But what if, as seems possible, the information revolution does lead to an increased concentration of economic and political power and an erosion of national sovereignty? Clearly, countervailing government intervention will be necessary to prevent frustration of the basic socio-economic objectives of Canadian society. Such intervention may mean more regulation and public ownership. There is, however, also scope for the fostering of competition whenever or wherever feasible, as in the content industry and the provision of new telecommunications services. In some areas, less regulation may be desirable because technological change has weakened the natural monopolies which originally constituted the grounds for such regulation.

But if government assumes a greater role, it would also have to be more accountable in order to render this increased power responsible for its actions. The new technology could serve such a purpose. Televised debates between candidates for office and the introduction of television in the House of Commons are already with us. These applications exemplify use of the electronic medium to enhance public awareness of important political issues.

But increased reliance on information technology in the political process is not without danger. Electronic image building can help distort political reality. Instant electronic referenda over interactive home terminals could result in demagoguery and crowd-pleasing. Increasing reliance by politicians on public opinion—a practice which the new information technologies greatly enhances—is an early portent of such a future.

The political implications of unequal or equal access to the electronic media by information providers and users may also surface as an important issue. Such "communications rights" may require much further elaboration in the future.

5

The experience of other countries

Canada should be concerned about what other countries, particular its major trading partners, are doing about the information revolution. Because our economy and society are open, economic and social changes abroad caused by the new technology can affect us profoundly. In light of the complex policy issues facing us, it is also pre-eminently sensible to review the game plans of our major competitors in order to arrive at our own strategy.

In the recent past, country after country has adopted policies intended to foster the growth of their electronic industries and encourage the use of the new information technology throughout their economies. Simultaneously, they have tried to assess and, where necessary, counter the potential negative effects of the information revolution.

The world information industry

A global picture of the world information industry is difficult to paint because information goods and services consist of a wide range of heterogeneous components. Information goods can be defined as goods which either intrinsically convey information (such as books) or which are directly useful in its production, processing or distribution (such as computers). Information services fall into four broad categories: technical and professional information services, cultural and entertainment services, communications services and data processing services. Unfortunately, readily available statistical sources provide no separate data on output and trade in information goods and services on an internationally comparable basis.

For this reason, we must restrict our attention to electronic goods. Electronic goods subdivide into three major groups: electronic capital goods (electronic computers and peripherals, telecommunications equipment, office equipment, test and measuring instruments, industrial control equipment and defence-oriented products), consumer electronics (television receivers and audio equipment), and components (the devices forming the systems and sub-systems of the other two sectors).

The annual sales of the world electronics industry were well in excess of $100 billion in 1977. In real terms, the market is expected to increase at an average annual growth rate of 10 per cent through 1980. Table 5.1 presents a comparison of electronics production in various countries.

As the table shows, electronics accounted for an increasing share of national output in Japan, France, the U.K. and Sweden between 1965 and 1975. As can be seen, *Canada has the weakest electronics sector both in absolute and relative terms.*

Significant increases in trade and shifts in the pattern of industrial specialization have accompanied the growth of output in the electronics industry. These changes occurred both in the distribution across countries of shares in export sales for electronics-based products, and in each country's ratio of exports to imports.

Between 1965 and 1976, the value of exports in electronics-based goods from OECD countries has increased faster than exports of finished manufactured products or OECD merchandise exports as a

Table 5.1a
Electronics output by country
Value of shipments 1975

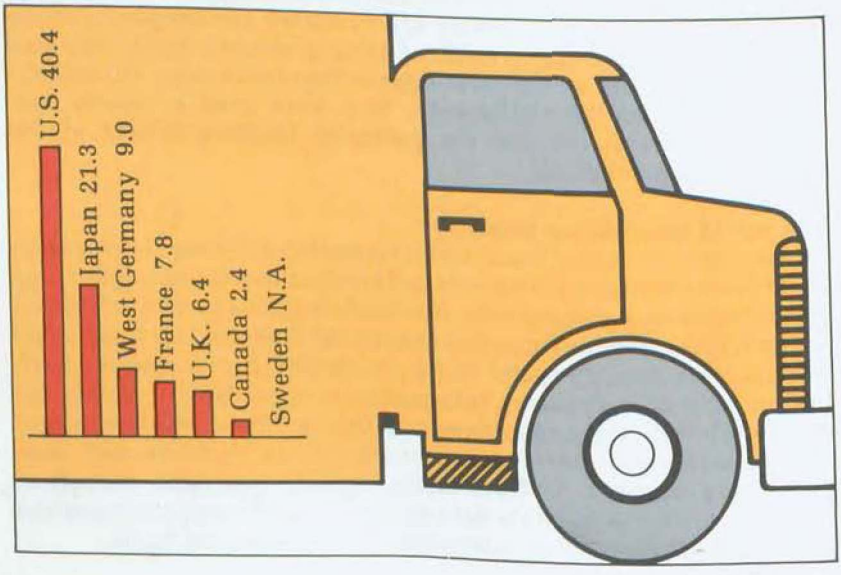


Table 5.1b
Electronics output by country
Average annual growth rate

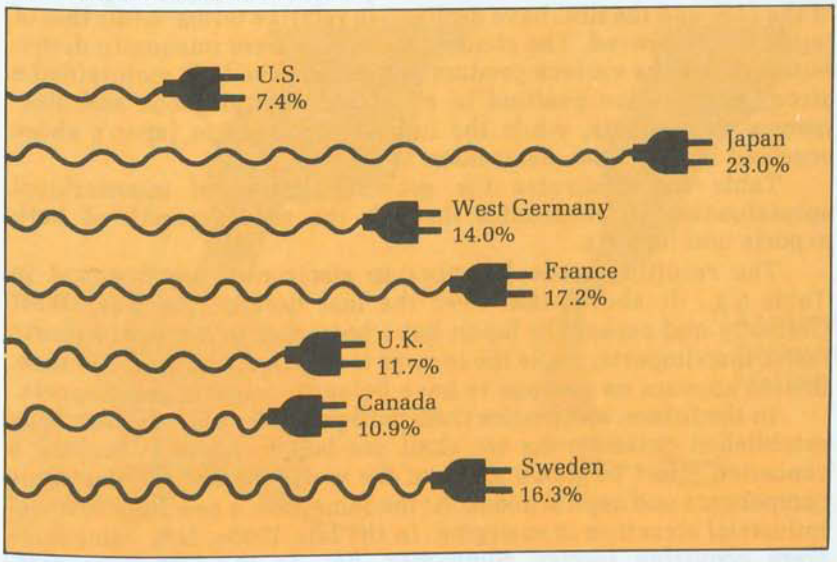
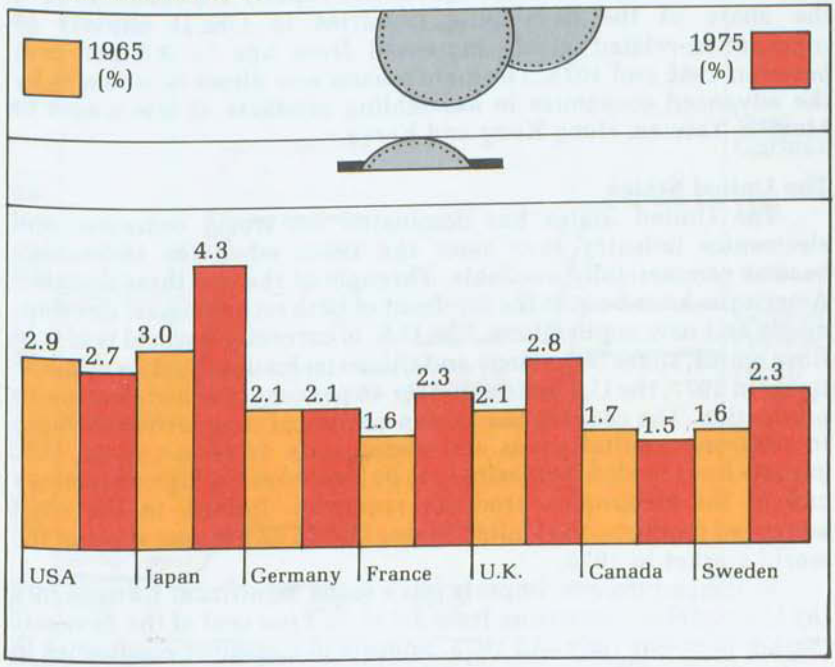


Table 5.1c
Electronics output by country
Contribution to GDP



Source: *A Report by the Sector Task Force on the Canadian Electronics Industry*, Canadian Department of Industry, Trade and Commerce, Ottawa, 1978.

whole. Significant shifts in trade structure have accompanied the increasing volume of trade in electronics. For example, the position of the U.S. and the EEC have declined in relative terms, while that of Japan has improved. The changes in shares were unequally distributed across the various product groupings. The U.S. maintained a strong competitive position in electronic capital goods and electronics components, while the largest increases in Japan's share occurred in consumer electronics.

Table 5.2 illustrates the growing degree of international specialization in electronics through the rapid growth of both exports and imports.

The resulting trade balances in electronics are depicted in Table 5.3. It shows that over the last decade, the U.S., West Germany and especially Japan have been able to increase exports faster than imports, while the reverse is true for Canada and France. Britain appears on average to have balanced exports and imports.

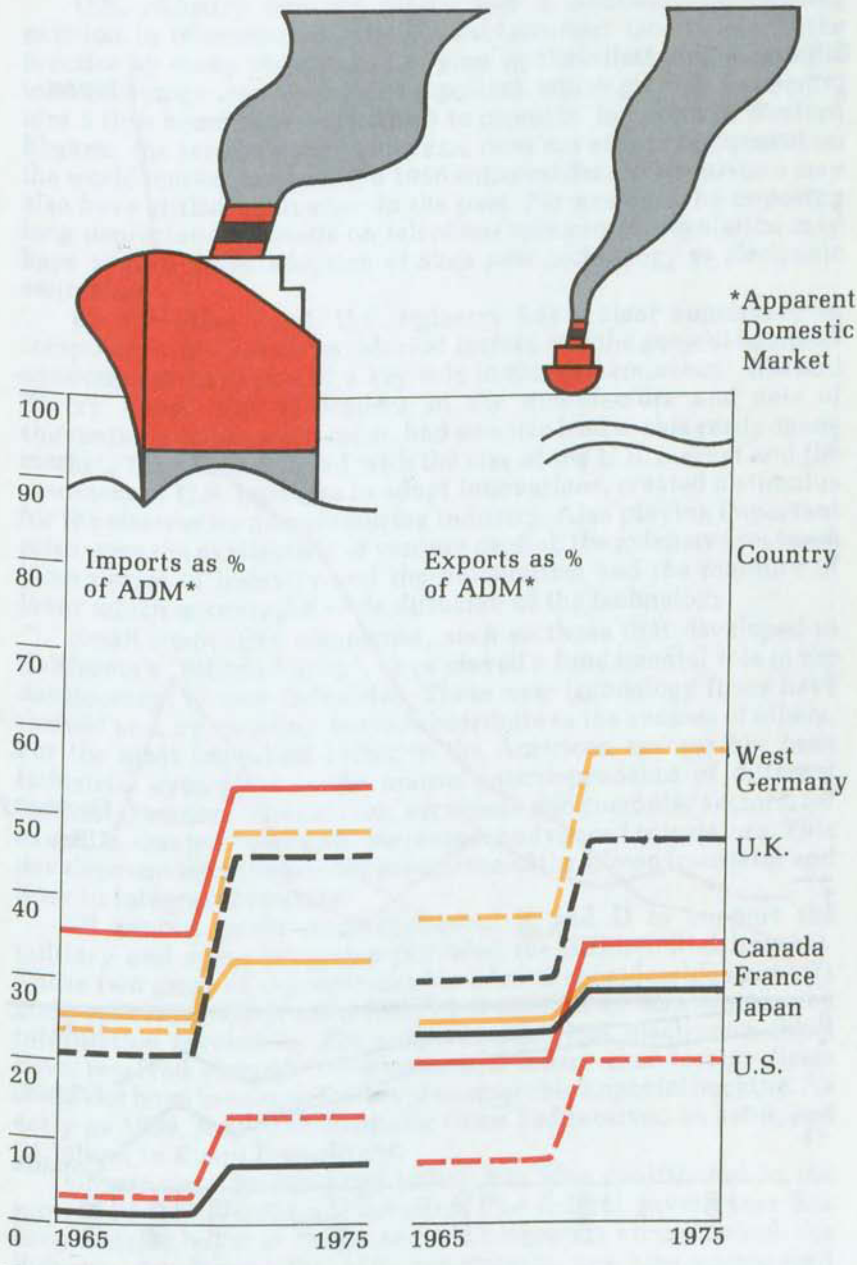
In the future, electronics trade will probably shift further from established patterns. As we shall see below, Japan is making a concerted effort to gain a share of the world market for electronic components and capital goods. At the same time, *a new international industrial structure is emerging. In the late 1960s, U.S. companies were acquiring foreign companies; but, in the last few years, European and Canadian firms have been acquiring small electronics firms in the U.S.* Meanwhile, the role of developing countries as suppliers of electronics-based goods has rapidly expanded. In fact, the share of the developing countries in OECD imports of information-related goods increased from one to 8.5 per cent between 1965 and 1975. The main reason was direct investment by the advanced economies in assembling products at low wages in Mexico, Taiwan, Hong Kong and Korea.

The United States

The United States has dominated the world computer and electronics industry ever since the 1950s when the technology became commercially available. Throughout the last three decades, Americans have been at the forefront of both technological developments and new applications. The U.S. is currently a world leader in fibre optics, space technology and silicon technology and its applications. In 1977, the U.S. accounted for 40 per cent of world electronics production. The country has shown continued competitive strength in electronic capital goods and components. In recent years, U.S. exports have tended increasingly to be located at the high technology end of the electronics products spectrum. Indeed, in the most advanced products, the United States had an 82 per cent share of the world market in 1975.

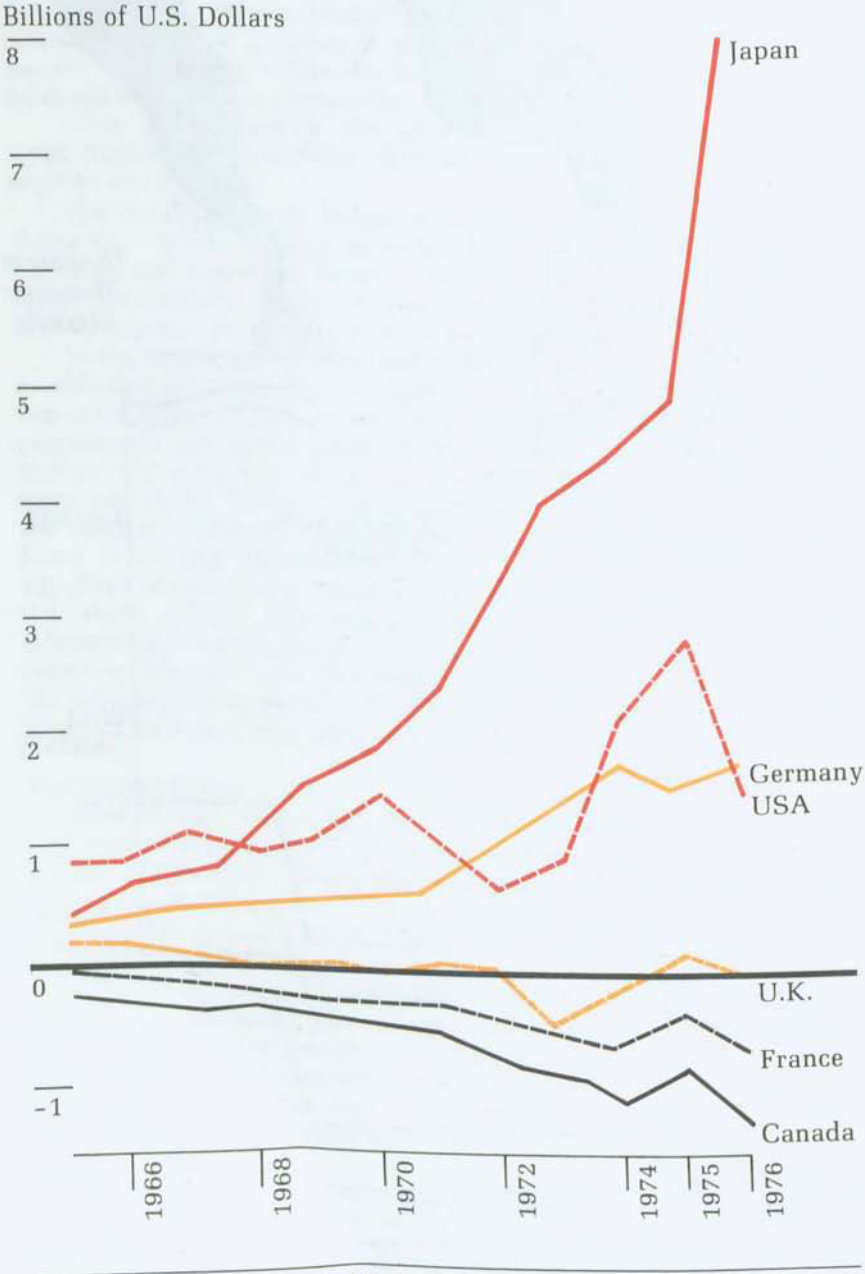
In the last decade, imports have made significant inroads into the U.S. market, increasing from 3.6 to 13.7 per cent of the domestic market between 1965 and 1975. Imports of consumer electronics in particular have increased rapidly, from 36 to 46 per cent of the

Table 5.2
International trade in electronics



Source: *A Report by the Sector Task Force on the Canadian Electronics Industry*, Canadian Department of Industry, Trade and Commerce, Ottawa, 1978.

Table 5.3
Electronic Industries trade balance



Source: *A Report by the Sector Task Force on the Canadian Electronics Industry*

apparent domestic market between 1972 and 1976. But exports have grown rapidly too, with the result that the 1975 trade surplus in electronics was almost $3 billion U.S.

U.S. industry has not established a similarly commanding position in telecommunications manufacturing. One reason is the practice by many countries of relying on their own major national telecommunications equipment suppliers, which gives these companies a firm home base from which to compete. In addition, Western Electric, the largest equipment firm, does not sell its equipment on the world market because of a 1956 antitrust decree. Regulation may also have stifled innovation in the past. For example, by imposing long depreciation periods on telephone companies, regulation may have slowed down adoption of such new technology as electronic switching.

On the other hand, U.S. industry has a clear supremacy in computers and electronics. Market factors and the general business environment have played a key role in this pre-eminence. IBM and Sperry Rand, already leaders in the manufacture and sale of conventional office equipment, had an early lead in this ready-made market. This lead, coupled with the size of the U.S. market and the readiness of U.S. business to adopt innovations, created a stimulus for the electronics manufacturing industry. Also playing important roles were the availability of venture capital, the extensive research laboratories of industry and the universities and the mobility of labor which encouraged wide diffusion of the technology.

Small innovative companies, such as those that developed in California's "Silicon Valley", have played a fundamental role in the development of new industries. These new technology firms have thrived and, by so doing, helped contribute to the success of others. For the most important factor in the American success has been industrial synergism — the mutual interdependence of different industrial sectors. The defence, aerospace and computer sectors, for example, created "user pull" markets for advanced transistors. This development led in time to the emergence of the silicon transistor and later to integrated circuits.

Of course, government-sponsored R and D to support the military and space programs provided the major initial impetus. These two areas of expenditures have led to considerable spin-offs and spillovers which have been instrumental in accelerating the information revolution. The support which U.S. electronics firms have received through these programs meant that foreign firms could not hope to compete without comparable financial backing. As early as 1959, American computer firms had received an estimated $1 billion in R and D contracts.

Government procurement policy has also contributed to the growth of the information industry. The federal government has been a major buyer of the large scale computers around which the industry developed. The U.S. government has also encouraged competition by diversifying its sources of supply.

At the same time, *the American government has effectively used tariff and non-tariff barriers to protect the developers of new high-technology products until the multinational enterprises were ready to enter world markets with a commanding lead.* For example, the United States, despite its commitment to free markets, placed a 25 per cent tariff on optical fibre so that domestic producers could grow large enough to supply most of the U.S. markets. Corning has now locked up most of the world with licence agreements.

American firms will probably continue to dominate the world information industry for a number of years to come, but threats to their dominant position are visible. Japanese products are increasingly penetrating the U.S., while Japanese strength in LSI (large scale integration) circuits is on the rise. Meanwhile, the foreign activities of the U.S. multinationals are growing in importance and posing an increasing threat to domestic production. The rising tide of economic nationalism sweeping through many of America's trading partners constitutes another menace to domestic production by U.S. companies. Barriers to imports of foreign-made products are rising along with requirements for local ownership of competing companies, as shall be seen below.

Concern has recently focused on the decline in technological innovation in the United States. Blame has been attributed to reduced federal expenditures on R and D and a decline in private spending on research because of inflation. In introducing the National Technology Innovation Act of 1979, Senator Adlai Stevenson stated: "We have ignored the warning that our competitors are moving ahead rapidly with advanced computer-aided manufacturing and design technologies, one of the keys to future productivity growth." The bill calls for expenditures of $270 million over the next five years to stimulate generation of technological innovations in universities and industry, to set up an Office of Industrial Technology in the federal government, and to create Centers for Industrial Technology to carry out research. In addition, the White House is currently reviewing its policies on domestic innovation and technological transfers to foreign countries.

The U.S. is also debating a national information policy which addresses itself to privacy and freedom of information issues arising from proliferation of public and business data banks.

In addition, the U.S. is now beginning to devote more attention to international issues in the information area. These include trade in information goods and services, as well as transborder data flows. According to recent statements by the President's foreign policy advisor and the Assistant Secretary for Communications and Information of the Department of Commerce, the U.S. is worried about the growing movement in many countries toward protectionism in the telecommunications and data processing industries. It is also concerned about policies that would restrict the free flow of information between countries.

A restructuring of policy-making agencies in the telecommunications field has taken place too. The National Telecommunications and Information Administration (NTIA) has replaced the Office of Telecommunications Policy and the Office of Telecommunications. One role of the new agency is to recommend policies on privacy, industrial competition and international telecommunications trade in light of technological developments.

Finally, the U.S. has been experiencing a trend toward deregulation over the past two years. This arises, in part, from the increasing erosion of the distinction between data transmission and processing. Deregulation, in conjunction with the U.S. 'open skies' satellite policy, is opening new markets to competition. Another consequence has been a proliferation of new services provided by telecommunications (for example, Satellite Business Systems, Xerox Telecommunications Network and A.T. and T.'s Advanced Communications Service) and broadcasting networks (pay TV, subscription TV and the use of communications satellites for so-called "superstations"). This telecommunications revolution and the resulting infrastructure will help to ensure the U.S. a leading role in the implementation of the information revolution.

Japan

In 1965, Japan accounted for barely 15 per cent of OECD high technology information exports. The next 10 years witnessed a considerable increase in Japan's share, accompanied by a rising ratio of Japanese exports of these products to imports. A main contributor to the trend was the growing United States market for consumer electronics products. By 1977, the U.S. absorbed more than 50 per cent of Japan's exports of electronic consumer durables. Japan's success in consumer electronics and telecommunications-related equipment was originally offset by a weaker position in electronic capital goods. But the Japanese competitive position in these product lines improved markedly between 1965 and 1975. Indeed, Japan has experienced a higher growth in electronics production than any major industrialized nation: in the decade, the average annual growth rate was 23 per cent.

The domestic market for electronics products has also expanded rapidly—at an average rate of 22.5 per cent a year during the decade, matching the increase in production.

One major factor in Japan's success has been the existence of a large protected domestic market throughout the development phase of the industry. Large firms in the Japanese electronics industry tend to participate in many subsectors of the electronics business. The Nippon Electronic Company, for example, participates in telecommunications (32 per cent of sales in 1976), electronic computers (23 per cent) and electronic components (16 per cent). The large size of these companies also provides the required financial base for huge marketing and R and D efforts. In addition, these firms have contributed to Japan's competitive success through the ability to

offset wage hikes and other cost-increasing factors by applying technological innovations which increase labor productivity.

Perhaps the most striking feature of the Japanese scene is the extent of industry-government co-operation through JEIDA (Japan Electronic Industry Development Association), which co-ordinates the activities of individual firms, studies technology developed abroad and represents the industry in dealings with the government.

The Japanese government has long recognized the strategic importance of electronics and computers. Government support began in 1959 with passage of an act to protect the Japanese electronics industry from foreign competition. Elements of the policy package included extensive support for industrial R and D and a procurement policy intended to strengthen the industry. The government also persuaded IBM to make the basic patents of computer technology available to Japanese firms. The financing of computer rentals also received support through Japan Electronic Computer Company (JECC) during the 1960s.

In 1971, passage of The Temporary Law for Strengthening Selected Electronic Equipment Industries launched a seven-year program to develop new types of computers, peripheral equipment, integrated circuits and software. In 1976, Japan announced a four-year, $1 billion program to support production of VLSI (very large scale integrated) circuits for computer and telecommunications applications. The government is also spending $150 million to help the Nippon Telegraph and Telephone Corporation (NTT) develop and produce new telecommunications devices based on VLSI components. In 1976, the Japanese Ministry of International Trade and Industry and 17 leading software companies established a joint venture software company, Joint Systems Development Corp.

Japan's policies are slanted heavily against foreign-owned subsidiaries. For example, IBM Japan must manufacture its most advanced products in Japan, is excluded from government procurement, has a restricted market share and has to license its technology to its Japanese competitors.

"Buy Japanese" government procurement policies apply to all telecommunications equipment purchased by NTT. Major equipment procurements mainly occur through contracts, which in many cases call for NTT and manufacturers to develop jointly equipment and communications systems.

Japan has also established a government-industry program, known as the "Methodology for Un-manned Manufacture", to foster CAD/CAM technology. The program includes a $100 million demonstration project to develop and operate a prototype "unmanned" machine-building factory.

The co-ordinated approach of industry and government will probably continue. Japan will also likely increase its share of international electronics trade during the next decade as it broadens the base of its export drive into areas such as computers and process control. In fact, Japan has already captured 35 per cent of the

American market for 16K random access memories (RAMs) and run up a $45 million surplus with the U.S. in semiconductors during 1978.

There is a new Japanese emphasis on software development and promotion of information systems such as health care networks, visual information systems for home use, energy-saving urban systems and trade information systems. These priorities arise from the enactment of the Information Industries Law in 1978. The act provides for financial assistance, tax measures to promote use of the new software and measures to encourage collaboration and rationalization of firms. A new association, the Computer Basic Technology Technical Association, has just been created to develop basic software and terminals for the next generation of computers.

West Germany

West Germany is the world's third largest producer of electronics, with 1975 production valued at $9 billion. Two of the world's 20 largest data processing companies are German: Siemens and Nixdorf. In recent years, much of the industry has been reorganized around these two firms.

Germany also has the most export-oriented electronics industry in the world. Although imports rose from 24 to 29 per cent of the domestic market between 1965 and 1975, exports as a percentage of shipments increased from 37 to 58 per cent and the trade balance improved. The majority of exports were to other EEC countries, while the U.S. was the main country of origin for imports.

Germany's trade figures reveal a certain pattern of specialization in the data processing industry. In 1974, the main categories of imports were components, input/output peripherals and complete central processors. On the export side, parts, peripheral memories and complete systems were the main types of products. The imported input/output peripherals were combined with domestically manufactured peripheral memories to produce complete systems, which were then exported.

One of Germany's main areas of strength is process automation. The industry has stressed development of automated processes for producing computers and integrated circuits. *Such process automotion is an importont element in mointoining internotional competitiveness for a country characterized, like Germany, by high labor costs.*

Despite these strengths, the German electronics industry is signifioantly foreign-owned. There is also a large foreign presence in the data processing market. Foreign-owned firms supply more than 75 per cent of installed computers. In addition, many firms are highly dependent on foreign technology and rely on technological agreements with U.S. firms to learn about new developments.

This pattern of development has its origins in the period immediately after World War II. At that time, limitations imposed on development of military hardware initially handicapped the German

information industry and caused an early dependence on American technology. The German domestic market was also small in comparison to that of the U.S. or Japan. But management was receptive to the new technology and the result was a rapid diffusion of innovations. Meanwhile, state and industry co-operated to foster development of autonomous production capabilities in certain specialized fields.

Individual firms such as Siemens developed their technological capability by first producing under licence to an American firm, then progressively obtaining autonomy. In order to gain entry into the microprocessor field, Siemens has entered into a joint venture with an American firm to found a company which will develop, manufacture and market microprocessors.

The relationship between banks and industry has also helped to make financing available for innovations.

Attempts to build a world class computer industry have largely failed. In 1972, AEG-Telefunken established the Telefunken Computer Company to produce mainframe computers. But lack of applications software for management tasks resulted in low penetration of the private market. In 1972 and 1973, the federal government had to provide DM 50 million in financial aid to the company. Siemens took over the company in 1974 and renamed it the Constance Computer Company.

Heavy foreign ownership in the electronics industry has negatively affected Germany's R and D efforts. Subsidiaries of foreign companies make heavy payments, usually to their parent companies, for technology transfers. As a result, fewer funds are available for financing R and D in Germany.

Government policy toward computerization 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 has been 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 gives preference to German products. Another support tool utilized has been direct financing through government shareholding in the capital of domestic firms.

These stimulative measures encouraged diffusion of computers through German industry. The number of process computers in operation rose to 5,600 in 1974 and 8,400 in 1975. Many were used in CAD/CAM applications.

Germany has been one of the first countries to address the social aspects of informatics. The West German state of Hessen became in 1970 the first to pass a Data Protection Act.

Both the national government and trade unions have been active supporters of training and retraining related to automatic data processing. Germany makes extensive use of apprenticeship programs to fill needs for skilled workers. In 1978, about 1.4 million apprentices received training in a labor force about twice the size of Canada's. Firms and government also support vocational training programs. In 1978, for example, Siemens spent $225 million to train 10,800 apprentices.

Germany is currently implementing its third computer development program. Its objective is to stimulate a broadly based data processing industry by supporting industrial R and D. The government is also providing support for applications in such fields as information systems, telemedicine, education, computer-assisted design, process control and user support. This program has a four-year budget of DM 1.5 billion or some $150 million a year.

The government has 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.*

France

After Germany, France is the second largest electronics producer in Europe. But the country has experienced a continual trade deficit in electronics since 1965. More than any other European country, the computer market in France has been captured by the U.S., which in 1974 accounted for 83 per cent of the French market compared to 75 and 60 per cent in Germany and Britain, respectively.

France's early start in the computer industry did not help too much. In 1951, Compagnie des Machines Bull, an established business machine company similar to IBM, entered this market. But the relatively small size of the French market, heavy development costs, remote (U.S.) component suppliers and lack of government financial support for R and D put the company in an unfavorable position compared to its American competitors. In 1964, General Electric bought Bull, and in 1970 control passed to Honeywell.

Since 1966, the government has been active in the computer and telecommunications industries. This government intervention may have been triggered by the U.S. government embargo in 1965 on a large Control Data computer which France wanted for conducting research on the atomic bomb.

Under its *Plan Calcul*, France set out to develop a national mainframe computer industry. The plan also provided for government subsidies to industry and for promotion of computer research.

In order to maintain a French presence in computer manufacturing a national company, the Compagnie Internationale pour l'Informatique (CII), was established in 1966 by merging a number of French firms. In 1972, the government took a 15 per cent holding in the company. Then in 1975, CII merged with Honeywell-Bull to form CII-HB, which was 53 per cent French-controlled.

By 1978, France's largest computer firm, CII-Honeywell Bull, had the greatest revenues of any non-American, non-Japanese computer manufacturer. The firm specializes in hybrid and analog machines and telecommunication peripherals.

IBM and Honeywell-Bull have dominated private R and D in computer technology. In many cases, technology has been transferred from foreign firms. For example, CII has made use of Xerox licences for data systems and Bull had a technology exchange arrangement with Nippon Electric Company of Japan.

The French government has spent some $350 million in an attempt to build Machines Bull and CII into world-class computer manufacturers. The government will also spend an estimated $1.5 billion on Honeywell-Bull until 1981, including $1 billion on guaranteed orders for systems.

Despite difficulties, the French electronics industry has recently gained strength. The average annual growth rate in electronics production was 25 per cent between 1970 and 1975—higher than any of the countries reviewed. Electronics grew from 1.6 to 2.3 per cent of GNP between 1965 and 1975.

Applications of new electronics technology have lagged until recently. Only about 100 systems using computer-aided design are in operation, compared to an estimated potential of 2,000. In general, management has been slower than in other countries to accept new methods based on electronic data processing. France is, however, developing new applications—including Antiope, its videotex system. In March 1979, France became the second country in Europe to have a public packet data network (Spain was the first).

Government has also set up a special program to strengthen the peripheral sectors, including mini and microcomputers. This program has had two major thrusts: first, to restructure the industry around CGE and Thomson-CSF; and, second, to support these poles through direct assistance and public procurement. A merger of minicomputer firms, backed by the government, has created Europe's biggest minicomputer firm, SEMS (Société Européenne de Miniinformatique et de Systèmes).

France is determined to develop indigenous capability in high technology fields. For example, in the planned major expansion of the telecommunications network, the government decided to have Thomson-CSF develop its own technology rather than buy foreign switching systems offered by Northern Telecom and Nippon Electric.

France has recently embarked on a massive investment plan in micro-electronics sparked by the report L'*informatisation de la société*, requested by the President of France in 1976 and published in 1978. This report discussed the impact on France of widespread distributed computing networks based on microprocessors. It increased political awareness of the importance of micro-electronics. The French president also announced new initiatives in December 1978. One was the allocation of 2.25 billion francs, about $625 million, to a program designed to make France a world leader in production and use of the new technologies. Another was the establishment of a special agency to promote applications development. The program also includes an increased emphasis on satellites and standards which will serve to promote development of domestic industry.

In November 1978, France announced a components plan valued at $140 million over five years to build up its domestic integrated circuit industry, principally through technology transfers from the U.S.

France's plans in micro-electronics heavily emphasize education at the industry, university and school levels. About 10,000 microcomputers are to be installed in schools. The government has also announced a push to introduce university students to computer techniques. Plans are also being developed to increase computer training and expertise in industry.

In addition, the President has established an inter-agency task force to advise on issues raised by transborder data flows. The French are very worried about the growing use of data banks located in the U.S. and the threat this creates to national sovereignty.

In 1979, France laid a significant emphasis on networks and new telecommunications services—especially such home data services as videotex, electronic mail and an electronic telephone directory. Through its efforts in these fields, the French government hopes to stimulate its industry into a leading position in the future home services market. France has also recently concluded a co-operation agreement with Canada on videotex.

In order to raise public awareness of the effects of computers and communications, France organized a "Computers and Society Week" in September 1979. Its importance was evident by its being opened by the French Prime Minister and closed by the President of the Republic.

United Kingdom

The United Kingdom is third in Europe—after Germany and France—in sales of electronics and electrical goods. In comparison to other European countries, Britain has been relatively successful in maintaining a national capability in computer manufacturing. In fact, the U.K. is the only nation in Europe where IBM does not account for more than 50 per cent of equipment installed.

Britain has also shown considerable strength in the development of home and business data retrieval systems. There are two operational broadcast teletext systems—ORACLE and CEEFAX—and the world's only commercial videotex system, Prestel.

Britain lags behind the U.S. and Canada in data transmission. It will not have a national packet switched network until later this year.

One reason for Britain's modest success is its development as early as the 1950s of a domestic computer industry. Many major manufacturers, companies such as Plessey and British Tabulating Machine (BTM), then produced under licence to American firms. In the 1960s, the industry underwent a period of consolidation, resulting in the formation of International Computer Ltd (ICL) in 1968. The government is a partner in this firm. ICL has sought to maintain its own technological capability, occasionally by joining forces with various American and European manufacturers.

In the mini and microcomputer fields, there are several British firms.

The advent of semiconductors was a setback to the British equipment industry. Government financed research in components has been generally less successful in producing commercial spin-offs than in the U.S. This partial lack of success has been attributed to a variety of causes: the concentration of university and government research programs on fundamental research rather than development, the relative lack of military orders and the public dissemination of results, rendering them available to firms everywhere in the world.

In the area of applications, one of the main problems facing the U.K. has been the general unawareness in industry of the potential of modern information technology. A 1978 survey indicated only eight per cent of the top 1,000 firms were sufficiently aware of microelectronics to study seriously how it could affect their businesses. The lack of large chip producers and trade union suspicions have also handicapped diffusion of the new technology. Lags in applications have also been blamed on lack of strong co-operation among industry and universities and research institutes. These factors, along with a lack of adequately trained engineers and designers, have been identified as contributing to a low level of industrial innovation and a consequent decline in industrial competitiveness.

Until now, U.K. manufacturers of television receivers have had a protected market due to the PAL TV standard which serves as a non-tariff barrier. But this industry is structurally weak because of fragmentation between too many manufacturers and the small size of factories.

The U.K. has in some ways not fully recovered from the failure of its government to stimulate its computer industry massively in the 1950s. Though the U.K. produced its first computer almost as early as the Americans, the U.K. government did very little to support the industry while the U.S. government provided massive infusions of funds.

Indeed, it was not until the 1960s that the British government began to play a role in the equipment industry. Its policies were a response to such issues as the need for technological sovereignty and the heavy balance of payments deficit due to U.S. domination of the industry. Developments in computer technology and applications received support, as did the securing of independent mainframe capability through the creation of ICL. The government provided this company with help in financing R and D and marketing new series, as well as support in the form of preferential public procurement policies. From 1963 to 1976, ICL received 60 per cent of government funds spent on data processing.

The government has also supported applied research in the industry through the Advanced Computer Technology Project. It has stimulated software product development and funded R and D for components in general, as well as, more recently, for integrated circuits in particular. The government has now moved into the semiconductor field through a $100 million investment to establish a semiconductor manufacturer. This firm, Inmos, will concentrate on production of high capacity semiconductor memories, beginning production in the U.S. and then transferring production to the U.K.

In June 1978, the government announced a plan to provide up to 85 million pounds (about $220 million) to encourage applications of microelectronics technology and to stimulate growth in the U.K. microelectronics industry.

In September 1978, the Advisory Committee on Advanced Research and Development reported to the Prime Minister on the policy implications of the micro-electronics revolution. The now widely known BBC film 'Now the Chips are Down' further heightened political awareness of the social and economic consequences flowing from the emergence of the microprocessor.

On December 6, 1978, the Labour government announced a wide range of new policy initiatives. It earmarked 100 million pounds for support to the electronics industry and applications over the next three years. The program will also support manufacturing—especially that related to silicon chips. There will be increased emphasis too on training and education and government procurement. The government will also launch a major awareness campaign to promote incorporation of the new technologies into business and government activities. In addition, the social impacts of the new technology—especially on employment—will receive increased attention and the Central Policy Review Staff will consider ways of improving policy co-ordination.

The Labour government set up Nexos too, an office information supplier, to co-ordinate a market drive for office products developed in the U.K.

The ascension of the Conservative party to power in May 1979 may affect some of these initiatives. There are indications that funds planned for education on the use of microprocessors may not be spent as originally intended. The new Minister of Industry has

stated that Inmos, Nexos and the Computer Services Company, Insac—all now government-owned—should be privatized.

On the other hand, the House of Commons has recently set up an all-party committee to study the impact of information technology. More specifically, the committee will look at the development and production of hardware and software devices, equipment and programs, as well as the implications of the new technology for employment, health care, legal procedures and privacy.

British industry is beginning to adopt microprocessors for use in production. The proportion of British companies using microelectronic techniques has grown from five to 17 per cent in the last two years. Few firms, however, are as yet involved in development of new products embodying microprocessors.

Semiconductor manufacturers are also appearing and Inmos expects to begin production this year. GEC and Fairchild have announced a joint venture to establish a semiconductor plant in Britain.

Sweden

Throughout the 1970s, Sweden experienced a positive trade balance in electronics. In 1977, exports came to $1.3 billion and imports to only $1.2 billion. The industry is specialized, notably in the manufacture of bank terminals and telecommunications equipment, through Ericsson, the huge Swedish multinational. Branch plants of foreign-based multinationals such as IBM and Philips account for a great deal of the production.

Sweden is also quite advanced in the application of automated production techniques. For instance, the Volvo factory uses industrial robots to weld car bodies. As estimated 600 industrial robots were in use within Sweden in 1977.

Sweden has an excellent telecommunications infrastructure. In terms of telephones per capita, it leads all the countries discussed here with the exception of the U.S. A public data network became available in 1979.

Sweden, however, is smaller than the other countries. In 1976, its population was 8 million, compared to 55 to 65 million in West Germany, France and the U.K. Because of the smaller population base and resulting tinier market, the electronics industry in Sweden has evolved differently from those in other countries.

Computerization hit Sweden in the early 1950s, and its use is now quite widespread in industry, commerce and government. A large proportion of transactions between banks and large companies are automated, and on-line automatic withdrawal machines are being introduced. In industry, machine and process control applications are leading to computerized assembly systems.

Sweden was an early equipment producer for the computer manufacturing industry; but, because the country is so small, lost its position on the world market. Up to 1975, Datasaab, a subsidiary of Saab-Scania, produced a complete line of hardware. Because of

marketing difficulties in the face of stiff international competition, the government bought a 50 per cent interest in Datasaab in 1977. The firm now concentrates on the production of small computers and bank terminals.

The entire data processing equipment industry now follows a strategy of specialization in areas of expertise—notably bank terminals and telecommunications equipment. These industries have been stimulated by the needs of the sophisticated banking industry and telecommunications infrastructure.

Sweden imports most of its components, and their major user is the telecommunications industry. Micro-electronics is also being incorporated into consumer goods such as automobiles, color television, alarm and security equipment and appliances such as microwave ovens and washing machines. The machine tool industry is also increasingly employing micro-electronics in its products.

In Sweden, trade unions have played an active role in supporting automatic data processing training and retraining. They are now negotiating to protect their members from the possible negative impacts of the technology.

The Swedish government has also actively tried to foster and shape the information revolution in a manner beneficial to its citizens. Two main thrusts have become apparent: the encouragement of production and use of the new technologies and a preoccupation with their social effects. Public awareness of computerization has been quite high: all the major political parties have information policies. The government has set up many temporary task forces or commissions to prepare proposals on various aspects of the information revolution.

Between 1972 and 1974, a Computer Industry Commission examined the viability of the Swedish computer industry. The reason for the study was worry about the growing dependence of Sweden on foreign producers of computers. The Commission concluded that the massive R and D efforts required to attain leadership in this field were beyond Sweden's resources. But it stressed the vital importance of support for users and applications of computer systems. It recommended the development of a strong software industry, the continued production of peripherals and small systems and a strong user capacity. Among proposed government initiatives were support of user training and increased R and D on dedicated systems and national action on standards and data communications. The Commission also asked the government to undertake national projects on social information systems for health records and traffic control, which could be sold abroad. These proposals were subsequently implemented to a large extent.

Since the early 1970s, public policies on privacy and freedom of information have taken into account the implications of information technology. The Data Act of 1973 protects the privacy of all personal files maintained by automatic data processors. The Act also established a Data Inspection Board to grant licences for the keeping of

personal files and to monitor compliance. Board activities have contributed to greater public awareness of issues such as vulnerability, security of data, transborder data flows and many others. The Freedom of the Press Act guarantees citizen's right of access to public information.

In response to union concerns about the effects of the new technology on employment and working conditions, the Joint Regulation Act was passed in 1976. It requires employers to negotiate with labor organizations before introducing major technological changes.

Through a Commission set up in 1977, Sweden also became the first country to study systematically the vulnerability of the computerized society.

In 1978, Sweden embarked on a reinvestigation of its dependance on foreign suppliers for electronic components. Because R and D on microprocessor production requires tremendous investments, the government decided to promote production only as a means of retaining competence with respect to components.

A new parliamentary commission is now investigating the effects of computerization and electronics on the development of industry and commerce. It is also assessing measures to stimulate greater and more effective use of the technology. Projects to use telecommunications technology as a means of stimulating regional development in areas such as health care and distributed education have also been undertaken.

The Ministry of Labor has appointed a commission to analyse the effects of computerization on employment and the working environment. It will consider the extent to which the state should take special measures to facilitate readjustment upon introduction of computers or automation.

The impact of the new technology on cultural policy and the media are also under study. A commission will investigate the roles of teletext, videotex and telefacsimile as well as changes in the press, media concentration, revisions to copyright laws and problems of access occasioned by the new technology.

The work of these commissions is providing a basis for movement in the country toward introduction of a national data policy encompassing all aspects of the information revolution. A top level interministerial committee is drawing up the guidelines for this policy.

In concert with these policy iniatives, Sweden is laying the technological groundwork for introduction of new services. The Swedish Telecommunications Agency is experimenting with videotex and fibre optics. The post office is planning the first stages of electronic mail through the electronic distribution of letters to 10 regional centres. Plans are also being developed to implement on-line funds transfers for retail shopping.

The strategic riddle

This brief review of the response to the information revolution by Canada's major trading partners illuminates the strategic issues faced by industrialized countries. *The larger European countries all seem to agree that government must provide massive support for industry if it is to remain competitive in the face of American and Japanese competition.* The U.S. industry has a large market and sizeable government funding, while Japan has commenced a massive thrust for foreign markets. The main questions which such a strategy must address are:

- Should computer applications be stressed or is support to the computer industry itself also required?
- How should areas of specialization be chosen?
- What tools can be used to strengthen the domestic industry?

In Europe, debate has raged over whether government should support the integrated circuit industry. One school of thought holds that the application of electronic components in processes and products is fundamental. Only such an emphasis will ensure the competitiveness of domestic industry. It follows that the major governmental thrust should be to foster diffusion of the technology, not development of a domestic capability in components. Sweden has taken the view that a strategy based on its capacity to use micro-electronics is more in line with its limited resources than an attempt to develop its own component manufacturing industry. This means that Swedish user industries would have to rely on foreign component development.

France, Britain and Germany have rejected this strategy for a number of reasons. One is the fundamental importance of technological sovereignty. Micro-electronic technology is viewed as such a crucial factor of production that no country can afford to depend on competitors for supply. A second reason derives from the argument that the skills required for successful applications are acquired at the production stage. A third reason is the dangerous possibility that, if a country ignores component manufacturing, domestic application industries will find themselves faced by component development which may not be attuned to their needs.

Agreement that support is necessary still leaves the question of the sectors chosen to receive that support. Most countries do not have the resources for a strategy encompassing all aspects of information technology. Areas of specialization are, therefore, inevitable. In the past, national efforts to develop mainframe computer production have not been universally successful despite massive government support. As J. M. McLean points out, the current French and German integrated circuit programs, despite massive injections of funds, are limited in scope and encourage the design and production of custom circuits for *specialized* applications.[1]

[1] J. M. McLean, *Op. cit.*, p. 32.

Whether such programs will be successful remains to be seen. Japan, which has had a sustained, consistent, massive effort for the last 20 years, has still not succeeded in achieving a dominant position in high technology products. The nationalistic approach adopted by European countries through procurement policies and non-tariff barriers may also result in market fragmentation which would hurt everybody by blocking the economies of scale necessary for international competitiveness.

In reaction to these nationalist policies, *the EEC Commission has recently launched a program intended to help Europe's telematics industry capture a third of the world market by 1990. The EEC plans to standardize components, to remove non-tariff barriers to trade between EEC countries, to provide more money for R and D on computers and chips and to set up an integrated digital telecommunications network throughout the Community.*

A complementary strategy frequently adopted is to acquire the technology from the U.S. This goal has been attained through technology transfer payments, investments in U.S. firms, encouragement of U.S. firms to invest in the home country or joint ventures with U.S. firms.

Many other tools for supporting industry are available. All have been used to some degree by the countries reviewed. They include:

- protection against foreign competition,
- government procurement policy,
- restructuring of industry,
- provision of venture capital,
- funding of R and D,
- use of standards to advance national interests,
- financial and taxation measures to promote development and use of the new technologies,
- government financing of training programs,
- aid in developing export markets, and
- establishment of public research institutes to conduct basic and applied research and transfer new technologies to the private sector.

Most countries recognize that, along with an industrial strategy, a wider approach is necessary to maximize the opportunities and minimize the threats posed by the information revolution. Government and the public must be made aware of the potential impact of the new technologies. In the words of Canada's Clyne Committee, *"Without a much wider appreciation of the fundamental nature of the changes taking place, it is unlikely that effective mechanisms for considering the issues will be developed, let alone the implementation of appropriate solutions."*[2]

[2]*Telecommunications and Canada*, p. 65.

It is also now generally conceded there is a need for a co-ordinated approach focusing not only on the computer industry and developing applications, but also on issues such as diffusion of the technology, training programs for the development of suitably skilled labor, provision of an efficient telecommunications infrastructure, and the social, economic, political and legal implications of the information revolution. Governments are placing a growing emphasis on developing national policies which recognize the interrelationships between these issues and the fundamental nature of the changes now taking place. A 1976 report to the President of the United States stressed the need for a National Information Policy. Since then, the National Telecommunications and Information Administration has been formed to consider policy issues in a co-ordinated manner. In the U.K., France and Sweden, interest and intervention at the highest political level are assuring the gradual achievement of an overall co-ordinated strategy.

These countries have recognized that only through co-ordination can a policy package be designed to maintain national economic strength. For the new world information economy is opening up new and significant areas to competition while intensifying it where it already exists. Our trading partners know that only a co-ordinated policy approach can preserve a viable balance of payments position and protect national sovereignty, society and the individual in the face of the information revolution.

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The Canadian experience

The uses made of computer, communications and microelectronics technologies by individual firms may well be similar in different countries. But the overall national impact of this technology will differ profoundly, depending on each country's particular situation and institutions. The responses by our major trading partners to the challenges of the information revolution are now apparent. How has Canada been faring over recent years in this environment of rapid technological change?

A number of recent studies have extensively discussed Canada's situation in the information revolution. These studies reflect the experts' growing belief that *Canada must exploit the new information technologies if it is to maintain some degree of economic, technological, political and cultural sovereignty in the future.* In February 1979, the Industrial Policies Committee of the Science Council of Canada released one such study, *Forging the Links: A Technology Policy for Canada,* which analysed the current problems of Canadian industries. The report sets out a series of policy objectives to address these problems and foster the development of technological sovereignty in Canada. In the same month, the Consultative Committee on the Implications of Telecommunications for Canadian Sovereignty (the Clyne Committee) published *Telecommunications and Canada,* which makes recommendations on a strategy to safeguard Canada's sovereignty through the effective use of telecommunications. The Institute for Research on Public Policy also published early last year

a paper by J.M. McLean dealing specifically with the impact of micro-electronics technology on the structure of the Canadian economy. *These studies were written from different perspectives and with different objectives, but all reflect the same anxieties about the vulnerability of Canada to the information revolution. All insist again and again on the urgent need to develop an appropriate and co-ordinated policy response to this sweeping challenge.*

The purpose of this chapter is not to provide a comprehensive review of Canada's performance, but to highlight what appear to be some of the most important problems and major policy issues facing Canada today. In performing this task, we shall review our situation with respect to the development and diffusion of information technology, the information infrastructure, new services and the content industries. We shall then look at the policy environment which has prevailed in the area of computer communications over the last few years, concentrating on the public policy responses developed to cope with the emergence of the new technology.

Problematics of an information economy

How successful has Canada been at developing and diffusing information technology throughout the economy? What policies have Canadian governments developed in response to this challenge? The answers to these questions require a treatment of both the production and exploitation of this new technology. Our prime concern is with the latter, but it may be that successful application depends on successful production, as seems to be the case in many other countries. For this reason, we shall briefly review the performance of the electronics manufacturing industry which produces information hardware.

Trends in Canadian use of electronic goods and services can provide a partial measure of the diffusion of information technology in Canada. Over the past decade, the Canadian market for electronics products has grown quite rapidly. Since 1971, the average annual growth rate of the market has been slightly over eight per cent in real terms, which is comparable to the pace observed in most other industrialized countries. The number of installed computers increased from 1,000 to an estimated 37,000 between 1965 and 1979[1], and there has been a gradual dispersion of computing power throughout the country.

More worrying is Canada's performance in the production of research intensive goods, which in many cases embody information technology. It is generally agreed that industrialized countries like Canada will have to rely in the future on advanced technology to maintain their competitive position with newly industrializing countries. These countries, because of their low labor costs, are

[1]See Chapter 3, footnote 1.

rapidly taking over the production of many mature technology goods. *Unfortunately, Canada is not doing as well as many other industrialized nations in the production and sale of technology intensive goods. By 1976, Canada's imports of research intensive manufactures were more than double its exports*[2], *resulting in a $2.6 billion trade deficit in this area.*

Nor has the growth of Canadian electronics production kept up with the market. Production has been growing at only five per cent annually in real terms. Employment in the electronics industry has declined from a high of 84,000 in 1969 to an estimated 60,000 in 1978. The reasons were the modest rise in production and the high growth in labor productivity which took place in this industry.

Over the past 15 years, the production of electronic products has also become much more international in scope. Canadian imports have grown from 36 to 65 per cent of the apparent domestic market between 1965 and 1978. During the same period, exports as a percentage of shipments rose from 20 to 42 per cent. In 1978, imports were valued at more than $3 billion and for the first time exceeded domestic production, which only rose to $2.8 billion. The U.S. played a dominant role in this international trade, supplying 73 per cent of electronics imports into Canada. Japan was next with 14 per cent. On the export side, the American market represented the principal destination for the industry's products, accounting for more than 68 per cent of exports in 1978. The Commonwealth countries (representing 11 per cent of exports) and Western Europe (nine per cent) were a distant second and third.

It is not very easy to interpret such statistics. One may argue that the deterioration in the trade balance reflects the weakness of the industry. One may also view the rapid growth in the domestic market as an important indicator of the growth in electronics applications in Canada, and of technological transfers which benefit Canada. The rising importance of exports in the sales of the Canadian industry is also a healthy sign.

But such interpretations can only be very tentative unless set in the context of a structural analysis of the Canadian economy as it is affected by the information revolution. We do know, for example, that use of the new information technology is important to the Canadian economy because this country is extremely dependent on the world economy. Foreign trade represents about one-third of our GNP. *Our dependence on foreign trade makes us particularly vulnerable to new developments abroad which could affect our competitiveness abroad and the international flow of capital and goods.*

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[2]Ministry of State for Science and Technology. *Canadian Trade in Technology-Intensive Manufactures 1964-1976.*

We know too that there appear to be a number of obstacles to diffusion of the new technology throughout industry in this country. Some of these obstacles arise from features unique to Canada as an industrialized nation. For example, the large size of the country, both in absolute terms and in relation to the Canadian population, has led to the geographical fragmentation of the economy into regional and local markets. The small size of the domestic market also makes it difficult for Canadian firms to exploit fully the benefits arising from economies of scale and specialization. With the formation of trade blocs, such as the EEC, Canada has become one of the few major advanced industrialized countries without free access to a market of 100 million people or more. As a result, with respect to economies of scale and specialization, our industry is at a considerable disadvantage, compared to those of our trading partners. In addition, small firms often lack the expertise or funds to undertake innovative activities.

Canada's reaction to the proximity of the U.S. has also significantly contributed to the current situation. In the past, in order to create employment for Canadians, Canada deliberately imposed high tariffs on certain imports as a means of encouraging U.S. firms to locate branch plants here for the purpose of serving the Canadian market. Especially in the 1930s, such Canadian action was largely defensive, a response to protectionism throughout the world and especially in the United States. But its consequence was a high level of foreign ownership. A particularly important question then, is how the operations of Canadian subsidiaries owned by foreign multinationals have affected the competitiveness of Canadian industries.

Because the foreign parents established many of these branch plants only to serve the Canadian market, the parents do not encourage their subsidiaries to export. Branch plants are also too diversified to benefit from economies of scale and specialization which would allow them to compete successfully in foreign markets. Because subsidiaries often rely on their parent firms for technology and management, they conduct less R and D in Canada than domestic firms. The result is more limited employment opportunities for Canadian scientists, engineers, technicians and technologists. In addition, interest and dividend payments to foreign owners represent an increasingly heavy burden on Canada's balance of payments, as does the importation of inputs from abroad by subsidiaries relying on their parents' suppliers. With respect to diffusion of the new technology, perhaps the most important concern arises from the types of technology transferred from parents to subsidiaries and the conditions governing use of this technology.

Canada has benefited too from the presence of foreign subsidiaries. Branch plants, for example, create employment opportunities by hiring Canadians. The relationship between parent and subsidiary constitutes a direct means of transferring new

technology to firms located in Canada[3]. It also stimulates economic growth by increasing the level of capital formation in Canada beyond what would have occurred without this capital inflow. A recent empirical study suggests that foreign direct investment may have spillover efficiency benefits for Canadian-owned firms in the same industry. Such investment may foster the adoption of new technology by domestically controlled firms in two ways: by increasing the level of human capital in domestically controlled firms through labor migration and by promoting efficiency through an intensification of competition.[4] Finally, although many branch plants only serve the Canadian market as pointed out above, this is not always the case. Some branch plants receive world mandates on some product lines from their parent companies and have been extremely successful in foreign markets. Plainly, *it is oversimplified, unfair and dangerous to blame all our problems on branch plants.*

Canada needs technology transfers in the rapidly evolving field of information technology in order to maintain its competitiveness, and here branch plants have played and can play an important role. But there are many means of acquiring foreign technology other than direct foreign investment. Joint ventures and licensing arrangements, for example, might be more beneficial to Canada. One might also question whether the widespread presence of subsidiaries of multinational firms will offer a net benefit or cost to Canada as the new technologies allow further opportunities for centralized management and control.

Another factor contributing to Canadian weakness in exploiting information technology has been our lack of effective training programs. Canada is not yet able to provide its labor force with the training and skill-upgrading necessary to meet the changing requirements of industry. Industry in Canada has traditionally relied on immigration to fill its skilled labor requirements, in contrast to Europe where apprenticeship programs are an important mechanism.

Canadian financial institutions have a reputation for ultra-conservatism and many observers believe they have hindered innovation through their reluctance to assume the risk of providing venture capital to innovative firms.

The low level of R and D in Canada, in comparison to that in other industrialized nations, has been another source of worry. *R and D and innovation have been the driving forces behind the information revolution and are perceived as an important*

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[3]O.H. Ganley in *The Role of Communications and Information Resources in Canada* estimates the invisible inflow of U.S. technology into Canada in 1976 at between $600 million and $700 million.

[4]S. Globerman, "Foreign Direct Investment and 'Spillover' Efficiency Benefits in Canadian Manufacturing Industries".

prerequisite for future success. Gross expenditures on research and development (GERD) in Canada average less than one per cent of GDP compared to more than two per cent in our major trading partners. Within GERD, the business sector in most industrialized countries is the source of 40 to 50 per cent of R and D funds and performs 50 to 65 per cent of all R and D. In contrast, business in Canada provides only about one third of R and D expenditures and performs only about 40 per cent of R and D. Thus, Canadian R and D is low overall compared to that of other industrialized countries and seems to be unbalanced, with a significant deficiency in the proportion of R and D paid for and performed by the industrial sector.

An important connection may exist between the low level of R and D in industry and the high level of foreign ownership in Canadian industry. According to one observer, "With one minor exception, (these) data show that even in the most research intensive industries, the R and D expenditures of Canadian-controlled firms are higher relative to sales than their foreign-controlled counterparts."[5]

The Federal Ministry of State for Science and Technology (MOSST) has estimated that the inclusion of flows of invisible R and D—that is, the part of R and D imported from parent companies to Canadian subsidiaries for which no identifiable payment is made—raises Canada's GERD as a percentage of GDP to 1.37 per cent[6]. Though still lower than France, Germany, Japan or the U.S., this figure compares favorably with Australia and the Scandinavian countries. It is possible to cancel the effect of Canada's relatively smaller industrial sector by comparing internationally the R and D resources of the business sector as a proportion of the sector's own GDP, with invisible R and D included for Canada. When this step is taken, the analysis reveals that industrial R and D as a percentage of industrial GDP in Canada is exceeded only by the U.K. and the U.S.[7] The MOSST author concludes that Canada, considering its access to foreign technology, does not lag greatly behind other industrialized countries of similar size with respect to R and D. This argument, however, as the author points out, ignores the hidden costs of invisible R and D. It leaves Canada open to foreign decision-making. It limits employment opportunities for scientists and engineers. It often does not result in an exportable product.

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[5]H.P. Bones, "Are Foreign Subsidiaries More Innovative?" p. 16.

[6]Ministry of State for Science and Technology, *Importation of Invisible Research and Development 1974-1976*, July 1978, p. 6. Invisible R and D is measured by estimating the entire R and D base made available to companies by foreign parents and deducting the visible payments. The model assumes that the level of R and D needed to support the subsidiary's sales is proportional to the R and D needed to support the parent's sales.

[7]These results are biased upward for Canada because invisible R and D has only been included for Canada.

Governments and universities are other important potential sources of technology transfer for Canadian industry. In the past, however, many government and university researchers did not accord a high priority to supporting industry. In addition, the great distances in Canada made personal contacts among different institutions difficult.

A number of mechanisms have now been set up to improve Canadian industry's ability to exploit information technology. The Department of Industry, Trade and Commerce has attempted to foster innovation and raise productivity through its Enterprise Development Program, its Program to Enhance Productivity and its Program for the Advancement of Industrial Technology. But these programs were not aimed specifically at information technology.

The federal government, recognizing the need to support the development and diffusion of information technology in particular, announced some special measures shortly before the 1979 election. These included a $115 million product development fund and a $50 million support program for the electronics industry. These amounts, however, are small compared to the resources allocated for this purpose by our major trading partners.

The money for assisting the electronics industry will be used in two ways. One is for expansion of the Enterprise Development Program in order to help electronics firms carry out large-scale projects that will increase production and R and D. These funds will also encourage increased use and production of integrated circuits in Canada through education programs and promote use of micro-electronics in products. Funds for research and incentives for the design and production of custom integrated circuits will also be made available.

The National Research Council (NRC) has encouraged use of computers in Canadian universities through early support for the acquisition of computing facilities. NRC also provides research grants for computer science, information science and operations research and has established a data bank of scientific and technical information accessible through libraries. The Council aids Canadian industry through its Industrial Research Assistance Program, which shares costs with industry for selected research projects. NRC's Program of Industry/Laboratory Projects also serves this purpose by promoting more rapid transfer to industry of the results of research in the Council's laboratories.

Some attempts have also been made in the last few years to create awareness of the benefits of the new technology. The CAD/CAM Technology Advancement Council, for example, was recently set up to disseminate information about computer-aided design and computer-aided manufacturing.

Some experts believe the information revolution may improve Canada's industrial situation. They claim the new technology may reduce considerably the importance of economies of scale and specialization in production and enable firms with relatively short

production runs to become competitive with firms having longer production runs. But, as already seen, many obstacles exist to diffusion of the technology. Lack of awareness, lack of venture capital, the role of branch plants—to mention only a few factors—may prevent Canadian industry from taking advantage of the new technology. Our efforts to overcome these obstacles will require a more coherent and co-ordinated effort than has been evident in the past.

Canada will also have to devote more attention to the broader implications of the changes precipitated by the information revolution. To date, little hard research has taken place on the impact of these developments on productivity, competitiveness, working conditions, industry structure or society as a whole.

The dilemma of a strong information infrastructure

Canada's ability to adopt successfully the new information technology will depend on the strength of our information infrastructure. This infrastructure is comprised of our telecommunications networks, our communications satellites, our computer services industry and our manufacturers of telecommunications and space equipment. Canada continues to be a pioneer in communications development. It was the first country in the world to establish a domestic geostationary communications satellite system. We have two operational national packet switching networks, in contrast to the U.S. which does not yet have one coast-to-coast network. Telidon, a second-generation videotex system developed by the Department of Communications, possesses features that are a marked improvement on any similar system. We are at the forefront of change in electronic switching and fibre optics.

The Canadian telecommunications carrier system is extremely efficient. It is also almost entirely Canadian-owned and Canadian-controlled through the regulatory system. *Canada leads the world in the total capacity of telecommunications facilities of almost all kinds on a per capita basis.* Telephone and television penetration are close to 100 per cent. Cable TV penetration is higher in Canada than in any other industrialized country.

This sophisticated and extensive system is available to serve our cultural and social goals. It also constitutes a vital infrastructure for Canadian industry. Equally important, it represents a tool for use in the development of further electronics-based manufacturing and service industries.

Our telecommunications manufacturing sector, dominated by Northern Telecom, is highly competitive on international markets. Bell-Northern Research has the largest industrial research establishment in Canada.

In the space manufacturing sector, Spar Aerospace, a public company 97 per cent Canadian-owned, has emerged through a "chosen instrument" approach as a manufacturer of international stature for earth stations, transmission equipment and subsystems

for communication satellites. Spar will be the prime contractor for the Anik D series of satellites which Telesat Canada, our satellite carrier company, is acquiring.

The computer service industry represents another area of growing strength. As recently as 1975, one knowledgeable observer characterized the service bureau portion of the industry as "a few moderately large but entrepreneurially owned and managed service bureaus plus a large number of very small service bureaus, all of which are usually hovering on the brink of both enormous success or financial disaster."[8] Since then, the profitability of the industry has increased overall. A study under the Department of Industry, Trade and Commerce's interfirm comparison program revealed that, for a small sample of firms, the median level of operating profits (less interest expense and as a proportion of total operating assets) rose from 0.6 to 5.6 per cent between 1974 and 1977. During the same period, the percentage of firms experiencing losses declined from 44 to 16 per cent. Mergers and acquisitions have been a continuing trend in the industry since its earliest days. Canadian-owned firms hold a position of striking dominance in both the software and systems sectors of the computer services industry. Indeed, they accounted for about 78 per cent of the industry's total revenues in 1978.[9]

Service bureaus, however, serve only a small part of Canadian industry's EDP needs. Purchased computing services account for an estimated 15 per cent of the total costs to users of electronic data processing in Canada; the remaining 85 per cent represents in-house costs and data transmission. This situation is probably comparable with that in the United States.

Recently, signs of increasing strength in some of Canada's data processing, software and carrier operations have become apparent. Some individual enterprises have taken steps to develop their capacity for providing service through the formation of close operational or corporate links. In this way, they have acquired the capacity to provide integrated services based on the use of both computers and telecommunications. *Some Canadian computer service bureaus are competing successfully in international markets and most are fully competitive in the domestic market. These pioneering efforts are an important example of what Canadian industry is, in fact, capable of doing.*

One reason for the relative strength of Canada's information infrastructure has been sustained action by Canadian governments. The federal government has long recognized the importance of communications in unifying the country and has therefore put a high

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[8]J. Scrimgeour, *On an Industrial Strategy for the Canadian Computer Industry*.

[9]B. Johnstone, "Services and Viewdata: Canada's New Strengths", p. 18.

priority on maintaining a healthy Canadian-owned industry in this area. Even in the 19th century, Canada was one of the first countries to apply telegraph and telephone communications technology.

The Department of Communications (DOC), since its creation in 1969, has pursued through research and policy its objective of promoting the development and efficiency of telecommunications in Canada. The main thrust of its research program has been to develop new technologies such as satellite communications systems, fibre optics, videotex and mobile communications. All of these will play a key role in the information infrastructure in the coming years.

Canadian research into, and development of, optical fibres commenced in 1972. Now there are three large fibre optics research centres and three important manufacturers of fibre optics equipment. Experimental and operational systems using optical fibres now exist in British Columbia, Alberta, Manitoba and Ontario. The first multimedia test of fibre optics in a rural environment is taking place in Elie, Manitoba, under the sponsorship of the Department of Communications and the Canadian Telecommunications Carriers Association. Saskatchewan Telecommunications has just announced a $56 million project to build the world's longest commercial fibre optic network connecting major communities in the province.

Telidon, the second generation videotex system developed by the Department of Communications, moved from the laboratory to the field in 1980. The federal government has put up $9 million for its further development. In a growing number of trials, the system's technical capabilities, its interface with a variety of new and existing telecommunications technologies, and its relevance to a variety of possible industrial and institutional users are being tested.

Cumulative Canadian investments in space communications are now in the order of $500 million. In April 1979, the federal government made available $20 million to help Spar tool up to meet Telesat's requirements for two Anik D satellites. A $20 million program to expand and upgrade DOC's space research centre is also underway.

In mobile communications, the department has been fostering the development of mobile radio data systems built by Canadian suppliers to meet Canadian needs. A pilot system has been made available to the Vancouver City Police. DOC is also taking part in a mobile radio system project with Alberta Government Telephones. These activities have helped to make Canada a world leader in communications technology.

On the policy side, the government has been developing an environment which would optimize the communications services available to Canadians and strengthen domestic communications industries. In recent years, the department has been working towards reform of existing legislation governing telecommunications, cable television and broadcasting. The first phase of the

legislation came into effect in April 1976 and established the Canadian Radio-television and Telecommunications Commission (CRTC) as the sole regulator of all broadcasting undertakings and telecommunications carriers subject to federal jurisdiction. The government has introduced Phase two of the legislation in Parliament three times since 1977, but it has not yet been passed. This legislation presents a coherent unified consolidation of federal communications legislation. It contains a statement of national communications policy and establishes the structure and guiding principles for regulation to meet the policy objectives. It also provides for the negotiation of federal-provincial agreements on the assignment of regulatory responsibilities. The government had planned to introduce a new version of the bill during the 1979-80 session of Parliament. This would probably have contained a number of amendments, some of which were submitted for discussion to the provinces at the October 1979 federal-provincial conference of Ministers responsible for communications.

Delay in passing the Phase two legislation has impeded formulation of a coherent framework for communications policy. This is vital to effective development of policies, to provision of appropriate guidance to the regulatory process and to a favorable environment for innovation and entrepreneurial activity. The passage of this legislation is especially important for the development and implementation of policies taking into consideration factors other than those of direct concern to the regulatory body. These include, for example, the impact of communications policies and regulations on industrial development—a fundamental issue to the telecommunications manufacturing industry in this country.

The appropriate level of competition in providing various services has been a subject of continuing discussion in recent years. The questions of monopoly, competition, technical change and regulation are central to the telecommunications industry. Developments in information technology, worry about the burden of regulation and the U.S. trend toward deregulation have all raised serious issues. These have caused telecommunications policy makers and regulators to consider whether the public interest is best served by maintaining the present industry structure characterized by the far-reaching monopoly of the telephone companies. In the past, a central rationale for regulation of the telecommunications industry has been the presumption that it is characterized by large economies of scale and is therefore a natural monopoly. But *rapid technical change is eroding the boundaries of the traditional monopoly held by the telephone companies. This change has created strong pressure for both systems interconnection and terminal attachment to the public switched telephone network.* A growing concern is that regulation may have impeded innovation and adoption of new technology by regulated carriers, thereby stifling the diffusion of new services.

In a recent landmark decision, the CRTC allowed Canadian National/Canadian Pacific Telecommunications (CNCP) to interconnect its facilities with the local telephone network of Bell Canada—this country's largest carrier—in order to provide certain categories of competitive services. This decision has important consequences for the future development of computer communications. The CRTC hopes that, by encouraging competition between CNCP and the TransCanada Telephone System (TCTS)—a consortium of Canada's major telephone companies—in certain services, it can contribute to better service and lower prices, thereby creating a more favorable environment for users of the new information technologies. Although telephone carriers' first reaction in Canada and the U.S. was to oppose interconnection, they are becoming more willing now to accept competition. They are also taking a more aggressive approach to the provision of innovative services. Interconnection could therefore stimulate the diffusion of computer communications.

Though this decision improved CNCP's competitive position in the duopoly, it does not necessarily confer similar rights on other potential competitors. In the near future, the prevailing situation will likely be characterized by regulated monopoly for basic services and regulated competition for other network services. But *the CNCP decision may create a precedent for further provision of competitive services, for example, by cable firms. This potential threat of further competition is likely to encourage further innovation by both TCTS and CNCP to maintain their market shares.*

A number of difficult economic problems go hand in hand with regulated competition, especially when it co-exists with a monopoly. One difficulty already mentioned is the drawing of an appropriate and enforceable boundary between monopolistic and competitive services in the face of technological changes which tend to erode such boundaries. A second problem is the determination of pricing policies for monopolistic and competitive services, which, of course, touches on the perennial problems of cross-subsidization and predatory pricing. Indeed, a viable solution to the cost separation problem lies at the heart of all pricing strategies. It will also be necessary to decide upon the conditions under which new entry into the area of competitive services is to be permitted. Value-added carriers have been suggested as a means of fostering competition in the provision of network services—especially new services—while maintaining Canadian control of the physical network.

Another important issue has recently emerged: the appropriate role for satellites in transmission. Canada's domestic satellite system, considered among the best in the world, was established to satisfy political commitments to equalize access to communications services by all citizens. But since the first satellite was launched in 1973, underutilization has been a problem. Telesat applied to join the TransCanada Telephone System in 1976. The CRTC rejected this request, but was overruled by the federal cabinet. Cabinet argued

that membership of Telesat in TCTS constituted an institutional arrangement more favorable to progressive integration of the terrestrial and satellite networks. The government also stated that the new arrangement would reduce involvement by the public sector in financing future satellites. Restrictions on ownership of earth stations, as well as the necessity of leasing only whole channels at a cost of $2 million a year, were serious obstacles for users other than carriers and the CBC to use satellites for commercial services. A decision in early 1979 improved access to Telesat facilities by permitting users to own receive-only earth stations. Ownership of transmitting stations, however, still remains in the hands of Telesat and TCTS. Critics of the government's decision complain that Telesat services are overpriced and TCTS members receive preferential treatment. Clearly, *Canada still has a number of problems to overcome if it is to reap the benefits of its pioneering technical achievements and make effective use of satellites.*

Cable is another important element of Canada's information infrastructure. In the early 1950s, cable television was introduced into Canadian cities to provide better access to and reception of television signals. Steady technical progress has improved the signal quality and capacity of cable networks. They now can transmit up to the equivalent of 35 one-way television channels and at least three two-way channels. *Recent technological breakthroughs such as fibre optics and short-haul microwave will continue to expand the capacity and reach of cable networks in the coming years. These developments will make it possible for cable companies to offer a whole range of new services to users, perhaps in competition with the telephone companies.* The provision of non-broadcast services by broadcasting receiving undertakings raises serious jurisdictional and policy questions.

The jurisdictional issue is particularly pressing in those provinces where the dominant carrier is provincially regulated. Situations may arise where federally regulated cable television undertakings could compete with provincially regulated common carriers in the provision of certain new services.

The provision of non-broadcasting services by cable companies also raises several policy and regulatory questions. First, cable TV undertakings may distribute local non-broadcast services in competition with services available—or potentially available—from telephone companies. Such a development raises the issue of competing local services and the extent to which distinct local distribution systems should provide competitive rather than complementary services. Second, how can we best ensure that provision of these new services does not diminish the ability of carriers and cable companies to meet their primary obligations? How too can we make sure that regulatory agencies possess the ability to enforce these obligations? Finally, there is the question of access. To what degree and under what conditions should a local distribution

system (cable or telephone company) permit access to its facilities by another party who wishes to provide local non-broadcast services?[10]

The principle of equitable access, achieved by separating carriage from content, governs the operations of federally regulated telecommunications carriers. They must carry the message of any potential customer without undue discrimination at fair and equitable rates and without interfering with the content of messages carried. By excluding content from the scope of regulation, it is possible to minimize any potential interference by regulators with the right to freedom of expression. In addition, because a natural monopoly is less likely in the provision of content than carriage services, competition may lead to economic benefits.

On the other hand, cable companies are capable of performing both carriage and content activities and currently do so to a limited extent with programming services. If demonstrated economics of scope exist between certain types of carriage and content activities, then enforcement of carriage/content separation could potentially be costly. This issue has already been raised in Canada, primarily over the provision of new services by cable TV companies. It could also arise over the provision of Telidon services and the role of intelligent carrier networks in electronic mail and electronic funds transfer systems.

The Federal-Provincial Working Group on Competition/Industry Structure has recommended that additional work should be carried out to analyse these policy issues and develop options on the respective roles of carriers and cable companies.

The interaction between the markets for terminal equipment and telecommunications services has also been a subject of lively concern. In the telecommunications manufacturing sector, two factors have greatly contributed to the success of Northern Telecom, the largest Canadian manufacturer. Western Electric provided extensive technical support until the late 1950s. When this support began to dry up by the mid 1960s, Northern established its own R and D facilities and began to develop its own designs. The company has also enjoyed a protected market over the years in the territory controlled by its parent, Bell Canada. Pressures for more liberalized terminal attachment policies and an inquiry into vertical integration between Bell and Northern now threaten this privileged position.

At the heart of the terminal attachment issue is the question whether the telephone carriers' monopoly on attaching network-addressing terminals to their networks is justifiable from a technical, economic and social viewpoint. Historically, the attachment of

[10]This description of the problems associated with the provision of non-broadcast services by cable companies is taken from the Report of the Federal-Provincial Working Grop on *Competition/Industry Structure in the Telecommunications Industry*, p. 18.

computer terminals obtained from non-carriers has accustomed customers to the idea of securing equipment from different sources. Such an approach has also provided a base from which to challenge other aspects of the carriers' monopoly over terminal equipment. But, until 1977, the telephone company's monopoly over the provision of network-addressing devices appeared unquestionable to regulators and the judiciary. Then came the Challenge Communications and Harding cases. Challenge obtained from the CRTC right of access to the Bell network in order to provide an automatic mobile telephone service competing with Bell's own service. In the Harding case, the Supreme Court of Canada ruled that Bell could not prevent Harding from installing for the Bank of Montreal a call-distributor attached to Bell lines.

These court decisions are establishing the right of users to attach their own terminals. In November 1979, Bell asked the CRTC to determine whether customers' equipment should be allowed interconnection with the Bell network. This decision may have important implications for Bell's pricing policies. At present, the price of local telephone service is based on a bundled charge, which includes the cost of terminal equipment, the cost of access to the network and the actual cost of local calls. Competition in the terminal market may require major changes in the pricing structure for local services. In response to Bell's application, in August 1980 the CRTC set out new interim requirements in this area. These requirements are considered to represent a considerable liberalization of the existing rules. Bell has petitioned the Governor-in-Council regarding the decision.

The corporate link between telecommunications manufacturers and carriers has also been scrutinized closely in recent years. The Restrictive Trade Practices Commission is currently inquiring into the effects of Bell Canada's vertical integration with its manufacturing subsidiary, Northern Telecom. Proponents of vertical integration claim that such a structure gives Northern Telecom guaranteed access to a large domestic market. According to its supporters, such access is vital to financing the vast R and D expenditures necessary to maintain leadership and international competitiveness in telecommunications equipment manufacturing. Opponents call for open, competitive procurement policies and even divestiture of the manufacturing subsidiary. They claim vertical integration has hindered or slowed down innovation in the telecommunications equipment market and prevented the emergence of small independent suppliers by foreclosing a major share of the market. Bell Canada has recently adopted a more open procurement policy, designed to favor small Canadian suppliers of telecommunication equipment. But it is too early to judge the effects of this change.

The computer services industry's main aims in recent years have been to remove impediments to development and to create a better business climate in Canada. Import tariffs and the 12 per cent

federal sales tax make computing equipment 20 to 25 per cent more expensive than in the U.S. The capital cost allowance relating to computing machinery has been another source of worry. Although the 1976 budget contained provisions recognizing the rate at which equipment becomes obsolete, the private sector is still concerned about the taxation treatment of software. The industry has also been critical of the lack of government support for software development. Several software firms believe that, because exports are a necessary factor in achieving cost effectiveness, government should do more to support development of software products for sale abroad.

New services — old questions

Perhaps one of the most exciting manifestations of the information revolution is the development of myriads of new information services. These are growing ever more feasible because of the technological advances in micro-electronics, digital communications and computer software. *These new services have the potential to increase productivity, provide new employment opportunities and generate wealth in their own right. But progress in implementing these services has not been as rapid as many predicted 10 years ago. Nor has it always been in the direction envisaged.* Many now realize that barriers must be overcome if the full potential of these new services is to be achieved for the benefit of Canadians. Consumer acceptance and economic viability are the key factors retarding implementation of new services. But institutional barriers and legislative and regulatory uncertainties may have also contributed to the slow development of certain new services.

a) *Who'll run the telebank? And how?*

On a per capita basis, Canadians use more cheques than any other nation: 2 billion in 1976 and an estimated 4 billion in 1980. Each cheque is handled on average some 14 times and banks are required by law to retain some cheques for 15 years. The cost of the present system is growing rapidly, and financial institutions are trying to minimize their administrative overhead by increasing use of computer applications. Canada's major banks now have at least three-quarters of their domestic branches on-line.

In this field, the government has formulated general goals. In the 1975 document, *Towards an Electronic Payments System*, the government said it would take the lead to ensure the orderly development of the payments system in Canada. According to the document, the system should be based on a common user communications network and on development of suitable standards to permit co-ordination between deposit-taking institutions, common carriers and computer manufacturers. The Canadian Payments System Standards Group, a committee representing the private sector, was subsequently established to make recommendations on standards requirements. Its final report contained no proposals for formal standards, but underscored the need for cohesive policy development and addressed some of the social issues.

In Canada, an electronic funds transfer system (EFTS) is in the early stage of implementation. As J. W. Lambie, an expert in the Department of Consumer and Corporate Affairs, states, "Early visions of electronic terminals in every store, restaurant and place of business have faded as the problems created by implementing an EFTS have been recognized."[11] *A variety of important issues have not been settled. Who should own EFTS systems? Who should have access to them? Who should regulate them and how? What effect will they have on the competitive balance among firms?* Ownership policies can affect the development of electronic payment systems and denial of access could place some firms at a competitive disadvantage. Another key question relates to public acceptance of terminals located in retail stores that would allow the store to debit customers' accounts directly. There is also the matter of setting standards for such terminals, so that they could be linked to more than one financial institution.

b) *Electronic mail and the Post Office*

The traditional services provided by the Post Office are also already beginning to encounter competition because of the new information technology. Several types of electronic mail services are available today in Canada. They include message record services such as Telex and TWX, computer communications based systems such as I.P. Sharp's electronic mailbox, and facsimile services such as Facscan offered by Ivor Kaye. CNCP has recently announced a service called Infotex, which the carrier hopes to introduce later this year (1980). This service, based upon a network of communicating word processors, will use CNCP's coast-to-coast digital switched network and will enable the electronic transmission of letters and documents.

An important uncertainty regarding electronic mail in Canada relates to the role of the Post Office vis-à-vis the telecommunications carriers. Legislation designed to establish a Post Office corporation was introduced, though not passed, in 1978 and covered electronic and optical means of transmitting mail. The bill, if re-introduced in the House of Commons, would grant the corporation the sole and exclusive right to collect, transmit and deliver letters in Canada and would empower it to define what is meant by a "letter".

c) *Videotex*

Computer-based information retrieval services for the general public represent one area where the federal government has an opportunity to stimulate the private sector through technological transfer. The Telidon system, developed by the Department of Communications, is being made available to the private sector for

[11] J. W. Lambie, *Electronic Funds Transfer Systems in Canada: Emerging Issues and Recommendtions.*

commercialization in Canada and abroad. Cable operators, telephone companies and other organizations are participating in field trials of the technology.

The Telidon system may have a significant impact on the Canadian computer communications industry. The beneficiaries include equipment manufacturers, a range of potential information providers and such information distributors as telephone companies, cable companies and broadcasters.

A great many obstacles confront further development and implementation of videotex services (the generic name for Telidon-like services). For example, no one yet knows for sure whether an adequate market for the system exists, and for this reason, many companies are reluctant to get involved. Meanwhile, foreign competitors—largely government-owned or sponsored—are plunging ahead with their own systems and terminals. Beyond this, the question of international standards remains largely unresolved. The establishment of such standards is crucial to assuring compatibility of different videotex systems and for opening export markets—especially the U.S. market—to Canadian manufacturers.

Another source of uncertainty in Canada is the institutional arrangements for provision of such services. In general, the problem of participation by various carriers in videotex services is part of the more general problem of rules governing participation in competitive areas by companies also offering regulated monopoly services. If these complications are satisfactorily untangled and a large market for the services develops, the next important step will be to tackle the problems arising from the socio-economic impact of such services. These include problems of access and the potential effect of these services on employment.

In order to address some of these issues, the Department of Communications has recently established the Canadian Videotex Consultative Committee (CVCC) under the chairmanship of the assistant deputy minister (research). The CVCC's objective is to provide advice to the deputy minister of communications on all aspects of videotex development in Canada and especially the federal government's Telidon program. The CVCC will also assist the Department of Communications in disseminating information to appropriate public and private organizations on the objectives and status of the Telidon program.

The Committee has up to 25 members and contains delegates from the broadcasting, cable television and telecommunication industries, as well as representation from information providers, labor, consumer associations and government. It will act as a focal point for videotex activities in Canada and it intends to consider a broad range of issues. These include policies for videotex standards, marketing and industrial strategy, and the social problems raised by the new technology.

d) *Pay TV*

Pay TV is another important application of the new information technology which may have major implications for the broadcasting industry, the cable industry and hardware supliers. It may also dramatically affect the Canadian content industry and the advertising industry.

Since 1970, the CRTC has been receiving proposals from groups and industries wishing to offer pay television services. After holding public hearings and listening to various proposals, the Commission concluded in March 1978 that it would be "premature to introduce a national pay television service at this time." The CRTC also recommended the development of a national policy on pay TV prior to its introduction.

At present, a number of factors favor the speedy introduction of pay television in Canada. The development of Canadian systems in a piecemeal fashion (e.g. Teletheatre in Saskatchewan) may prevent a national policy from being implemented. Communities in the North are acquiring equipment for illegal reception of U.S. pay TV signals distributed by satellite. Surveys indicate that effective demand by consumers for pay TV is growing in Canada. The cable industry has been exerting pressure for the introduction of pay TV. Clearly, action on pay TV has acquired a new urgency in order to ensure that developments do not erode the opportunity to develop a Canadian pay TV system which will meet national goals.

Much of the opposition to pay TV arises from fear that it will further fragment television audiences and multiply the volume of foreign programs made available to Canadian viewers. In this view, introduction of pay TV could undermine the economic viability of broadcasting and intensify our problems of cultural identity. In response to these concerns, the federal government has proposed a number of objectives and guidelines for a national pay TV system. These are intended to ensure that the system benefits Canadian program production and distribution.

Uncertainties also abound on such crucial matters as institutional arrangements, Canadian content regulations and the types of service (per program or per channel) to be allowed. Cable operators favor a pay-per-channel system consistent with their delivery technology. Broadcasters, program producers and the Clyne Committee generally prefer a pay-per-program service which is more costly and complicated to implement. A former Minister of Communications proposed to his provincial counterparts a process of public consultation to resolve the issue of pay TV in Canada. In November 1979, the Minister and the CRTC announced the Commission's intention to hold a two-phased public hearing. The first phase of which would be conducted by a committee to be appointed by the CRTC. The committee's public report was released in July 1980. The second phase of the process will occur when the CRTC calls for specific licence applications for the implementation of services and schedules one or more public hearings to consider them.

Content: a foreign word

The content industries range from operators of data banks to television program producers. They constitute another major element of the information sector in the Canadian economy and have a crucial role to play in protecting Canada's sovereignty and contributing to employment and economic growth. Canada has sophisticated distribution networks, but many observers fear that the content accessed through these networks will be mainly foreign.

This situation already exists in television which, perhaps more than any other industry in recent years, has profoundly influenced the social and cultural life of Canadians. An estimated 95 per cent or more of all households in Canada own a TV set and the average Canadian spends more than 20 hours a week watching television. *But foreign—particularly American—programming dominates TV viewing in Canada more than in any other country in the world.* It is estimated that more than 70 per cent of English-speaking viewers watch American programs in prime time viewing hours. Historical, geographical and cultural factors have, of course, played a major role in creating the current situation. But technical progress in telecommunications and cable television has also contributed greatly to this cultural invasion. More important, the situation may intensify with the emergence of new, more powerful distribution technologies such as satellites and fibre optics, each of which are capable of bringing in even more foreign channels.

In an attempt to maintain the viewing share of Canadian programs, the CRTC has imposed Canadian content quotas on private broadcasters. These quotas require that 60 per cent of a licensee's schedule from 6 a.m. to midnight, averaged annually, be Canadian. The CBC's requirements are considerably more stringent. These regulations, which are only quantitative, have been criticized as ineffective. They have also been attacked for providing no incentive to produce Canadian programming with an audience appeal matching American programs.

Essentially, the problem boils down to economics. Private television stations are in the business of producing audiences for advertisers. These stations can buy a U.S. program, costing $500,000 to make, for less than it costs to produce a Canadian show. And the U.S. program, with its lavish production and well-known stars, will receive a larger audience. Morever, broadcasters tend to obtain Canadian-produced programs from vertically integrated production houses, rather than independent producers. This discourages the growth of an independent domestic program production industry.

The development of information retrieval systems has also given rise to worry about whether Canadian information will have an adequate place in data banks accessible in Canada. A number of commercial on-line data base distributors now operate in Canada. They provide a wide range of data bases dealing with everything from business and management concerns to pollution, energy, agriculture, engineering, education and many more. Subscribers in

Canada are using these services at a rate of about 20,000 connect hours a year.[12] Every year for the past three, the number has doubled. The consumer market, however, has barely been penetrated.

The Canadian government has developed some of these data bases. CANSIM, Statistics Canada's socio-economic data base, is widely used by government, industry and universities. The National Research Council has also developed an automated bibliographic service, CISTI, which local computer terminals across the country can access. This service also has an on-line information search capability.

If services to the home, such as videotex, receive consumer acceptance, the cultural implications of computing applications may become more obvious. As with broadcasting, it may be desirable to require computerized information services to be Canadian-owned and to have certain Canadian content requirements. On the other hand, content restrictions could easily become regarded as a form of censorship and cease to be acceptable to most Canadians.

The uneven record

The impact of the new technology on all segments of Canadian society was highlighted very early in Canada. *Instant World*, published in 1971 as a result of the Telecommission studies undertaken for the new Department of Communications, emphasized computer communications as a key area requiring particular government attention. This conclusion impelled cabinet to establish the Canadian Computer Communications Task Force "to speedily develop and recommend specific policies...". Its final report, *Branching Out*, was published in 1972 and contained 39 recommendations developed by some 25 experts participating in the Task Force's work.

After stressing the importance of computer communications to Canada's economic and social well-being, the Task Force recommended:

Rec. 1 Computer communications (i.e., computer services by remote-access through communications facilities) should be recognized by governments as a key area of industrial and social activity, and steps should be taken towards strengthening of the Canadian industry in this field, and co-ordination of its development to the benefit of Canadian society.

Rec. 2 The federal government should take specific measures, as outlined throughout this report, to promote a high degree of co-operation between public and private sectors in the development and execution of policies for computer communications in Canada.

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[12]P. Robinson and C. Gotlieb, p. 24.

Rec. 3 In the formulation of national computer communications policy a unified approach throughout Canada should be stressed as a key factor requiring close co-ordination between federal and provincial actions.

Rec. 4 In the area of federal responsibilities a Focal Point should be established within the government for co-ordination in the development, formulation and continuing evaluation of national policy in all matters pertaining to the field of computer communications.

This last recommendation was regarded as particularly important. The solutions to the complex and important problems posed by computer communications cut across the jurisdictional boundaries of many government departments and agencies. The Task Force suggested the Department of Communications as the logical focal point.

After a review of the recommendations, the Canadian government published its *Green Paper* on computer communications policy in April 1973. It was presented "not as a firm statement of settled government policy" but to "provide a positive basis for discussion...".

In the *Green Paper*, the federal government set out the goals for a computer communications policy. In essence, it endorsed the recommendations of *Branching Out* by emphasizing the key importance of computer communications in industrial and social activity and by stressing the need for federal-provincial co-operation to stimulate development of the computer communications industry. Within this framework, the government laid particular importance on creation of a Canadian-controlled data transmission network to permit universal access to data processing services. The government also stated its intention to encourage expansion of a computer services and software industry based on free competition. It also emphasized the desirability of Canadian ownership and control in this sector. In addition, the government proposed to encourage development of systems and applications with broad social benefits, especially in education.

Unfortunately, political and institutional arrangements in Canada have, to date, constituted a barrier to developing a concerted, comprehensive approach to the information revolution. Linkages between government and industry are weak, compared to those in countries such as Japan or West Germany. One reason is the highly fragmented nature of the Canadian economy. Subsidiaries of foreign companies also often have different interests than domestically controlled firms. Indeed, *the high proportion of foreign ownership makes Canada particularly vulnerable to conflicting interest.*

In addition, under Canada's federal system of government, federal and provincial jurisdictions are unclear, divided and—as in

the information area—bewilderingly mixed. Obviously, strong co-operation between federal and provincial governments is a vital prerequisite for the success of any policy. But this is not easy to achieve. Jurisdictional disputes between the two levels of government and disagreements among the provinces on key issues have delayed policy development on many questions crucial to the future of this country. Communications is one area affected by such disputes. Interconnection issues and the regulation of cable television systems constitute two excellent examples of how jurisdictional issues can hamper the development of policy. Jurisdictional problems may also have contributed to the limited effectiveness of the education system in providing the Canadian labor force with the training and skill upgrading necessary to meet the changing requirements of industry.

The very diffuse nature of the issues has also meant that they cut across the lines of responsibility of many federal departments. For example, stimulation of the development of new applications of information technologies could involve the Department of Finance with respect to taxation; Communications in the area of communications infrastructure; Industry, Trade and Commerce for support programs; Consumer and Corporate Affairs with respect to competition policy or the legal protection of software; and perhaps others such as the Post Office, depending on the types of service application involved.

In addition, the public has in the past generally lacked awareness of the developing issues. In contrast to trade publications, the popular press has paid little attention to the issues and there has been little public discussion of the new technology or its potential impact. Given this lack of public interest, the political parties have not yet addressed the issues. The experience of other countries suggests that political awareness and concern constitute an essential basis for effective policy formulation.

Another important source of weakness is the small, fragmented Canadian market, which has hindered development of a strong industrial base in Canada, particularly in high technology industries such as electronics. The same factors have slowed implementation of the new technology. Our dependence on foreign trade and the inflow of primary inputs from abroad have only intensified the vulnerability of the Canadian economy to actions by other countries—especially our major trading partners as they face up to the challenges of the information revolution.

But Canada has many sources of strength too. As well as an extensive resource base, we have strong technological capabilities in areas such as space and telecommunications. These strengths are significant and can be built upon to strengthen the Canadian economy and to enable Canadians to reap the benefits of the information revolution.

7

The challenge for Canada

An investigation of issues in the broad perspective requires a new conceptual approach to policy formulation that many find difficult to accept. The issues appear too broad, too all-encompassing, to be developed; there is difficulty in accepting that the issues are different in kind or degree from the types of issues that governments have faced for years; there is only now a growing awareness of the rapid changes taking place and the wide extent of their implications; there is little understanding of the inter-relationships among the issues and among the events taking place in widely different areas of the economy.

Data for Development
National Policies and the Development of Automatic Data Processing

Canada could clearly derive substantial benefits from the information revolution, but a number of stumbling blocks exist and concrete action is difficult, given the rapidity of technical change and uncertainty about the potential of the myriad of possible applications of the new technology.

Skeptics may, of course, question the need for government action to deal with the information revolution. They might argue that market forces will provide sufficient impetus to required adjustments. But there are a number of reasons why government must be involved.

First, the governments of our major trading partners are taking action on a wide range of fronts to stimulate, support and protect

their own industries. Without similar support, Canadian firms may find it difficult or impossible to compete, either in the domestic or the international market. Second, the diffusion of the technology will have important consequences for productivity, growth and the balance of payments, all of which are major areas of government concern. In addition, the impact of the technology on the individual is likely to become increasingly important, as its exploitation will change skill requirements, employment patterns and distribution of income. Such consequences will warrant government interest and possibly action. Fourth, certain uses of the technology may pose threats to our sovereignty and therefore represent a legitimate political concern. In fact, *the issues are so broadly societal in scope that their satisfactory resolution will require a policy environment in which it will be possible to develop appropriate balances among the often competing economic, social, political and cultural goals of Canadian society.*

The creation of such a favorable policy environment will not be easy. In addition to problems of jurisdiction and consultation, which were discussed earlier, the close interrelationships among the various issues pose further complications, for action in one area could have impact in others. Some of these impacts could be negative and could, in fact, close off some policy options which would otherwise be available.

Since the early 1970s, many authors have perceived the need for an integrated approach to policy formulation. For instance, Barron and Curnow recently pointed out in *The Future with Microelectronics* that "the developments of the technology mean that electronics, computing and communications need to be seen as interrelated aspects of a more basic information technology. The reduction in cost of this technology means that its use will be pervasive, extending throughout commerce and industry, with far greater impact on the individual than has been the case in the past. For these reasons, policy will need to be formulated on a much wider basis."[1]

But policy formulation is in itself a major task. It will require a great deal of research and consultation among the two levels of governments, labor and industry. In order to develop policy, we need to identify more clearly the problems we wish to address, the objectives we are trying to achieve and the various policy tools at our disposal.

Defining the problem

The formulation of clear policy objectives is vital to policy development. Unfortunately, it is very difficult to establish objectives which are simultaneously specific enough to be useful for

[1]Ian Barron and Ray Curnow, *The Future with Microelectronics*, p. 225.

policy-making and general enough to be acceptable to a wide segment of the population concerned. Also, policy objectives are also not always internally consistent. Trade-offs need to be clearly identified before one can arrive at a satisfactory policy solution.

The objectives we want to achieve are relatively easy to formulate in general terms. In essence, we wish to learn how we can maximize the benefits derived from development and adoption of the new information technology in light of Canada's particular situation. We also want to find ways of alleviating the potential undesirable side effects described in Chapter 4.

These objectives can also be expressed in terms of economic prosperity, social equity and civil liberties, as well as national and cultural sovereignty. The information revolution will probably affect all these areas. Even at this "motherhood" level, however, these objectives are not fully consistent and trade-offs must be considered. For instance, the exclusive pursuit of national sovereignty has obvious economic costs. A single-minded preoccupation with economic prosperity can have undesirable consequences for social equity unless corrective action is taken. In short, differing opinions on policy prescriptions often reflect differences of opinion with respect to objectives.

Of particular concern is the potential conflict between the objective of achieving prosperity and those of preserving sovereignty and social equity. For example, the pursuit of technological sovereignty may involve, at least in the medium term, higher R and D costs than the alternative of technology transfer through Canadian subsidiaries of multinationals. The pursuit of cultural identity has entailed costs at both the federal and provincial level, such as those of operating the CBC and the National Film Board and provincial television networks. Measures to retain economic sovereignty may reduce economic efficiency. Declines in foreign direct investment could mean fewer employment opportunities and less economic growth. Restrictions on transborder data flows might increase somewhat the cost of data processing to multinational firms.

The tools available to implement the chosen strategy include the reallocation of resources—between the public and private sectors, among industries and among occupations—through tax incentives, grants, loans on preferred terms and many other instruments. In each case, because resources are finite, a reallocation to one activity entails a reduction in another. As a case in point, increased spending on R and D means fewer funds available for other purposes.

A second set of tools involves restructuring industry. For example, some observers suggest rationalization to achieve economies of scale and economies of specialization. Others call for changes in regulatory requirements: new areas perhaps require intervention while more traditional areas may in future demand less.

Another tool is trade policy. We could negotiate to increase the foreign market for Canadian products in exchange for increased acceptance of foreign products. Foreign investment policy repre-

sents another set of policy tools. We could initiate policies governing investment by foreign multinationals in Canada and by Canadian multinationals abroad. Measures available in these two areas include imposition or removal of tariffs, the use of non-tariff barriers to trade such as preferential procurement by government as well as the regulation of direct and portfolio investment.

Human resource policies constitute another set of options. These include measures to affect labor force movements and manpower development. Such steps are vital to developing a human resource base with the required skills, helping the existing labor force adjust to a changed environment and avoiding growing labor-management confrontation over implementation of the new technology.

Any policy solution will involve the selection of broad policy tools, taking into consideration the interrelationship between the various issues. It also cannot ignore the key characteristics of the information revolution if it is to have any chance of success. A brief recapitulation of these characteristics and of their implications for policy development is presented below.

First, *the information revolution is international in nature and reflects a fundamental structural change through which all developed economies are passing*, as evidence presented in the first part of the report shows. It cannot be stopped at the border. Thus, the only strategy with a chance of success is one which attempts to take advantage of the benefits of the technology with respect to devising new products and improving productivity. Any attempt to slow down the revolution out of concern for possible employment effects will backfire. Such an approach would inevitably lead to an erosion of Canadian industry's competitiveness, resulting in declining exports, falling output and collapsing employment.

Second, *the information revolution is causing increasing international interdependence*. Multinational firms have been growing in importance in the international economy and international data flows, often between parent firms and their subsidiaries, have been rapidly increasing. In response to the consequent erosion of national sovereignty, many countries have been experiencing a trend toward economic nationalism. Among the manifestations of this nationalism are strong non-tariff barriers to trade in areas perceived as involving strategic goods and services. Telecommunications and data processing fall into this category.

Third, *the continued rapid development of the technology means that the R and D costs entailed in being a world leader in development of the technology are beyond the capabilities of many firms and, indeed, of many smaller countries*. As indicated in Chapter 5, even Japan has not yet succeeded in catching up with the U.S. at the high technology end of the spectrum, even though it has dedicated enormous resources over several decades to achieving world leadership in electronics products. Small countries such as Canada will not be able to produce the whole range of information technology. We will have to adopt various alternative measures to acquire the

advanced technology needed to make industry in this country competitive. These include technology transfers from abroad, importation of goods embodying the technology and domestic R and D.

Ideally, given the policy objectives we wish to achieve, the policy tools at the disposal of the government and the characteristics of the information revolution representing constraints on Canada's options, we would like to outline a coherent policy strategy for Canada in coping with the challenges of the information revolution. Unfortunately, such a task is well beyond the scope of this report. There may well be a growing recognition of the broader implications of technological developments in computers and communications. But many questions still remain unanswered about the interrelationships between issues. There are also still many gaps in our knowledge about the likely impacts of developments occurring now and in the future. Thus, the remainder of this chapter will restrict itself to suggesting the actions to be taken right away and the research needs which are a necessary precondition to further action.

Creating the Canadian information economy

The application and diffusion of information technology throughout the economy is a central issue. They will probably not only strengthen Canadian industry, but also significantly contribute to solving other pressing issues raised by the information revolution. For instance, if the new technology succeeds in stimulating Canadian industry, it will also contribute to improving the balance of payments and alleviating the potential losses in jobs precipitated by the information revolution. In effect, increases in output will lessen the decline in jobs attributable to growing automation. The developing of our own industry will also counteract the erosion of economic sovereignty precipitated by the increasing power of multinational corporations. If we can develop Canadian content industries such as information provision, film and television program production, the threat to cultural sovereignty will be less intense. Finally, increased wealth in the country will make it easier to perform the necessary reallocation of resources and to deal with social problems such as unemployment because more resources will be available for income redistribution.

The vital importance of exploiting information technology is perhaps even more evident if one considers the consequences of failure in this policy area. Clearly, a weakening of our industrial base would inevitably lead to an erosion of our competitive position on foreign markets. This, in turn, would cause a deterioration in our balance of payments and a worsening of unemployment, not to mention downward pressure on the Canadian dollar. The burden of unemployment would be especially difficult to alleviate because support for the jobless would mean employed workers had to accept a net decline in their standard of living.

Not all the feedback effects, however, of a successful policy to encourage use of the technology are necessarily positive. Indeed,

such a policy can have a negative social change at an unacceptable rate. There is a danger that this outcome could lead to rejection of the technology with catastrophic long-term implications. In short, a strategy to promote use of the technology must not operate in isolation. In tandem, there must be co-ordinated programs to increase public awareness of the benefits of the new information technology, to dispel unwarranted fears and to cope effectively with any resulting social problems.

In addition, a successful strategy resulting in more economic growth may lead to increased pressure on scarce resources. It must be noted, however, that the new information technology is not resource intensive and indeed offers exciting opportunities for energy saving and more effective use of our natural resources. In short, the information society can be a conserver society.

Canada has no choice but to promote vigorously introduction of the new technology in order to maintain and increase its international competitiveness. But the unrelenting internationalization of production and the rapid rate of technical change imply that a nationalistic approach based strictly on home-grown technology is bound to fail. Japan, with a population of 113 million, may be able to develop a global scientific and technological capability—that is, one which promotes innovations in all the relevant industry sectors and can market products in all these areas. But Canada simply does not have the resources. Yet a completely international approach based on elimination of trade barriers and the principle of comparative advantage is not realistic either, especially in view of our trading partners' policies.

The Canadian approach must be more pragmatic. It must take into account our small base for supporting R and D, as well as our linguistic and geographic proximity to the Americans, which gives us a unique opportunity to adopt their state-of-the-art technology. In short, the major accent should be on increasing adoption and diffusion of existing technology from all available sources.

Many means of acquiring technology exist. Foreign direct investment has been the traditional Canadian route to technology transfer. But there are other methods successfully applied by our trading partners and available to Canada. These include licensing arrangements, joint ventures with foreign firms, technical information services, transfer of key technicians from abroad and Canadian direct investment abroad to acquire firms with specialized expertise.

These various types of technological transfers may exhibit important differences both in the cost of acquiring the technology and in the terms and conditions for using the technology. We need a better understanding of these differences. We also need more intensive study on the role which Canadian subsidiaries of foreign multinational firms play in influencing adoption and diffusion of technology in Canadian industries. Only with such information will we be able to develop the technology transfer policies most appropriate and beneficial to Canada.

As a first step to diffusing the technology, Canadian businessmen must be made to understand the potential range of applications of the new technology. A recent study by R. Wills for the Ministry of State for Science and Technology underscored the need for an information program. Wills analysed the information channels through which Canadian companies obtain technical information. He also compared variations in the information sources of domestic and foreign-owned firms, while controlling for differences due to firm size. Respondents from medium (100-500 employees) and small Canadian companies (less than 100 employees) cited suppliers among the three most frequently used sources of technical information; respondents from medium and small sized foreign-owned multinationals used other channels. The author concludes, *"Small and medium-sized Canadian companies rely excessively on suppliers who have a vested interest in selling particular and perhaps inappropriate product as a source of technical information."*[2] This finding underlines the need for new means of disseminating technical information to Canadian business.

Barriers to adoption of new technology must also be overcome. In a recent seminar sponsored by the Department of Communications, a number of participants asserted that Canadian firms are reluctant to risk adopting new technology because they fear the technology will quickly become obsolete, leaving them with a high capital investment and a still outdated production process. This attitude likely arises in part from a failure to appreciate the benefits of the new technology and reinforces the need for technical information. But such incentives to technological diffusion as loan assistance, tax-based incentives and shared investment costs also deserve consideration. Measures to promote leasing arrangements may also help to reduce the risks related to rapid obsolescence of new technology.

More specificity about measures to encourage diffusion of the technology would be inappropriate without a better understanding of the factors affecting the rate of technological diffusion in Canadian industry. More study is also necessary on the effects of the technology on our industrial productivity and competitiveness. Without an understanding of the structural, organizational and institutional factors affecting the process of technological change in Canadian industry, it is unclear what policies governments should pursue to encourage firms to obtain and apply the new information technology most effectively and efficiently. Research aimed at identifying these factors is a necessary prerequisite to policy development.

Canada no longer has much chance to enter successfully into the mass production of general-purpose integrated circuits, despite the arguments which influenced the larger European countries and

[2]R. Wills, *Research, Development and Communication in the Canadian Economy*, p. 18.

Japan to favor domestic manufacture. Competition in the production of these integrated circuits is so intense as to make sheer survival in the industry problematical. Some semiconductor companies are attempting to solve this problem by forward integration into the end product. But in many products using silicon chips, the cost of the integrated circuits is only a very small percentage of the product's total value. These products are probably not attractive for forward integration because their production demands knowledge of product technology, application marketing know-how and substantial investments. Applications firms, however, will require expertise in the design and use of micro-electronics. Even General Electric Company, a well-known supplier of consumer and industrial products employing microprocessor technology, buys the integrated circuits it needs in its products.

In addition, Canada should only develop applications of the technology in areas where we have the basis for a comparative advantage. Canada appears, for example, to have a competitive advantage in resource processing, telecommunications and transportation technology. The development of new applications is a difficult task and requires selectiveness because of high entry costs and the formidable competition from our trading partners. *Even the question of who should "try to pick the winners" poses a dilemma: though direct government intervention has a number of disadvantages, total reliance on market forces to achieve desired results is naive.* Competing industries in other countries are receiving heavy backing from their national governments.

Support to Canadian applications industries might include measures to make venture capital and funds for applied R and D easier to obtain. Additional measures might be designed to improve the export orientation of these industries. These could include marketing support and correction for market distortions caused by the policies of foreign governments. Action is also necessary to reduce U.S. non-tariff barriers to Canadian products because the U.S. represents the market for 70 per cent of Canadian exports.

Nor should software and information content industries be overlooked. Some observers still believe that there is a definable maximum ratio of service to goods producing industries which an economy can support. Gordon Thompson of Bell-Northern Research has recently written a report challenging this assumption, which is also contradicted by the experience of countries other than the U.S. which have successfully exported software and information products.

Thompson argues that *information technology can not only serve as a substitute for industrial technology, by developing new network-based information services, information technology can also generate wealth in its own right.* He notes, however, that "innovative applications of information technology that have significant higher order impacts and are wealth creating, transformative, and socially beneficial seem to be constrained from occurring. Our

centuries-old experience with the trade of hard goods, our dedication to industrial technology, and our poor understanding of wealth creation seem to be amongst the constraints."[3] He likens modern-day skeptics of the information revolution to the physiocrats who argued 200 years ago that only in "husbandry" (agriculture) did positive effort produce a surplus over cost. In their view, "wealth creation was the sole prerogative of husbandry". In the same manner, argues Thompson, their descendants perceive that wealth creation depends on physical exchangeables.

Information technology may be wealth-creating, but markets for information present the price system with more difficulties than traditional goods and services. Many information goods have public good characteristics, with the result that markets will not produce an optimal allocation of resources. Some information outputs are incompletely appropriable and, consequently, resources will be underallocated for their production. Property rights in many information goods and services are either ill-defined or difficult to enforce.

In spite of these considerations, realistic options for the provision of information goods and services do exist. For example, in the case of the existing commercial broadcasting services, business, which employs the service as an intermediate commodity towards the sale of final goods and services, pays by purchasing advertising time from broadcasters. New technologies are also making feasible the privatization of certain information services. Pay TV is a prime example. A multitude of alternatives are available to encourage the provision of information through the market. These largely involve the assignment of property rights to overcome inherent investment disincentives.

In deciding between alternatives, the net benefit of each to society definitely deserves consideration because each alternative for provision has its own associated costs. The development of distribution mechanisms and institutional arrangements to overcome the problems associated with information commodities will have significant positive effects. Such a step will create a new source of economic growth, but one which will not impose the same demand on our limited national resources as most primary and secondary industries. *The software and content industries are also very labor intensive and can help alleviate unemployment problems.* Measures to encourage development of software, data banks and information processing activities are therefore desirable.

Policy measures to encourage emergence of new information industries may include the development of appropriate infrastructures, the protection of property rights for information and software

[3]G. Thompson, *Memo from Mercury: Information Technology is Different*, p. 29.

(e.g., copyright laws) as an incentive to production and a re-assessment of regulation on institutional arrangements for providing such services. In addition, procurement policy might effectively foster development of software products which could then be exported.

Information technology is, in large part, based on the convergence of communications and computer technology. For Canada to achieve the benefits offered by this new technology, we must build on our strength in telecommunications, the infrastructure of the information economy. In order to achieve competitive efficiency for our production process in an information-based economy, we must have economic efficiency in the underlying communications system. An efficient communications infrastructure is also fundamental to developing the market for goods and services. Telecommunications is also crucial to the maintenance of Canadian sovereignty, as the Clyne Committee pointed out.

Developments in telecommunications are a key factor in Canada's ability to benefit from the information revolution. A major gap currently exists between the spearhead advance of technology and the operational implementation of its use and manufacture. It is this gap our major trading partners are now beginning to fill with policies and actions. Canada must do the same in a way that fits our own unique needs and interests.

Coping with employment problems

Policies to encourage the exploitation of information technology cannot be successful unless complemented by policies ensuring Canada an adequate human resource base to support this exploitation. An important question facing Canada is: will there be people ready to make the new systems work? In the past, Canada has drawn much of its skilled labor requirements from the ranks of those trained in other countries. Will this source of supply remain freely open to us? Is immigration necessarily the best way to obtain the required skills? If necessary skills are in short supply, the price paid for these skills may rise until much of the cost advantage of the new technology is lost. We urgently need a plan of action to ensure that Canada will have a good supply of workers with the necessary skills.

At the same time, the new technologies will destroy many jobs. In a recently completed report to the Department of Communications, the Institute for Research on Public Policy reviews more than 40 seminal documents on the impact of computer communications on employment. The Institute concludes, "Most of the reports are in agreement that in the secondary sector we might well witness job displacement." The report continues, "Job destruction... is thought to be more severe for older workers who have less flexibility in retraining, re-education and relocation and for the lower-level skilled labor force. But, overall, it is the women, who form the bulk of information manipulators in the service sector, who are expected to bear the brunt of the impact."[4]

Policy development will have to address these two issues: the need to develop a human resource base with the required skills and the need to help the existing labor force adjust to a changed environment.

Appropriate educational and training systems are vital to this task of readjustment. *Two types of educational activity will be necessary:*

- *formal education to equip the young with the particular skills needed in the new information economy;*
- *adult re-education and training programs for large parts of the workforce to upgrade their skills and adapt to the new needs of the work place.*

The task of helping people to acquire the necessary skills should not be left to government alone. In Europe and Japan, both industry and labor unions are active in creating appropriate training mechanisms to ensure a supply of workers with the necessary skills. Canadian industry has a responsibility to understand its future skill requirements and make them known, so that educational institutions can adjust their programs. Unions must also act responsibly to help their members adjust to the information revolution.

The new information technology may displace major functions within industries on which the economies of certain areas depend. Policies to encourage labor mobility from these areas to growth areas may become necessary. Regional and personal income redistribution schemes may also be needed to alleviate hardship. We stress regional income redistribution because there is a trade-off between regional development policy and initiatives to foster economic growth in the face of the information revolution. Because resources should be encouraged to move from low to high productivity uses, particular adjustment problems may face regions with economies based on labor-intensive activities using conventional technology. Knitting mills and the clothing and textile industries fall into this category. Further studies are necessary, however, on the impact of emerging information technologies on the geographical location of economic activity.

At present, not enough hard facts have been collected to indicate with any certainty how the information revolution is affecting industry and consequently labor. The comprehensive IRPP reports says, "On the key question of the net job balance effect for the whole economy, there exists no consensus in the literature." The report also states, "Concrete situations examined differed radically from what

[4]Z. Zeman, *The Impacts of Computer/Communications on Employment in Canada: An Overview of Current OECD Debates*, p. 47-48.

the reviewed reports, based in turn on aggregate statistics, would have led us to believe."[5] It stresses the need for gathering more factual information relevant to the current debates, both through aggregate statistical approaches and case studies at the sectoral and company level.

Knowledge of what is happening is essential as a basis for formulating policies to deal with probable future developments. Therefore, such studies must be a high priority. The IRPP study represents a first step in the Department of Communications' research effort in this area. Econometric and case study approaches to gathering evidence on the employment impacts are currently proceeding.

Shaping the information society

Canada must also address the sweeping socio-political issues raised by the information revolution. These include retention of national sovereignty and identity, lessening of vulnerability, and protection of privacy, civil liberties and freedom of information. The broader economic consequences of the diffusion of new information-based technological devices also cannot be ignored.

A growing conviction has recently emerged in many countries that the continuation and intensification of current trends in transborder data flows (TBDF) could pose a serious threat to national sovereignty, jeopardize national culture and national identity, intensify threats to national security, allow invasions of personal privacy, add to unemployment problems and increase the balance of payments deficit. After reviewing the implications of TBDF, the Clyne Committee concluded, "The government should act immediately to regulate transborder data flows to ensure that we do not lose control of information vital to the maintenance of national sovereignty."[6] *The broad political, social, cultural and economic implications of TBDF mark it as a priority area for policy research and development.*

But the feasibility of regulating TBDF is still questionable, as are the possible negative effects. In short, a clearer understanding of this matter is necessary before developing specific policies. For transborder data flows are a manifestation of the impact of information technology on production processes and, as a result, the impact of information technology on industrial structure and location must be better understood. Policy development in this area must also be founded on comprehension of other governments' concerns because TBDF, by definition, relates to international flows of data and information. Without such understanding and a co-operative approach among nations to resolving the issues, unilateral measures to regulate TBDF could lead to conflict. Fortunately, such discussions

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[5] *Ibid.*, p. 48.

[6] *Telecommunications and Canada*, p. 64.

are taking place within international forums such as the OECD and the Intergovernmental Bureau for Informatics. Canada must play a major part in the development of co-operative approaches to dealing with the issues, so that agreements reached reflect our national concerns.[7]

A policy to protect the privacy of personal information, especially in foreign data banks, is an equally pressing concern. The 1978 Human Rights Act shields personal data stored in federal government data banks. Similar legislation in Nova Scotia applies to provincial government data banks. In Ontario, the Krever Commission is investigating the privacy of health records. On the international level, the Department of Justice has been representing Canada in negotiations at the OECD to obtain international consensus on measures to protect private and personal information flowing across national borders.

Freedom of information concerns have also surfaced. The Secretary of State introduced in July 1980 new freedom of information legislation which creates a public right of access to government information; extends the individual's right of access to and protection of personal information in government files; and eliminates absolute Crown privilege, giving the courts right of access to all government documents in litigation.

But the situation is not static. For instance, if federal and provincial governments approve OECD guidelines on protection of privacy, they will need to consider what additional measures are necessary for compliance. *Further study and action are needed to ensure the protection of civil liberties and equitable access to information supplied through communications systems, as well as to reduce the vulnerability of computer-based systems.*

Finally, the economic and social effects of diffusing information technology require further investigation as a guide to planning by the public sector in this area of rapid change. This research effort must include the gathering of actual information, economic analysis and forecasts concerning the main effects of the new technology on productivity growth, industry structure, demand patterns and other factors, as well as forecasts on its impact on employment and the location of industry. The effects of this new technology have been recognized and have formed the subject of considerable speculation. But speculation must give way to formal studies systematically tracing these effects. Only such hard information can serve as a basis for developing appropriate policy responses.

Research on changes in industry structure is particularly important because such changes may have direct implications for regulatory requirements, competition policy and trade policy. They

[7]The above discussion of TBDF is based on the papers by P. Robinson cited in the references.

may also have an indirect impact on regional economic development policy.

The Department of Communications is currently undertaking preliminary studies to assess both the micro- and macro-economic impacts of diffusing information technology in Canada. The micro studies will identify sectors of the economy where information technology will have maximum impact. The macro studies are designed to measure how different rates of technological diffusion will affect such macro-economic indicators as output, employment and productivity.

The promise and the peril

Although the information revolution raises many complex and interrelated issues, it also offers unique opportunities for solving many of the serious problems which will face Canada in the years ahead.

Indeed, in a sense, the new information technology is "a solution in search of problems". For instance, applications of microelectronics, digital transmission and allied technologies could constitute an important means of alleviating the energy crisis by reducing the need for transportation and increasing the efficiency of vehicles and heating systems. This technology can also play an important role in harnessing new sources of energy such as solar energy. The diffusion of the new technology throughout production processes can also help diminish our use of resources by reducing wastage and rejects. Moreover, it can offer new opportunities to industry by enabling some firms to achieve efficient levels of output even with relatively short production runs. This consequence could considerably enhance the position of some of the industries engaged in selling exports or competing with imports. In this way, the new technology could have a favorable impact on our balance of payments. Imaginative applications of the new technology in the public sector could help to increase significantly the efficiency of many government activities and reduce the need for additional resources in that sector in the years ahead.

But if we are to benefit fully from the information revolution, we must keep abreast of the rapid changes in the technology, of our major trading partners' actions and of the new products and services continually emerging. *We need to develop a forward-looking approach. We must identify opportunities rather than adopt a purely reactive attitude restricted to correcting situations which have developed outside our control.* In such a dynamic area, these situations may well be past the stage of effective correction before we can react.

In addition, many of these matters bear upon areas of provincial responsibility. There is, accordingly, a pressing need to ensure that provincial governments are aware of the contribution they might make in their own jurisdiction to the safeguarding of Canada's economic, political and cultural sovereignty.

The world today is in the midst of a revolution which will bring about significant and far-reaching changes. Governments everywhere are implementing policies designed to gain international competitive advantages. *Canada has the basic strengths to emerge a winner from this revolution. If we build on these strengths, the information revolution can represent a great opportunity for the future of this country.*

Appendix

Table I: Typology of Information Occupations

(These tables have been taken from a forthcoming document of the Organization for Economic Co-operation and Development entitled *Report on Economic Analysis of Information Activities.*)

Information Producers	Scientific and technical workers (components) Information gatherers Market search and co-ordination specialists Consultative services
Information Processors	Administrative and managerial Process control and supervisory Clerical and related (components)
Information Distributors	Educators Communication workers
Information Infrastructure Occupations	Information machine workers Postal and telecommunication

Table II: Inventory of Information Occupations

The table below presents an inventory of "information occupations" with their associated ISCO code numbers at the "unit group" level. Researchers should examine the appropriate ISCO publication (1) for occupational detail at the fiber "category" level.

I. Information Producers

Scientific and Technical

0-11	Chemists	0-29	Engineers N.E.C.
0-12	Physicists N.E.C.*	0-51	Biologists, zoologists and related
0-13	Physical scientists N.E.C.	0-52	Bacteriologists, pharmacologists
0-22	Civil engineers	0-53	Agronomists and related
0-23	Electrical and electronic engineers	0-81	Statisticians
0-24	Mechanical engineers	0-82	Mathematicians and actuaries
0-26	Metallurgists	0-90	Economists
0-27	Mining engineers	1-92	Sociologists, anthropologists and related
0-28	Industrial engineers (Except 0-28.30)		

Market Search and Co-ordination Specialists

4-10.20	Commodity broker	4-41	Insurance and stock agents, brokers and jobbers
4-22	Purchasing agents and buyers	4-42	Business services/advertising salesmen
4-31	Technical salesmen and advisors	4.43.20	Auctioneers

Information Gatherers

0-28.30	Work study officers	0-33.20	Quantity surveyors
0-31	Surveyors (land, mine, hydrographic, etc.)	4-43.30	Valuation surveyors
1-39.50	7-54.70		
3-59.30	8-59.20 } Inspectors, viewers and testers (various)		
3-59.45	9-49.80		
3-91.50	5-89.20 Information gatherers N.E.C.		

Consultative Services

0-21	Architects and town planners	0-84.20	Computer programmer
0-32	Draughtsmen	1-10	Accountants (except 1-10.20)
0-61	Medical practitioners	1-21 and	
0-69	Dietitians and nutritionists	1-29	Barristers, advocates solicitors, etc.
0-75.20	Optometrist	1-39.20	Education methods advisor
0-83	Systems analyst	1-62	Commercial artists and designers

Information Producers N.E.C.

1-51.20	Authors	1-71.20	Composers

(1) International Standard Classification of Occupations (ISCO) Revised Edition 1968, I.L.O. Geneva. It includes 284 "unit groups" embracing 1,506 "occupational categories".

* N.E.C. means not elsewhere classified.

II. Information Processors

Administrative and Managerial

1-22	Judges	2-12	Production managers
1-39.40	Head teacher	2-19	Managers N.E.C.
2-01	Legislative officials	3-10	Government executive officials
2-02	Government administrators	4-00	Managers (wholesale/retail trade)
2-11	General managers		

Process Control and Supervisory

0-33.40	Clerk of works	3-5	Transport and communication supervisors (except 3-59.30 and 3-59.45)
0-41.40, 0-42.30	Flight and ship navigating officers	3-91.20	Dispatching/receiving clerk

3-0, 4-21, 7-0	5-20 6-00.30, 5-31.20 6-32.20	Supervisors: clerical, sales and other Supervisors and general foremen (production)

Clerical and Related

1-10.20	Auditor	3.93	Correspondence and reporting clerks
3-21	Stenographer, typists and teletypists (except 3-21.50)	3-94	Receptionist and travel agency clerks
3-31.10	Bookkeeper (general)	3-95	Library and filing clerks
3-31.20	Bookkeeper (clerk)	3-99.20	Statistical clerk
3-39.20	Cost computing clerk	3-99.30	Coding clerk
3-39.30	Wages clerk	3-99.40	Proof reader
3-39.40	Finance clerk		
3-91.30	Stock records clerk		
3-92.20, 3-92.30	Material and production planning clerks		

III. Information Distributors

Educators

1-31	University and higher education teachers	1-34	Pre-primary teachers
1-32	Secondary teachers	1-35	Special education teachers
1-33	Primary teachers		

Communication Workers

1-51.30, 1-59	Journalists and related writers (except 1-59.55)	1-73.50	Storyteller
1-73.30	Stage director	1-74	Producers, performing arts
1-73.40	Motion picture, radio, television director	1-79.20	Radio, television announcers

IV. Information Infrastructure Occupations

Information machine workers

1-63	Photographers and cameramen	9-21	Compositors and typesetters
3-21.50	Teleprinter operator	9-22	Printing pressmen (except 9-22.70)
3-22	Card and tape-punching machine operators	9-23	Stereotypers and electrotypers
3-41	Bookkeeping and calculating machine operators	9-24	Printing engravers (except 9-24.15 and 9-24.30)
3-42	Automatic data-processing machine operators	9-25	Photo-engravers
3-99.50	Office machine operators	9-26	Bookbinders and related
8-49.65	Office machine repairmen	9-27	Photographic processors
8-62	Sound and vision equipment operators		

Postal and Telecommunications

3-70	Postmen, mailsorters, messengers	8-56	Telephone and telegraph installers/repairmen
3-80	Telephone operators	8-57.40	Telephone and telegraph linesmen
8-54	Radio and television repairmen	8-61	Broadcasting station operators

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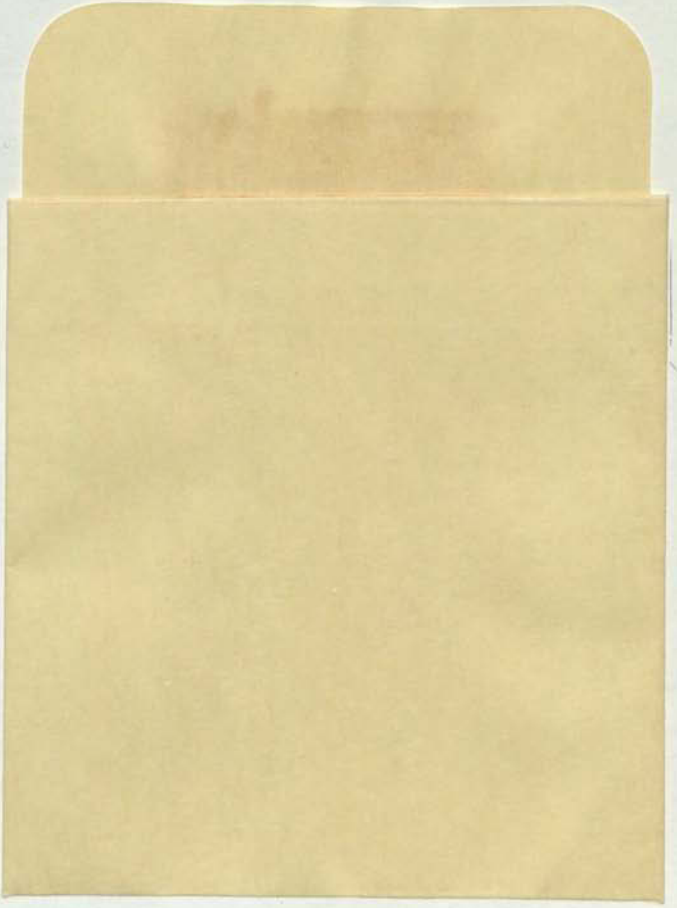

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