Communications: The Canadian Experience

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Introduction

"Canada is a Distant Early Warning System for the American experience." The words belong to communications theorist Marshall McLuhan who in the 1960s revolutionized everyone's understanding of the social impact of communications. Canadians are conscious of the pervasive implications of modern communications media since few countries in the world are as dependent as Canada on telecommunicating for their existence as a nation.

About 23 million Canadians occupy the northern half of North America – an area comprising 9,976,139 square kilometres (3,851,809 square miles) and extending from roughly the same latitude as Rome in the south to far beyond the Arctic Circle in the North. In the far north Canadians live in small communities, separated by hundreds of miles of wilderness and forbidding terrain. More than three-quarters of Canadians live in cities close to Canada's southern border in a narrow strip stretching about 6,500 kilometres from the Atlantic to the Pacific Ocean. Even these urban Canadians, however, are divided from each other by vast distances and such formidable geographic barriers as the Canadian Shield and the Rocky Mountains.

Because of the continuing Canadian preoccupation with communications as an instrument of national will, the country is developing new communications technologies which together are creating the global information revolution.

Canadian communications scholar Marshall McLuhan. Through books such as The Gutenberg Galaxy, Understanding Media *and* The Medium is the Message *(the latter with Quentin Fiore), Mr. McLuhan has revolutionized popular and critical thinking about the mass media.*

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Telidon: TV that responds

About two years ago, Canadian researchers developed a two-way TV or videotex system called Telidon.

Telidon promises not only to transform the idea of the home computer from a high-tech hobby into an everyday reality, but to make feasible such services and activities as teleshopping, electronic publishing, participatory television, telebanking, electronic mail and electronic newspapers — all of which would be available over a person's home TV. Canadians may soon be able to retrieve textual and graphic information from data banks all over the world without leaving their home.

The information-retrieval capabilities of Telidon also make it useful to business and institutional users. Telidon could permit some Canadians to become electronic publishers from their own homes. The unique computer-graphic capabilities of the system may also transform certain businesses. For example, two architects a continent apart may be able to share the same electronic blackboard — their own TV monitors — and correct each other's drawing with a light pen or "joy stick".

Telidon was developed by the research arm of the Canadian government's Department of Communications and moved from the laboratory to the field in 1978. The Canadian government put up $9 million for its further development — a sum which has been matched by companies in the private sector. In a growing number of trials, the system's technical capabilities, its compatibility with a variety of new and existing telecommunications technologies, and its relevance to a variety of industrial and institutional users, are being tested.

Telidon differs in several important respects from systems developed in Europe. Telidon has four main components: (1) a slightly modified TV set (display monitor) equipped with a micro-computer; (2) some associated electronics and a key pad; (3) a telecommunications network and (4) a central computer. The nature and configuration of some of these components can be varied to meet the user's specific needs.

Field trials are now underway in several Canadian communities which will permit Telidon subscribers to call up information on a full array of consumer services.

Telidon, the Canadian-developed videotex system, will soon transform the familiar television set into an innovative information tool, and, eventually, a two-way communications centre from which viewers may conduct business, take educational courses, or send and receive mail at the speed of light.

With the basic Telidon service, the user can phone a data bank and then, by punching a few buttons on his keypad terminal, retrieve pages of information for display on his modified TV set. With a keyboard terminal, a business user with more sophisticated needs could exchange information with a friend or colleague possessing a similar unit. In either case, the information displayed could be either textual or graphic.

This graphic information can be precise: the Telidon system can transmit and display signatures accurately enough for legal purposes. Telidon images have a much higher resolution than those of the European videotex systems.

Designed primarily for the display of textual information, the European systems build up a page or image on their screens line by line, moving from left to right. In effect, their screens are divided into a mosaic, with each small square being filled by a letter. Though these squares can be subdivided for graphic displays, a diagonal line on the screen will still look jagged and resemble a flight of stairs.

In contrast, Telidon uses the natural language of drawing, building up an image progressively from its basic geometric elements. The result is much higher resolution. Telidon images also employ about 40 per cent less network capacity and require much less storage capacity.

Telidon can describe images with much higher resolution than a typical color TV and can meet the standards of the highest-resolution TV monitors in the world. The system, however, will only resolve an image to the degree required by the display monitor in use. It will also be adaptable to all display monitors in general use for the foreseeable future. For images indescribable in terms of geometric elements, the system contains a photographic capability: an image, such as a photograph, can be displayed on a point-by-point, facsimile-like basis.

The federal Department of Communications is conducting several field trials to test Telidon and encourage industrial participation. Residents of the small town of Elie, Manitoba, for example, will have access to stock exchange reports and will also be able to experiment in teleshopping.

In consequence, the Telidon system will work, no matter what changes may occur in the technology of display monitors. The data base is also independent of any particular type of terminal or communications medium used to transmit information to or between those terminals. Telidon signals can be transmitted over telephone lines, coaxial cable, optical fibre, satellite link, off-air broadcast or some combination of these.

The independence of Telidon components from each other is a unique feature of the Canadian system.

"We wanted this independence because we know there are different rates of change for the terminal, transmission and data base management technologies," says Herb Bown, manager of the image communications laboratory in the Canadian government's Department of Communications. "For example, existing communications are constantly being improved with fibre optics, satellite and other broadband services, as well as improvements in the telephone networks. And we know the resolution of TV itself may well be improved, or it may even be replaced by a totally new display technology.

"It is important we adopt a methodology and an over-all systems approach that permits independence of information storage from the delivery and receiving systems. Otherwise, we'll be stuck with a systems approach with a life of about five years before much of the information in the data banks will have to be redone for the next generation of systems."

Telidon terminals contain a tiny computing device which can serve as a mini-computer at home or in the office. They can be easily modified to display signals from the British Prestel or French Antiope videotex systems. Telidon terminals are also 'smart' enough — because of their mini-computer—to communicate directly with other terminals without help from a central computer. These features are unique and give Telidon a considerable competitive advantage.

For the field trials, Norpak Ltd., a Canadian manufacturer of computer display equipment, started producing Telidon units in 1980. Each is the size of a telephone book and sells for around $1,200. Its mass-market model may sell for about $250 and consist of from one to 10 silicon chips mounted on a board which could fit right into a TV.

Telidon is capable of very advanced graphic representation, enabling the electronic transmission of mathematical, scientific and technical illustrations; charts and statistics; maps and cartoons; as well as signs and symbols for the deaf and other users.

An independent marketing study, sponsored by the Canadian government, has predicted there may be 600,000 Telidon subscribers in Canada by 1986 and about 1.9 million by 1991. Major telephone companies across the country are participating in videotex field trials.

Bell Canada, in co-operation with the Canadian government, will embark in 1981 on a $10-million field trial using 1,000 of its own Vista terminals, all of which use Telidon electronics. About 100,000 pages of information — including from travel schedules, news, weather, sports, stock market quotations, consumer bulletins, entertainment guides and classified ads — will be available on demand over residential and commercial participants' color TVs, by pushing a button on a keypad or keyboard. Users may also be able to reserve plane tickets, teleshop and leave messages for other participants with the new system.

Three other major Canadian telephone companies will start their own videotex field trials soon. The Canadian Telecommunications Carriers Association, the trade organization for Canadian telecommunications carriers, is co-operating with the Canadian government in a field trial which will test Telidon transmissions over optical fibres in a small town on the Canadian prairie.

Two Canadian cable TV companies will soon begin videotex field trials. A spokesman for one of these has suggested he might eventually go to more specialized commercial information: "With videotex, we'd like to offer a service to car dealers, for example, where they can get the latest information from Detroit on parts and descriptions of parts, with exploded diagrams."

In September 1979, an electronic newspaper was delivered faster than ever before from Canada across the Atlantic to four Telidon terminals located in Geneva, Switzerland, at Telecom '79, the international telecommunications exposition sponsored by the International Telecommunications Union.

TV Ontario, the educational TV network operated by the government of Ontario has begun an extensive three-phase Telidon trial. The network plans to distribute information on a retrieval basis from existing data bases and then move into computer-based learning systems, both of which could be picked up by Telidon terminals in the home.

Telidon subscribers will be able to call up weather conditions, news reports, restaurant and theatre listings, and real estate information.

Nerves of glass, thoughts of light

The future of Canadian telecommunications may in no small way be determined by tiny glass fibres about the thickness of a hair.

These frail strands of glass may in the next few decades replace most of the traditional copper cable and wire which carry Canadian telecommunications signals. And these glass hairs will not be carrying those electrical pulses and waves which are the very stuff of electronic communications at present. They will be carrying pulses of light.

Canadian research into and development of optical fibres began in 1972. There are now three large fibre optics research centres and three important manufacturers of fibre optics equipment.

The equipment is already being used in a few Canadian telecommunications facilities. Optical fibres are being tested under real conditions in nearly every Canadian region for many different telecommunications applications.

With Canadians so dependent upon telecommunications, existing transmission facilities may well become overloaded in the future. Already, the off-air radio-frequency spectrum is quite congested in many Canadian cities. Some Canadians have expressed concern that, with the burgeoning of telecommunications services in the future, their urban and rural areas will be transformed into a spider's web of copper wire and cable.

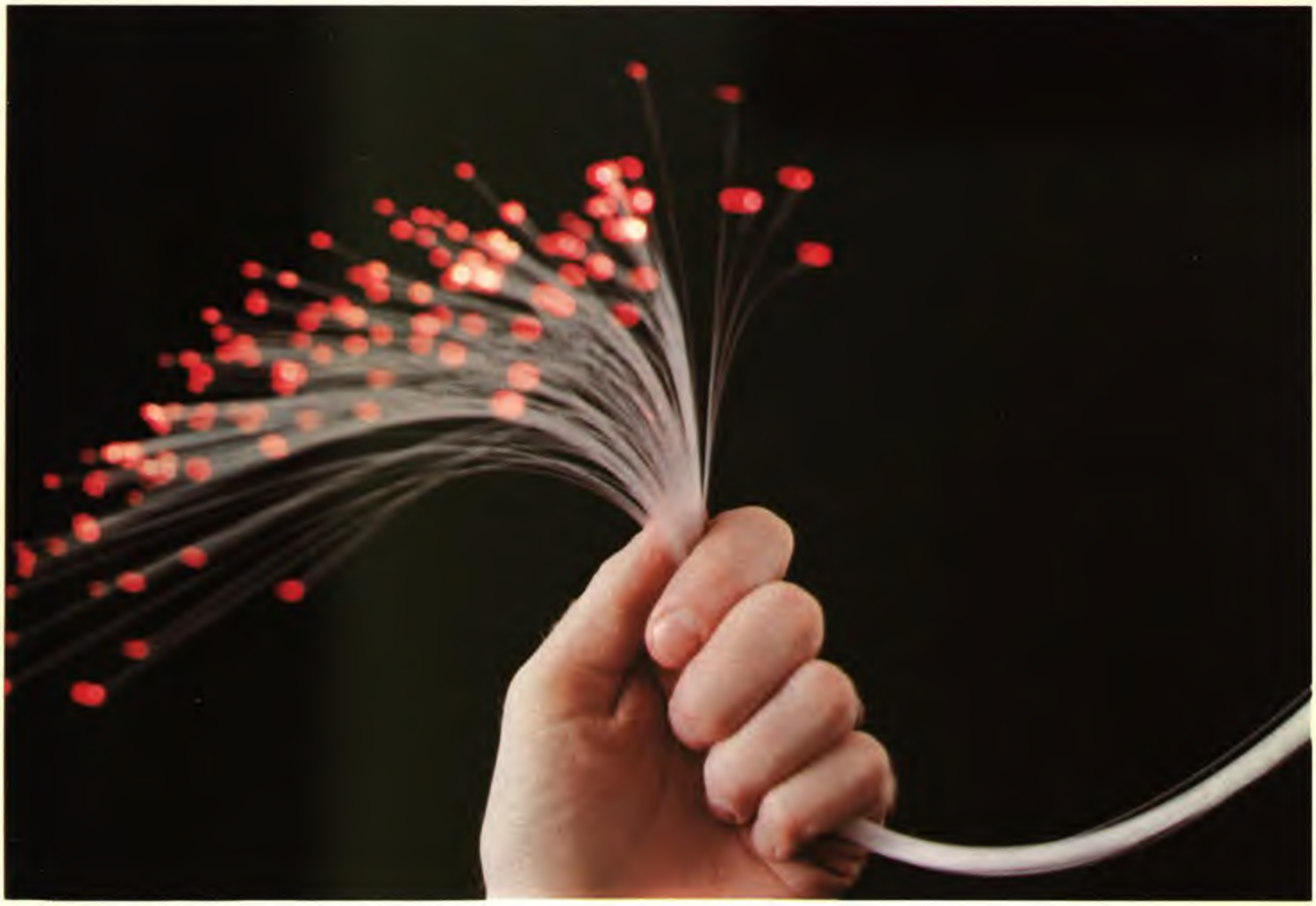
Optical fibres carrying light may solve the problem. Light is a form of electromagnetic energy with a much higher frequency — and, therefore, greater information-carrying capacity — than the electricity now used in our telecommunications systems.

A glass fibre carrying light can be much smaller in size than a copper cable carrying electricity. A few optical fibres can carry far more information or different kinds of telecommunications services than a copper cable, while occupying only a fraction of the space. The small size of fibres gives optical-transmission systems an unprecedented flexibility. The addition of another optical fibre to an existing system — with a resulting increase in information-carrying capacity or the number of telecommunications services available to users — does not require the excavations or large expenditures of time and money required for the installation of another copper wire or cable.

Optical transmission systems have other advantages. An optical fibre can carry a signal much farther than a copper wire or cable of equal capacity without equivalent loss of signal strength or fidelity. Most copper transmission lines require repeaters every 1.8 kilometres to amplify the signal; the comparable figure for optical fibres is from 10-12 kilometres.

Because optical fibres carry light rather than electricity, they are not subject to interference from lightning, high-tension lines, power surges or other communications systems. Their raw material is also not a potentially

Because optical fibres carry light pulses rather than electricity, they are not disrupted by lightning, power lines and the like. They are made of silica, a basic constituent of ordinary sand, which, unlike copper, is in great abundance.



scarce commodity like the copper used in cable. Optical fibres are made of silica, which is found nearly everywhere in the world in large quantities. It is a basic constituent of ordinary sand.

Northern Telecom and Canstar Communications are already producing those strands of incredibly pure and exceptionally transparent glass which form optical fibres. They are also making the different kinds of optical fibres for a variety of applications. These fibres are constructed so that the glass used in the outer skin of the fibre bends light more than the glass of the inner core. The two bending effects combine to keep the light trapped inside the fibre and to prevent its escape into the environment where it would be quickly absorbed. The fibres themselves can be bent quite sharply without loss of light, despite the fact that unrefracted light only travels in a straight line.

Some light can be lost when one fibre meets another. Canadian industry has developed an ingenious detachable connector which reduces this problem to manageable proportions. Northern Telecom has produced a suitcase-sized portable fibre fusion splicing set which cuts the time and effort required to splice two fibres together so that the join will result in minimal light loss.

Telephones, television sets and data terminals use electricity which must be converted into light for passage through a fibre-optics transmission system. Canadian industry produces laser diodes and light-emitting diodes to perform this function at the transmission end of a telecommunications system. They also make photo-sensitive detectors to convert the light back into electrical signals at the receiver end of the system.

Glass fibres used for communications are hair-thin, solid, flexible filaments which can carry light beams from end to end, around bends and corners, without interruption. One fibre can carry more than 4,000 one-way voice circuits, many times more than traditional copper wire.

Two Canadian manufacturers are capable of designing and installing complete optical transmission systems. Northern Telecom offers not only installation services and training but also a complete system of compatible components and ancillary electronics for both digital and analog applications. Canstar Communications specializes in designing optical-transmission systems and also manufactures bi-directional couplers, a fibre optics switching device which permits two-way traffic through a single optical fibre.

Research and development are continuing into fibres which would lose even less light than those now in use. Government and industry scientists are also working on optical transmission systems which could form a complete integrated telecommunications network and be economically adaptable to any future technological advance in telecommunications. There is also a strong research interest in fibre-optics terminal devices which would carry much more information, especially in digital form.

At present Canadian optical transmission systems mainly operate inside a single office or installation. Bell-Northern Research, the research arm of Bell Canada and Northern Telecom, installed in 1976 a fibre optics link in Canada's National Defence Headquarters. This link provides secure customized telephone service, two-way closed circuit TV and a high-speed data service.

When they look further into the future, Canadian policy-makers and scientists expect that optical fibres, because of their small size and information-carrying capacity, might lay the basis for a fully integrated telecommunications system. Cable TV, data communications, videotex and telephone conversations may all eventually travel along the same optical link, instead of a different cable being allocated for each, as is the case now.

The first North American test involving the delivery of telephone service to homes by optical fibre began in December 1978 in the Yorkville area of Toronto. The fibre optics network contains both one and two-way links and is capable of simultaneously carrying telephone, video and data signals. Bell Canada, sponsor of the field trial, will be assessing the physical strength and reliability of the fibres as well as their over-all performance in real-life conditions. Ninety-five per cent of the system's components were made in Canada.

A multi-media test of fibre-optics technology in a rural setting has also begun in the small Manitoba community of Elie. Initially, this five-year, $6.1-million project will use optical fibres to bring to about 150 homes private telephone service, FM radio broadcasts and multichannel television. Eventually, this integrated fibre optics system will deliver Telidon as well as such services as teleshopping, telebanking and computerized information retrieval. The project is intended to demonstrate the role of fibre optics in the integrated telecommunications system of the future. It may also illustrate how optical fibres, with their lower installation costs and capacity for carrying signals over longer distances without amplification, can help to create in Canada a new dimension in rural telecommunications service.

Canadian cable companies, as well as other Canadian telephone companies, are conducting their own field trials. A consortium of cable companies in London, Ontario, have begun tests on an optical transmission link 7.8 kilometres long, consisting of eight fibres and capable of carrying 15 channels and two-way video transmission. Meanwhile, just east of the Rocky Mountains, Alberta Government Telephones will soon have installed a 53-kilometre fibre link to test the efficiency of the new technology over long distances.

Optical fibres will soon begin to replace copper cables and wire. The next step will be to use fibre optics technology in the transmission lines required for new telecommunications services. It will only be a little further down the road that Canadians begin to receive all their telecommunications services in light pulses travelling along glass fibres which together form a completely integrated fibre optics telecommunications network.

Canadian National/Canadian Pacific Telecommunications introduced its Broadband Exchange Service in 1967. The broadband computer communications network can send signals at high-speed over a wider portion of the electromagnetic spectrum than the telephone network.

The digital revolution

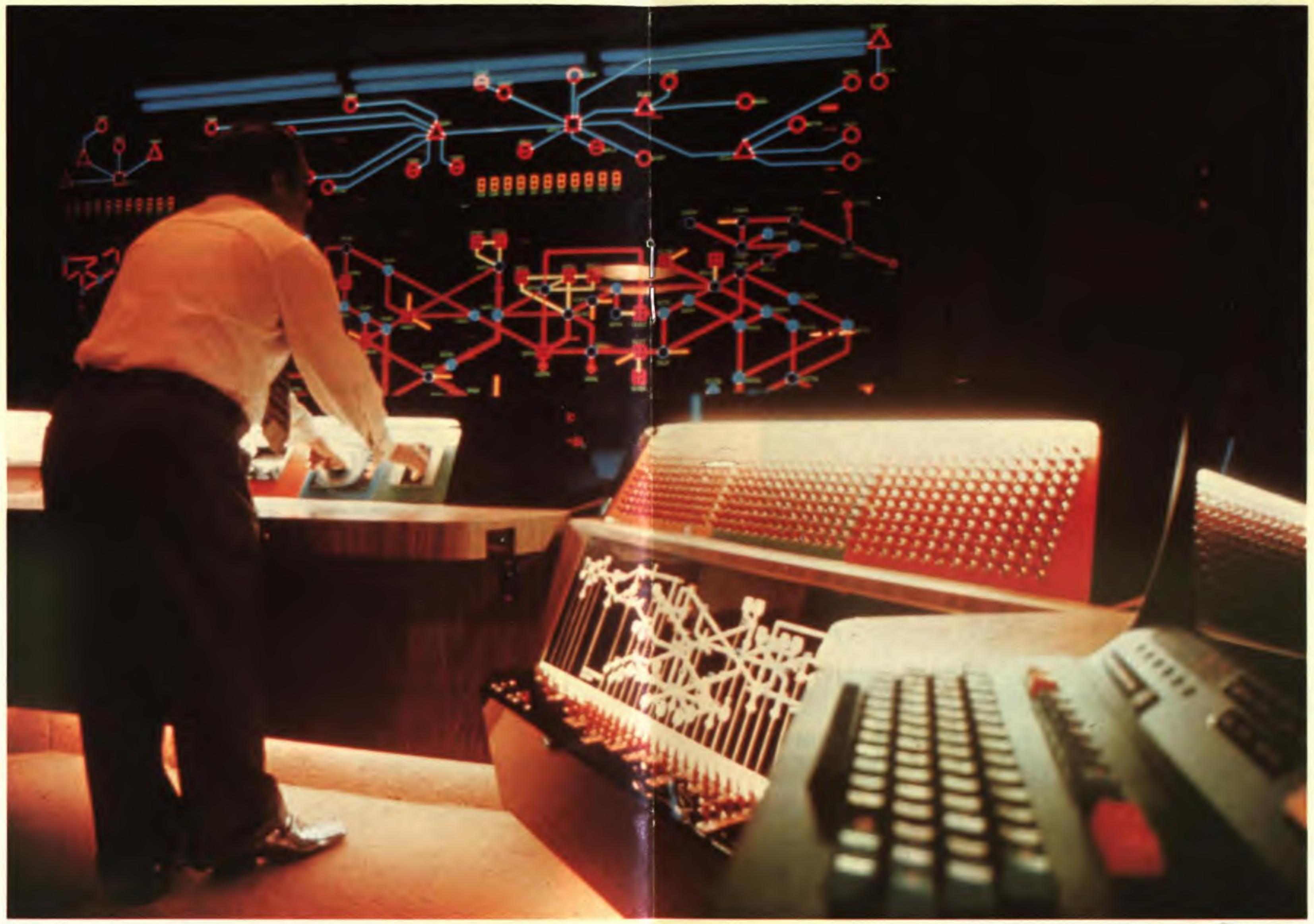
"Energy and information are basic to organic and social systems," says the Science Council of Canada. "A new technology that alters the terms on which one or the other is available can lead to profound changes in the operation of the system. The electronics revolution could spur creative drive and thus reshape society in new directions."

The Science Council — adviser to the Canadian government — was referring to the marriage of computer and communications technologies which could set in motion a social and economic transformation comparable to the Industrial Revolution of the late eighteenth and early nineteenth centuries.

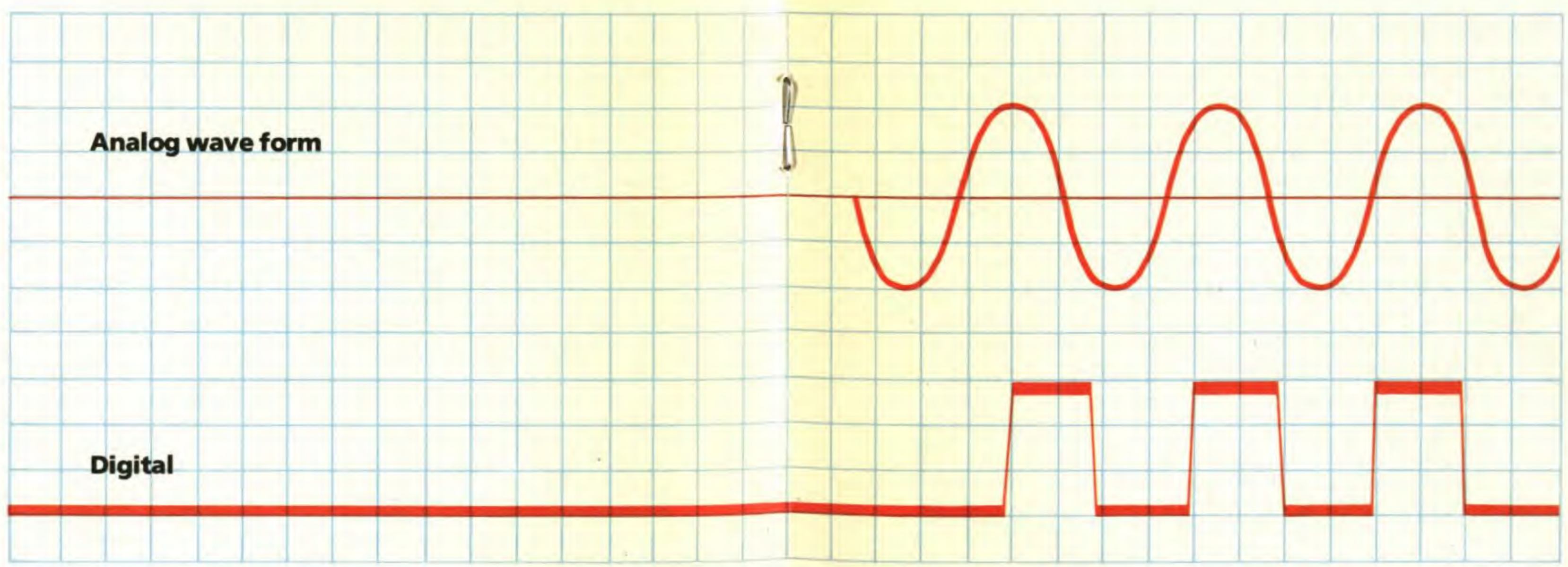
Despite soaring inflation, the price of executing an instruction on a computer has declined by a factor of about one million since the early 1950s, while the cost of most major computer components has been falling at a rate of about 30 per cent a year. In 1971, the first computer on a single silicon chip measuring about 12.3 square millimetres in area was produced. In the ensuing years, hundreds of thousands of these micro-computers have been made, and they have continued to diminish dramatically in size, price and energy consumption. One of these shrinking computers can perform almost the same functions as one of its room-sized ancestors 25 years ago.

The significance of this revolution in computer technology does not lie just in the emergence of digital watches, electronic calculators, computer games for consumers, or even in the contented smiles of statisticians with new and ever more powerful number crunchers. The marriage of the computer with new telecommunications technologies will open an era of unprecedented information exchange which may transform not only the Canadian workplace but also the Canadian home.

Canada has been in a unique position to take advantage of this convergence of technologies. The trick has been to ensure that telecommunications links are able efficiently and effectively to handle the high rates with which computers generate data.



The Canadian telecommunications industry employs well over 100,000 people and has a capital investment of over $17 billion. Telecommunications networks, be they telephone, telex, telegraph, broadcasting or computer, span six time zones and blanket some 10 million square kilometres. The control centre of one such network is pictured above.



The Infodat network is a digital transmission service of Canadian National/Canadian Pacific Telecommunications and has over 30 servicing locations from St. John's, Newfoundland to Vancouver, British Columbia.

Networks: analog to packet-switched

In 1967, Canadian National/Canadian Pacific (CNCP) Telecommunications introduced its Broadband Exchange Service (BES) — a high-speed, high-capacity network in Canada designed specifically to meet the exacting demands of computer communications. Because the broadband network could send signals over a wider portion of the electromagnetic spectrum than the telephone network, the former had a significantly greater information-carrying capacity. Subscribers could exchange computer data, monitor the performance of a distant operation or set up conference calls.

Signals travelled over the broadband network in analog form or in continuous waves. These signals were subject to damaging distortion or interference when they came at high speeds from computers. In addition, computers generate their data in digital form: their switches are either "on" or "off". The result is not a continuous wave pattern but a series of discrete pulses. Why not have a telecommunications network which sends its signals like a computer?

In 1973, a nation-wide digital system available on a commercial basis was introduced by the TransCanada Telephone System (TCTS), a consortium of Canada's major telephone companies. Still recognized as one of the most advanced systems in the world, Dataroute sends its signals in the same digital form employed by computers and, as a result, experienced up to 10 times fewer errors than analog systems.

In the same year, CNCP Telecommunications introduced Infodat, a Canada-wide network which uses digital transmission and time-division multiplexing to increase speeds and improve reliability. Time-division multiplexing, also a feature of Dataroute, is a technique for permitting several users to employ the same transmission line by allotting each a unit of time on that channel. Each user at a given point controlled his own private network. Because CNCP could make more efficient use of bandwidth than with the old Broadband Exchange Service, it was able to cut some of its tariffs by as much as

90 per cent and compete vigorously for traffic with TCTS.

Even with time-division multiplexing, these early digital systems had their flaws. When one terminal in a multipoint system is using the system, the others are effectively closed down. Neither the computer nor the terminals nor the people operating them are used to their full capacity. Only about 10 per cent capacity is used in a multipoint system. In addition, when the circuit is not being used by one of the original users, it is unavailable to a new user because the system only permits private-line arrangements.

Such networks pose other difficulties too. For example, what do you do when several terminals are trying simultaneously to communicate with a data base? The only solution is to install communications control programs which will organize the traffic flow. But such programs take up valuable mainframe and front-end capacity on the computer and add to the overhead of data base operations.

Large businesses and institutions could absorb these added costs. But many smaller businesses and organizations could not and were unable to take advantage of the digital revolution until 1977.

In that year, TCTS (TransCanada Telephone System) introduced its Datapac network, which employs packet switching technology. CNCP Telecommunications introduced its Infoswitch service, which uses both packet switching and circuit switching. Packet switching technology has radically cut the cost of data communications by improving the efficiency with which existing digital networks are used.

The new technology enables many users to employ the same circuit simultaneously, with no loss of privacy or confusion of messages. A computer breaks every message down into packets—short bursts of information representing a fraction of the entire message. Each packet has appended to it a "header" containing a variety of control functions and an address indicating its destination, as well as a Frame Check Sequence which checks for errors on the local access line.

The packet then travels to a packet-switching node which is a specialized computer. This computer decodes the header, checks the packet for accuracy and routes it to its destination by the best route, taking into account the volumes of traffic, the possibility of trouble and other factors on the different routes available.

How does packet-switching permit different users to send messages over the same route simultaneously? Each packet — or fraction of a message — is sent on separately from the switching node. If there are two messages from different terminals, the packets composing one message will be mixed together with the packets composing the other as they travel along the high-capacity digital line between switching nodes. Both messages will travel along the line at the same time. At the end of the line, another switching node will separate the packets composing each message and send each group in the proper sequence to the appropriate destination where a computer terminal reassembles the message.

Because many users can simultaneously use the same line, its capacity is not wasted and the cost of using it declines sharply. Users are charged for the amount of information sent, not for connection time or bandwidth leased. Even distance is less a factor than in the past.

In the TCTS Datapac system, the packets are automatically checked for accuracy at each switching node. If errors are found, the packet is automatically retransmitted from its last correct location. Estimated accuracy is one undetected packet error for every 10 billion packets transmitted.

Both CNCP and TCTS offer a wide range of terminals — the users' windows into the digital world. The simplest is the basic teletypewriter terminal. The trend, however, is not only towards terminals capable of displaying information on a cathode ray tube (CRT), but also towards intelligent and programmable terminals containing mini computers with memories or the capability of formatting information, checking its accuracy and a host of other communications functions.

The mini computers inside the intelligent terminals are of course becoming progressively cheaper. New applications are becoming possible. For example, it is no longer necessary to be wholly dependent on a group of programmers huddled around a central computer. In the new "distributed networks", a person can use his smart terminal to perform sophisticated manipulations on the central computer himself or to carry out complicated data transactions with the operator of another smart terminal.

With many different types of terminals and computers sending packets of information into Canadian digital networks, there was obviously a need for standards. Without them, the packet-switching nodes in the networks might not understand the coded instructions for handling packets, while terminals and computers might not be able to figure out what to do with packets received from the network.

TCTS has come up with such a standard and calls it "SNAP" (Standard Network Access Protocol) or "X.25". It has been ratified by the CCITT (Consultative Committee on International Telegraphy and Telephony) as the agreed international standard for packet mode operations. It is also the first step towards eventual world wide communications on a packet basis without costly interface arrangements between nations. In 1980, Teleglobe Canada, the government-owned corporation which links Canadian telecommunications carriers with other countries, expects the completion of a packet-switching link with such networks in the United Kingdom, France and Japan.

The computer economy

The improved efficiency, falling rates and growing reach of the Canadian digital networks have caused many smaller firms to take advantage of data communications. Other factors include the increased processing power and declining cost of computers themselves. There has been a rapid increase in the number of computers used by Canadians — from about 1,000 in 1965 to an estimated 37,000 in 1979. The greatest increase has been in computers with a monthly rental less than $5,000.

With the advent of packet switching, a small data-processing firm in southwestern Ontario, Cableshare Ltd., was able to expand dramatically its traditional services to cable TV companies and move into new markets. Not only does it provide computerized general ledger, subscriber accounting and other similar services to Canadian cable TV companies across more than half the continent, it also provides software for such two-way TV services as remote

The Toronto Stock Exchange is linked by computer to 750 terminals throughout North America. It provides the exchange's traders with up-to-the-minute reports on a wealth of financial and business events.

monitoring of homes for fires or burglars. In order to improve the quality of its expanded services, the same company also developed packet-switching hardware which is now being sold abroad.

The computer inside the Toronto Stock Exchange is linked to 750 terminals throughout North America. As well as price quotes, statistics, previous trades and group comparisons on stocks, bonds, options, commodities, and U.S. mutual funds, the system provides commission calculations, full inquiry and response capabilities for all customers and complete wire service information.

Air Canada, Canada's government-owned airline, developed in the early Sixties one of the first commercial on-line real-time computer systems. Reservation clerks at all major airports and downtown centres have direct access to terminals hooked into the system. The system is also hooked into a computerized clearing house which makes reservations on other airlines.

The tellers in nearly every branch of Canada's five largest chartered banks (Royal Bank of Canada, Canadian Imperial Bank of Commerce, Bank of Nova Scotia, Bank of Montreal and Toronto-Dominion Bank) have access to computer terminals to register instantaneously deposits, withdrawals and other transactions. Automated "cash dispensers" are becoming increasingly common, as is automatic payment out of pre-authorized accounts. Inter-branch banking, by which a customer may pay into or withdraw from his account at any of a bank's branches, is being introduced, while computerized inter-bank clearing houses are in the planning stages.

The original stimulus to branch bank computerization may have been the continuing rise in the number of cheques issued and, as a result, the increasing difficulty of handling so many paper transactions. Now bank credit cards — based on computerized information systems — are beginning to cut down on the increase in cheques issued. There is some pressure now to introduce "debit cards". These would have a certain value and fall with each purchase. Some experts envisage a cashless economy in the future.

The technology exists now to enable the electronic transfer of funds. Some Canadian supermarkets are using automated check-out counters to identify goods by the "Universal Product Code" now found on much merchandise. The system provides automated inventory control, credit authorization and information on the customer's record. Consumer organizations have, however, expressed concern about potential abuses.

In Toronto, customers can telephone the computer at the Simpsons-Sears department store. The computer orally gives the customer instructions on how to get information on the goods to be purchased. The customer then places an order with an ordinary touch-tone telephone. He can choose to have his account debited directly or have the merchandise delivered C.O.D. He can even give limited instructions about the place and timing of the delivery.

The traditional cash register is also beginning to give way to new point-of-sales terminals. When networks for transferring funds electronically come into existence, these terminals will debit a customer's bank account for the price of the purchase. Some point-of-sales terminals are also capable of automatically initiating the re-ordering of goods when their supply falls below a certain level.

Eventually, when these terminals are directly connected to automated warehouses, re-ordering may become fully automatic, as will the electronic transfer of funds to the wholesaler.

Most major Canadian libraries now belong to one or more national and regional computer-communications networks which have sprung up in the last decade. These information retrieval services provide access to a host of computerized bibliographic data banks, many of them Canadian. The library loan function has also become automated, as has book-ordering and cataloguing in many cases. Without computer communications, it seems doubtful that Canadian libraries — many of them with limited budgets — would have been able to cope with the information explosion without some reduction in service. The new intelligent terminals have meant most Canadian libraries can share a central computer facility with many other libraries and users. Some librarians see the possibility of the electronic book, which could be transmitted from the library over a digital network to the user's home computer.

Business and government have been affected by the computer communications revolution. Automatic word processors — computerized systems for printing, storing, transmitting and recording words — will soon outsell typewriters in Canada. In 1981, CNCP Telecommunications plans to introduce its Infotex system, a national network of word processors, rendering electronic mail a reality. Facsimile printers, renting for under $200 a month, may also serve as electronic mail terminals. Many organizations already have internal computer message

Many Canadian supermarkets, such as Steinberg's, have introduced computerized check-out counters which can automatically identify the "universal product code" now found on much merchandise.

Computer terminals are an increasingly common sight in many of Canada's chartered banks, permitting instantaneous recording of transactions. Automatic cash dispensers and inter-branch banking are other popular, new features.

services. Some Canadian salesmen, for example, now use cassettes to record customer requirements and use acoustic couplers to transmit the information by telephone to their company computer. A few computer service bureaus now offer an "electronic mail box" service. Electronic mail is faster than traditional mail, and its costs are already competitive.

Word-processors can simplify enormously the preparation and processing of correspondence, purchase orders and invoices. The electronic mail capabilities of the digital networks of the future will enable the easy transmission of such material to other locations. File clerks may be operating a terminal which permits the storing and retrieval of documents in a computer. Systems for transferring funds electronically will automate the financial side of a business. Forecasters predict that the average annual increase in purchases of such equipment will be 32 per cent over the next five years. As data communications, data processing, word processing, electronic mail and electronic funds transfer functions all blur together, business offices could become multifunctional work stations located in employees' homes. Commuting might become a thing of the past in an age of energy scarcity and enhanced computer communications.

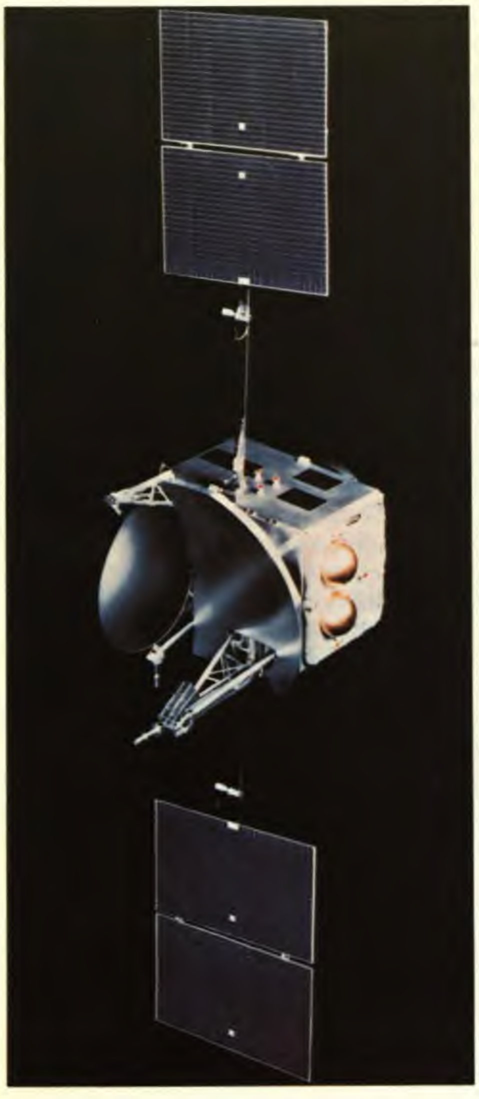
Canadian economist Stephen Peitchinis recently estimated that one half of all the technical changes occurring in Canadian industry were computer-related. Resource industries were particularly affected. Various processes in the Canadian pulp and paper industry are now electronically controlled. Computer-simulation models and computer communications have already played an important role in a major oil find in western Canada. Computer simulation models developed by the University of Alberta can also play a significant part in determining how best to extract the oil.

Computers, almost since their inception, have been used in Canada for engineering design. Automated drafting systems are a commonplace in many manufacturing plants, development laboratories and architectural offices. Printed circuit boards, bottles and jet engine impellers are only a few of the manufactured goods designed by computer in Canada. The computerization of production, material and inventory control has long been an accepted practice in Canadian industry. Computers are providing on-line direct control of machine tools used in manufacturing. About 1,500 numerically controlled machine tools are in place in Canada. The trend to electronic control is spreading to metal-cutting equipment and such processes as flame cutting, brazing, plating, welding, flow soldering, pattern and fabric painting and spray painting. The Canadian Pacific Railway (CPR) shops in Winnipeg use industrial robots and other computerized machine tool combinations. Government officials anticipate the first fully automated factories by about 1985.

The digital revolution will move growing numbers of Canadians from production jobs to information-related jobs. With 40 per cent of its work-force employed in information-related activities, Canada has an information-intensive economy and is second only to the United States in this respect. In the next few decades, some predict that three out of four Canadians in the labor force may be working in information. The structural changes in the Canadian economy will be enormous, and have already begun. Perhaps the Science Council of Canada sums it up best: "Just as the introduction of electricity had profound impact on mankind, so the introduction of the new information communications leads to developments that strain our powers of projection. One could, however, attempt to list the uses of the new technology and the ways in which it will transform society. Such a list would reach into almost all aspects of life, almost all industries and professions."

The gallows frame telephone was developed by Alexander Graham Bell. It transmitted the first speech sounds on June 3, 1875.

Anik B, a Canadian communications satellite launched in December 1978, makes 12 channels available for commercial domestic use. The satellite weighs 923 kilograms and is 1.8 metres wide and 11.3 metres high with its solar panels extended.



The electronic bond

Canadian determination to overleap vast distances and difficult geographical barriers electronically emerged early. In 1852, Canada became the first country in North America to lay a submarine telegraph cable – between New Brunswick and Prince Edward Island on Canada's Atlantic seaboard. The first long-distance telephone conversation in history was carried in 1876 between Brantford and Paris, Ontario, on lines provided by the Dominion Telegraph Company of Canada. The first transatlantic radio signals, resulting from research substantially funded by the Government of Canada, were received in Newfoundland.

Canada now has a total telecommunications capacity greater in nearly every category than any country in the world. As a proportion of total population, Canada has more telephone subscribers, broadcast receivers, broadcast channels available by cable and cable television subscribers than any other nation.

With a small population scattered throughout a vast country divided by formidable natural barriers, the creation of an elaborate and highly sophisticated telecommunications system was a vital necessity. These factors also set their impress upon the system and shaped it in a unique way. There were too few people and too much territory in Canada for private investors to finance the construction of such a system almost wholly out of their own pockets, as was largely the case in the United States. On the other hand, the tradition of private enterprise was too strong throughout much of this country for Canadians to imitate many European examples in which nearly the entire telecommunications plant was owned and operated by a state agency. Instead, Canadians opted for a mix of public and private enterprise, with the latter predominating. The public sector still plays a key role on the Canadian prairies and in the provision of such special services as overseas and space communications.

In the case of telegraphic communications, Canada's two transcontinental railroad companies – the publicly owned Canadian National Railways and the privately owned Canadian Pacific Railways – had taken over most of the business by 1920. Now, with their telecommunications divisions united under the name "CNCP Telecommunications", a unique blending of public and private enterprise operates the Canadian public message telegraph service, as well as Canada's telex traffic, a national data communications system. Though 250 telephone companies still survive in Canada, two private companies and their subsidiaries own and operate most of the facilities in the west coast province of British Columbia and in central and eastern Canada. On the prairies, agencies of the three provincial governments own and operate telephone systems serving an area of 1,763,142 square kilometres. In the area of broadcasting, the publicly owned Canadian Broadcasting Corporation operates six national networks in two languages, in competition with a vibrant private sector. Canada's extensive satellite system is owned and operated by Telesat Canada, a corporation jointly owned by the Government of Canada and a consortium of Canada's major telecommunications carriers, both public and private. Teleglobe Canada, owned by the Government of Canada, links the Canadian telecommunications system with its counterparts in countries all over the world.

This earth station at Inuvik in the Northwest Territories is one of 100 in the national network of Telesat Canada, an enterprise owned jointly by the federal government and Canadian telecommunications carriers.

Canadians probably have access to more television than any other people. The Canadian broadcasting system is a mix of public and private, national and provincial networks. Above, a studio of the government-owned Ontario Educational Communications Authority, familiarly known as TVOntario.

This mix of public and private ownership has served Canada well. Until the advent of the communications satellite, microwave was regarded as ideal on long-haul, high-density routes and for television transmission because of its capacity for carrying large quantities of information economically. In 1958, the Trans Canada Telephone System (TCTS) completed its cross-Canada microwave route, thereby permitting live nation-wide television programming. Now a CNCP route and a second TCTS one span the 6,500 kilometres of rough terrain between Canada's east and west coasts. Microwave towers, spaced about 50 kilometres apart and capable of amplifying and relaying signals, reach into Canada's North. One microwave channel can transmit more than 1,200 telegraph, data or telephone messages, and the system can carry radio and television programs, computer communications, telex and other telecommunications services. The microwave system is one of the two major components of Canada's electronic nervous system.

The other is the communications satellite. In 1973, Canada entered the space age with its own domestic commercial communications satellite service. The Canadian communications satellite system provides a complete range of telecommunications services and vital communications links for Canadians in remote areas – especially in the far north. New higher power Canadian satellites – the prototypes for the direct broadcast satellite of the future – have been tested, and will in the near future make possible a qualitative leap in the level of service to remote areas (See *Communications Satellites: The Canadian Experience*, another publication in this series).

The satellite is only one of many recent advances in communications technology which is challenging the assumptions of Canadian users and suppliers of telecommunications services. As the 1980s begin, even the traditional distinctions between the different modes of telecommunications are shifting and blurring.

Telegraphy, for example, is a diminishing part of the business of CNCP Telecommunications which, with its 16,000-kilometre microwave network, was Canada's telegrapher *par excellence*. Now the network is ever more an electronic highway for telex messages, computer data, an early and partial version of the prototypal electronic letter, television signals, facsimile, voice transmissions and other information being moved by industries, businesses and government.

Telephony is also no longer the only concern of Canadian telephone companies, even though they own and operate some 15 million telephones and 23 million kilometres of circuits. The major telephone companies now provide competition for telex, a wide variety of data services and the plant for distribution of television and radio signals. Bell Canada, the largest private telephone company in Canada, will soon be conducting field trials with a videotex or two-way TV system which could transform Canadian homes into electronic windows on the world.

The telephone network itself is being transformed. The digital electronic switch is gradually supplanting the electro-mechanical step-by-step and crossbar switching equipment. Electronic switching systems can handle calls faster and more economically. The first became operational in 1977 and they are now widely used in Canada. In January 1979, Bell Canada brought into service in Canada's capital a new digital multiplex telephone switching system, the DMS-200, with a capacity of 60,000 trunks – more than double the capacity of any analog switching system now in use. With the new digital technology, it is possible to carry simultaneously 24 conversations over one circuit at a transmission speed of 1,544 kilobits* a second. And the sound of a caller's voice will be much clearer and freer from interference than with the traditional analog system.

**a bit is the smallest unit of measurement of capacity in a memory storage device.*

Bell Canada and its subsidiaries now lead the world in designing, developing and manufacturing the electronic telephone, the first radical change in design since the inventor completed his experiments 100 years ago. These telephones of the future have already been introduced into some Canadian homes and offices. Their integrated circuitry means that they have fewer parts, are cheaper to repair, use less energy and are cheaper to produce than the traditional electromechanical phone. The new phone will also offer sound of the same quality as a hi-fi radio-television console. In the future, it may contain a computer memory bank capable of listing frequently called or emergency numbers, and a custom display capacity which looks and acts like a pocket calculator and can tell in advance the cost of long-distance calls. And perhaps by the end of the 1980s, Canadians will be able to dial their home number and their electronic telephone will automatically turn off their lights or turn on their microwave oven.

The new communications satellite technology has meant that about 99 per cent of the people in this country can now be reached by both radio and television programming. The demand for such programming is strong: 97 per cent of Canadians have radios, 86 per cent have FM radio, 97 per cent have at least one television set and 74 per cent have a color TV. The publicly owned Canadian Broadcasting Corporation (CBC) meets this demand every year with 18,000 hours of original TV programming and 150,000 hours of radio programming.

Canadians want more than the CBC or Canada's private stations deliver. More than 51 per cent of Canadians are hooked into cable TV systems and the figure approaches 80 and 95 per cent in such major cities as metropolitan Toronto and Vancouver. One government task force recently suggested that the era of off-air broadcasting, which is subject to interference from high buildings and power lines in urban areas, may soon be over. Canadian broadcasters may soon hook up directly with urban cable systems and provide a closed-circuit service to Canadian homes.

The Canadian government may also license a pay-TV system which would use satellites to broadcast signals directly into cable systems serving subscribers' homes across Canada. With the direct broadcast satellite just over the horizon, government officials are anticipating a whole new constellation of television services in Canada. Such satellites, capable of carrying up to 100 television channels, could transform Canadian television. Canadians may eventually be able to choose among 100 channels, each devoted wholly to serving some special group — children, the elderly, opera fans and sports buffs. Some, like the Science Council, even go so far as to say that the transformation of such a powerful medium as television could inaugurate a new cultural revolution, one which strengthens the diversity which is the central fact of the Canadian cultural experience.

The CN (Canadian National) telecommunications tower in Toronto, at 1,800 feet, is the tallest free-standing structure in the world. It has broadcast facilities for television (UHF, VHF and cable), FM radio and microwave transmission.

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