Scientific and Technical Information in Canada

Part 1

Prepared for
The Science Council of Canada

SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

PART I

Special Study No. 8

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THE SCIENCE COUNCIL OF CANADA

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FOREWORD

This Report on the Study conducted by Mr. J.P.I. Tyas and his colleagues is published as one of the series of Special Studies commenced by the Science Secretariat and now being continued by the Science Council of Canada.

The origin and status of this report are somewhat different from others in this series. The study was originally proposed by the Department of Industry in 1967, was by agreement taken over by the Science Secretariat, and is now being considered by the Science Council of Canada's Committee on Scientific and Technical Information Services as an important background study.

As in all other special studies, the report represents the opinions of the authors only and does not necessarily represent the opinion of the Science Council of Canada, or the Science Secretariat.

This publication contains Part I of the report. Part II is being published separately and will be available shortly in seven separate sections, each containing the report of a major subgroup, thus providing background data and considerations to complement the recommendations in Part I.

P.D. McTaggart-Cowan
Executive Director
Science Council of Canada

PREFACE

The Honourable C.M. Drury, Chairman of the Committee of the Privy Council on Scientific and Industrial Research, inaugurated the Study of Scientific and Technical Information in Canada on March 20, 1967, under the auspices of the Science Secretariat.

The charge of this Study Group has been to deal with "scientific and technical information". However, it is rather the information requirements of the scientist, technologist, and technician that must be considered. These include such things as economic, statistical, and engineering data, medical and pharmaceutical information. As knowledge pervades all aspects of our lives, the evolution of scientific and technical information services in Canada must also relate to information services of a more social and economic nature.

In examining the many facets of the creation, handling, and use of scientific and technical information, the Study Group concerned itself with services and users in the industry, government, and university sectors; information handling techniques and types of sources, specifically library and international resources; education and training of information personnel and the user; and the economics of information handling. Detailed discussions of these areas will be published separately as Part II of this report. The individual chapters of Part II reflect the views and recommendations developed by the subgroups acting independently. Summaries of the subgroup reports and their full recommendations are given in the appendices to this section, Part I, of the report.

Part I of the report represents the consensus of the committee of subgroup chairmen which was chaired by the Leader of the Study Group. The recommendations in Part I cover only the major actions required to implement the findings of the Study Group. Recommendations on specific areas or details will be found in the appropriate subgroup summaries.

Acknowledgment is made to the large number of people who contributed to the Study through consultations and submissions, especially Mr. W.T. Knox, former Chairman, COSATI, and members of the Science Secretariat. Special appreciation is expressed to Mrs. A.M. Mitchell and Mrs. R.S. Bennett for their excellent secretarial help and for their immense fortitude.

J.P.I. Tyas, Study Group Leader
Subgroup Chairmen:

H.C. Campbell	A.B. Hunt
J.A. Campbell	R.E. Pomfret
J.W. Cherry	L.G. Vagianos
Guy Forget	H.J. von Baeyer

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Chapter I

KNOWLEDGE: THE MASTER RESOURCE

Knowledge permeates all interests and areas of our lives. It is vital to our existence and must be effectively utilized for our development. A fundamental Canadian need today is to encourage the use and further the exploitation, throughout all regions and all sectors, of the vast amount of world knowledge. It is the master resource.

More and more people appreciate that the chief source of wealth lies in human intellect: it is simultaneously the largest underdeveloped resource in the world. At one time the most valuable national acquisition was land, then mineral resources, then military power: today we are moving toward the acceptance of new technology and its economic benefits as the most essential ingredient of, and means to, future security, prosperity, and socio-economic well-being. Minds are far more flexible and expandable than land, but they need a suitable environment and adequate nutrition. Education and new ideas are their diet.

A dynamic economy requires an expanding industry, optimizing the use of resources to increase productivity. In addition to generating new knowledge through research, this requires the fullest possible application of available knowledge, the transfer of new technology to industry and of new ideas to the most fertile minds.

We have been inclined to look at the good things that science and technology have given us, disregarding the concurrent problems—social turmoil related to the adoption of new technology and automation, the wide divergence between wealth and poverty, the lack of food and education in a world with agricultural surpluses and satellite communications, the pollution of our world through excessive dumping, and the squandering of resources. Our society demands and our affluence now allows us to consider these problems and their possible solutions. We are moving from limited disciplinary to broad mission-oriented issues. We need to know more about pollution, urbanization, transportation, and communication. We need invention, innovation, and education.

Economist Barbara Ward, giving her Noranda Lecture at Expo '67, stated:[1]

> "Our institutions, statecraft, habits of mind, practice of politics and economics do not match the new facts. This generation fights a 'morning's war' where light and dark contend and new opportunities and old habits are intertwined in

> every society and indeed in every soul.... The speed of change in mankind, conditioned by education and environment and a certain rhythm of growth, does not necessarily match the speed of the changes that can be made in scientific research and technological development. There is, and probably must be, a time lag. But delay does not change the fact that men confront their gravest dangers when too great a disproportion develops between technical and physical reality on the one hand and normal political and social habits on the other... so our 'morning's war' between the old and the new may well determine our very survival. We have to realize the incongruities and imbalances. We have to see where we are still slaves to the old. We have to seize on the signs of a breakthrough to the new realities. We have to be ready to use them as springboards for further advance."

The aim of an industrial society is the timely transformation of the maximal amount of new knowledge into the production of goods and services for the achievement of social advances. The most efficient mechanism for this transfer lies in building scientific and technical information (STI) services co-ordinated and tailored to the diverse areas and levels of interest and to user needs. It is necessary to stimulate the optimum utilization of STI, not only by the scientist, but by all potential users in the community. People must be trained to operate in this environment and use the newly developing STI services.

Only the very largest nations can support an R & D effort in more than a few selected areas. However, most of the world-wide advances in science and technology are publicly available in some 2 000 000 documents and articles, 26 000 reputable journals, and over 30 000 books published each year. This enormous flood of printed matter, growing by a factor of 10 every 50 years since the 18th century, is now being augmented and sometimes replaced by other storage media. Data and information are being compactly and rapidly handled by photographic and electronic means. Increased use must be made of new techniques, media, and methods to cope with this continuing deluge of STI and a similar explosive increase of users.

A comprehensive automated STI network would potentially ensure complete awareness of all available technology, meet the increasing user demands, and improve accessibility to this resource. Such a network would be designed to make the most economical use of modern technology to reduce housekeeping functions and unnecessary human handling, while ensuring optimum accessibility to STI. Initially, electro-optic consoles connected directly to computers in regional information centres would provide local access to regional bibliographic resources and transmit messages requesting documents. Later, similar consoles would be in direct communication with computerized data and information banks. Any item of information available in such Canadian computerized resources would be directly accessible from coast to coast.

Chapter II

KNOWLEDGE MANAGEMENT IN CANADA

Knowledge is the master resource of our time. Particularly valuable to the economic growth of the nation is that form of knowledge called "scientific and technical information", or STI. Men and nations create it, buy it, sell it, process it, mould it, package it, and barter it. It knows no national boundaries. This STI forms the "know-how" and "know-why" the Economic Council of Canada sees as the application of knowledge to the production of goods and services that satisfy human needs. With STI we master other resources.

One large Canadian company will invest more than $270 000 in its own STI services during 1969. Similar investments have enabled this organization, in less than 10 years, to reverse its trading position. From a purchaser and importer of foreign technology it has become an originator and exporter of its own new technology. Thus application of STI enables companies and countries to flourish in the face of world-wide industrial competition, create new jobs, train people for meaningful occupations, develop natural resources, and understand new technology introduced from abroad.

Canada consumes, processes, stores, and applies much of the world's output of STI although originating less than 3 per cent herself. Canada operates expensive institutions or systems for gathering this information and distributing it to the people who can apply it. The cost of STI in Canada's economy comes to several hundred million dollars a year, a large percentage of her expected 1968 research and development expenditure. Yet many of these millions are in danger of being wasted. Duplicated and unused data warehoused in seldom-entered places threaten to price STI beyond our means to recover and apply it. Canada's STI services also neglect many users.

II.1 Shaping the Study

In March 1967 the Study of Scientific and Technical Information in Canada was asked to survey existing scientific and technical information services, their availability and the extent of their use, for example by scientists and engineers, medical and health professionals, food processors and drug developers, and managers of manufacturing and industrial concerns. These users are Canada's technologists, men and women whose economic

future depends on how well they acquire, manage, and apply the master resource of STI in their professional services and commercial enterprise.

Industry, government, and the Canadian universities had approximately equal representation within the Study Group. Study Group members probed into national government departments and agencies. They consulted with provincial and university officials from Halifax and St. John's, in the Atlantic Provinces, to Victoria and Vancouver, in British Columbia. Formal briefings and consultations took place with responsible people from the United States, the United Kingdom, the U.S.S.R., and the Organization for Economic Co-operation and Development (OECD). The Study Group examined, assessed, and discussed 233 written briefs filed with it by affected agencies, individuals, groups, and associations. Over 1 000 relevant documents were studied and evaluated. A survey of user costs was conducted; replies were received from 2 500 individuals from industry, government, and universities. The Study Group also benefited from studies completed by the President's Science Advisory Committee[2] and the Committee on Scientific and Technical Information (COSATI)[3] in the United States, and the Parliamentary and Scientific Committee,[4] in the United Kingdom. Significant recent Canadian reports included those by Downs[5] and by Bonn[6] on libraries, and by Brown and Lamb[7] on government information services.

From this experience the Study Group's members obtained a clear picture of the strengths and weaknesses of the present information systems and services for Canada.

Findings of the Study Group reach into the heart of governmental data-handling procedures, the practices of the country's 4 300 libraries, and the use of information by more than 34 000 manufacturing establishments. Major discoveries include the approximate costs being paid now for STI, the general lack of satisfaction with STI services in Canada, and the willingness of industry to pay for improving these services. People expect to pay because a specific piece of information from the sea of knowledge gains value when put into the hands of the user when he needs it.

II.2 Changes Needed Now

Immediate action is required by all sectors to:

1. Improve the transfer and exploitation of new technology to promote Canadian industrial expansion and to maintain a competitive world-wide position;
2. Apply effectively our knowledge resources in the training and efficient utilization of our rapidly increasing manpower pool;
3. Avoid the habitual subsidy of existing inadequate methods of STI transfer.

Many systems in government and university centres are underused, duplicative, slow, and increasingly incapable of coping with an explosive situation. Barriers exist between users and the institutions that provide STI;

we must dissolve these barriers. Installing new communications networks between the STI warehouses and the STI users will make much duplication unnecessary and speed delivery of STI to the right people, at the right place, and at the right time.

Modernizing the STI system in Canada will cost tens of millions of dollars. However, supporting present methods of STI handling will eventually commit Canada to spend unnecessary hundreds of millions of dollars within a few years.

II.3 Cost of STI Search

Sifting the master resource of STI knowledge for needed information costs Canada dearly now. The Governments Subgroup, as shown in Part II of this report, estimates that the limited number of federal government departments and agencies who have current figures spend $24 million annually for library and information services. The Industrial Subgroup estimates that manufacturing concerns spend $45 million, and the construction industry, $30 million. Universities estimate that their annual library expenditures amount to $40 million. Figures are not available for provincial, municipal, and other educational institutions, but they likely run into tens of millions of dollars annually.

Further expenditures are incurred by the users of STI in searching out useful information. The Economics Subgroup carried out an extensive user study and determined that scientists, engineers, and technological managers spend about 15 per cent of their time searching for appropriate STI. Average cost in salaries, as determined by the Economics Subgroup, amounts to more than $1 800 a year. Applied to the 120 000 such professionals in Canadian industry, salary costs alone for STI search exceed $200 million annually.

Canadian technicians, the craftsmen of our modern industry, impose further incalculable expense upon library and information systems of the country. Some metropolitan librarians report that about 20 per cent of their effort is now directed toward answering enquiries from industry employees, seeking to adjust their training and experience to the demands of industry moving into more complicated and technical operations. Library and user costs are not available for this large and growing sector of Canada's technical population, but a conservative estimate would place this cost in the order of $100 million annually.

Clearly, management of this master resource of knowledge is expensive. The above estimates reinforce the Study Group's opinion that actual costs exceed half a billion dollars a year. It is a cost the country and its industries bear to remain prosperous, competitive, and expansive. It is evident, also, that introducing new efficiencies into any system involving such large sums will reflect as a real economic gain, through reduced costs for each user and in greater accessibility to the available STI for the time and money invested.

II.4 Service: Improvement Desired

Cost and efficiency would concern the Study Group less if the present arrangement satisfied STI users. It does not. And no evidence was presented to indicate that better utilization of our STI resources would result from paying more to expand library and data-gathering systems as they now exist at federal, provincial, and university levels. Indeed, independent studies of the library system show that the expected doubling of university enrolments likely will far more than double present library expenses. One social science and humanities research library complex for the University of Toronto alone will cost more than $42 million. And the expense of bringing the country's library system up to the standards set by library associations calls for the purchase of books costing several hundreds of millions of dollars. Caring for these volumes, in effect a duplication of books already on the shelves of many Canadian libraries, will require the training of many hundreds of additional librarians. There is doubt that the schools of library science can meet this demand.

Such duplication appears too expensive for STI purposes. Each year new STI appears in 26 000 periodicals, which carry more than two million articles; the most ardent full-time reader could not absorb even a thousand of these a year. In addition, more than 30 000 new books on science and technology come out yearly. Scientists and engineers work mostly from journals and texts that are less than five years old, so it is necessary to catch this flood of information when it is fresh.

Already the system breaks down for STI users. Interlibrary loans take days to arrive with information needed within 24 to 48 hours. The Study Group heard from one research centre which must order documents shortly after the first of the year in order to conduct its summer operations.

The style and mode in which information is stored pose other service problems. Written originally by specialized researchers, much STI appears in words that have little meaning for people outside the specialties. Because it is difficult to cross specialty lines, much of the STI resource lies unworked or its practical value unrecognized. Recently a group of North American businessmen was amazed to discover in Germany a new means of burning garbage under controlled conditions without air pollution; the method also produced usable heat. The process had been operating for 10 years without coming to their attention.

Service of STI to potential users breaks down in another area also. University library officials informed the Study Group that they give little encouragement to industry to use the universities' vast STI stores. With some justification, these officials feel that their staff and facilities are strained now to meet faculty and student requests. A few instances of co-operation, ranging from pleasant to grudging, were found between certain industry librarians and some university librarians. But generally, after a scientist, engineer, or industry manager leaves the campus, the university

and its library are through with him. Where co-operation exists, the industrial user experiences delays because he is not the main customer.

Only rarely do the municipal libraries stock the materials that prove useful to the industry technologist.

Service to managers of technological industries, scientists, and engineers from STI resources in government appears little better. Although the spirit may be more willing, the problems of slow delivery, inadequate organization of STI, and lack of knowledge on how to use the services of federal and provincial departments and agencies flourish in government also.

II.5 A Few Satisfied Users

Study Group members found only one group of reasonably satisfied users of the present STI services of libraries and data collections. This group consists mainly of the researchers for whom the systems were originally devised. These are the very specialized graduate students and the discipline-oriented researchers in university, government, or advanced industrial R & D laboratories. Generally they hold one or more graduate degrees. They have the time and desire to conduct their own extensive literature search. They have a relatively few and well-known personal contacts with whom they need to consult. These men occasionally have one or more highly trained assistants who can help them sift the resources of STI. All of this contributes to their satisfaction.

However, the Study Group found some reason to question how much confidence is justified among these users. Several times references were made to inadvertent duplication in R & D projects. Such duplication cannot be brushed off lightly, considering the present high cost of research.

Another group of partially satisfied users was found among industry. This group includes scientists, engineers, and managers working for the handful of companies experimenting with automated STI systems. When the costs of locating technical information approach $30 000 a year, companies start to consider computerized systems as a way to get more information for their money. Results are far from perfect so far, but the speed and greater variety of material provided are justifying their further development.

II.6 Industry's Needs

Advantages of the present services generally are lost for the average industrial engineer, manager, and technologist. They want to spent the least amount of time away from their work hunting STI. Information may be needed to solve some sudden production crisis, for example. Thus, their search becomes limited to a few easily available journals, trade publications, or personal sources of STI.

Present services work definite disadvantages on managers of the many smaller companies. They struggle to meet market competition nationally and internationally while searching out STI on new materials, techniques, and processes by slow and less thorough manual methods. Only a few of

the 34 000 manufacturing establishments in Canada seek STI through more than one government agency, for example.

Since much of the available STI is unknown or inaccessible to the majority of potential users, proposed expansion costs of bigger library and data storage systems as they exist today generated grave concern. Industry bears a high tax burden, and federal and provincial taxpayers support more than 80 per cent of university and governmental library expenses. Industry users should receive easier, more useful access to the STI materials held in Canada. Canada's government agencies and universities rank seventh and eighth, by 41 companies surveyed, as sources of useful STI. Slow response and ignorance of the available services appear to be the chief reasons for this.

Only total reformation of government and university data and information collection, processing, and distribution can help supply the needs of future industrial growth. A comprehensive, automated STI system must evolve, serving the community at large. For value received, industry is willing to pay.

II.7 Proven Technology Available

The most encouraging finding of the Study Group: proven new technology now exists to mine the master resource of STI more efficiently. Practicality demands the use of these new products of science and technology to contain the explosion of technical knowledge and to ensure its accessibility to a rapidly growing number of users. An integrated, automated STI system evolving from the old and the new methods of information storage, retrieval, and communication can supply more effective STI services than existing systems. Costs appear much lower than for mere expansion of present methods. Canada can move knowledge around the country at a fraction of the cost of duplicating and storing books and other materials in existing and proposed libraries. The Study Group's cost estimates indicate that a broadly based national system would meet the essential information needs of professional scientists, doctors, engineers, managers, and industrial technologists for a few hundred dollars a year per user.

New technology alone is not a solution. Technology must be supported by a set of national policies covering the purchase, handling, copying, and distribution of STI resources in Canada and in training people to manipulate and use STI. A sprouting of diverse, unco-ordinated systems will increase the costs unnecessarily; guidance must be applied in the national interest.

II.8 Communication Networks

Speed of service for all STI literature requests can be improved through communications networks which connect the STI user with all possible sources, and then fulfill his requests with copies of any book, set of journal articles, abstracts, and bibliography references he seeks. For Canada's purposes, such a communication network will have regional and perhaps municipal outlets based initially on telephone and teletype facilities. Even

today services could be speeded immensely by more use of the telephone or telegraph. As communication networks and terminal equipment improve and become more economical, the Study Group predicts the eventual installation of private audio-visual terminals in homes, offices, and medical consulting rooms.

II.9 New Techniques

Microphotography, reproduction by digital computer codes, facsimile transmission, and closed-circuit, fine-screen television cover only a few of the many ways documents will be transmitted in the future. Microform storage on film has been used for a number of years, particularly for old and rare documents. Photocopying techniques have gained tremendous commercial acceptance in business and industry. They are becoming more widely used in libraries as well.

Automatic reader-printer equipment allows a user to scan films containing greatly reduced images of the information he needs and to make legible photocopies of selected material. The U.S. Patent Office is developing a system in which windows in computer cards contain filmstrips showing complete patents. Several commercial companies sell similar applications of this new technique. In the near future, installation of this general type of equipment will be desirable for information centres. But for the present, sizeable gains in speed of service can be registered by replacing second-class mail service for lending library requests with photocopy and first-class air mail. Librarians at a library reproduction centre can fill a telephoned book request with a sheaf of micro-image cards reproducing the book or document. Sending these by first-class air mail will bring a user his STI within 24 hours anywhere in Canada.

II.10 Computers

In the near future computers will handle most of the tedious chores of library management and supply input to the communications networks that can shift information and data around the nation. Eventually they will form the backbone of information services, aiding users through remote, time-shared computer consoles.

Canada can profit most immediately by using proven computer programs to perform the library housekeeping. Several Canadian libraries are working on this now, and the Government should give them every encouragement. Bell Telephone Laboratories, in the United States, keeps track of loans, returns, renewals, reservations, requests, and overdue notices for three large company libraries this way, eliminating 60 000 hand-processed notices a year. Computers can maintain card catalogues, directory-type catalogues, and speed many other functions that make the professional lives of many librarians little more than a clerk's job. The University of Toronto was one of 16 libraries working with the U.S. Library of Congress on a successful experimental cataloguing system.

Canadian Industries Limited uses key words to search reels of magnetic computer tape for its machine-prepared indexes and for custom searches of U.S. chemical patents. Other automatic indexing systems suitable for Canada can create bibliographies on requested STI search topics. The National Science Library provides an automated Selective Dissemination of Information (SDI) service based on *Chemical Abstracts.*

II.11 Toward a National Policy

Once STI is recognized as an essential activity for resource allocation, cost of the network and system operation appears to be one of the least expensive investments supporting economic growth. If each agency develops its own unique facilities, a colossal waste of resources will result; a large part of this waste will be financed by government. For, directly or indirectly, government pays the bill for most activities in the STI field.

The Study Group considers that present major libraries, special libraries, and newly developing information services and data banks are essential elements in the evolution of a nation-wide STI network. Such evolution will require a higher degree of co-operation between the operating agencies. It will require constant co-ordination nationally. Compatibility between the subsystems on a national and international basis will be essential when it is economical to link sources and services internationally.

Estimates prepared by the Economics Subgroup proposed establishment of a swifter STI network, containing six main regional information centres, introduced over a two- to three-year period. Cost for these centres was estimated at $1.5 to $2 million each for initial input and programming; the annual operating costs came to $2.5 million per centre. When all six are fully operating, the Government would have a capital investment of $12 million and running costs of $15 million yearly. This network can be increased to 20 centres over another three to five years, and the Government would be committed to no more than $50 million in operating costs annually and an additional capital investment of $25 million. This is a fraction of the suggested amounts—$300 to $400 million—likely to be spent for conventional facilities over a similar period.

The world is already saturated with information accumulating in our society, minds, libraries, and information centres. The Study Group concludes that attention needs to be focussed on the problems of information retrieval, classification, and storage; our most advanced techniques must be applied and a highly sophisticated system developed to recover this knowledge. Otherwise business, commerce, universities, and governments will find it increasingly difficult to function efficiently. STI must be applied to the more practical problems facing our society, not to R & D alone.

Chapter III

THE WORLD ENVIRONMENT

III.1 Canada Past and Present

The explosion of knowledge in science and technology for the past two decades has produced a jumble of ways to record, translate, analyze, abstract, store, reproduce, and account for the master resource of information. Like Canada, most of the world's advanced countries and many underdeveloped ones are trying to improve their use of knowledge resources.

Canada many times led the world in developing new ways of dealing with technical information and technology transfer. Much of the theory and methodology for automated data recovery stems from the DATAR system conceived more than 15 years ago for the Royal Canadian Navy. Canada's Technical Information Service, established in 1945, uses field officers to give personal assistance to small-business men seeking guidance in adopting new technology. The information services of the Division of Building Research of the National Research Council of Canada pioneered special industrial information services for the construction industry.

Last year the former Department of Industry launched a new and welcome program in industry–university co-operation. The department's goal is the establishment of many Industrial Research Institutes at Canadian universities. Already four institutes provide research services, for a fee, to industry. They will promote closer relationships through proposed consultations, specialized training projects, and seminars.

National Science Library

Further recognition of the importance of STI transfer was given in the revisions of the National Research Council Act of 1966, which established the National Science Library (NSL). It is Canada's foremost library of scientific and technical documents, the depository for all NRC publications and those issued by the atomic energy establishments of the United States and the United Kingdom and by the U.S. National Aeronautics and Space Administration. The NSL also keeps the publications of scores of other foreign government agencies and scientific organizations.

The richness of the NSL information store is indicated by its possession of 360 national and international abstracting and indexing services. NSL also maintains widely used journals and operates a translation service. Yet in spite of efforts to publicize its services, in one recent year the NSL

resources were utilized by only a few hundred companies. Only a fraction of the 34 000 manufacturing establishments are even aware of its existence. However, it daily assists many municipal, university, and government libraries.

National Library

The National Library was born in 1953 as the national depository for Canadian books, science and non-science. The National Library maintains a national union catalogue of books held by selected Canadian libraries. Its monthly *Canadiana* is a national bibliography of books produced in Canada or having special significance to Canadians. The library also publishes annually, on microfilm, a bilingual list of Canadian theses. The Study Group found these resources virtually unknown and little consulted by STI users.

Canadian Library Associations

The Canadian Library Association and l'Association canadienne des bibliothécaires de langue française represent over 1 000 institutions and some 3 000 individuals. Among the associations' 10 sections there are groups for information services, research and special libraries, and technical services. They also arrange special committees to study specific problems, such as library mechanization, and issue qualitative and quantitative standards for Canadian libraries.

Government Information Resources

Federal and provincial government information resources are of four general types: libraries, information services, specialized information centres, and data banks. Most have developed in response to particular departmental needs. Considered together, they form the basis of individual mission-oriented sources of documents and information.

Many libraries contain valuable archival collections of documents in specific fields which are available nowhere else in Canada.

Information services have developed to furnish particular segments of the public, such as farmers, fishermen, and foresters, with technical information for their work. Other services, such as health and consumer information, are for the use of the public generally.

Specialized information centres have arisen to permit the rapid retrieval of information in specific fields such as tree diseases, food and drugs, and pesticides and herbicides. They are primarily for the private use of the groups developing them.

Data files of various degrees of sophistication have been set up, those in the fields of natural resources being most numerous and highly developed. Some, such as those involving geological data, operate on a national basis, mainly for the use of government departments and related industry.

Technical Information Service

Twenty-three years ago Canada recognized the need to move meaningful information to users in industry and business. It created the Technical

Information Service (TIS), now managed by the National Research Council of Canada. The TIS, operating 11 field offices that take more than half of its $800 000 budget, serves industry free. TIS field officers answer about 14 000 enquiries a year on materials, properties, processes, research results, technical advances, and plant operation. This personal service, the key to TIS operations, rates very high with users. However, officers soon find themselves concentrating on repeated enquiries from regular customers while many other companies remain unaware of TIS services available to them.

Associate Committee on Scientific Information

Since 1957 the Associate Committee on Scientific Information of the National Research Council of Canada has attempted to look after Canada's information problems. Its members—many from government, industry, and university libraries—have led efforts to try to bring Canadian library and information groups together. The Associate Committee sponsored the Bonn report and instituted postgraduate library scholarships in recognition of the acute shortage of specialist librarians. The effectiveness of the Associate Committee suffers, the Study Group feels, because it meets rarely, has only advisory powers and, by appointment and definition, is wedded too strongly to traditional concepts of libraries and document transfer procedures.

University Regional Programs

The Halifax Area Regional Information Centre, planned to serve all major scientific and technical establishments in that area, illustrates for the Libraries Subgroup the present trend in Canadian universities. British Columbia universities are already automating their services and looking toward a regional network between local universities, educational institutes, and municipal libraries. In Ontario a daily station-wagon service links many university libraries, and consideration is being given to extending this service to the Province of Quebec.

III.2 The United States of America

Canada has not ignored the STI problem, but her efforts should be compared with those of her closest neighbour, the United States, and some STI problems created there. As one of the major producers of STI, the United States has seen more than 500 separate services develop to process world-wide STI literature as well as economic and social data. U.S. officials are very concerned by this sprouting of highly independent services with disparate computer systems, and by the lack of intercommunication and compatibility of programs and equipment. For Canadians, the attempts of the United States to co-ordinate its information systems are most significant.

National Co-ordination

Attempting to order the chaos of computer and information systems in the United States has become a very high-level responsibility, that of the President's Office of Science and Technology and the Federal Council for

Science and Technology. In 1962 the FCST formed a working group now known as the Committee on Scientific and Technical Information (COSATI).[8] Its mission is to:

> "... develop among the executive agencies a coordinated but decentralized scientific and technical information system for scientists, engineers and other technical professionals. As a secondary objective, COSATI will be concerned with coordinating and cooperating with improved Federal and national systems for handling scientific and technical information."

With this charter, COSATI has encouraged development of communication systems to link ultimately all federal systems and provide swift, in-depth information on scientific and technical knowledge.

Federal agencies in the United States evolved independent systems for storing, analyzing, and retrieving information. Now these departmental systems are moving together. Additional pressures for information exchange are being exerted by the Bureau of the Budget and the General Accounting Office, for economy's sake.

Presently, COSATI seeks a consensus from industrial, academic, and government information leaders on methods for assembling a national plan for compatibility of U.S. information systems. This will become the basis for a U.S. position in negotiating international agreements on compatibility.

Paralleling COSATI is the Committee on Scientific and Technical Communication (SATCOM). The U.S. National Academy of Sciences and the National Academy of Engineering set up SATCOM in 1965 as a forum where the private and professional problems of information system development could be discussed and brought before the Government and the public.

In 1965 the Interuniversity Communications Council (EDUCOM) was established. Through this focus the academic community in North American universities can collectively utilize the communications sciences and relate to the efforts of the industrial and government sectors. It deals with information-handling techniques, critical areas of development, and basic research on the different modes of human communication.

Supporting Services

Several private organizations and professional societies receive government grants and contracts to help them develop computerized abstracting and information systems. These serve major areas of physical, medical, and social sciences. The American Chemical Society's *Chemical Abstracts,* in wide use internationally, has been very valuable to Canada.

The Library of Congress in the United States has become a national and international force in developing computerized cataloguing and library systems. The University of Toronto co-operated with the Library of Congress in the MARC system's development.

Another U.S.-developed system to be used in Canada is the Medical Literature Analysis and Retrieval System (MEDLARS). The computer program, developed by the U.S. National Library of Medicine, can pick out title or author of medical documents from more than half a million entries.

The U.S. State Technical Services Act was enacted in 1965 to promote commerce and to encourage economic growth by supporting state and interstate programs to place the findings of science usefully in the hands of American business. Each state, with matching funds from the Federal Government, is encouraged to accept responsibility for information transfer. The Federal Government authorized $20 million for this program for the first three years of operation. In the first two years, ended June 30, 1967, the actual expenditures totalled over $8 million.

III.3 The United Kingdom

The United Kingdom is moving rapidly toward modernized systems of STI transfer and utilization. The Parliamentary and Scientific Committee brings Members of Parliament together with scientists and technologists. Its Subcommittee on Scientific and Technological Information recently issued its report[4] evaluating government information services, measures to consolidate the National Scientific Reference Library, and liaison with other countries. Comprehensive library and information services were termed urgent requirements, and its recommendations point out the Government's responsibility to plan such services and to determine its role in their operation, planning, and co-ordination throughout the country. It also recommends unifying the services under one Minister. Responsibility is now divided between the Department of Education and Science and the Ministry of Technology.

Soon Britain's National Libraries Committee will complete a report of extreme significance to British STI users. The committee was set up after the discovery that the existing systems of book purchasing, filing, and distribution were breaking down. The committee is examining operations of the British Museum Library, the National Central Library, the National Lending Library for Science and Technology, and the Science Museum Library. Committee members were asked to consider bringing the four into a unified library system. Information received by the Study Group indicates that the review likely will lead to the economic application of new technology to reduce duplication and provide easy national access to books and other documents.

Office for Scientific and Technical Information

Britain's Office for Scientific and Technical Information (OSTI) operates in the widest of spheres. Created in 1965 in the Department of Education and Science, OSTI encourages all government departments to improve their STI systems, and stimulates the training of specialists to operate the system. The OSTI managers extend their influence to private sectors of the economy and promote educational programs to train technologists how to use the new services. OSTI also promotes the co-ordination of British efforts in international co-operation and strives to keep national systems compatible with each other and with the systems of other countries.

Ministry of Technology Liaison Services

One main goal—increasing technology transfer to industry—lies behind Britain's creation in 1965 of the Ministry of Technology Liaison Service. The Ministry supports 70 industrial liaison centres which draw upon the Ministry, universities, and research associations for new STI that helps industry innovate. Personal contact and specific problem-solving remain the chief commodities. The centres operate from universities and advanced colleges of technology. The Ministry is setting up a clearinghouse for government scientific and technical documents at St. Mary Cray.

National Lending Library for Science and Technology

In 1962 the National Lending Library for Science and Technology supplanted the overburdened lending service of the Science Museum. It concentrates on the needs of practising scientists and engineers, but also covers agriculture and medicine. Overlap in areas of management and social psychology led to the extension in 1967 of the library's services into the social sciences.

The library has accepted the view that its scientific staff should have both scholastic and organizational functions; that an experimental approach is necessary; and that fluidity is needed to deal with peak loads.

Library managers make special efforts to promote use of the literature and to provide the fastest possible service to customers. The library supplements services of existing organizations and provides its loan services to approved borrowers. Users pay a fee in the form of charges for pads of loan request forms.

III.4 Union of Soviet Socialist Republics

The All-Union Institute for Scientific and Technical Information (VINITI), under the State Committee for the Co-ordination of Research, systematically abstracts world literature in the natural sciences and technology. Its scientific staff of 2 500 scans more than 17 000 world journals and 100 000 patents each year. It abstracts about one million individual articles (70 languages, 105 countries) through 22 000 translation specialists. This output goes to 260 000 organizations and individual subscribers. VINITI gives special attention to preparing bibliographic and reference literature aimed at solving specific industrial problems. VINITI also carries responsibility for training graduate and undergraduate specialists in STI, for international contacts on co-operation and compatibility questions and for basic research.

III.5 Poland

Poland, a small but advanced country, is making tremendous efforts to enter the international market place. The state STI system, formed in 1961, is vital to this effort. Poland's nation-wide STI network is based on government departments, but it beams the STI down to related industrial

centres; these centres supply individual plant information centres. Co-ordination of all the different information centres comes from the Central Institute for Scientific, Technical and Economic Information (CIINTE). CIINTE represents Poland in international STI activities, assumes responsibility for all published STI works, oversees training and research to improve information techniques. This generally resembles the organizations found in other Eastern European countries, including Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, and the U.S.S.R.

III.6 France

French-language coverage of world-wide STI began in 1945 by the Centre national de la recherche scientifique, in Paris. Its documentation centre is now the major source for STI in France, providing extensive abstracting, photocopying, and translation services.

A new development is *Revues-Sommaires,* a monthly compilation of the tables of contents of 400 French-language scientific and technical periodicals; 12 000 copies circulate in Canada.

R & D on information processing has proliferated, and a national inventory of such work has just been completed. An agency has been established under the Délégation générale à la recherche scientifique et technique, in the Prime Minister's office, to undertake and support R & D for information processing and automation, and to co-ordinate the handling of information.

III.7 Japan

Japan owes much of its industrial success of the past 20 years to importing STI under licence and screening it from published literature. The Japan Information Centre for Science and Technology (JICST) has a budget of about $3 million. Organized in mid-1957 as a special, non-profit corporation, it operates under the Science and Technology Agency in the Prime Minister's office. It offers new STI regularly to subscribers; on request, it provides special services including photocopying, translation, content analysis, and literature search.

III.8 International Organizations

Progress toward truly compatible international exchange systems has been slow, somewhat uncertain. A few groups of international STI users are moving in this direction, but most international agreements have been bilateral. One of the most progressive groups is the Organization for Economic Co-operation and Development (OECD).

In OECD, many of the more advanced nations are trying to unravel the tangle of independent systems and develop international compatibility. Delegates to the Third Ministerial Meeting[9] early in 1968 agreed:

> "... that the exchange of scientific and technical information constitutes one of the most important ways of ensuring the progress of science and the effective transfer of technology between Member countries."

and that:

> "... in order to avoid gaps and overlaps, it is essential to co-ordinate information services and systems originating in dispersed initiatives. The magnitude and urgency of the problem called for appropriate action by Governments."

Ministers called for mechanisms within OECD to uncover obstacles to compatibility and to pave the way for international agreement. Recommendations should evolve within a year. The OECD Scientific and Technical Information Policy Group has active studies under way on medical information and on the economics and standardization of STI systems. Of its 18 member countries, 11 have recently created national focal points for STI.

The Secretary-General of OECD recently set up a high-level Task Force of six internationally recognized specialists to consider policies and problems relating to STI. Canada's representative on the OECD Science Policy Committee belongs to this Task Force.

Other new arrangements are being forged in very special fields. Active in this are the International Federation for Documentation (FID), the United Nations Educational, Scientific and Cultural Organization (Unesco), and the International Council of Scientific Unions (ICSU).

Unless properly co-ordinated, these activities, along with those of individual scientific associations and various national academies, will complicate, rather than facilitate, the evolution of internationally compatible systems. Since Canada, like other advanced nations, must process a great deal of the world's information production, she must move to protect her interests in this master resource.

Chapter IV

TOWARD A CANADIAN SOLUTION

IV.1 Moving into Tomorrow

Leading industrial nations are moving to improve their use of knowledge to strengthen their industries and advance economic positions. Canada also must apply this knowledge to her social and economic problems. The most effective action is to organize the STI resources within Canada into a more articulated, integrated set of information services which eventually will evolve into a nation-wide knowledge network.

Future services must provide information in a variety of forms for a wide range of users. This means condensations, evaluations, and interpretations of raw material from scientific and technical publications. This means supplying needed STI anywhere in Canada without handicapping people's access because of their geographical location or their preferred language—English or French. This also means easier access and faster delivery.

We can develop a network of closely knit regional and local information transfer centres to process information, shape it to specific industrial needs, and notify users of its availability. Linking these centres by modern communication services can give the user access in his home town to people and documents that may be physically located elsewhere. Telecommunications with computerized data banks will perform much of the information collection and distribution. Fewer large local collections are needed when STI can be moved easily from point to point. Proven technology exists to do this.

IV.2 Basis for a Network

For some time libraries will remain the basis of our national information network. The collections of documents, data, and other materials found in government, university, municipal, and industrial agencies must be linked to provide the basic resource for information transfer. It is not necessary to discard everything developed thus far. Rather, a network should use existing elements wherever possible, funding the expansion of some services but discarding only what is obsolete or unworkable in the new operation. There must be no disruption in the present service. New functions will give each library a new dimension. Libraries and information centres supply very specialized services and should not be considered as performing relatively low priority administrative functions in any agency. Librarians should

respond to the senior scientist, engineer, or manager to assure high quality of STI collections and services. While librarians continue to serve their local users across their desks, the national network can provide service to new users and new resources to any library.

Applying new technology, especially computers, can relieve librarians of routine processing, housekeeping, and accounting tasks, thereby using more fully their professional capabilities. Computers will also enable Canadian libraries to supply current listings of all major STI holdings, a necessity for the national network's operation. Future technical advances will aid development of improved files, specific bibliographies, and extracts, full text services, language translations, and delivery to the user's home or office. The economic value of presently using very advanced techniques has to be carefully considered, but major improvements in the speed of delivery will occur simply by using the telephone and teletype services presently available at relatively low cost.

Additional support will be required in three areas:

1. A national referral centre to aid all sectors, especially industry, locate publicly available document and information services and people or agencies to supply expert answers quickly;
2. A clearinghouse to ensure the provision of STI documents from international organizations and provincial, federal, and foreign governments;
3. A more effective "lending" service, preferably a cheap copying service, to facilitate access and delivery of STI documents throughout the country.

IV.3 Organizing the Network

The creation of a nation-wide network will necessitate some changes in the structure and functions of existing libraries. Basic among these is the establishment of services through an integrated information network, composed of national and regional libraries with designated responsibilities. Together they will provide the balance of centralized sources and decentralized services. National government libraries can provide greater depth in their document holdings and maintain current catalogues that enable them to be the larger and archival stores of STI material. Local and regional libraries can provide the closeness of service and delivery essential to local users. The Study Group envisions the communications linking of a group of government libraries that have national responsibilities to the larger group of libraries serving the regions and provinces. Universities or special libraries wishing to serve as regional information centres for industry or other users should receive every encouragement to enter more broadly and deeply into the functions of the network.

A report[7] by the former National Librarian, W. Kaye Lamb, and Jack E. Brown, Chief Librarian of the National Science Library, was issued

independently as this Study closed. They recommended increasing reliance of all libraries on smaller and more current local collections, more reliance on communications and photocopy to eliminate much duplication, and less reliance on the number of volumes as an indicator of a local library's merit.

The use of copying more than justifies itself in the eyes of the Study Group. Non-returnable copies will end the costly methods of shipping, accounting, and recalling the books now physically in transit through inter-library loan services. Few actual volumes need ever leave the library building. Accounting costs can be cut even more by using computers for automatic processing or by service coupon sales.

A basic policy question concerns copyright. Government must preferably come to some understanding that protects the rights of authors and publishers where documents are copied as national procedure. The alternative—changing present copyright laws and international agreements—would be extremely time-consuming and uncertain in its ultimate effect on the creation, publication, and flow of much valuable STI.

IV.4 Government's Role

Government's role in processing world-wide STI for the benefit of the Canadian economy is firm. As seen by the Glassco Commission:[10]

> "The dissemination of information as a service to the Canadian public is either the sole or principal reason for the existence of some departments and agencies and is an explicit or essential corollary to the operations of others. The purpose may be to develop and propagate a body of knowledge to promote efficiency, economy or market opportunities in a particular industry."

At other times the Government steps into the role because the information is not otherwise available to users.

Members of the Study Group see the government information services as the initial basic group of activities, out of which a nation-wide STI network will evolve. Already government departments and agencies bear nation-wide responsibilities for acquiring and distributing STI documents and co-operating closely with Canadian researchers. They will assume increased responsibility for comprehensive information services to augment and supplement needed information not readily available to universities and industry. These activities would be co-ordinated by a single agency which will provide a focus for all STI activities in Canada.

National Library for Science and Technology

Government libraries should be reorganized along the following lines:

1. While departmental libraries remain in their departments, serving traditional users, they will, where appropriate, also take national responsibility in their fields as sources and central depositories for the nation;
2. The libraries will make their own material accessible to national network users and adjust procedures to ensure compatibility;

3. Each library will have adequate facilities to support its share of interlibrary "lending" services which should, as soon as possible, become a copying service.

The major departmental libraries will supply copies of their documents for national use, contribute to a union catalogue of holdings of all the government libraries, and make their handling procedures and formats compatible. The National Science Library (NSL) should lead the integrated operation of these libraries, rapidly introducing automation and computers; in consequence, it must be adequately staffed and funded.

NSL should also place the existing interlibrary loan system on a formal basis until this can be replaced by a cheap interlibrary and consumer copying service. Exchange services now suffer because many libraries cannot participate fully. Local laws, manpower shortages, and lack of funds deter services outside the local area. In recognition of its expanded functions and the emphasis placed on technology as well as on science, the total complex of the NSL and other contributing departmental libraries should be recognized as the National Library for Science and Technology.

STI Clearinghouse

Clear responsibility should be assigned to a single agency to provide copies of documents from provincial, federal, and foreign governments and international organizations. With very little additional effort these could be made available through bookstores of the Queen's Printer; however, it is thought that there are insufficient local outlets at present. More outlets should be set up with readily available microfiche copies of the documents.

National Referral Centre

Much ignorance about Canada's knowledge resources traces back to one fact. There is no single place where all information sources are listed; there is no assurance that any agency can supply a complete listing of people or documents relevant to an endeavour.

Study Group members believe that a national referral centre should be set up as soon as possible. The urgency and nature of this task make a national referral centre a logical function of the Federal Government. Within two years a telephone call, in French or English, to this centre would provide a user with the location of all relevant information sources in Canada, a list of all centres of expert advice in Canada, and a list of people who can lend skilled personal assistance on any problem. Within three years such a centre can have an up-to-date index of ongoing Canadian R & D programs and the major R & D programs in other countries. These services would be continuously advertised and available from coast to coast for no charge.

Government-sponsored researchers will be required to register their programs with the centre as a condition to receiving grants and contracts. Academic and industrial research workers would be encouraged to do so whenever practically feasible.

The function of such a centre, like that of the yellow pages in the telephone directory, is to guide STI users to the most appropriate organizations or individuals who are able and willing to provide authoritative answers. This service, which would supplement the informal referral services now provided by many libraries and other information services, would be concerned particularly with improving user accessibility to sources capable of providing information in depth in specialized fields.

It is necessary that automation of a national referral centre develop apace with the nation-wide STI network and utilize its communication facilities. The success of the entire system depends upon the effective establishment of a referral centre as the master directory to the resource.

IV.5 Regional Development of the Network

Universities hold some of the largest collections of the master resource. Other important local collections rest in provincial research councils, the larger municipal libraries, and some special libraries. With co-operation and co-ordination, resources can become easily accessible to all the nation.

Since no country or province can afford to build up indefinitely their document resources, many groups are already moving toward co-operative schemes. The librarians in west-coast universities and in the Halifax area are planning regional systems for British Columbia and the Atlantic Provinces. Ideally, in the Study Group's view, this collaboration will proceed geographically. This would produce initially five regional subnetworks located in the Atlantic Provinces, Quebec, Ontario, the Prairie Provinces, and British Columbia, besides the government services in Ottawa, each with an automated regional information centre. Government should encourage this systematic organization and automation of document resources in every possible way. The Study Group believes that the Government should encourage regional pilot projects and assist in their planning, funding, and development. Once subnetworks with their regional information centres evolve, collaboration and participation will become easier between all sectors on a national basis.

From the outset, the Government will co-ordinate the national activities and assist with communication and computer facilities. The result would be a unified scientific and technical information network in which government, academic, and industrial resources interchange easily and rapidly. Some centres within the subnetworks may be able to assist by accepting national responsibility for STI in special subjects or areas of interest. This should be encouraged.

IV.6 Service to Industry

In the present industrial environment more emphasis must be given to increasing the potential of secondary industry, which requires sophisticated

production processes and the greater application of technical innovations. This in turn has to be matched by an increase in educational standards and further understanding by the technologist. Present technology, if effectively disseminated and applied, could stimulate our industries for many years.

The existence of scientific knowledge is no assurance that it will be used. The process of translating technology into industrial products is not automatic. Much greater emphasis is required now to improve the assimilation of new scientific and technical information within industry if Canada is to attain its productivity goals. All sectors of industry must be encouraged to make the best use of this master resource.

One group of STI-user firms in industry, some 1 000 companies that are performing R & D, have strongly asserted the advantages of improved STI services. Although these firms employ highly trained researchers, their work is generally mission-oriented. This increases their need for multi-disciplinary information from many sources.

A second group, approximately 4 000 companies, includes those firms in which a risk-taking management understands the need for new technology and innovation in their business. They have qualified staff to apply new concepts but have few or no R & D facilities.

Numerically the greatest untapped potential for future application of technology lies with a third group of smaller companies or businesses. Here the advantages of new technology may or may not be recognized. In such firms personal guidance is needed. This third group includes a large proportion of the 34 000 manufacturing establishments in Canada.

Proposals for Industry

Study Group members propose several ways of helping industries where lack of sufficient information facilities is a problem or the advantages of new technology go mostly unrecognized.

Universities and other institutes should be encouraged financially to set up their own Information Analysis Centres (IAC) to further the evaluation and interpretation of new technological developments for specific applications. These centres should sift, process, and package raw information to fit Canadian needs. New knowledge gradually becomes packed down and better understood; this scholarly compression has long been a tradition of our universities. Government should encourage them to perform this function for the STI network.

Recent establishment of several Industrial Research Institutes on university campuses points the way toward the evolution of other services. After the mechanics of document transfer are established, special centres can enter a phase of more sophisticated services. With government assistance, the universities can recognize a responsibility to provide industry with local access to their resources. This will open to industry a new lode of the master resource of knowledge. To encourage this, payment for service becomes important.

This approach calls for co-ordination of government and university resources to make them and their facilities more accessible to industry. Alignment of the R & D facilities of government and universities with industry needs will improve the technical support available to technically oriented segments of Canadian industry. The university system should recognize and reward technology transfer activities by the faculty, much as it does teaching or research. Similarly, university scientific and engineering data banks and document centres should be accessible to all sectors.

It is further envisaged that the Government will encourage companies in particular industrial sectors to sponsor their own mission-oriented information services, preferably through information specialists. These, like those of the best trade associations, e.g. the Pulp and Paper Research Institute, or the Division of Building Research of the National Research Council of Canada, will collect and disseminate very specialized know-how to members. The textile, furniture, and construction industries are examples of Canadian industrial needs for this type of service. The Government should provide only the impetus to organize the services, leaving operational support to members. A strong central information agency is essential to co-ordinate and support the development of these specialized industrial services and to cover the cost of communication services to eliminate handicaps of geographical location.

With the development of comprehensive information services for companies performing R & D, and the establishment of specialized mission-oriented information services for individual industrial sectors, improved technology transfer centres are required to meet the local needs of other industrial users, especially medium and small companies. These technology transfer centres constitute a most important link in the whole system of industrial STI dissemination and technology transfer. Mature technical officers at the centres will diagnose industrial problems and assist small businesses in identifying, interpreting, and applying new technology. These companies do not need to do research but they do need the results of research. The pump must be primed and kept going.

This problem of preparing data for small business concerns and then making it understandable is probably the most difficult of all the problems involved in technology transfer. The mechanisms of technology transfer are not clearly understood. There should be increased emphasis on the exploitation and flow of information, besides the repackaging of information for different levels of industry and sizes of firms.

In depressed areas, the technology transfer centre is of particular industrial importance. Access to new technology through these local centres, at least in part, takes the place of research centres and technical universities which require many years of development.

Because of the local nature of such services, provincial authorities should be encouraged to increase their responsibility for the administration and promotion of technology transfer centres.

Industrial Scientific and Technical Information Office

The Federal Government must initiate these national STI services, specifically oriented to industry, to ensure the appropriate communication and rapid application of relevant information, new ideas and concepts. One central office can provide the necessary co-ordination to bring these proposals into effective operation. It should provide a focal point for policies on industrial information services and for bringing industrial sectors into closer co-operation.

Where a responsible agency—public or private—already operates a service, this office will encourage its industrial use. Where there is a gap in a given sector or discipline, it will promote the establishment of a new service, preferably operated and financed by industry. This office will ensure that the following STI services are provided:

1. An easily accessible source for industry of scientific and technical documents, information, and supporting data banks;
2. Evaluation and interpretation of documents and information into more understandable forms for industrial users, through such devices as Information Analysis Centres (IAC), assisted by group Selective Dissemination of Information (SDI);
3. Establishment of mission-oriented services, ranging from information on industrial plants up through production to the R & D phase; also assurance of full co-operation with similar services operated in other countries;
4. Easier and closer co-operation between university and government R & D groups and similar agencies in industry;
5. Establishment of regional technology transfer services to aid small businesses and commerce in the exploitation of STI.

Private Information Services

With the growing recognition of information as a marketable commodity, private enterprise will assume a new role in the dissemination of STI. This will be accelerated by the rapid emergence of computer utility services providing remote access to computers for subscribers regardless of location. Based on the flexibility and speed of computer operations, information data centres can be operated by private organizations and scientific, technical, or trade associations, making available to their subscribers selective services in any field in which there is a sufficient demand.

This type of service can perform an important function in the overall information complex, and it is of national interest that the facilities providing the service are co-ordinated with, or directly connected to, the national STI network. Government should therefore encourage the development of useful commercial information services. Situations should be avoided in which the Government's information activities frustrate private initiative.

IV.7 Further Evolution of the Network

The requirement for special information services, information analysis centres, data banks, and technology transfer centres will lead to some 10 to 15 automated information centres during the next five to six years. Some of these centres will evolve in universities, others in federal, provincial, or municipal government agencies, and others associated with industry in such locations as the Sheridan Park research community. These will be in addition to the six major regional information centres.

IV.8 Information Systems Research

Canada's STI network will need research support. Researchers in both the physical and social sciences can assist in developing new knowledge on the ways man can communicate, innovate, and use his resources in an increasingly technical society.

Research tasks for information systems offer real challenges and rewards for members of the scientific and engineering communities in industry, the universities, and government. Research in universities can make a significant contribution to national and international knowledge of how man manipulates his information resources. New computer programs, electro-optical and electro-mechanical devices, and other information appliances offer prospects for marketable innovations that can be sold at home and abroad. New ideas and imagination are required to develop new systems and solve the interrelations between humans and machines.

IV.9 Education and Training

Developing new information systems calls for radically different talents and education for the people who operate the systems and the people who use them. Universities and government must have a keen interest in the emergence of a fresh approach to training in this field. While it is appropriate for present library schools to improve the subjects they now teach, the Study Group also sees a new curriculum evolving around the information sciences, covering such topics as data banks, computing science, systems design, and management. Two advanced institutes of information processing would likely be required to train people to establish, maintain, and improve the STI services.

Unless the user understands the network's capabilities, he gains little from its ability to deliver STI rapidly. Therefore, the advanced institutes and universities must promote user education, including the sponsorship of short courses.

IV.10 International Services

As the OECD General Report on Scientific and Technical Information Systems and Policies recommends:[11]

> "Government, in developing a policy for science, should therefore recognize also its responsibility to facilitate access, for the nation's qualified scientists, technologists, management and others, to all the significant world-wide scientific

> and technical literature. A policy for information forms an integral part of every national science policy. It seems important, therefore, that government establish, in each country, a high-level focus to co-ordinate information developments nationally and to form the necessary contacts and links internationally."

Canada lacks an effective focal point for co-ordinating national contacts in international STI problems. To protect her own interests in world-wide information which Canadian industry requires, government should assign this responsibility at a high level. Through such a focal point Canada can further world co-operation, compatibility of systems, and her active role in international decisions now evolving.

Canada's network must be capable of accepting world-wide STI in any format. We must process and adapt this material for our own use, and this will give the country a capability that may be extremely useful to other countries. Canada would therefore be able to help other countries solve STI problems in both French and English.

IV.11 Payment for Services

Libraries and information services long ago demonstrated their value. Traditionally, services are considered free to the user, although this cost has been borne by the taxpayers for the general and educational benefit of the nation. However, the special information services proposed in this report have specific economic value to the user and involve more than merely maintaining the basic resource materials.

Government should continue to acquire and store information as a necessary public service. However, the expense of analyzing and disseminating this information through the scientific and technical information network should be offset by charges for services received. Payment acts as a feedback to ensure the service satisfies the user.

Methods should be established whereby services rendered by the STI network can be paid for on an equitable basis by the user.

IV.12 A New National Asset

Canada spends very large sums of money to bring scientific and technical information into public and private use. The cost of present services runs to several hundreds of millions of dollars yearly. Co-operation and co-ordination of present services can reduce the rate at which scientific and technical information expenditures increase and curtail unnecessary expenditure.

This nation-wide STI network can evolve as a new Canadian asset as all institutions commit themselves to working together. The Study Group members see governments and the universities co-operating to build a strong information resource for Canadian industry. With unity of spirit and purpose, all levels of government, universities, and industry can use this information network to lift Canada's economy to a new level of achievement.

Chapter V

FORGING A KNOWLEDGE NETWORK

The Study Group on Scientific and Technical Information concludes that Canada can devise new mechanisms that will increase technology transfer and the use of information in public and private sectors of the economy. By these means scientific and technical information will be made more accessible to all those who need it, when they need it; neither location nor language should interfere.

Action now will encourage the timely evolution of our present scientific and technical information services into a coherent nation-wide information network able to move the resource of knowledge wherever it is needed in Canada. Such a network will provide a diversity of services suiting the needs of the users. Services must include the optimum means to acquire, store, analyze, evaluate, interpret, repackage, and communicate scientific and technical information. This will call for applying the most suitable new developments, particularly electronic and mechanical techniques, wherever economically possible.

V.1 Scientific and Technical Information Agency of Canada

To forge the desired network, we recommend the Government of Canada take at once the appropriate steps to set up a Scientific and Technical Information Agency of Canada.

It is further recommended that one Minister be made responsible for all government activities in this field and, therefore, that the Agency report directly to a Minister-designate, possibly the Chairman of the Committee of the Privy Council on Scientific and Industrial Research.

The Agency will act as the high-level focus bringing together the interests of all sectors to develop a comprehensive national scientific and technical information policy and the plans for its implementation. It will respect the independent jurisdictions and constitutional framework of the present information complex at all stages in the evolution of a nation-wide network.

The Agency will consist of a Board and a permanent staff with an Executive Director as chief executive officer. The Board will include the Executive Director, whom we envisage as the Chairman of the Board, two senior members of the permanent staff, and representatives from information

producers, processors, and users. Its members should be drawn from industry, universities, federal and provincial governments, the library community; possibly including the Canada Council, the Economic Council of Canada, the Science Council of Canada, and the National Research Council of Canada. The Board will have power to control and direct the work of the Agency through the Executive Director.

It is recommended that the Agency have direct responsibility for the following:

1. The development and co-ordination of a plan for a nation-wide Scientific and Technical Information Network, including the assignment of areas of responsibility, and better information analysis services;
2. The operation of the National Referral Centre for Science and Technology;
3. The operation of the Industrial Scientific and Technical Information Office, which will co-ordinate scientific and technical information facilities and services for industry, e.g. to encourage the development of:

   New and improved information services for major industrial sectors;

   Effective information analysis centres to be operated by public or private scientific and technological institutions;

   Private commercial scientific and technical information services based on computer utilities, especially those directed toward business and commerce;
4. The co-ordination of the National Library for Science and Technology;
5. The co-ordination of the computer and telecommunications facilities of a nation-wide Scientific and Technical Information Network;
6. The co-ordination of Canadian participation in international scientific and technical information developments;
7. The initiation of grants supporting training and contracts for research in information technology and related fields;
8. The production of a yearly survey and report on scientific and technical information network development and operation;
9. The preparation of recommendations to Treasury Board on all aspects of federally financed scientific and technical information operations.

It is further recommended that the Agency study:

1. The basis for optimum funding of the network and charges for scientific and technical information services;

2. The resolution of national and international copyright questions raised by network operations;
3. The mechanisms of technology transfer;
4. The processes and techniques of communicating scientific and technical information, such as:

   Announcing, storing, and distributing Canadian and foreign government and international scientific and technical information in the appropriate media:

And that the Agency advise on Canadian policy relating to:

1. The optimum exploitation of the vast resources of scientific and technical knowledge available to Canadians;
2. The evolution of a nation-wide Scientific and Technical Information Network for the governmental, industrial, and educational sectors;
3. The national expenditure on scientific and technical information services.

The Agency, with a carefully selected staff of 30 to 40 professionals, would translate policy decisions into action to provide the continuity and direction necessary for the operation of the evolving network. It would promote the co-operation of governments and universities to ensure that the total knowledge resource is accessible to the nation. In conjunction with the Economic Council of Canada and the Science Council of Canada, the staff would explore regularly the optimum funding of scientific and technical information services compared with other major national endeavours. Staff members would continually review experimental systems and services, training programs, and funding of research in scientific and technical information, to assess their effectiveness. The Agency should run an information centre on information systems to support its own work and assist other agencies in setting up information services. This would be the Information Systems Analysis Centre (ISAC). The Study Group envisages the organization of the Agency as shown in Figure 1.

V.2 National Referral Centre for Science and Technology

One of Canada's most urgent needs is a central point of contact which supplies a directory of all major sources of information.

We recommend that a bilingual National Referral Centre for Science and Technology be established and operated by the Scientific and Technical Information Agency of Canada, to promote maximum accessibility to all sources of scientific and technical information in Canada.

This Centre—the "yellow pages" of the network—requires a small staff, highly skilled and experienced in locating scientific and technical information sources. Identifying these sources and building the necessary catalogues, indexes, and directories will take time, but every effort should be made to have it operational within two years.

SCIENTIFIC AND TECHNICAL INFORMATION AGENCY

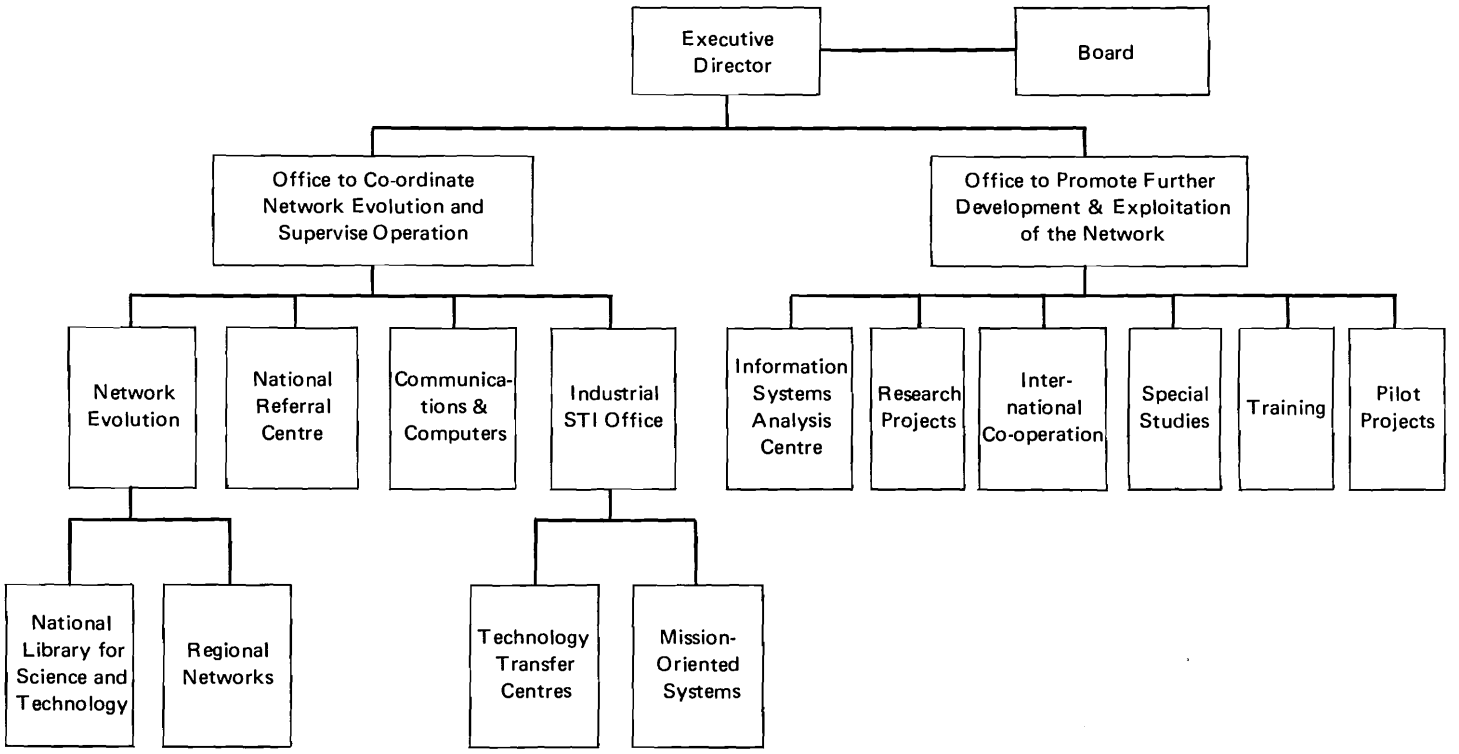

Figure 1. Organization of the Agency

V.3 Benefits to Society

The wealth of knowledge generated by research can lie dormant and unused without effective information transfer. The generation and transfer of such knowledge are interdependent and should rank with equal importance in stimulating economic growth. Methods of conducting research have progressed in pace with the rapid acceleration of research itself. Information transfer methodology, however, has lagged far behind. Opportunities for success in this field are legion, and greater social and economic returns will undoubtedly result from the evolution of an effective scientific and technical information transfer system than from most other endeavours used to stimulate economic growth.

To accomplish this will require a harmonious government–industry–academic relationship that will be scientific and technical—one of ideas and imagination but financially and economically sound.

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Appendices

Appendix A

TERMS OF REFERENCE

1. To survey existing scientific and technical information services in Canada, their availability and extent of their use by scientists, engineers, and technologists in industry, universities, and government agencies.
2. To assess the current and future requirements of present and potential Canadian users of scientific and technical information.
3. To review existing and new techniques for handling scientific and technical information in Canada and other countries.
4. To study the present pattern, future growth, and potential changes in the mechanisms for the international exchange of scientific and technical information.
5. To formulate a long-term policy and program for the evolution of a co-ordinated national information system, which will ensure that:
   (*a*) The scientific and technical information resources of the country are sufficient, readily available, and in a suitable form to keep pace with the present and future needs of all users;
   (*b*) The optimum utilization is made of these resources in all sectors of the economy.
6. To develop guidelines to assist departments and agencies in providing scientific and technical information services.
7. To study, appraise, or recommend for further study any other matter that is pertinent to the present and future effectiveness of scientific and technical information systems in Canada.

Appendix B

STUDY GROUP PROCEDURE

The Study Group was set up on March 20, 1967. Its task was divided into eight subject areas relating to services and users in the industry, government, and university sectors; information handling techniques and types of sources, specifically library and international resources; education and training of information personnel and the user; and the economics of information handling.

Consultations with Canadian users were both written and verbal. Advertisements were placed in the leading newspapers across Canada inviting briefs. Background information was sent to 80 English-language and 33 French-language technical journals, primarily directed at the individual scientist or engineer. A set of guidelines to assist in the preparation of briefs was distributed to over 500 agencies, including trade associations and technical societies, manufacturing establishments, educational and research institutions, and individuals. As a result, 233 written briefs were received. Special surveys were conducted within the Canadian Research Management Association, the Agricultural Institute of Canada, and the Canadian Library Association.

In addition, approximately 2 500 individuals associated with industry, universities, and government answered questionnaires to enable the Study Group to make some estimate of individual costs using present methods. Over 1 000 published documents were collected and evaluated, and the Information Systems Analysis Centre of the former Department of Industry, containing extracts of another 1 000 items, was utilized.

Members of the Study Group held open meetings with industrial, university, library, and provincial government representatives across Canada, followed by private briefings as requested. Visits were made to Victoria, Vancouver, Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Toronto, London, Waterloo, Kingston, Montreal, Québec, Sherbrooke, Halifax, Fredericton, Moncton, Charlottetown, and St. John's.

Study Group members also contacted major international organizations, in many cases actively participating in meetings and seminars as well as visiting foreign institutions working on the STI problem. The Study Group was given verbal briefings by many visiting international experts, including the following:

Eugene Garfield	Director, Institute for Scientific Information, Philadelphia, Pa.

P. J. Judge	Directorate for Scientific Affairs, Organization for Economic Co-operation and Development, Paris
R. A. Kennedy	Information Retrieval Director, Bell Telephone Laboratories, Murray Hill, N.J.
Alexander King	Director for Scientific Affairs, Organization for Economic Co-operation and Development, Paris
W. T. Knox	Former Chairman, COSATI. Presently Vice-President, McGraw-Hill Inc., New York, N.Y.
B. M. Fry	Former Director, Clearinghouse for Federal Scientific and Technical Information. Presently Dean, Graduate Library School, Indiana University, Bloomington, Ind.
D. H. May	Office for Scientific and Technical Information, Department of Education and Science, London, Eng.
R. C. Sheldon	Massachusetts Institute of Technology, Cambridge, Mass.
C. W. Sherwin	Former Assistant Secretary of the Department of Commerce, Washington, D.C.
J. R. Smith	Director of INSPEC, Institution of Electrical Engineers, London, Eng.
Yuri Sorokin	Director, All-Union Institute of Scientific and Technical Information (VINITI), Moscow, U.S.S.R.

STUDY GROUP

Study Group Leader, Mr. J.P.I. Tyas, Department of Industry

Chairmen of Subgroups

Federal–Provincial Governments	Dr. J.A. Campbell, Department of National Health and Welfare
Industrial	Dr. A.B. Hunt, formerly of Northern Electric Company Limited
Universities	M. Guy Forget, Université Laval
International	Dr. R.E. Pomfret, Department of Industry
Techniques and Sources	Mr. H.C. Campbell, Toronto Public Libraries
Libraries	Mr. L.G. Vagianos, Dalhousie University
Economics	Dr. H.J. von Baeyer, Acres InterTel Limited
Training	Mr. J.W. Cherry, Imperial Oil Limited

Members

Dr. G.X. Amey	Defence Research Board
Mr. W.C. Brown	National Research Council
Professor D.E. Coates	University of Waterloo
Fr. E. Desrochers	Université de Montréal
Miss S.Y. Fraser	Science Secretariat
Mrs. D.M. Heaps	University of Alberta
Mr. R.J. Hill	Defence Research Board
Professor B.A. Hodson	University of Manitoba
Professor W.J. Kurmey	University of Toronto
Professor Paul Lorrain	Université de Montréal
Dr. F.W. Matthews	Canadian Industries Limited
Mr. G.T. McColm	Science Secretariat
Mr. R.E. Metcalfe	Sheridan Park Association
Mr. P.M. Nobbs	Pulp and Paper Research Institute of Canada
Mr. F.T. Rabbitts	Department of Energy, Mines and Resources
Dr. S. Rothstein	University of British Columbia
Mr. R. Scott	Technical Information Service, NRC
Mr. E.R. Shanks	National Science Library
Dr. H.D. Smith	Nova Scotia Research Foundation
Mr. R.C. Stewart	Department of Agriculture
Mr. G.P.L. Williams	Atomic Energy of Canada Limited

An *ad hoc* panel of senior departmental officials having special interests in the field of STI was set up to assist the survey of federal government STI services.

Dr. J.E. Brown	Chief Librarian, National Science Library, National Research Council of Canada
Dr. J.B. Bundock	Principal Medical Officer, Department of National Health and Welfare
Mr. L. Cameron	Chief, Forestry Information Service, Department of Forestry and Rural Development
Dr. G.M. Carman	Director, Information Division, Department of Agriculture
Mr. A.C. Jones	Director, Scientific Information Services, Defence Research Board

Mr. R.E. McBurney	Chief, Technical Information Service, National Research Council of Canada
Dr. S.C. Robinson	Chief, Geology Division, Department of Energy, Mines and Resources
Dr. J.C. Stevenson	Editor, Fisheries Research Board
Mr. G.P.L. Williams	Technical Information Branch, Atomic Energy of Canada Limited
Mr. A.H. Wilson	Economic Council of Canada
Mr. J.E. Woolston	International Atomic Energy Agency, Vienna

In conjunction with the preparation of the Universities part of the report, special discussions were held with the following members of the academic community.

Dr. W.E. Beckel	Vice-President—Academic, University of Alberta
Dr. B.L. Funt	Dean of Science, Simon Fraser University
Dr. Philippe Garigue	Dean of Social Sciences, Université de Montréal
Professor Michael Gregory	Department of English, Glendon College, York University
Dr. D.McN. Healy	Vice-President for Academic Affairs, York University
Dr. J.E. MacDonald	Vice-President, Committee of Presidents of Ontario Universities
Mr. A.K. Mackworth	Department of Industrial Engineering, University of Toronto
Dr. M.O. Morgan	Vice-President—Academic, Memorial University
Dr. Arthur Porter	Professor of Industrial Engineering, University of Toronto
M. Pierre-Paul Proulx	Executive Director, Committee of University Presidents of Quebec
Dr. F.F. Sheffield	Professor of Higher Education, University of Toronto
Dr. Ernest Sirluck	Dean, School of Graduate Studies, University of Toronto
Professor Don Theall	Department of English, McGill University
Dr. D.T. Wright	Chairman, Committee on University Affairs of Ontario

The Study Group has conducted a comprehensive survey and submits its findings as representative of the present Canadian situation. In developing its report, outside consultants were used to advise on special areas and sub-group reports.

Principal Consultant

Mr. W.T. Knox	Former Chairman, COSATI. Presently Vice-President, McGraw-Hill Inc., New York, N.Y.

Consultants

Dr. J.J. Deutsch	Principal and Vice-Chancellor, Queen's University, Kingston, Ont.
Dr. D.G. Fish	Research Director, Association of Universities and Colleges of Canada, Ottawa
Dr. Bernard Fry	Dean, Graduate Library School, Indiana University, Bloomington, Ind.
Professor Robert M. Hayes	Director, Institute of Library Research, University of California, Los Angeles, Calif.
Dr. Arthur Porter	Professor of Industrial Engineering, University of Toronto, Toronto, Ont.
Dr. J.W.T. Spinks	President, University of Saskatchewan, Saskatoon, Sask.

Assistance in editing the report was provided by:

Mr. Warren Burkett	Science-Technology News Editor, McGraw-Hill World News, Washington, D.C.
Mr. I.R. Dutton	Ryerson Polytechnical Institute, Toronto, Ont.
Mr. G.D. Kaye	Defence Research Board, Ottawa
Mr. Gerald Waring	Editor, Canadian–American News Service, Ottawa.

SUMMARIES OF SUBGROUP FINDINGS

Appendix C

GOVERNMENT DEPARTMENTS AND AGENCIES

The efficient communication of scientific and technical information is a prerequisite for the advancement of science and technology. The well-being and economic growth of Canada depend on utilization of this information by all sectors of the economy. Since many government department and agency missions are based upon, or related to, science, their effectiveness can be greatly enhanced by the greater use of modern methods for information transfer. They also have a major role to play in the transfer of scientific and technical information to industry, to centres of learning, and to the general public.

The major scientific and technical information resources in Canada are supported largely by the Federal Government and, to a lesser extent, by the provincial and municipal governments. They consist of libraries, data files, specialized information centres, and field services: all of them created and operated in support of the endeavours of the particular department or agency concerned.

These resources have developed largely on a piecemeal basis to service the needs of individual groups. They lack co-ordination in their development and in the services they provide. Nevertheless, there is a growing awareness of the importance of the co-ordination of information services and of the benefits that can accrue from the improved utilization of known information.

The Canadian Government has no overall policy concerning the handling of scientific and technical information, and some government departments providing such services have no mention of the subject in their legislation. The need for a national information focus is now evident. It is a particularly appropriate time for a definite policy to be established and for plans to be made for putting it into effect.

The massive store of documents and data accumulated over the years, combined with the present high rate at which new material is being generated and the increase in numbers of users and the complexity of their needs, are overtaxing existing methods of handling documents and data. New technologies in the field of information transfer have developed to a point where their use can alleviate this problem; they must be applied as soon as possible. Means must be sought to reduce duplication of effort and ensure compatibility between systems.

If Canada is to improve its expertise in information-handling methods, the capability for research on information transfer, for the application of new technologies, and for training information personnel, must be significantly improved. Although the Federal Government must take a leading role in enhancing this capability, it must do so only in co-operation with all interested groups.

As a result of these findings the following recommendations are made:

1. The Government of Canada define a national policy with respect to scientific and technical information to stimulate and guide the evolution of nation-wide information services.
2. A central agency be established to implement government policy with regard to scientific and technical information.
3. Where appropriate, federal government departments and agencies be designated as responsible agents for information activities that are relevant to their missions.
4. The central agency review the many assessments made in this report and take appropriate action to develop an effective national information network.
5. Government departments accepting the role of responsible agents assess the significance of scientific and technical information to their operations and take action to improve its generation, handling, and use.
6. An advisory committee for scientific and technical information, representative of all groups concerned with information, be established to advise the central agency.

Appendix D

INDUSTRY

The rapid growth of scientific and technical information (STI) in its many forms and from a multiplicity of sources, both national and international, is placing unprecedented demands on industry to cope with the ever-increasing volume. Nevertheless, if Canadian industry is to maintain a leading position in domestic and foreign markets, information that is pertinent must be obtained quickly and utilized effectively for the development and application of new technology.

Canada provides less than 3 per cent of the STI generated in the world and therefore relies heavily on imported technology. It is now recognized that the technological gap between the United States and most other industrialized countries is not solely related to the level of scientific research but has a more direct relationship to the utilization and exploitation of scientific and technical knowledge. Canada has access to a large portion of foreign STI; therefore the effective dissemination of this information and its exploitation can contribute greatly to the economic growth of the country.

A great deal of information is at present stored in government departments and agencies, in universities, and within industry itself, but it is unknown or inaccessible to most potential users. Canada, of all industrialized countries, can least afford to have valuable information restricted to a few users or have it lie dormant and unused.

A freer flow of information could reduce duplication and unnecessary research and will expedite innovation. Industry today cannot afford to ignore improved technology that can promote greater efficiency and stimulate economic growth. Much of the STI held by government, universities, and industry could be co-ordinated and exploited through regional and national communication networks to make it more readily available to all potential users. Modern methods of storage, retrieval, and dissemination could be utilized to provide information that is timely, appropriate, and effective.

Industry has made large expenditures and devoted considerable effort to the mechanization of industrial processes through the use of computers and special mechanical handling of materials to improve efficiency and expedite production. Similar attention devoted to computer storage, searching, and dissemination of STI could improve the efficiency and output of managers, scientists, engineers, and technicians, who presently rely almost entirely on reference to a few technical journals, their own memories, personal contacts and, probably lastly, on the conventional library.

Co-operation in applied research between government, universities, and industry in Canada lags far behind most other industrialized countries. This is partially due to the low level of research and development contracted to industry by government, both in the defence and commercial fields. It can also be attributed to the lack of centres of excellence in universities to attract the support of industry. These circumstances have limited the transfer of STI, and therefore Canada is in an outstanding position to benefit greatly by the development of a national network which would stimulate co-operation and support between these sectors of our society. The cost of a comprehensive STI service, although high, is within Canada's capabilities and, if efficient and effective, the service will be financially supported by industry on an equitable basis with all other users.

It is therefore recommended that:

1. The Federal Government establish a co-ordinating agency responsible for the orderly development of national and regional systems to provide scientific and technical information services in Canada, using as far as possible existing facilities in both the public and private sectors.
2. The co-ordinating agency establish a national referral centre that would become the principal point for directing users to the best available information sources.
3. The co-ordinating agency promote the creation of regional information systems with the primary objective of serving industry.
4. The Technical Information Service of the National Research Council of Canada become more specialized and be partially paid for by industry. The provincial governments be encouraged to assume the administration and promotion of technical information field services.
5. The co-ordinating agency explore the feasibility of developing specialized technology-oriented information centres to meet the needs of particular industries or groups of industries to supplement the more general field services.
6. The co-ordinating agency encourage or direct responsible agents to develop, where appropriate, other special services such as information analysis, abstracting, indexing, and translating.
7. The Federal Government establish a high priority for research and development in the fields of communication and information sciences to encourage government laboratories, universities, and industry to devote more effort in this field with, if necessary, a reduction in other disciplines having a lower impact on the growth of the economy.
8. Industrial management accept the responsibility to provide adequate internal information facilities and to ensure that technical staff at all levels is trained to appreciate their value and encouraged to use them.

Appendix E

UNIVERSITIES

The primary function of the university is to teach. However, alarm is growing that the universities may be unable to discharge this function effectively in the future, for undergraduate enrolment is expected to double by 1975, graduate enrolment, to triple. This explosive growth is well beyond the capabilities of the universities to handle, even taking into account the maximum increases in plant and staff that financial resources will permit, unless the universities scrap teaching methods as old as Aristotle in favour of a new, automated, electronic, audio-visual teaching technology that is only now being conceived and developed.

Moreover, the universities will have to specialize. First, they must specialize on teaching, if necessary at the expense of in-house research that some academics already deplore as being too diversionary of time, effort, interest, and money from the teaching function. Second, they must specialize among themselves, co-operating to make optimum use of all the resources available to them—the talents of their teachers, the knowledge stored in their libraries, the physical plant on their campuses, and the share of public funds that may be apportioned to them.

In the long run, the knowledge emanating from universities that will be the most beneficial to society will not be in theses, books, and magnetic tape, but in the minds of graduates who go forth to work in society and eventually to direct the affairs and create the achievements of society. Consequently, urgent attention must be given to the development and introduction of new equipment and techniques to enable the universities to cope with their looming crises.

A strong instinct for intellectual and corporate autonomy partly accounts for the universities being ill-equipped to deal with the population explosion, and is evident as well in the university libraries. Every university wants a great library. Every university library wants to become a great library. This has led to wastefully expensive duplication of holdings which, in turn, contributes to pressures for expansion of library plant. Authoritative sources put the bill over the next decade at three quarters of a billion dollars, of which a third will be for more buildings. University administrators, who can see five ways to spend every dollar, are faced with determining whether this vast outlay is really necessary.

The universities' need for knowledge is expanding with the knowledge being created, but the need is for knowledge to be readily available, not necessarily for it to be permanently stored on each campus. The answer to the $750 million question is at hand. It is logical, economical, and philosophically in harmony with life in our interdependent world. It entails dedicating existing libraries to the service of all universities through interlibrary loans, extending interlibrary co-operation to embrace co-ordination of purchasing and cataloguing, establishing regional storage centres for little-used books and other material, and acceptance of a retirement policy for library holdings that would optimize conservation of useful knowledge, on the one hand, and use of storage facilities and human resources, on the other.

This new approach must also bring university libraries with their stores of scientific and technical information into much more relevant and meaningful relation with society, especially the science-based segment of society, the industries that create much of the wealth that goes first to the tax collectors and thence into university treasuries.

Universities also should be developing new information services such as documentation centres, data banks, and referral, abstracting, selective dissemination, and translation services. Such a program of marshalling and augmenting the information the university can supply would be designed to make that university a powerful unit in a national information network.

Hand in hand with this should go a great deal of rationalized and mission-oriented university research aimed at such targets as improved techniques of information classification and retrieval, selective dissemination of information, scanning and abstracting, automatic translation, more effective use of computer-assisted instruction, and better understanding of the human problems involved in information transfer. This will require money, and money should be provided.

The concept of a national network of scientific and technical information would not be feasible without the active participation of the universities. Not only do they have information indispensable to the economy, but they are a major source of manpower possessing the skills needed for creating a national information network and for training the variety of personnel required to operate the network. With the universities' co-operation, pilot projects in information handling should be established in a co-ordinated pattern that will facilitate their link-up at a second stage to create regional networks that would meld into the proposed national information network.

To assist in the formulation of policies to achieve this objective, the Universities Subgroup recommends that:

1. A task force be established by the Association of Universities and Colleges of Canada, or a similar body, to plan a university information network which would develop in phases from present facilities to a fully integrated nation-wide network.

2. A national agency be established with responsibility for stimulating, assisting, and co-ordinating the development of information systems in all sectors of the economy.
3. National and regional university groups be organized to work with the national agency in developing the university information network.
4. As automated information network operations become more widespread, the universities should assume a responsibility for providing scientific and technical information outside the academic sphere.
5. Goals and priorities be established for research on information science, and adequate funds be provided to support such research.
6. Universities develop curricula to train the variety of personnel needed to plan, develop, and operate a comprehensive information network and encourage the development of courses which instruct and involve the user in the exploitation of information resources.

As a result of its examination of the present situation in Canada regarding the need for trained personnel to manage and exploit the country's information resources, the Training Subgroup recommends that:

1. A Federal Government agency be set up as an essential instrument in assuring that Canada develops and maintains an adequate supply of people trained in the field of information management, and that her scientific and technical community is trained to find and use the information of its specialties. The Federal Government should establish such an Agency at the earliest possible moment to provide leadership, co-ordination, and support of plans for the development of adequate information personnel in Canada.
2. The Agency be mandated to gather and to publish the statistical data that will precisely identify the problems that bedevil those responsible for the training of information personnel.
3. Considerable expansion of the present scheme of federal scholarships (offered through the National Research Council of Canada) for science and engineering graduates to enroll in library schools and schools of information science be initiated, and that this scholarship funding be a responsibility of the Agency.
4. The Agency be funded and authorized to administer federal grants to library schools and schools of information science, paralleling those that the National Research Council of Canada, the Defence Research Board, *et al.* now make for equipment and staff in scientific and engineering departments of universities.
5. The Agency be funded to support and co-ordinate Canada's research efforts in the information field.
6. University science and engineering faculties and technical institutes consider making a good working knowledge of the scientific literature an essential requirement for graduation.

Appendix F

INTERNATIONAL AGENCIES AND FOREIGN COUNTRIES

International organizations, both governmental and non-governmental, concerned with information handling are working toward the adoption of compatible procedures and the eventual development of information networks capable of identifying and retrieving any published information from any country. This ideal will be realized only through better co-ordination of information activities within countries and more exchange and agreement between nations.

Scientific and technical information services in selected countries bordering the North Atlantic, in Scandinavia, Western Europe, Eastern Europe, and the Orient have been reviewed. The emergence of comprehensive national abstracting services in France, Japan, and the U.S.S.R.; the development of information services for discrete industrial sectors of the economy in Eastern Europe; and the vigorous exploitation of mechanization in many countries for purposes of compiling abstract journals and disseminating information selectively to subscribers are among the outstanding items identified in the Study.

Several reports by national and international groups of considerable stature have concluded that a country needs a high-level national focus to co-ordinate and stimulate internal information activities and ensure effective national participation in international measures facilitating world-wide co-operation in information exchange. Some countries have such a focus already; others are moving toward the establishment of one.

Canada depends heavily on foreign information and technology and uses various foreign information services extensively. Knowledge networks are gradually developing in other countries and on an international basis. Effective exploitation of networks providing relevant information when and where it is required will accelerate the rate of economic growth. Canada should, therefore, ensure the continued and improved availability of information by developing internal networks and by co-operating diligently with foreign and international networks, and create an intellectual climate that encourages the utilization of information.

It is therefore recommended that:

1. A national focus for scientific and technical information be established to ensure that the best interests of Canada are con-

sidered in international negotiations affecting the availability of foreign information in Canada and the dissemination of Canadian information abroad.

2. The national focus be charged with co-ordinating and stimulating the development and exploitation of internal information networks that will contribute to, and make use of, appropriate information services in other countries and of international organizations.
3. The national focus stimulate the export of indigenous communications technology and information-exploitation expertise, and work toward the international adoption of compatible operating procedures.

Appendix G

TECHNIQUES AND SOURCES

The introduction of the newly developing techniques could greatly improve and expedite the present scientific and technical information (STI) services available to Canadian users. Existing libraries and information services of both private and public sectors, because of the multitude of sources and the ever-increasing volume of information being generated, are unable to provide adequate service using traditional methods that have changed little during the past 50 years.

Interest and activity in the use of computers for the storage, retrieval, and dissemination of STI are increasing rapidly in Canada. Some applications are operational, but the majority are still in the development stage. The Canada Land Inventory is an example of a relatively large system that is unique for Canada. With few exceptions, however, most other systems are relatively small and deliver specialized services. Practically every system developed so far in Canada is a specialized service unco-ordinated with any other system. Within the major government installations there is little joint planning and consultation between departments or agencies.

The subgroup has investigated a number of large systems operating in other countries. Some of these systems or combinations of them can be used as models for pilot applications in Canada. Some research and considerable development are required, however, to enable them to meet specific Canadian requirements. To create regional and national networks of systems, Canada should increase her research effort in information science. Further education and training of librarians, information specialists, and users will be required to cope with extensive changes in staffing and organization of STI services.

Standardization in the methods and procedures for indexing, coding, storage, and retrieval of STI is essential for national and international exchange of information. Canada is represented on a number of international committees but active participation is limited. As Canada provides less than 3 per cent of the STI generated in the world, she relies heavily on imported technology. Canadians should be seriously concerned with developing systems that can utilize information from many sources. Active participation in international standardization bodies is, therefore, necessary to assist Canada in developing STI systems that will be compatible with systems in other countries.

It is therefore recommended that:

1. A national policy for handling scientific and technical information be formulated to establish national objectives, delineate areas of responsibility, and assure the user accessibility to this vital resource.
2. A federal government agency be established to implement national policy for scientific and technical information in appropriate areas, as follows:

   Evolution of nation-wide scientific and technical information services, including regional information services;

   Co-ordination of government, academic, and industrial programs in this field;

   Assignment of responsibilities to agencies encompassed by a national information network;

   Establishment and support of a central group for participation in international information activities and to ensure compatible national coding, formatting, indexing, and cataloguing of information;

   Efficient utilization of communication facilities;

   Agreement between all levels of government to ensure that information is readily accessible.
3. The formation of specialized information centres be encouraged as regional, national, and international needs dictate, with the co-operation of the industrial and academic community, and that they form a basic element in any future national or regional information networks.
4. National funds be allocated to support:

   A detailed systems study of a national scientific and technical information network and its component elements to meet the needs determined by this Study;

   The establishment of one or more pilot scientific and technical information systems as is necessary and feasible;

   The training of system designers, information specialists, and users;

   Research in Canadian universities, government laboratories, and industry to ensure continuing improvement of the network.
5. Special efforts be directed to develop compatible information systems for French-language scientific and technical information to reduce to a minimum reprocessing and duplication between French and English services.
6. Consideration be given to employing common facilities wherever practical to service both information and educational networks.

7. A federal clearinghouse facility be established to undertake the announcement and distribution of government reports.
8. Special attention be given to providing selective dissemination of information in any national or regional information network program.
9. Experimental programs be initiated involving computer typesetting and photoreproduction of a number of Canadian scientific and technical journals.
10. The matter of copyright be studied, and early attention be devoted to it.

Appendix H

LIBRARIES

Sociological change has forced the functional role of Canadian libraries to change from that of custodian of knowledge and ideas to that of an organizer and disseminator of information. This change in function, combined with the phenomenal growth in the quantity and breadth of our knowledge, has caused a physical, operational, and intellectual crisis. The antithetical nature of providing access to, as opposed to conserving, information is viewed with apprehension by many members of the library profession, resulting in a conservative passive approach to library service.

The four types of libraries—special, academic, public, and school libraries—collectively constitute a large part of the knowledge available in Canada. Consequently, a scientific and technical information network will be heavily dependent on these established library collections. All libraries have a localized conception of users' needs, varying degrees of specialization in their collections, and varying degrees of sophistication in processing methods. It is apparent that libraries adequately perform physical description, physical retrieval, and identification of documents. Special, academic, public, and school libraries, in that order, stand to benefit most and contribute most to a national network. Communication across the "type of library" boundaries is lacking, contributing to the failure of efforts at co-operation and co-ordination. Additional factors inhibiting voluntary co-operation include a lack of leadership, no overall co-ordination, authoritarian administrative organization, lack of consistency in processing practices, and a fear of loss of autonomy.

Libraries accommodate all types of information but it is clear that the most immediate socio-economic benefits on a national level will accrue from improving the transfer and application of scientific and technical information. It is unlikely that the present users of scientific and technical information will change their behaviour. Accordingly, the rather passive, indicative service provided now must be changed by adopting the sophisticated new processing methodology and the concept of responding to new user needs. Library service must change from passive to active, resources are already being consolidated into regional systems, and evolution must be such that mission- and user-oriented services are available.

To facilitate the transfer of scientific and technical information in Canada, a network should be established that will build on existing strengths and

resolve the present situation. Such a network will eventually include many existing libraries. This will require agreements and funding on a national and provincial basis. A regional system of decentralized service units, some of which may be located in libraries, will require a sophisticated communications network. Functional operations may include co-operative acquisition, storage, and dissemination of information in all forms. Access to all information in the network should be provided to the user at any service unit with "in-depth" and current awareness services. Minimum levels of service should be defined. Compatibility, initially with existing information services and with international services, will be necessary. Responsiveness to user needs will be the key factor in demonstrating the success of the network. Imaginative and capable personnel will be required to function in an administrative structure that will co-ordinate the design and implementation of the network. Education of personnel will be required as well as education of users and potential users. Public relations efforts will be required, although the most effective public relations person will be the satisfied user.

On the basis of the above considerations, the following recommendations are made:

1. Establishment of a national scientific and technical information network that would embrace:

   Integrated information services;

   Regional development of the network;

   Services based on user needs ensuring the maximum accessibility and distribution of information;

   A capability for handling information recorded in any existing form;

   Compatibility with networks designed by other countries and with international systems;

   Flexibility to adapt dynamically to progressive changes in the system and to user requirements.
2. Establishment of educational and training programs in the information sciences for all personnel associated with the design, operation, or use of the network.
3. Agreement between all levels of government to remove administrative barriers restricting co-operation among libraries and other information services.
4. Appropriate funding schemes to ensure both adequate and equitable support of units making up the national scientific and technical information network and to expedite the transfer of funds within the network.
5. Establishment of a permanent method for the continuing education of the general public in matters pertaining to the importance of information and communications services to society.

Appendix I

ECONOMICS

The spread of scientific and technical knowledge is one of the main factors in the process of economic growth. In its Fifth Annual Review, *The Challenge of Growth and Change,* the Economic Council of Canada stated:

> "There is a very large economic stake in these matters, for the spread of knowledge is a diffuse process which reaches deeply into every area of economic life, affecting the skills of the labour force, the efficiency of plant and equipment, the capabilities of management, and the quality of the institutional framework which serves society."

In this report the various economic indicators of the extent and value of scientific and technical information transfer in Canada in government, industry, and education are described and expressed in quantitative terms derived from available statistical figures.

Projections into the future are based on the estimated growth rates of scientific and technical manpower, scientific and technical literature, and demand patterns in Canada. Today's information transfer systems, in spite of steadily increasing costs, are also increasingly incapable of coping with the situation. However, available new technology, together with appropriate organizational measures based on a co-ordinated network evolution, promises substantial benefits at costs which, on a per user basis, are easily justifiable.

The main thesis of the report is that the transfer of scientific and technical information must be recognized as an important sector of resource allocations related to the support of the individual user's work. Since the user's needs are of an infinite variety and subject to continuous change, the information transfer system must perform a true service function with a strong feedback interaction between the user's demands and the system's offerings. Technical success or failure of the system depends entirely on the degree of flexibility of the system's responses. The user will shape the system's characteristics by the process of feedback adaptation between question and answer. The advantages of service charges have been considered. This leads eventually to self-support of the system as the ultimate indicator of its adequacy.

Institutional prerogatives and peculiarities may remain unchanged, reflecting the diffuse nature of knowledge transfer, but a co-ordinated network function must be established by which a member institution contributes to and benefits from the system.

For overall co-ordination, a national focus is recommended which, in the political, administrative, and economic senses, recognizes the independent jurisdictional and institutional characteristics of the components of the national information complex and acts as a point of contact for international activities. A number of objectives and criteria have been described which can serve as guidelines in the assessment of alternative ways of meeting the needs of various user communities. Overall estimated cost figures were derived for both the growth rates of existing establishments and the addition of a computer-based network intended to tie together existing facilities of federal, provincial, and municipal governments, industry, and educational institutions.