Scientific and Technical Information in Canada

Part II

Chapter 4

International Organizations and Foreign Countries

Prepared for

The Science Council of Canada

SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

PART II

CHAPTER 4

INTERNATIONAL ORGANIZATIONS AND FOREIGN COUNTRIES

Special Study No. 8

Scientific and Technical Information in Canada

Part II

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International Organizations and Foreign Countries

Prepared for

THE SCIENCE COUNCIL OF CANADA

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SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

is submitted by the International Subgroup.

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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 Chapter 4 (International Organizations and Foreign Countries) of Part II. Part I of this Special Study has already been published. The other chapters of Part II are

Chapter 1 – Government Departments and Agencies
Chapter 2 – Industry
Chapter 3 – Universities
Chapter 5 – Techniques and Sources
Chapter 6 – Libraries
Chapter 7 – Economics

and will be published separately. Each of these seven separate sections contains 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

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Section I

SUMMARY

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 considered 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.

Section II

INTRODUCTION

Throughout the course of this Study it has been indicated that scientific and technical information is a major resource that should be accorded the same importance as other factors in the encouragement of the economic growth of Canada. It has been maintained that Canada does not make the most effective use of existing knowledge in the pursuit of its private, public, corporate, and national objectives. In short, there are innumerable intellectual bricks available now with which to build new mansions of prosperity, and it is just as important to spend money on the utilization of the existing bricks as it is to spend money on the creation of new ones by research and development.

Unwillingness or inability to cultivate an awareness of relevant new ideas, techniques, materials, and methods; and failure to introduce them quickly and effectively into the operations of our various enterprises will inevitably relegate Canada to an unenviable position on any scale that measures the technological gap between the most advanced and the most backward nations. Adoption of the opposite posture could do much to raise our standard of living and create employment for our rapidly increasing labour force. Japan has indicated what can be accomplished:[1]

> "For more than a decade the Japanese have achieved the fastest economic growth of any major nation (about 10 per cent per year). Japan has become strong in the production of electronic devices, optical instruments, steel, and chemicals. Today Japan is the leading shipbuilder, and the Japanese have been pioneering in the construction of gigantic oil tankers and bulk carriers. Japan has become a leading exporter of steel, despite the fact that it must import iron ore from overseas and much of its coking coal from West Virginia. Japan did not discover or develop any principal plastic material, yet today it is second only to the United States in the production of plastics. In achieving this progress, Japan utilized foreign R & D, purchasing technical know-how and encouraging the establishment of foreign-owned subsidiaries.
>
> "In part, the Japanese success is due to a willingness – even an eagerness – to work. In part, it is due to a policy of using and improving on the best ideas of others. Another important factor is educational policy. The Japanese educate a larger proportion of their youth than the Europeans do. More than 80 per cent of the top industrial managers in Japan have a university education, as compared with 30 per cent in Britain."

Although it has a number of outstanding scientific and technical achievements to its credit, Canada is largely an importer of scientific and technical information, and international relations and co-operation play an important part in the country's growing technological development. International organizations facilitating the exchange of scientific and technical information have increased in recent years. Canada should decide on the contribution it can make to these organizations and assume a role in keeping with its capabilities. Scientific and technical information is an international resource to be used by any nation: some nations have already grasped this fact and taken steps to improve the handling and use of information. Large countries are major suppliers of information but small countries have information systems whose operations may have relevance to Canadian conditions. This chapter, therefore:

(1) Reviews the extent of international co-operation in matters relating to the handling and exchange of scientific and technical information;
(2) Highlights the pertinent activities in some foreign countries;
(3) Discusses developments in other countries and in international organizations, and proposes suitable measures for Canada.

Section III

INTERNATIONAL ORGANIZATIONS

The establishment and growth of national organizations concerned with studying, promoting, or undertaking work in a specific field of endeavour invariably lead to the development of extranational relationships, culminating in the formation of international organizations. Such organizations may involve and be supported by national governments, e.g. the United Nations, or may involve representative national organs and individuals acting independently of government control, e.g. the International Standards Organization. The field of library activities, documentation, and information science is no exception, and what follows is a brief review of some of the more important international organizations concerned. The intent is not to provide an exhaustive and detailed statement of international activities in this field but rather to indicate the variety of organizations involved, with a view to suggesting that Canada should become increasingly involved in such activities in a more co-ordinated and useful manner.

Present practice is for different organizations to represent Canada in dealings with foreign or international bodies concerned with information matters, e.g. the Associate Committee on Scientific Information of the National Research Council is the Canadian member of the International Federation for Documentation; the NRC International Relations and Economic Studies Office, and the Science Secretariat, are involved in the work of the Policy Group for Scientific and Technical Information of the Organisation for Economic and Cultural Development; the Canada Council sponsors the Canadian National Commission for UNESCO, which is responsible for Canadian relations with the United Nations Educational, Scientific and Cultural Organization; and the Canadian Standards Association is the principal contact with work of the International Standards Organization.

At the present time there is no effective co-ordination of Canadian participation in exchanges of views and materials and the conclusion of agreements in all these areas that relate to the handling of scientific and technical information. Further, there is no effective reporting back to Canadians of the work accomplished or the opinions expressed by persons representing Canada during the many international meetings. Finally, funding of Canadian participation in such international work is inadequate, e.g. the Canadian Standards Association is experiencing considerable difficulty in meeting the increasing financial assessments levied by the International Standards Organization.

III.1 United Nations Educational, Scientific and Cultural Organization (UNESCO)

UNESCO was founded November 16, 1946, under a Convention signed in London by 41 states:[2]

> "... believing in full and equal opportunities for education for all in the unrestricted pursuit of objective truth, and in the free exchange of ideas and knowledge ... for the purpose of advancing through the educational and scientific and cultural relations of the peoples of the world, the objectives of international peace and of the common welfare of mankind and for which the United Nations Organization was established and which its charter proclaims."

Activities of UNESCO that are relevant to this Study are centred in the Department of Documentation, Libraries and Archives, although it should be mentioned that complementary activity is also undertaken by the Department of Social Sciences. The former department has three divisions, responsible for (*a*) international co-operation, exchange of information, studies, and research; (*b*) development of documentation services, libraries, and archives; (*c*) library service.

The Division for International Co-operation provides the secretariat for the UNESCO Advisory Committee on Documentation, Libraries and Archives, and works closely with the ICSU Abstracting Board, the International Standards Organization, and other national or regional documentation organizations. The Development Division provides aid to member states for the development of documentation services, training of librarians, establishment of school libraries, etc. By means of pilot projects it is assisting with such work in 12 countries and has plans for another 8 countries. The Division of Library Service is responsible for the operation of the organization's library. The department edits and publishes the bi-monthly *Bibliography, Documentation, Terminology,* and has published several pertinent special bibliographies.

The general aim of UNESCO in this broad field is to encourage, promote, and strengthen scientific and technical documentation and information activities in all countries. In collaboration with the International Council of Scientific Unions, it has recently established a joint study on the communication of scientific information and on the feasibility of a world science information system. Consultations with existing national and specialized international information services and the convening of *ad hoc* study groups are in progress and will result in an international conference in 1969 or 1970.

In the field of mechanized and computerized storage and retrieval of information, UNESCO promotes the dissemination of information on existing projects and facilitates contacts between specialists. It has established a clearinghouse for English-language keyword lists, classification schedules, thesauri, etc., at the Bibliographic Systems Centre, Western Reserve University, Cleveland, Ohio, and negotiations are in progress for the establishment of a clearinghouse for similar materials in languages other than English. A symposium on Mechanized Abstracting and Indexing was held in Moscow in 1966.

With regard to scientific publications, an *ad hoc* "committee by correspondence" is studying the indexing and abstracting of periodicals, and new techniques and forms of scientific publication. A similar committee is studying the flow of information from international scientific meetings. The *Code of Good Practice for Scientific Publications* is being reviewed in association with the International Union of Pure and Applied Physics, and assistance is being given to the establishment of regional associations of editors of scientific periodicals. The European Association of Editors of Biological Periodicals was founded at a meeting in Amsterdam in 1967.[3]

III.2 Organisation for Economic Co-operation and Development

The Convention of the Organisation for Economic Co-operation and Development (OECD) was signed on December 14, 1960, by 20 countries wishing to convert the Organisation for European Economic Co-operation (OEEC) into a new organization comprising the 18 member countries of the OEEC, Canada, and the United States. Japan subsequently became a member. The objectives of the organisation are:[2]

(1) To achieve the highest sustainable economic growth and employment and a rising standard of living in member countries while maintaining financial stability, and thus contribute to the development of the world economy;
(2) To contribute to sound economic expansion in member as well as non-member countries in the process of economic development;
(3) To contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The OECD has recognized the important role that science and technology play in economic growth by establishing a Directorate for Scientific Affairs and by the creation of several special committees charged with examining areas and methods for fruitful international co-operation and assistance in this field. Major concerns have been the development and harmonization of national science policies and the promotion of research at the international level.

Realizing that communication of scientific and technical information plays an important part in research and technical innovation processes, the member countries established a Scientific and Technical Information Policy Group (responsible to the Committee for Research Co-operation) to study the organization of information in their countries and the implications for government action to ensure:[3]

(1) The effective co-ordination of information systems and sources nationally;
(2) The efficient use of possibilities for international collaboration in information activities;
(3) A high level of compatibility among the advanced information systems under development in different countries and in various subject areas.

To support the work of the Policy Group, several Working Panels have been set up to investigate specific questions. One panel is studying the Economics of Information with a view to defining the kind of economic data needed for policy decisions and for surveying the resources devoted to information in member countries. Another has examined the present state of information services in chemistry to see what governmental action may be necessary to take full advantage of the opportunities in new kinds of information service available. A third is considering the practical questions associated with establishing a European network of biomedical information services, based on the U.S. MEDLARS system. Another panel has recently been established to examine the need for standardization of the materials and procedures involved in information transfer.

The Ministers responsible for science and technology in the OECD member countries met for the third time in Paris on March 11 and 12, 1968. They reviewed (*a*) the impact of technological gaps between member countries on social and economic development, and (*b*) the development of both national and international capabilities to cope with the rapid growth of scientific and technical information.

With regard to the latter subject, the following statement was subsequently issued:[4]

> "The Ministers took note of the discussions of the Committee for Science Policy based on the work of the OECD Scientific and Technical Information Policy Group. They recognized 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. Nevertheless, the volume of such information, which is doubling every 10 years or so, threatens to swamp the traditional ways of handling it. New techniques based on computers provide the potential means for dealing with this problem, but international co-operation and exchange will be undermined unless national systems are developed which are compatible or convertible at the international level.
>
> "Ministers noted 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.
>
> "The Ministers agreed that a policy for scientific and technical information necessarily forms part of the national science policy, and that each Member Government should establish a high-level focus for information questions.
>
> "The Ministers were convinced that there is a need for immediate co-operative efforts at the international level to promote the introduction of the necessary basic standards for assuring the compatibility of the various information systems, whose object would be to provide, eventually, easy access for users to scientific and technical information.
>
> "The Ministers requested that OECD continue to evaluate the new information techniques, identify possible aims in regard to the development of these techniques and, as a matter of urgency, further develop its means for promoting co-operation and agreement in establishing comprehensive and compatible or convertible information systems, and make proposals to this end."

III.3 International Federation for Documentation (FID)

The *Institut international de bibliographie* was established in Brussels in 1895 to promote the international exchange of bibliographical information. In support of this work, the *institut* compiled a comprehensive world bibliography on cards. Although the bibliography was discontinued in 1914, the modification of the Dewey Decimal Classification scheme which the compilers had developed became widely employed and has since become known as the Universal Decimal Classification (UDC). For many years work on the UDC was the collective effort of individual experts associated with the *institut*. However, as national documentation organizations gradually came into existence it became centred in them. This led in 1924 to the reorganization of the *institut* as the International Federation for Documentation.[5] FID consists of:

(1) National Members (organizations representative of documentation activities in their countries);
(2) Associate Members (international organizations active in the field of documentation);
(3) National Associates (representing information organizations in developing countries, not yet able to join as National Members);
(4) Affiliates (organizations and individuals interested in the objectives of the federation).

At present FID has 41 National Members and 200 Affiliates.

The operational budget of the federation in 1967 was approximately $110 000. Two thirds of this was contributed by members, one quarter was derived from sales of the federation's publications, and $3 500 was received as an annual subvention from UNESCO. The activities of FID are based on the guidelines outlined in the FID program adopted in 1965, and cover the following areas:

(1) Research on the theoretical basis of information;
(2) Universal Decimal Classification;
(3) Classification research;
(4) Theory of machine techniques and systems;
(5) Linguistics in documentation;
(6) Technical information for industry;
(7) Training of documentalists;
(8) Needs of developing countries.

The major work of the federation is done through its many committees, such as:

Study Committee FID/TI – Technical Information for Industry;
Study Committee FID/TD – Training of Documentalists;
Study Committee FID/RI – Research on the Theoretical Basis of Information; which issue reports, and through the holding of its annual conference.[3,6]

The publication program of FID includes:

(1) *FID News Bulletin,* a quarterly survey of developments;
(2) Various editions of the UDC;
(3) Manuals and directories, e.g.:
   Modern Documentation and Information Practices
   Abstracting Services in Science, Technology, Medicine, Agriculture, Social Sciences, Humanities
   A Guide to the World's Training Facilities in Documentation and Information Work
   Bibliography of Directories of Sources of Information
   National Technical Information Services
   Bibliography of Standards on Documentation.

The Associate Committee on Scientific Information of the National Research Council is the Canadian National Member of FID.

III.4 International Council of Scientific Unions

The International Council of Scientific Unions (ICSU) was founded in 1931 as a direct successor to the International Research Council. The objectives of ICSU are:

(1) To facilitate and co-ordinate the activities of international scientific unions in the field of the exact and natural sciences;
(2) To act as the co-ordinating centre for the national organizations adhering to the council.

There are two categories of membership: National Members and Scientific Members. A country is represented either by its principal scientific academy or its national research council or any other institution or association of institutions or, failing these, by its government. Scientific members are international scientific unions, i.e. unions interested in one or more branches of the exact or natural sciences, that have been in existence for at least six years and have held or sponsored at least two international meetings.[2,3]

ICSU activities relating to information are (*a*) ICSU Abstracting Board, (*b*) Committee on Data for Science and Technology, (*c*) ICSU-UNESCO Study on the Communication of Scientific Information and the Feasibility of a World-Wide Science Information System.

The ICSU Abstracting Board is an international scientific organization which has legal existence in Belgium. Its general objectives are to organize, promote, and improve on an international scale the exchange and publication of primary or secondary scientific information. To this end it has made arrangements between those concerned for proof copies or advance copies of primary scientific periodicals to be sent to *Bulletin signalétique, Referativniy Zhurnal, Physics Abstracts, Physikalische Berichte, Chemical Abstracts, Chemisches Zentralblatt,* and *Biological Abstracts.* The ICSU Abstracting Board also provides advice and information regarding new scientific journals and methods of improving scientific publications, conducts statistical studies on abstracting periodicals, and publishes each year a comprehensive study of ICSU activities in the field of scientific information.

A Committee on Data for Science and Technology (CODATA) was established in 1966 with the general purpose of promoting and encouraging on a world-wide basis the production and distribution of compendia and other forms of collections of critically selected numerical and other quantitatively expressed values of the properties of substances of importance and interest to science and technology.

A preliminary meeting of a Working Party to consider the Communication of Scientific Information and the Feasibility of a World-Wide Science Information System was held in Paris in January 1967. The Working Party has suggested that:

(1) The world-wide science information system should be a flexible network based upon the voluntary co-operation of existing and future information services;

(2) Initially, the system should be restricted to the basic natural sciences but, in formulating the system, attention should be paid to the possibility of covering technological and other fields of learning.

III. 5 International Organization for Standardization

The International Organization for Standardization (ISO) is the successor to the International Federation of National Standardization Associations (ISA) which was formed in 1926 but ceased to function in 1942. ISO developed from the activities of the United Nations Standards Co-ordinating Committee, comprising the national standards organizations of 18 allied countries and acting as a temporary successor to ISA, and was firmly established in 1947.

The objective of ISO is to promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing mutual co-operation in the sphere of intellectual, scientific, technological, and economic activity. ISO members are the national bodies most representative of standardization (one for each country) that have agreed to abide by the organization's Constitution and Rules of Procedure. The Canadian Standards Association is the Canadian National Member. Financial support for the functioning of ISO is derived from annual contributions of National Members which are related to the economy of the country concerned.

The detailed work of ISO is performed by 118 technical committees, each concerned with a specific field of interest. Technical committees are composed of delegations from National Members wishing to take part in the work. Each technical committee has a secretariat, supported by one of the participating National Members, which is responsible for the satisfactory conduct of the committee and for reporting annually to the council of ISO on the results achieved. One of these technical committees, ISO/TC 46, is especially concerned with documentation and has produced recommendations concerning titles, layout of periodicals, microcopies, etc. Another committee, ISO/TC 97, is concerned with computers and information processing.[3,7]

III. 6 International Atomic Energy Agency

The objectives of the International Atomic Energy Agency (IAEA), which has its seat in Vienna, are to accelerate and enlarge the contribution of atomic energy for peaceful uses. The program of the agency is devoted to all major fields of the peaceful uses of atomic energy, including exchange of information and co-operation in the field of nuclear energy. The governing bodies of the IAEA include the General Conference, consisting of representatives of 97 Member States, and the Board of Governors, composed of 25 members. The staff of the agency is headed by a Director General. A Scientific Advisory Committee provides advice to the Director General and, through him, to the board.

The agency proposes to establish an International Nuclear Information System (INIS) for the world-wide exchange of scientific and technical information in the field of nuclear science and technology. The system would be based on close collaboration among the countries producing information in this field. Basic to the proposal is the premise that some literature-handling functions are best centralized and others decentralized. The selection, scanning, and abstracting of appropriate materials for the system should be decentralized, with overall central co-ordination. The processing of the material, with the subsequent production of the various products desired, and the dissemination of these products, are best done centrally.

In general terms, it is proposed that the participating countries and organizations be responsible for scanning all the literature they produce in the field of nuclear science and technology and selecting that which falls within the agreed subject scope of the system. Bibliographic information and subject analysis in a form suitable for computer input, an abstract of each item, and a copy of the non-journal items would be provided to a centre at IAEA. INIS would thus receive routinely, without duplication, descriptive material, indexing information, and abstracts for all appropriate publications and documents generated by each participant, and complete copies of all the items not published in periodicals available through the normal channels. The text material, i.e. abstracts and documents, would be put into a form suitable for direct reproduction and filed for ready access. Copies of the abstracts could be distributed routinely to participants desiring them. Microfiche copies of the complete documents could be made available on request. The descriptive information about the documents and the subject indexing would be prepared for input into a computer system.

The centre would create and collect computer programs to produce a variety of bibliographic products. To begin with, magnetic tapes containing the descriptive information and subject analysis of all documents would be produced and distributed to participants on a periodic basis. A classified and indexed acquisitions list would be printed by computer and distributed regularly as an announcement of all new information entering the system and as a tool for retrospective searching for individual scientists and for countries that lack adequate computer facilities. Information retrieval programs would be developed for rapid machine-searching of the files, and machine searches would be made for those participants who do not have their own mechanized systems. The search programs would be used to prepare bibliographies, and for special selective current information dissemination desired by participants. Machine indexes to the information in the system would be issued as needed.

An INIS Study Team was established in Vienna during the period March to June 1968 to prepare the detailed plan of operation. The report of the Study Team contained a number of specific recommendations governing the way in which material would be received from participating countries. The Study Team recommended that:

(1) Input need not necessarily be submitted in machine-readable form;
(2) The preferred form would be magnetic tape, with punched paper tape as an alternative;
(3) Work sheets would be acceptable and encouraged.

Countries with large annual productions would send their entries on magnetic tape. The agency would have to have consultations with each national or regional centre to ensure that the local code will match the 120-character code of the agency's IBM 360/30.

There are five countries, each with a production of 4 or more per cent of the total, whose input would probably arrive as separate magnetic tapes and would cover about 64 per cent of the total. For the remaining 36 per cent, the simplest and least error-producing procedure would be to provide the entries on standardized work sheets (26 000 sheets a month). This would impose a heavy strain on INIS headquarters and deprive some national centres of the experience of creating machine-readable input which could also be incorporated in their own information store. While INIS would not impose on its Member States, it would urge that the choice made by each national centre should be guided by the need to maintain the maximum integrity of the merged file. In other words, the smaller the producer the more desirable it is that input should be on work sheets to INIS headquarters. For each national centre that provides its input on paper tape, individual arrangements would be made by INIS headquarters so as to ensure that the tape typewriter used conforms with certain minimum standards.

While the above proposals for input media seem to be the most suitable for an INIS which is to start in 1970, the team also considered other possibilities, particularly for the middle seventies. The most attractive is optical character recognition, a rapidly developing field in which equipment costs, though still very high, might become reasonable for the needs of INIS in the not-too-distant future.

III.7 European Atomic Energy Community

The European Atomic Energy Community (EURATOM) was founded in 1956 with a membership of six governments: Belgium, France, Germany, Italy, Luxembourg, and the Netherlands. EURATOM has its seat in Luxembourg. Its objectives are to contribute to raising the standard of living in Member States and to the development of commercial exchanges with other countries by the creation of conditions necessary for the speedy establishment and growth of nuclear industries. In the field of scientific and technical information, the EURATOM Centre for Information and Documentation (CID), created in 1961, is responsible for carrying out all the activities related to documentation, information, publications, and libraries.

Activities in documentation include bibliographical information (literature searches made either by computer or by traditional means), document analysis for information storage and retrieval, research in problems of documentary sources, abstracts of relevant documents on nuclear matters in answer to a definite question, as well as selective dissemination of information. Experimental operation of a computer-aided system began in October 1966 exclusively for the searchers of EURATOM's Joint Research Centre, and in May 1967 it was opened to all interested parties inside and outside EURATOM. Indexing data for more than 500 000 documents, dating back to 1947, have been stored in an IBM 360 computer. Information on about 120 000 documents per year is acquired, indexed, and stored. Fifty thousand of the references are from *Nuclear Science Abstracts*.

The system depends on the use of a thesaurus of terms. These terms are selected by professional research workers with a few weeks training in indexing.

The first thesaurus published in 1964 was replaced by an updated one in 1966. The continuing costs and effort of such updating are the main objections to the thesaurus procedure. The thesaurus is in machine form. There are graphs of hierarchical associations to aid the user. Terms for documents are stored on tape and matched against assigned descriptors of the question. Trained professional staff is used to translate a user's query into a form suitable for input to the computer. Depth of indexing averages 15 descriptors per document, 3 for a query. Full-text storage is not used and there is heavy dependence on abstracts.

The documentary language is exclusively English, corresponding to the fact that over 60 per cent of the nuclear literature is in English, as against 25 per cent in other western and 15 per cent in eastern languages. However, every part of the system that is in natural language, such as the bibliographic data and the text of the abstracts, remains in the language of the source document, generally an abstract journal. The material in the file thus includes a number of French and German abstracts, whereas most of the Russian and Japanese literature is represented by English-language abstracts. Operation of the system involves no translation of abstracts.

The scientific staff of the project includes 12 university graduates speaking an average of 3.3 languages and with an average of 9.5 years' experience in various parts of the nuclear field. In addition, over 50 scientists located in European research institutes have been trained by EURATOM staff to do scanning and indexing work, so that part of the system's intellectual output is decentralized. Some of the subject specialists on the editorial staff of *Nuclear Science Abstracts* have received similar training under an agreement between EURATOM and the U.S. Atomic Energy Commission which started late in 1964 and provides for the assignment of descriptors to documents referred to in *Nuclear Science Abstracts*.

The publications section of EURATOM is responsible for communicating information of immediate industrial interest to Member States, their national centres and industries, and for publication and distribution of scientific and technical EURATOM reports and publication of EURATOM's own periodicals: *Transatom Bulletin, EURATOM Information*, and *EURATOM Bulletin. Transatom Bulletin* reports translations of scientific and technical documents of nuclear interest written in the lesser known languages, and indicates how they can be obtained. Since 1966 it has been announcing a selection of Eastern European documents of nuclear interest not yet translated. *EURATOM Information* gives abstracts of all research contracts concluded, of all patents granted, and abstracts and bibliographies of all scientific and technical reports issued by EURATOM. *EURATOM Bulletin* covers the peaceful uses of nuclear energy in general and EURATOM's activities in particular.

III.8 Other Organizations

The foregoing has outlined the interest and activity of a few international organizations whose work deals with the exchange of scientific and technical information. Many others could be included, among which are:

Advisory Group for Aerospace Research and Development
International Association of Documentation and Information Officers
European Organization for Nuclear Research
International Council for Building Research Studies and Documentation
European Space Research Organization
Food and Agriculture Organization of the United Nations
International Federation of the Periodical Press
International Association of Technological University Libraries
International Council on Archives
International Federation of Automatic Control
International Federation for Information Processing
International Federation of Library Associations
International Patent Institute.

Section IV

INFORMATION ACTIVITIES OF SELECTED COUNTRIES

The greatest development of scientific and technical knowledge has taken place where there has been the greatest industrialization accompanied by large populations. As a result, small countries depend on their larger neighbours for information, since they do not have the specialized manpower nor the economic resources for a full program of research and development to create the wide spectrum of information required. Canada is likely to benefit from other industrialized countries through information flow from the large countries such as:

United States of America	Germany
United Kingdom	Japan
France	U.S.S.R.

and through study of the organization of information services in the smaller countries such as:

Sweden	Netherlands
Denmark	Poland.

The following examination and comparison of the awareness of several countries of the value of scientific and technical information are based on a review of the more significant developments that have taken place in these countries. The material presented is not meant to be exhaustive, nor is the efficiency of the various organizations or systems considered. The countries that have been selected were chosen for one or more of the following reasons:

(1) Relationships with Canada are likely to be significant;
(2) Present accomplishments warrant study;
(3) Problems are similar to those in Canada.

IV.1 The North Atlantic Community

IV.1.1 United States of America

The extent of concern and involvement with scientific and technical information in the United States is of great importance to any examination of the present state of affairs in Canada and the assessment of what should be done in Canada in the future, particularly on account of the following:

(1) Canada and the United States share a common language which greatly facilitates the exchange of ideas and knowledge;
(2) The geographic proximity of the United States to Canada and its considerable influence on the Canadian economy invariably mean that developments in the United States soon have repercussions in Canada;

(3) The United States is the largest producer of scientific and technical information in the Western World;

(4) Considerable research and development effort is taking place in the United States on all aspects of information handling and exploitation. In 1966, the total federal obligations for scientific and technical information amounted to $277 million, of which $47.9 million were devoted to R & D.[8]

Policy Formulation

The Executive Office of the President of the United States includes the Office of Science and Technology (OST), which is charged with assisting the President on matters of national policy affected by, or involving, science and technology and with reviewing, integrating, and co-ordinating major federal scientific activities.[9] This latter responsibility includes the development of a co-ordinated program for the scientific and technical information activities operated or supported by the Federal Government.

The Adviser to the President on Science and Technology is the Director of OST. He also acts as chairman of two committees formed to investigate specific problems and activities and to recommend government action. The first of these committees, the President's Science Advisory Committee, with members drawn from outside the Federal Government, was responsible for the now classic document *Science, Government and Information.*[10] The second committee is the Federal Council for Science and Technology, which is concerned with establishing more effective co-ordination of federal science and technology, identifying research needs, achieving better use of facilities, and furthering international co-operation.[11] Its members are responsible for science and technology in each federal department or agency and are able to commit their respective agencies to courses of action. Consequently, recommendations emanating from the Federal Council for Science and Technology are tantamount to agreements to adopt the proposals.

To assist the Federal Council for Science and Technology, various panels and committees have been created. Among these is the Committee on Scientific and Technical Information (invariably referred to by its acronym COSATI) which is composed of the senior personnel who are responsible for the scientific information activities of each agency. COSATI is the principal mechanism for obtaining individual agency views and reaching agency consensus on desirable activities and programs of the Federal Government with respect to information systems for science and technology. The Office of Science and Technology provides an executive device for implementing the recommendations of COSATI. COSATI itself has developed Working Panels to provide detailed reviews of various aspects of the problem. These include:

(1) Operational Techniques and Systems
(2) Information Sciences Technology
(3) Education and Training
(4) International Information Activities

(5) Management of Information Activities
(6) Information Analysis and Data Centres
(7) Task group on National Information Systems
(8) Task group on Legal Aspects involved in National Information Systems.

It has also sponsored the study of a document-handling system for the United States [12,13] and introduced several specifications, including those for microfiche used in processing technical reports, and the format to be employed in preparing technical reports.

Experience gained as a result of the work of COSATI pointed up the need for a similar organization by which people in the non-federal sector of the United States economy could exchange views and participate in national planning of scientific and technical information activities. Consequently, in 1966 the National Science Foundation requested the National Academy of Sciences – National Academy of Engineering to set up a Committee on Scientific and Technical Communication (SATCOM) whereby scientists and engineers could, through their societies, express their views and exchange ideas with others in the non-federal sector. By late 1967 SATCOM had 17 members and had enlisted the support of 155 consulting correspondents.

> "Succinctly stated, SATCOM conceives its purpose as that of making available, for the guidance of national initiatives in the improvement of scientific and technical communication, the considerations of the professional community at large as they relate to the sound design and effective utilization of pertinent services and reflect contemporary ways of doing the work of science and technology".[14]

To this end the committee has undertaken a series of studies to familiarize itself with the extent of information activities in the non-federal sector and in November 1967 held a Consulting Correspondents Conference at which the statements prepared by various review groups were discussed. To date, no documents have been published concerning the results of SATCOM's efforts other than informal reports [14, 15] by the Executive Secretary addressed to the Director, Office of Scientific Information Services, National Science Foundation. However, a report is expected by the end of 1968.

Federal Departments and Agencies

Two components of the Legislative Branch of the Federal Government play an important role in the *de facto* "system" that presently exists in the United States. These are the Library of Congress and the Government Printing Office.

The Library of Congress is the largest and most important library in the United States. In keeping with this position, it undertakes extensive bibliographic work resulting in publications such as the *Catalogue of the Library of Congress,* the *National Union Catalogue* of books in selected libraries of the United States, *New Serials Titles*, and a catalogue of manuscript collections in the United States. It is actively developing an automation program, one aspect of which will make bibliographic data concerning additions to the library available on magnetic tape for use by other libraries. This work is complementary to the present program of publishing Library of Congress catalogue cards for use by other libraries. In 1962 the Library of Congress established the National Referral Center for Science and Technology to act as a clearinghouse to provide comprehensive, co-ordinated access to the national resources of scientific and technical information by identifying and cataloguing all significant scientific and technical information resources.[16]

The Government Printing Office, as its name implies, is responsible for making available all the publications of government departments and agencies. It co-operates with the Library of Congress in its widespread foreign exchange of official documents produced by the Federal Government. The physical arrangements for shipping these documents are made by the Smithsonian Institution which has been active in the international exchange of scientific literature since the days of the first Secretary of the Institute, Joseph Henry, over a century ago.

Several components of the Executive Branch of the Federal Government have substantial interests in the production and dissemination of scientific and technical information pertinent to the specific missions of the respective departments and agencies.

The Department of Agriculture has a comprehensive information service, much of the information generated by the department being distributed as publications issued by the Government Printing Office. The department maintains the National Library of Agriculture which collects all significant material in agriculture and related subjects and publishes the *Bibliography of Agriculture.* It has recently organized a Pesticide Information Center to facilitate the obtaining of information on the hazards and benefits of such materials.

The Department of the Interior, which is concerned with the conservation, management, and exploitation of the land and water resources of the country (including minerals, fish, and wildlife), has a large technical library with nearly 50 branches serving its own staff and the public. It is proposed to create a National Library of Natural Resources. A Water Resources Scientific Information Center (WRSIC) was established in 1966 as the first component of the Natural Resources Scientific Information Center.[17] WRSIC services will include the selective dissemination of information, current awareness bulletins, abstract bulletins, topical bibliographies, and requested searches. The Geological Survey, in co-operation with the Geological Society of America and the American Geological Institute, issues a bibliography of the geology of North America; the two societies issue one on the geology of the world exclusive of North America.

The Department of Health, Education and Welfare is responsible for a number of scientific and technical information activities both within and without the department. The Public Health Service maintains the National Library of Medicine which publishes the *Index Medicus,* an indexing journal covering the biomedical sciences, and which has pioneered in the application of computers to information handling in the MEDLARS program.[18] It also maintains information centres in various parts of the United States and is developing new ones concerned with drug information and water and air pollution. Many of the National Institutes of Health maintain, or support by contract, specialized information centres, e.g. the Parkinsonian and Related Disease Information Center; the Brain Information Center; the Special Information Center for Hearing, Speech and Disorders of Human

Communications; the Information Center for Vision and Diseases of the Eye; all supported by the National Institute for Neurological Diseases and Blindness.

The Department of Commerce is responsible for the Bureau of the Census which gathers large amounts of data and produces analytical studies based thereon. It also operates the Patent Office which, in addition to issuing patents and describing them in the Patent Office *Official Gazette,* has now started to publish the *Official Gazette–Patent Abstract Section.* This contains summaries, plus drawings, of the technical content of patents, avoiding the use of the legal and patent phraseology characteristic of patents and patent applications. The objective of this new journal is to provide non-patent-oriented scientists, engineers, and businessmen with easier access to important technical information contained in patents. For this purpose, abstracts have been required as part of patent applications since January 1967. Another unit of the department directs activities under the State Technical Services Act which has "the objective of promoting commerce and encouraging economic growth by supporting state and interstate programs to place the findings of science usefully in the hands of American enterprise". The National Bureau of Standards has a number of activities of which the Clearinghouse for Federal Scientific and Technical Information (CFSTI) and the National Standard Reference Data System (NSRDS) are perhaps best known. The CFSTI is the central organization for collecting, announcing, and distributing unclassified, unrestricted reports produced by the government and government contractors. It produces an abstract-index bulletin to such reports and also issues "Fast Announcements", i.e. abstracts of the more important new reports organized in 57 industrial categories. Copies of reports usually cost $3 as hard copy or 65 cents as microfiche. The NSRDS was established in June 1963 with the objective of developing an integrated nation-wide complex of data centres responsible for the collection and critical review of data in various fields. Approximately 30 such data centres are now operating, about half of them in Institutes of the Bureau and the others in universities and industrial research and development organizations.

The Department of Defense has many information services for its own purposes. Of immediate interest to this report is the Defense Documentation Center, which abstracts and indexes all classified or restricted reports and other selected documents and publishes *Technical Abstract Bulletin.* The latter publication is circulated to Department of Defense agencies, contractors, and other qualified organizations which may obtain individual reports by application to the Defense Documentation Center. The department supports many specialized information centres concerned with special subject areas of interest to, and available only to, the department and its contractors.

The Atomic Energy Commission (AEC) maintains a Technical Information Division which produces *Nuclear Science Abstracts* and carries on a widespread exchange program with interested organizations in the United States and abroad. Likewise, the National Aeronautics and Space Administration (NASA) has a large information organization for its own internal purposes and also produces two abstract journals, *Scientific and Technical Aerospace Reports* (STAR) and *International Aerospace Abstracts* (IAA), in co-operation with the American

Institute of Aeronautics and Astronautics. Both AEC and NASA are promoting the transfer of knowledge generated within their organizations to industry. *Tech Briefs* describing new devices or techniques that may have application in other fields are issued regularly. NASA has also established a series of regional dissemination centres based in universities across the country.[19] Each of these centres is supplied with the abstract journals, reports, and indexes on magnetic tape produced by NASA, and offers an information service to industry based on these tools. Financial support for these centres is provided by NASA on a decreasing scale over a number of years with the hope that they will eventually become self-supporting.

The Smithsonian Institution operates the Science Information Exchange (SIE), a clearinghouse for information on unclassified research in progress in the life, physical, and social sciences. Project descriptions are collected and catalogued so that questions as to who is doing what, where, at what cost, and by the support of which agency, can readily be answered. SIE does not collect reports, abstracts, or other forms of published research results; it is concerned only with research proposed or in progress.

The National Science Foundation is an independent agency of the Federal Government, established by Congress in May 1950, "to promote the progress of science; to advance the national health, prosperity and welfare; to secure the national defense; and for other purposes". Its principal activities are the development of national science policy; the support of basic research in the mathematical, physical, medical, biological, engineering, and other sciences; and the furtherance of education in the sciences through the award of graduate fellowships and other means. As part of this work, it maintains an Office of Science Information Service which provides financial support for research efforts by the non-federal sector in the area of information handling and subsidizes new journals or other appropriate ventures.

Professional Organizations

The National Academy of Sciences–National Academy of Engineering have, as mentioned earlier, established SATCOM. The National Academy of Sciences also co-ordinates the activities of the World Data Center A System, i.e. those centres located in the United States, and maintains the World Data Center A: Rockets and Satellites. The World Data Center System was established in 1957 by the International Council of Scientific Unions to assemble the data collected during the work of the International Geophysical Year. The resulting network of centres has been continued on a permanent basis by international agreement. The Academy is also participating in the work of the Committee on Data for Science and Technology (CODATA) organized by the International Council of Scientific Unions in 1966. For the first two years the central office for the committee is located in quarters supplied by the Academy in Washington.

The many professional scientific and technical societies in the United States hold frequent meetings for the exchange of new ideas. Many of them publish one or more primary journals and a few of them are responsible for discipline-based abstracting journals.

Primary responsibility for national (United States) and international dissemination of secondary chemical information in the English language rests with the Chemical Abstracts Service (CAS) of the American Chemical Society (ACS). The principal product of CAS is *Chemical Abstracts,* a weekly publication containing informative abstracts of the world's published literature on chemical and related research, development, and applications. In 1967 *Chemical Abstracts* contained 223 000 abstracts. Since 1955 a research and development program has been undertaken at CAS, later supplemented by similar work at ACS headquarters, with the goal of developing a unified, computer-based information system that will produce both a full, printed record of chemical and chemical engineering knowledge and a variety (in kind and form) of timely, special-subject alerting services, while simultaneously providing a mechanized search and retrieval system that is sufficiently flexible to meet the varied needs of its users.[20] CAS is presently exploring the feasibility of establishing, in various places outside the United States, fully responsible and largely independent national documentation authorities for storing and utilizing CAS-generated information and magnetic tapes *(vide* U.K. Consortium on Chemical Information).

The only private secondary communication service in English which provides broad coverage of the biological sciences is the BioSciences Information Service (BIOSIS) formerly called Biological Abstracts. BIOSIS functions as an independent agency but maintains close ties with its four founding agencies: the American Institute of Biological Sciences, the Federation of American Societies for Experimental Biology, the American Association for the Advancement of Science, and the Division of Biology and Agriculture of the NAS/NRC. Its principal medium of dissemination is the semi-monthly journal *Biological Abstracts* which contains about 175 000 abstracts per annum from over 7 000 journals. Experiments are in progress concerning special literature searches, current awareness services, and the production of specialized abstract services, e.g. *Abstracts of Mycology,* begun in 1967.

The development of an overall information system for engineering is a principal concern of the Engineers Joint Council (EJC), a federation of 39 engineering societies with a combined membership of more than 500 000 engineers. A comprehensive secondary information service in engineering is presently offered by *Engineering Index,* while certain member societies of the EJC also produce more specialized secondary publications, viz. The American Society for Metals–*Review of Metal Literature**, The American Society of Civil Engineers–*SAE Journal and SAE Transactions,* and The American Institute of Aeronautics and Astronautics–*International Aerospace Abstracts.*

In November 1965 representatives of the EJC, the United Engineering Trustees Incorporated, and the Engineering Index formed a Tripartite Committee to develop plans for an overall engineering information management structure. The committee produced a report in November 1966 calling for the establishment of a new corporate entity, the United Engineering Information Corporation, capable of

*The *Review of Metal Literature* terminated on January 1, 1968, being replaced by *Metal Abstracts*–a joint publication of the American Society for Metals and the Institute of Metals in the United Kingdom.

bringing together the engineering information activities of the member groups of the committee. The corporation would be charged with providing the management structure for an information service that is considered as a co-ordinated decentralized system, comprising and taking maximum advantage of existing engineering information and data services. The report has been accepted and endorsed by the organizations responsible for the committee which has now been authorized to continue work towards the development of a corporation.

Secondary communication services for the mathematical sciences are provided by the following: the American Mathematical Society–*Mathematical Reviews,* the Association for Computer Machinery–*Computing Reviews,* and the Operations Research Society of America–*International Abstracts in Operations Research.* The entire world literature relevant to psychology is covered by the abstracts appearing in *Psychological Abstracts* published by the American Psychological Association.

A recent estimate [21] has identified 55 regularly scheduled abstracting and indexing publications that are issued by professional societies in the United States. Those mentioned above are perhaps the major ones, but they demonstrate the extent to which American societies are active in this field. Substantial financial support for activities of these societies is provided by the National Science Foundation ($15.8 million in 1966).

Trade Associations

In addition to the well-established information services, such as primary and secondary publications, dealing with the different scientific disciplines, similar services have been developed to meet the needs of specific industrial sectors by trade associations and some universities. Prime examples are the work of the following: American Petroleum Institute–*Abstracts of Refining Literature, Abstracts of Refining Patents*; The University of Tulsa–*Petroleum Abstracts* (covering exploration, development, and production of crude oil and natural gas); The Institute of Paper Chemistry–*Abstract Bulletin of the Institute of Paper Chemistry*; the Institute of Textile Technology–*Textile Technology Digest*; and the Copper Development Association–*Extracts of Documents on Copper Technology.* Information centres on behalf of *Le centre d'information du cobalt S.A.* and the Tin Research Institute are operated by Battelle Memorial Institute to provide any necessary technical assistance to the users of cobalt and tin, respectively.

Commercial Enterprises

American publishing houses are the producers of a prodigious stream of scientific and technical material either in the form of books or trade magazines. In addition, there are a few companies specializing in the organization and dissemination of published information. The Institute for Scientific Information provides three *Current Contents* journals in the fields of life sciences, physical sciences, and chemical sciences, which contain the tables of contents of a wide selection of journals reporting work in these fields. Where necessary, the tables of contents of foreign journals are translated into English. If a subscriber requires a particular article referred to in *Current Contents,* it will be supplied. The Institute for

Scientific Information also produces the *Science Citation Index* and *Index Chemicus*, and provides selective dissemination of information services either directly or by the provision of magnetic tapes which may be searched by the client in his own organization.

Information for Industry, Incorporated, produces a uniterm index of all United States chemical patents issued since 1950. This is published in printed form as a dual dictionary and a book of chemical patents; the dual dictionary is also available in a magnetic tape version for searching by computer. Information services of value to design engineers, purchasing agents, manufacturers, architects, and building contractors are provided by Sweets Industrial Microfilm Service, Sweets Construction Catalog File, and Dodge Construction News Reports.

Universities

Implementation of services under the State Technical Services Act (STSA) is the responsibility of appropriate degree-granting institutes in the individual states under the general direction of a co-ordinating "designated agency" for each state. While the technical services provided may take many forms, they all tend to bring the university community into more intimate contact with local or state-wide industry and help industry to benefit from the knowledge and facilities of the universities. Many universities have established specialized information services, such as the *Petroleum Abstracts* of the University of Tulsa, and others are being created–some with the assistance available under the STSA.

To facilitate collaboration among institutions of higher learning in their efforts to utilize effectively developments in communication science, the Interuniversity Communication Council (EDUCOM) has been formed. In July 1966 some 180 individuals from educational, governmental, and industrial organizations met under the aegis of EDUCOM to consider the desirability of establishing an education communications system. Agreement was reached on the need for a country-wide interuniversity information network (EDUNET) and on proposals for establishing a development program for the network.[22] Estimated cost of the development program is $11.6 million.

Libraries

Library automation efforts are proceeding at many of the major libraries in the country but apparently on a largely independent basis. Co-ordination of the development work in hand at the Library of Congress, the National Medical Library, and the National Library of Agriculture has been instituted, and a special task group representative of the three libraries has already agreed upon the development of a national data bank of machine-readable catalogue information to be located in the Library of Congress, and a national data bank of machine-readable information related to the location of serial titles held by research libraries.

Regional library networks are taking shape with the general purposes of improving the service available from each individual component of the network and extending the clientele to which services are provided. Typical cases in point are (*a*) the network of the west Gulf Coast area with headquarters at Rice University[23], and (*b*) the Central New York Reference and Resources Council which was formed to provide improved access to advanced reference and research library materials; it is the first of nine such regional networks to be developed in New York State. Discipline-based networks are also developing. A user-oriented, on-line, real-time, computerized library system is being developed by the State University of New York at the Upstate Medical Center in Syracuse which will link the three libraries of the State University of New York Medical Center and the University of Rochester Medical Center Library. The network is expected to make it possible for clients to search the list of recent medical books and journals available in the participating libraries in less than two minutes by means of computer input-output terminals. The list will include approximately one million items published in the last five years.

Recent Studies and Proposals

Professional associations of all kinds in the United States are concerned with the growing problems of handling information and the library profession is no exception. The American Library Association constituted an *ad hoc* Joint Committee on National Library/Information Systems (CONLIS) since it was felt that the Recommendations for National Document Handling Systems in Science and Technology as proposed by COSATI were basically inadequate to the real needs of the situation by virtue of their limitation to science and technology. CONLIS proposed:[24]

> "... that there be established within the Federal Government a single agency with the responsibility to assure that there is ready access to all significant published information by all elements of the economy and with the continuing budget support that will enable it to fulfill this responsibility."

On September 2, 1966, a President's Committee on Libraries and a National Advisory Commission on Libraries were created by Presidential Executive Order. The committee was charged with appraising the potential role of libraries as components of a network of information exchange, evaluating the present posture of both private and public agencies in relation to the total library resources of the nation, and developing recommendations for action. The commission was charged with submitting a report within one year of its first meeting to be used by the committee as the basis for accomplishing their charge. This report was presented to the committee in December 1967 but has not yet been made public, nor has the committee published any recommendations.

IV. 1.2 United Kingdom

Beginning with *Philosophical Transactions* in 1665, British scientists and engineers have contributed significantly to the information fund of published knowledge. Many organizations, particularly the learned societies, professional and technical associations, publish journals containing original contributions of knowledge, and some produce abstract journals to assist their members in maintaining an awareness of developments in their own and related fields of interest. The British book-publishing industry is a major supplier of publications to the English-speaking world, and most of the periodicals published by the trade press have a world-wide readership. Major libraries are operated by certain national institutions, e.g. the British Museum, by universities, industrial research associations, and by the principal cities. The inclusion in the Royal Society Empire Scientific Conference of 1946 of a session devoted to scientific information services created a recognition in scientific circles of the mounting importance of the subject and did much to improve the status accorded to it. Since then, increasing attention has been paid to the need to document scientific and technical achievements and to facilitate the dissemination and exploitation of known knowledge.

Office for Scientific and Technical Information

The Office for Scientific and Technical Information (OSTI) was set up in 1965 within the Department of Education and Science.[25] It was formed around a nucleus of staff transferred from the now disbanded Department of Scientific and Industrial Research (DSIR), which had been giving increasing attention to information problems during its last few years. The functions of OSTI have been made very wide so that within the resources at its command it may stimulate or, if necessary, undertake almost any activity that can contribute to the better handling or utilization of information in both the natural and social sciences and their related technologies. The promotion of research and development work on information handling and data compilation are the long-range activities of OSTI, but help is being afforded to existing information organizations to improve their services, and educational activities are being stimulated. OSTI has recognized the need for co-operation with other countries and is assisting international organizations to promote co-operation. In particular, OSTI is supporting Anglo-American co-operation in the fields of medicine, chemistry, and physics.

There is a growing recognition that the task of data compilation now needs proper stimulation and co-ordination rather than being left to the initiative of enthusiastic individuals or groups. A list of subject areas in which a clear British interest already exists has been drawn up and support provided for some of these items. OSTI is also considering what experiments should be made in Britain with specialized data centres for scientists, combining a measurement service and perhaps research on methods of measurement with the collection, evaluation, extrapolation, dissemination, and retrieval of data. So far as education work is concerned, OSTI is trying to accomplish two fundamental tasks—systematic training for information work and systematic education of scientists and engineers in the use of literature and information services.

Ministry of Technology

The Ministry of Technology is charged with promoting the growth and efficiency of technologically based industries. As part of its responsibility in this regard, it provides government subsidies to 48 of the 50 industrial research associations in Britain that play a major role in generating and disseminating technical information to member companies. Many of the research associations spend up to 25 per cent of their incomes on communicating technical and management information to industry. Besides the usual library services, they are active in issuing research reports, technical bulletins on practical problems, films, and abstract journals. In addition to normal liaison work by staff members who visit firms regularly, a number of associations have mobile demonstration units.

The ministry has also taken over from DSIR the establishment of industrial liaison centres. These centres, based on technical colleges and advanced colleges of technology and financed 50 per cent by the ministry, each have one or more industrial liaison officers who are members of the college staff. They are responsible for maintaining contact with local firms, particularly the smaller ones, and encouraging them to make greater use of existing scientific and technical information and services. By the end of 1966, 59 such centres had been established and it was planned to have 70 of them by the end of 1967.

By virtue of its computer and communications interests, the ministry is looking ahead to the stage when technical data will be stored in computerized data banks at certain designated specialized centres in the United Kingdom and elsewhere, each of them being interlinked and accessible to users through a network of data transmission lines. Meanwhile, it is emphasizing the need to create or recognize such centres—at research associations, technical institutions, or other appropriate establishments—over the range of its interests and pressing on with the development of the theory and technique of information storage and retrieval so that a viable system can be brought into service at the appropriate time.

National Libraries

The establishment of a National Reference Library of Science and Invention was approved in 1951, but the library was only created in 1966 by combining the contents of the Patent Office Library and the scientific holdings of the British Museum. The library is under the control of the British Museum. Earlier plans to have the library housed in a new building have recently been frustrated and it continues to be split between two locations. Opinions differ, among both users of the library and professional librarians, as to the precise role of the library. Nevertheless it has been suggested:[26]

> "... since the Library could well serve as one of the major information 'laboratories' in the country, there is clearly much to be said for grouping it with such bodies as Aslib and the authority responsible for planning and co-ordinating the nation's scientific information services, and developing the site as an information 'precinct' of which the nation would be justly proud."

The intention to set up the National Lending Library for Science and Technology (NLLST) was announced by the Government in 1951 and it was officially opened in 1962. It is now the responsibility of OSTI. The purpose of the library is to obtain all literature that is likely to be of interest to the practising scientist and technologist and make it available through loan and photocopying services. Loans are made to organizations on an approved list of borrowers and not to individuals. Only in exceptional circumstances are loans made to organizations outside the United Kingdom. The library is basically a lending library for other libraries to draw upon. Every effort is made to deal with all loan requests the day they are received and, as far as possible, items are sent by letter post to ensure the quickest delivery. The NLLST is widely used (almost 600 000 loans in 1967) and has gained a national and international reputation for handling business promptly. In 1966 it was decided that the NLLST should also collect periodicals in the social sciences; it now receives almost 30 000 periodicals annually.

Approved borrowers are provided with loan request forms, supplied in pads of 50. To cover the average cost of postage of 50 loan requests, a charge of £3 is made for each pad. Loan requests are accepted by Telex provided each request is accompanied by the number from an unused loan request form. A photocopy service is available to organizations and individuals anywhere, but photocopy must be requested on special prepaid forms. The charge covers the production cost and postage. Owing to the extra handling involved, the photocopy service is marginally slower than the loan service.

The NLLST is responsible for operating the United Kingdom MEDLARS service. The library edits the enquiries it receives into a form suitable for computer searches, while the actual searching is done at present by the Computing Laboratory of the University of Newcastle-upon-Tyne. The average number of searches in 1967 was about 35 per week. The NLLST makes special efforts to promote the use of the type of literature it collects, although not necessarily of the copies it holds. Regular courses are organized on the use of scientific literature for academic staff, university library staff, and others, including members of the staffs of the larger public libraries and lecturers in library schools. The aim of these is to promote the development of courses in academic institutions on the use of the guides to the literature. Courses are also held for potential users of MEDLARS.[27]

Until the creation of the National Lending Library for Science and Technology, the Science Museum Library (some of the material from which was incorporated in the NLLST) was the principal public scientific library in the country. Its principal function is to serve as the nation's centre for the history of science. However, it also provides postgraduate and staff facilities for the Imperial College. In addition, the Science Museum Library lends material to the public and to specialist users through a supplementary service provided for the NLLST.

Other Libraries and Co-operative Ventures

Many libraries in universities, colleges of technology, technical colleges, research associations, and scientific and engineering institutions have significant holdings of scientific and technical material. So do certain libraries financed by local authorities. Libraries in all these categories have tended to concentrate on local or subject needs, and there has not been any necessity for them to see themselves as part of a coherent national system. However, modern means of communication allow them to become more interdependent and there is now a need that all library services in the country concerning science, technology, industry, and commerce should be looked at as a whole. The Department of Education and Science has set up a special *ad hoc* committee under Dr. F.S. Dainton to examine the question, and it is expected that the committee will have some positive recommendations regarding the establishment of comprehensive, nation-wide library services.

Some tentative first steps that could lead to greater co-operation and interdependence have been made. For example, since 1955 the librarians of the eight largest British cities outside London have met at 6-monthly intervals to discuss problems of common interest and to inspect the latest developments in each library. There is also a Standing Conference of Commercial and Technical Library Services which was formed in 1964. It covers the individual co-operative schemes provided by 13 other city libraries outside London. Typical of such co-operative schemes is that provided by the Liverpool and District Scientific, Industrial and Research Library Advisory Council (LADSIRLAC) based on the resources of the libraries of the City of Liverpool. LADSIRLAC gives special extramural services to industry over and above the services offered through public, technical, and special libraries. The special services are paid for by contributions from local industry, public utilities, technical colleges, and the City of Liverpool, but the special libraries on which they are based are staffed and maintained wholly by Liverpool City Council, as part of its policy of encouraging industrial and commercial development and efficiency. In 1966 there were 273 subscribing organizations to the scheme, almost 17 000 enquiries were received, and over 14 000 items were loaned. Many of the enquiries were answered with the assistance of firms in the Liverpool area. LADSIRLAC also organizes exhibitions and lectures on various technical matters and arranges for the translation of articles from any foreign language into English.

Aslib

Aslib was formed in 1924 as a result of the initiative of a small group of people concerned with metallurgical research. The original name, under which it was incorporated in 1926 as a company limited by guarantee, was the Association of Special Libraries and Information Bureaux. In 1949, the association merged with the British Society for International Bibliography and took the registered title Aslib. The general purpose of Aslib, as of its predecessor, is "to facilitate the co-ordination and systematic use of sources of knowledge and information in all public affairs and in industry and commerce and in all the arts and sciences". The microfilm work undertaken by Aslib during World War II and its work as a co-ordinator of information services resulted in the British Government's assisting Aslib through a system of annual and special grants.[28] Such grants are presently provided by OSTI.

Aslib's membership is almost 3 000, of which about 2 400 are organizations with the rest being individuals interested in information matters. Its income of £150 000 a year is derived approximately equally from OSTI, membership contributions, and services provided. The latter include consulting services, training courses, specialist publications, photocopying and microfilming services, and the tracking down of information relative to specific scientific and technical enquiries. Aslib acts as a "referral centre" for enquiries, putting enquirers in touch with the most appropriate source of information, and is the British National Member of the International Federation for Documentation. It also publishes four serials:

(1) *Journal of Documentation*, devoted to the recording, organization, and dissemination of specialized knowledge;
(2) *Aslib Proceedings*, which contains reports of meetings organized by Aslib;
(3) *Aslib Book List* of recommended scientific and technical books in English;
(4) *Index to Theses Accepted for Higher Degrees in the Universities of Great Britain and Ireland.*

With the assistance of a basic research grant from OSTI and special research contributions from industry, Aslib is expanding its research effort and consulting services with emphasis on computer-aided systems, operations studies, and user studies. It has recently held two "teach-ins" in an attempt to create better mutual understanding between information specialists and computer systems analysts and programmers.

Development Work

With the support and encouragement of OSTI, development work is now proceeding apace in the United Kingdom. A number of examples are illustrated below.

(*a*) As mentioned previously, the National Lending Library for Science and Technology is co-operating with the National Library of Medicine in the United States in the exploitation of MEDLARS tapes. At present, searches of the tapes are provided free but users are expected to evaluate the relevance of the references resulting from each search. The NLLST is now preparing British input for the MEDLARS tapes.

(*b*) In 1966 the Chemical Society, in co-operation with the American Chemical Society, established the Chemical Society Research Unit in chemical information at the University of Nottingham.[29] This unit has been experimenting with the magnetic tape version of *Chemical Titles* and *Chemical-Biological Activities.* Computer programs enabling the tapes supplied by Chemical Abstracts Service to be searched on the KDF-9 computer have been prepared, and for 18 months a selected population of 250 United Kingdom chemists has been receiving a selective dissemination of information service. This experiment has now been completed and evaluated, with the result that the service is being offered, still on an experimental basis, to any chemist prepared to pay the fee of approximately £40 per annum.[30] With the direct support of OSTI, the research unit is also providing the same service for a 12-month period to all interested Ph.D. chemistry students now in their final year who are supported by the Science Research Council.[31] At a meeting called by OSTI in February 1968 to consider the United Kingdom's reaction to proposals being made in OECD, there was strong support for greater intersociety collaboration on matters in the chemical information field.[32] As a result, 10 scientific societies have formed a United Kingdom Consortium on Chemical Information with the following objectives:

(1) To ensure the planning, development, and ultimate provision of a comprehensive mechanized information system in pure and applied

chemistry, designed to serve chemists and all other users of chemical knowledge;

(2) To ensure full collaboration with all developments in information services in other sciences and technologies and with chemical services in other countries;

(3) To ensure effective collaboration with and advice to government departments on chemical information matters on behalf of all chemists and users of chemical knowledge;

(4) To encourage the more effective use of existing and new services;

(5) To encourage the improvement of existing services, particularly primary and tertiary publications;

(6) To ensure that the scientific public is alerted to the potentiality of these services and trained in their proper use.

(*c*) The Institute of Electrical Engineers (IEE) has provided an information service in the fields of physics and electrical engineering since 1898, by the publication of *Science Abstracts*. In 1965 work was started to exploit the capabilities of computers for this purpose (INSPEC-Information Service in Physics, Electro-technology and Control), and beginning in 1968, parallel production of the abstract journals by the established procedure and by the use of computer composition will take place to verify the acceptability of the new techniques. It is hoped that in 1969 preparation of the journals will be carried out solely and entirely by computer. The magnetic tapes containing the information incorporated in the abstract journals will be used to develop the selective dissemination of information service originally proposed by the National Electronics Research Council and subsequently transferred to the IEE. As a significant amount of information is accumulated on magnetic tape over the years, it is expected that retrospective searching services will be introduced. Co-operating in this venture with the IEE are the Institute of Physics, the Physical Society and the Institution of Electronic and Radio Engineers in the United Kingdom, and the American Institute of Physics and the Institute of Electrical and Electronic Engineers in the United States. It is anticipated that the latter groups in the United States will eventually be responsible for providing American input to the system on magnetic tape and for distribution of the service on the American continent.[33]

(*d*) The Commonwealth Agricultural Bureaux (CAB) already produce several series of abstract journals. In collaboration with the American Institute of Food Technologists (AIFT) and the *Institut für Dokumentationswesen,* in Frankfurt, it is now establishing the International Food Information Service (IFIS) which will begin publishing in 1969 *Food Science and Technology Abstracts.* Abstracts of the world's patent literature will be compiled by the AIFT, and abstracts of the remaining literature will be compiled by the CAB who will also carry out the indexing and provide edited copy to Frankfurt where the journal will be printed by computer-aided typesetting.

(*e*) Assigning a specific identifying number to each book and periodical would greatly simplify ordering, accounting, circulation control, interlibrary loan procedures, etc. Progress has been made in this direction by the inclusion of LC catalogue card numbers in books published in the United States, and the development of CODEN by the American Society for Testing and Materials (ASTM) which assigns a unique five-letter code to each periodical. The British book-publishing industry has now adopted a system of Standard Book Numbers (SBN). Each SBN (nine digits in length) consists of three parts—the publisher's prefix, the title number, and a check digit. The latter digit is computer-generated so that the final SBN conforms to a certain weighting system designed to facilitate computer identification of the particular book in question.

(*f*) An interesting commercial service has been put into effect by INDATA (a subsidiary of CENTREFILE, a computing service for stockbrokers). With the assistance and co-operation of the British Scientific Instrument Research Association, INDATA is compiling a file of manufacturers' specifications of measuring devices and sells to subscribers selected sections of the file chosen from the total of 309 categories. Each week, a subscriber receives product cards, containing detailed specifications, illustrations, and up to 800 words of descriptive information concerning devices in the categories desired. Each card also has a detachable stub which can be returned to INDATA requesting delivery dates, demonstrations, etc., from the manufacturers. Long-term plans envisage on-line access to a computerized data bank from remote terminals in subscribers' offices.[34]

IV.1.3 France

The first major national centre devoted to indexing systematically the world literature of science and technology was established in France in 1945 by the *Centre national de la recherche scientifique* (CNRS), which operates under the aegis of the Ministry of Education. The Documentation Centre of CNRS now issues the abstract journal *Bulletin signalétique* in 18 sections each month and in 6 additional sections every three months. Abstracts are generally of the indicative rather than the informative type. Four hundred and seventeen thousand abstracts were produced in 1967, 42 per cent concerning medical and biological sciences, 47 per cent concerning natural sciences and technology, and 11 per cent the social sciences. Operating with a staff of 290 in 1967, the Documentation Centre also maintains a substantial library and provides photocopy and translation services. Photocopies are currently being supplied at the rate of over 1 000 articles a day. The Documentation Centre co-operates with the many specialized documentation centres in France in the development of new indexing methods, specialized thesauri, and mechanized information retrieval systems.[35]

A number of research and reference organizations provide specialized document services in fields such as standards, patents, textiles, ferrous and non-ferrous metals.[36] Altogether, there are approximately 600 documentation centres of various kinds in France, of which more than 70 are part of the public service.[37, 38]

In 1963 the French Scientific and Technical Advisory Board to the Prime Minister *(Délégation générale à la Recherche scientifique et technique)* commissioned a study group to build up an inventory of research and development work in the field of non-numerical information processing. This inventory has now been established and will be used to facilitate French activity in the general fields of information science, mechanical translation, artificial intelligence, etc.[39]

To pursue such work, an information and automation agency has been established under the Prime Minister's Office. The *Institut de recherche d'informatique et d'automatique* (IRIA) will undertake and support fundamental and applied research in the fields of information processing and automation, and will develop an educational program for technicians and other relevant personnel. IRIA will also be responsible for the collection and dissemination of relevant information from both France and foreign countries.[40]

A *Section d'Automatique documentaire* has been established at the *Institut Blaise Pascal* and work is in hand concerning the processing of scientific information by computer and the sorting of documents by means of punched tapes.[41]

The *Union française des organismes de documentation* (UFOD) is a private organization established in 1932 which promotes co-operation between persons working in the field of documentation and encourages research and general improvement of information services. The organization representing the professional interests of French documentalists and special librarians is the *Association des documentalistes et bibliothécaires spécialisés.*

The *Association nationale de la recherche technique* (ANRT), consisting of public and private organizations concerned with applied research, attempts to organize joint action by research organizations on matters of common interest. Forty technical commissions devoted to particular fields of endeavour have been set up to initiate joint action. The Documentation Commission has two subcommittees, one dealing with internal library and documentation services, the other with documentation centres and documentation techniques. Working groups are also studying certain problem areas such as standardization in technical journal editing, personnel needs of documentation services, automated documentation.[42]

The *Comité de la documentation,* which represents France in the *Fédération internationale de documentation* (FID), consists of delegates from the above-mentioned organizations–UFOD, ANRT, CNRS, and the French standards association (AFNOR). The *comité* has no other functions beyond representation at FID.

The French Association for Increased Productivity (AFAP) provides various information and technical assistance services. For example, the Orientation and Documentation Service answers questions concerning new industrial techniques, properties of products, sources of materials, etc.[36] Twenty-two regional productivity centres, jointly financed by the central and local governments, provide local information services particularly to medium and small organizations. These autonomous centres specialize in economic studies and documentation but provide assistance in securing loans for local industries. "Consultation loans" are available from the government which enable industrial firms to obtain advice from private consulting firms.[43]

IV.2 Scandinavia

IV.2.1. Norway

Information services in Norway emphasize the useful application of knowledge for the benefit of the economy. The Royal Norwegian Council for Scientific and Industrial Research (NTNF) supports research projects at universities and research institutes, establishes or sponsors research institutes, initiates research projects of national interest, co-ordinates research activities, and acts as an advisory body on scientific questions.

One of the institutes established by NTNF is the Norwegian Industrial Development Association (SNI) whose purpose is to help Norwegian industry and research workers obtain scientific, technical, and industrial information from both Norwegian and foreign sources. To this end, it provides a literature-searching service based on its library and publishes a monthly industrial bulletin *Ajour-Teknisk Informasjon*, with each issue usually being devoted to some special field, and a monthly abstract bulletin *Artikkel-Indeks*.[43,36] The abstracts are divided into 20 industrial categories and drawn from approximately 1 000 technical publications. Special emphasis is placed on the literature of shipbuilding, for which *Artikkel-Indeks* provides a service covering all of Scandinavia. Work is in hand to place the bibliographic data from *Artikkel-Indeks* on magnetic tape for subsequent manipulation by computer.

IV.2.2 Sweden

The Government Research Advisory Board, consisting of the Prime Minister and 30 members from universities, government, and industry, was established in 1962 "to advise on the long-term planning of Swedish research policy". The board has commissioned surveys of the long-term development of science and trends in research. A report on "Scientific Information" was completed in 1963.[44] In essence, this report called for greater funding, better organization, and improved co-ordination and development of library and information activities in Sweden. Among other things, the report suggested a system of selective dissemination of information to researchers and the use of experts to disseminate information to industry, the introduction of courses on documentation at Stockholm University, and training in the use of the literature in secondary schools and universities. It also proposed that the Swedish National Committee for Documentation, under the Royal Academy of Sciences, be responsible for representing Sweden internationally in this field.

During subsequent years several of the proposals have been implemented. More important, perhaps, is the decision that has recently been taken to establish a centre for national and international co-ordination and co-operation in the field of information and documentation, *Statens Råd för Vetenskaplig Information och Dokumentation* (SINFDOK). This centre will have responsibilities similar to those of the Office of Science Information Service of the National Science Foundation in the United States, and the Office of Scientific and Technical Information in the United Kingdom, but will be part of the Ministry of Finance to obviate any conflicts of interest such as have developed in the United Kingdom between the

Ministry of Education and Science (responsible for OSTI) and the Ministry of Technology.

In addition to the Royal Library, university libraries, and public libraries, there is a well-developed series of research and trade institutes dealing with important aspects of the Swedish economy.[43] These bodies provide information services based on their libraries, and often produce primary periodicals and abstract services, e.g. the Swedish Paper Mills Association–abstracts of pulp and paper literature published in *Svensk Papperstidning* (the Swedish Paper Journal) and the Swedish Shipbuilding Research Foundation–monthly reports on research in progress.

The information service of the Royal Swedish Academy of Engineering Sciences acts as a clearinghouse for research information. The Corrosion Committee of the academy co-ordinates research on corrosion at various institutes and publishes bulletins, appearing at irregular intervals, and *Corrosion Abstracts (Korrosionsnämndens Litteraturöversikt).*

The Swedish Foundation for the Exploitation of Research Results (EFOR) was established in 1963 as a private, non-profit organization. Subsidized by the Swedish Government, EFOR attempts to close the gap between research and industry by promoting the transfer of exploitable results from research to industry and promoting communication between non-industrial researchers and industry. In 1964 the Swedish Government established the Institute for the Utilization of Research Results (INFOR). While EFOR provides information, INFOR provides financial support for efforts to develop new processes and products.

Development work on new information services is proceeding on several fronts in Sweden. Magnetic tapes from MEDLARS and Chemical Abstracts Service are being utilized by the Karolinska Institut, and an industry-oriented service is being developed at the Royal Institute of Technology in Stockholm in collaboration with the Swedish Atomic Energy Company. This latter service is based on magnetic tapes received from the Institute for Scientific Information, Chemical Abstracts Service, National Aeronautics and Space Administration, in the United States, and *Artikkel-Indeks* in Norway, and is supplemented by locally produced tape covering hundreds of additional journals not covered by the other sources. Conversion programs have been developed for reformatting these information records into a common scheme, and a weekly selective dissemination of information service will be introduced on an experimental basis late in 1968.[45]

IV.2.3 Denmark

The Danish Council for Scientific and Industrial Research promotes and co-ordinates research. Grants are made for specific projects carried out by university laboratory and research institutes, and fellowships are awarded to junior research workers. The Danish Academy of Technical Sciences was established jointly by industrial and scientific groups to promote research and the application of research findings in industry. Research projects are sponsored and research institutes established, e.g. Acoustics Laboratory, Central Research Laboratory of the Danish Paint and Varnish Industry, Danish Wood Council, Danish Central Welding Institute, Danish Fat Research Institute.[36,43]

In 1956, the Danish Council for Scientific and Industrial Research established the Danish Technical Information Service (DTO) which has developed a comprehensive program for the dissemination of scientific, technical, and economic information to Danish industry. An independent agency, DTO is governed by a body including representatives from the Danish Academy of Science, the Federation of Danish Industries, and four universities or technological institutes. DTO stimulates relations between industrial enterprises and 400 laboratories and research institutions, refers enquirers to sources of information, arranges lectures to further the utilization of technical developments by industry, and promotes the use by industry of the Danish Gentre for Documentation and the Danish Central Technical Library. It endeavours to familiarize itself with industry's problems and, by the active dissemination of selected material, to anticipate requests for information. DTO makes wide use of consultants who are financed by the Danish Academy of Technical Sciences.

A selective dissemination of information service based on *Chemical Titles* tapes issued by the Chemical Abstracts Service is in operation at the Danish Central Technical Library. A working group of the Danish Science Advisory Council is presently planning a proposal for the establishment of a national co-ordinating centre for scientific and technical information.[45]

IV.2.4 Co-operative Activity in Scandinavia

Norway, Sweden, Denmark, Finland, and, to some extent, Iceland form a regional grouping of countries that has established a pattern of co-operation for their mutual benefit which now covers many areas of importance to the economy of the region. Science and technology, including information, are no exception. The respective national councils for scientific and industrial research established a common organization (NORDFORSK) for the furtherance of research about 20 years ago. For the past 16 years, NORDFORSK has had a special committee on technical information (SCARINFO) which has attempted to formulate policies mutually acceptable to the member countries. A particularly interesting example of the work of SCARINFO was the establishment of the Scandinavian Documentation Centre in Washington, D.C., in 1960. This centre procures specific documents on request, makes literature searches, and generally serves as a central point of contact with U.S. sources of information for the various information services in the Scandinavian countries.

Joint action has also resulted in the production of several important primary scientific publications such as *Acta Chemica Scandinavica, Acta Polytechnica Scandinavica,* and *Mathematica Scandinavica.* In addition to the work done by *Artikkel-Indeks* in the secondary publication field, co-operation in the construction field is also taking place through Building Abstracts Service in Norway. This latter organization exchanges abstracts with the International Council for Building Research on behalf of the Scandinavian countries.

The Scandia Plan was established in 1957. This attempts to divide the responsibility for acquiring collections of literature between the research libraries of the four continental countries so that material which would not otherwise be available in Scandinavia can be procured and unnecessary duplication of collections avoided.

While information sources in Finland have not received specific mention in this report, it should be pointed out that Finland was the first Scandinavian country to establish a top-level body to co-ordinate national activity, formulate national policies, and be responsible for international co-operation in the field of information services. This body was established in the Ministry of Education in 1967.[45]

IV.3 Western Europe

IV.3.1 Federal Republic of Germany

Since information services of all kinds are basic to the effective conduct of research and the development of new technology, they are included in the planning and execution of national science policy. Considerable effort is now being expended on the creation of an efficient network of information services, based on existing institutions, which will meet the requirements of science, industry, and government.[46,47]

The organization responsible for promoting and co-ordinating the development of the components of the information network is the Institute for Documentation (*Institut für Dokumentationswesen*-IDW) of the Max-Planck Institute for the Advancement of the Sciences, Frankfurt am Main. The IDW is financed by contributions from the Federal Government and the provincial or state governments (Laender). It uses most of its funds to provide initial support for new information services and to finance research on information theory and methodology. It also fosters the training of information specialists and the establishment of international contacts. It performs no documentation functions itself.

The role of the Federal Government in the creation of the information network is to provide effective information services, as required, in those government departments or federally supported institutes promoting or undertaking research and development and subsidizing essential components of the network outside the public service. For these purposes, the federal Ministry for Scientific Research has set up a special section for scientific documentation and information, and the Interdepartmental Committee for Science and Research has set up a Documentation and Information Commission. The latter group will be responsible for co-ordinating information activities and reviewing problems within the federal service. It will also give attention to German co-operation internationally and to German participation in international documentation projects (c.f. Federal Council for Science and Technology and COSATI in the United States). The three major abstract journals are now subsidized by federal funds: *Chemisches Zentralblatt* and *Zentralblatt für Mathematik* by the Ministry for Scientific Research, and *Physikalische Berichte* by the Ministry of Economics.

Approximately 500 documentation institutions are presently in existence. These institutions provide a variety of services, e.g. issue abstract cards, publish abstract journals, technical journals, reviews, bibliographies, handbooks, and answer specific requests for information. Most are associated with a special library. About half of them are supported by trade and industry, a quarter by public authorities, a quarter jointly by public and industrial groups, and a small proportion are public companies or supported by personal subscriptions, etc. Typical examples, which demonstrate the mission orientation of these institutions, are the Central Institute for Aeronautical Documentation and Information; the Nuclear Energy Documentation Centre; the Documentation Centre of the Research Council for Agriculture, Food and Forestry; the Construction Engineering Documentation Institution; and the Building Documentation Centre. A comprehensive listing of such institutions is given in *Verzeichnis der Schrifttumsauskunftstellen.*[48]

Several other organizations are concerned with information problems without themselves providing specific documentation services. The German Society for Documentation is concerned with promoting research in the field of information processes and providing for the training of information specialists. In this latter regard, it is envisaged that a Training Institute for Documentation Specialists will be established at Frankfurt am Main to provide training at three levels. The Association of German Information Specialists is the relevant professional association. The Association of Special Libraries supports collaboration between technical and special libraries.

The German Research Association, a self-governing body of German science, is a central organization for the promotion of research and as such supports the system of scientific libraries. The library section of the association provides a national exchange service by sending German scientific documents to foreign countries and distributing foreign exchange shipments in Germany. The German Standardization Committee (DNA), a non-profit association representing companies, unions, and other bodies interested in standardization, has three technical committees concerned with (*a*) libraries, books, and journals, (*b*) classification, (*c*) terminology, and issues German standards in these fields. The DNA is the German National Member of the International Standards Organization and the International Federation for Documentation.

The Central Institute for Machine Documentation (ZMD) is being established with initial capital financing by the Volkswagen Foundation of Hanover. Initial current operating expenses will be met by the Institute for Documentation. Ultimate financing of ZMD has yet to be decided. The main tasks of ZMD will be to advise documentation institutions on the mechanical handling of information and to process information on magnetic tape obtained from foreign countries for national documentation and information purposes.

Technical assistance programs for German industry are provided by the German Productivity Council (RKW), which is a private, non-profit organization. RKW is organized on a regional basis with offices in each of the states. It uses consultants for field work.

IV.3.2 The Netherlands

The promotion of documentation and information services in commerce and industry is the objective of the Netherlands Institute for Documentation and Filing (NIDER). The institute acts as a referral centre and will undertake to trace material that is not readily available. It also engages in research on documentation and acts as the National Member to the FID. NIDER has official access to the Netherlands Patent Office documentation material and will conduct searches for prior art or maintain a continuous watch on patent literature. These services cover patents issued in the major industrial countries and are available to clients outside the Netherlands.[49]

The Netherlands has developed a comprehensive library network based on university, special, and public libraries that enables participants to locate and obtain materials quickly. Key features of the network are the *Union Catalogue of Books*, and the *Union Catalogue of Periodicals*, maintained by the Royal Library. The Library of the Technical University, Delft, houses the European Translations Centre (ETC) which operates a union catalogue of scientific and technical translations from languages regarded as difficult of access to western readers. ETC will provide copies of translations or locate copies existing elsewhere. It is supported by 17 countries. The Microfiche Foundation, an international organization that promotes the use of microfiche, is also housed in the Library of the Technical University.

Heavy emphasis is placed in the Netherlands on co-operative industrial research and the exploitation of information by industry. The Central Institute for Applied Research (TNO) was established in 1932. TNO now has a central organization and four branches, as follows: (*a*) The Organization for Industrial Research, (*b*) The Organization for Nutrition and Food Research, (*c*) The Organization for Health Research, (*d*) The National Defence Research Organization. The first of these organizations maintains research institutes devoted to several industrial fields, e.g. building materials, metals, paint, ceramics, rubber. Each institute maintains a library pertinent to its needs and provides information to industry on request.

The Netherlands Technical Consulting Service (RND) was established in 1910 with the principal aim of promoting and developing small industries. It maintains a network of field engineers stationed in the main cities who provide technical advice of all types. It also provides a management consulting service and a technical information service.[36,43]

The only major abstracting service operated in the Netherlands is *Experta Medica*, issued in 23 sections, under an international board of editors.

IV.4 Eastern Europe

IV.4.1 Union of Soviet Socialist Republics

For the past 50 years considerable emphasis has been given in the U.S.S.R. to the development of science and the utilization of scientific and technological advances. V. I. Lenin indicated that the early plans of the government for development of the economy would depend in large measure on the creative study and utilization of everything of value to be found in the scientific and technological achievements and industrial experience of the advanced, i.e. capitalist, countries. Consequently, as early as 1921, the Soviet of People's Commissars promulgated the decree "On the Order of Purchasing and Distributing Foreign Literature". This decree established the Central Interdepartmental Commission for Purchasing and Distributing Foreign Literature (KOMINOLIT) with the objectives of acquiring from abroad all necessary literature in all branches of knowledge, concentrating this literature in appropriate scientific institutions and libraries, and organizing the efficient exploitation of the literature by all institutions and individuals. KOMINOLIT was also charged with the publication of systematic indexes of the more important political, scientific, and technical publications with exact designations of the libraries and depositories where the publications were located.

This was the beginning of the organization of scientific and technical information in the U.S.S.R. The development of a comprehensive and efficient information system, collecting new knowledge generated throughout the world and disseminating it to interested domestic organizations and individuals is now one of the national priorities of the U.S.S.R. To this end, the resolution of the Council of Ministers of the U.S.S.R., dated May 11, 1962, contained a comprehensive program for the creation of an information network under centralized control. This was further defined by Decree 916 in November 1966.

Organization and Objectives of the Information Network

The general management of the activities of the information services in the country is presently carried out by the State Committee for the Co-ordination of Scientific Research, U.S.S.R. The main parts of the information network are (*a*) the all-union institutes of scientific information, (*b*) the central institutes of scientific and technical information and technical-economic research (one for each branch or industrial sector of the national economy), (*c*) the information bureaus of the research and development institutes, industrial enterprises, and enterprises concerned with transport, communication, and agriculture. Other components of the network are (*a*) the republican institutes of information (in each of the republics), (*b*) the central bureaus of technical information for individual economic regions of the Russian federation, (*c*) the special libraries of the country.

The previously independent activities of these various organizations are being co-ordinated into the integrated network. The functional responsibilities of each agency have been clearly delineated and arrangements have been made for the necessary co-operation between information agencies and scientific and technical libraries for (*a*) the acquisition of domestic and foreign literature, (*b*) the creation of special collections of literature, (*c*) the introduction of classification systems for scientific and technical literature, (*d*) the methodical management of library networks, (*e*) the development and adoption of mechanized and automated processing and retrieval techniques. In keeping with this activity, it is proposed that personnel in information bureaus and libraries of industrial and research organizations participate actively, rather than passively, in the planning and execution of research, design, and planning operations. It has also been decreed that all domestic literature in the natural sciences and technology will have abstracts included with the published articles to obviate abstracting of such literature by a central organization.

All-Union Institutes

These organizations collect, process, store, and disseminate information and guide the activities of all information agencies under their jurisdiction. All-union institutes exist for the following major areas:

(1) Science and Technology (The All-Union Institute for Scientific and Technical Information, VINITI);
(2) Medical Sciences (The All-Union Research Institute for Medical and Medico-Technical Information, VNIMI);
(3) Agriculture (The All-Union Institute for Scientific and Technical Information in Agriculture, VINTISKH);
(4) Construction (The Central Institute for Scientific Information on Building and Architecture, TsINIS);
(5) Classification and Coding (The All-Union Research Institute in Scientific and Technical Information, Classification and Coding, VNIIKI);
(6) Standards (The All-Union Information Fund of Standards and Specifications, VIFS);
(7) Patents (The Central Research Institute for Patent Information and Technical-Economic Research, TsNIIPI).

Typical activities of these all-union institutes are exemplified by those of the largest of them, i.e. VINITI, which is responsible for systematically and exhaustively examining the current world literature of natural sciences and engineering and for carrying out research on information processing. To accomplish this, VINITI has a staff of about 2 500 (not including the staff of the publishing, printing, and reprography sections) many of whom are scientists and engineers, and calls upon the services of about 22 000 specialists outside VINITI, particularly for the preparation of abstracts of foreign articles. About 17 000 periodical titles per annum in more than 70 different languages (among them 19 national languages of the U.S.S.R.) from more than 100 countries are now regularly received by VINITI.

The principal publications of VINITI are:

(*a*) *Referativniy Zhurnal.* This is an abstract journal published in sixteen series. The series "Scientific and Technical Information" is now published in English as well as Russian and in 1967 contained 3 925 abstracts. The time-lag between receipt of an article by VINITI and publication of an abstract in the journal is about six months but steps are in hand to reduce this to a maximum of three months.

(*b*) *Ekspress-Informatsiya.* A periodical publication designed to disseminate rapidly foreign information concerning particularly interesting developments in science and technology. Each issue contains complete or abridged translations of about 10 articles, patents, etc., including any tables, graphs, or diagrams. Items selected for inclusion in *Ekspress-Informatsiya* appear about one month after receipt of the original article by VINITI. *Ekspress-Informatsiya* is published in 50 series which appear 48 times per annum. Typical of the subject series are: railroad transportation, petroleum industries, ferrous metallurgy, computer techniques, space navigation, and rocket dynamics.

(*c*) *Itogi Nauki.* Reviews of various fields of science and technology covering literature reported in *Referativniy Zhurnal* over a certain period of time (usually a calendar year). Issues include a complete bibliography of the subject and are prepared in such a way that each issue concerned with a particular subject is a continuation of the preceding issue. Typical subjects reviewed are: chemistry and technology of synthetic high-molecular compounds; chemistry, metallography, and processing of titanium; progress made in studies of oceanic depths.

In summary, VINITI is faced with the complex problem of scientifically processing the world's scientific and technical literature, the mechanization and automation of these processes, and the development of new forms of information service to the scientific and engineering personnel of the country.

Central Institutes of Scientific and Technical Information and Technical-Economic Research

These organizations are concerned with meeting the information requirements of specific sectors of industry and serve as the principal contact point in the information network for the information bureaus at enterprises concerned with that particular sector of industry. A principal task of each central institute is the organization of the information resources pertinent to the industry concerned. All documents that might be of interest to the industry must be collected by the institute, or their location in some scientific or other specialized institution identified, so that they can be supplied rapidly on request. However, very few requests are received for specific articles identified by bibliographic citation. Most requests are for information on a specific subject and the staff of the central institute must be able to identify quickly articles relevant to the subject, i.e. undertake a rapid literature search, and then provide the appropriate data or information to the requester.

On the basis of the informational material available to it, the central institute may also carry out additional operations such as the collection and distribution of information on the state of the art or the anticipated development at home and abroad of those scientific and economic matters relevant to the technology practised by the industry served. In particular, the central institutes are responsible for accumulating, reviewing, and collating various unpublished reports, technical memoranda, and statistical data produced by the individual industrial enterprises. This material is abstracted or suitably compiled and distributed to all interested organizations and enterprises in the U.S.S.R.

Information Bureaus

The efforts of the information bureaus at industrial enterprises are directed toward the utilization of information contained in publications issued by all-union institutes and central institutes. They are also charged with collecting local data on experimental work or the implementation of new technology, and supplying it in suitable format to the appropriate central institutes. Information bureaus are perhaps the most important points in the information network since they cater to the information needs of the user who can convert information into improved or new processes and products. The efforts of the all-union institutes and central institutes will have been in vain if the information bureaus at the industrial enterprise level are ineffective or inefficient.[50,51]

IV.4.2 Poland

A nation-wide network for the communication of scientific, technical, and economic information now exists in Poland based on government departments, industrial sector information centres, and industrial plant information centres, plus information bureaus in the individual institutes of the Polish Academy of Sciences. The last-named are largely concerned with basic scientific information, while the first three are concerned with technical and economic information. The individual government departments maintain information centres to satisfy their internal information requirements and to develop and administer the related industrial sector and industrial plant information centres. Co-ordination of the activities of all the different information centres is the responsibility of the Central Institute for Scientific, Technical and Economic Information (CIINTE), under the State Committee for Science and Technology. CIINTE also provides specialist (as distinct from administrative) supervision for the departmental, industrial sector, and industrial plant information centres. This is achieved mainly by a process of inspection, and inspectors are constantly visiting the centres to examine and report on their operation and development.

The industrial sector information centres, of which there were 159 in 1964, are responsible for satisfying the total information needs of their respective industrial sectors, e.g. coal, forestry, machinery, food, clothing, and supplying information as necessary to other such centres and to CIINTE. This is accomplished by the collection of appropriate documentary information and its provision as required to the industrial plant information centres, of which there were over 1 600 in 1964.

CIINTE is responsible for the overall growth of the information network, the co-ordination of the activities of the component parts of the network, and international co-operation in information work. In pursuit of this objective it publishes various periodicals including *Polish Technical Abstracts,* which contains abstracts in Russian and English of significant articles, books, etc. published in Poland. Every year CIINTE publishes a *Guide to the Operations of the Network of Information Centres,* and every few years a *Handbook for the Workers in Technical and Economic Information.* The director of CIINTE is advised on the general policy, operation, and development of the institute by a council consisting of professors from universities, industrial specialists, and representatives of government departments and institutes.[52,53,54]

Similar organizational structures exist also in the other Eastern European countries, i.e. Bulgaria, Hungary, Czechoslovakia, and the German Democratic Republic. With minor differences between countries, the basic elements are a number of information sub-networks operating in parallel and devoted to natural sciences, medical sciences, agricultural sciences, etc., and industry. Each sub-network is administered by a State Academy of Science, Medicine, etc., or a government department, but the technical operations of the components of the system are supervised and co-ordinated by a national office for scientific and technical information reporting at a high level in the administration of the country. This latter office is usually also responsible for the further development of the information network, for contacts with external information organizations, and the encouragement of research and development work in the field of information processing.[50]

IV.5 The Orient

IV.5.1 Japan

Japan Science Council

Soon after World War II, the Japan Science Council was formed with the aim of promoting the development of science and permeating it into government and industry as well as into the life of the nation. The council consists of a secretariat and seven major divisions: the humanities, law and politics, economics, natural sciences, engineering, agriculture, medicine and pharmacology. The members of the council are elected by their professional colleagues for terms of four years with the voting privilege being limited to those who are professionally active and have graduated from a college at least five years before the elections. Candidates for the council seats are normally men and women of national distinction in their own intellectual fields.

The council provides a forum for the exchange of ideas at the highest level. Although it lacks authority to compel acceptance of its advice by the government, its decisions and recommendations do carry considerable weight. Consequently, the primary function of the council is that of policy-making. Its secondary function is to stimulate co-operation among all Japanese institutions concerned with science and technology. It also represents the country in international scientific activities. To stimulate public interest in scientific matters, the council carries on a modest publication program. It issues discussion papers and sponsors public lectures and symposia.

Committees of the Japan Science Council concerned with scientific information activities include the Committee for International Scientific Exchange and the National Committee for Documentation. The former promotes representation at meetings of international organizations, such as UNESCO, ICSU, ISO, OECD, and is also concerned with the publication of Japanese primary journals in western languages. The latter committee acts as the official Japanese representative to the International Federation for Documentation (FID). The library of the council exchanges publications of the council with over 70 centres throughout the world.

Science Information and University Library Section, Ministry of Education

In May 1951 the Japan Science Council advised the government to create a large science information centre within the Ministry of Education. A scientific information section was established in the ministry but the budget for a large centre was not forthcoming, so the section had to carry on its activities on a limited scale. The Scientific Information Section started by preparing a union catalogue of foreign-language scientific books and periodicals in major Japanese libraries. The section also provides financial and technical support for the publication of *Japan Science Review.* The review is published in three parts: (*a*) Mechanical and Electrical Engineering, (*b*) Medical Sciences, (*c*) Biological Sciences. Each part contains bibliographies and abstracts in its own field. The Scientific Information Section has now been renamed the Science Information and University Library Section.

Japan Information Centre of Science and Technology

In 1956 a Science and Technology Agency was established in the Japanese Government as an advisory body. It vigorously promoted the earlier idea of a central organization in the country responsible for scientific and technical information. As a result, in 1957 the Japan Information Centre of Science and Technology (JICST) was formed as a non-profit institution, funded equally ($220 000 each) by government and industry, responding to the Science and Technology Agency. The functions of this institution are:

(1) To collect both domestic and foreign information in the fields of science and technology;
(2) To classify, organize, and retain that information;
(3) To disseminate that information to its clientele quickly;
(4) To solve problems of information handling that individual institutes or enterprises are not able to manage.

Situated in Tokyo, JICST presently has a staff of about 300, one third of which has majored in some branch of science or engineering. It also uses the services of over 2 000 outside abstractors and translators. Foreign and domestic journals now received by the centre number over 6 000; approximately 35 000 patent specifications on chemical subjects from the United States, the United Kingdom, and West Germany are also received annually. About one thousand issues of foreign journals are obtained weekly by air cargo from agents in Dusseldorf and New York.

Major publications of the centre include:

(*a*) *Current Bibliography on Science and Technology,* an abstracting journal issued in 10 series, as follows:

Chemistry and Chemical Industry
General Engineering and Mechanical Engineering
Electrical Engineering
Geology, Mining and Metallurgy
Civil Engineering and Architecture
Pure and Applied Physics
*Atomic Energy–Radioisotope and Radiation Application
Business Management
*Chemistry in Japan (successor to Japanese Chemical Abstracts)
Foreign Technical Information for Smaller Enterprises.

In addition to the abstracts, each series (except those marked*) has a news section in its issues. About 100 titles of foreign periodicals of general science and technology, such as *Science* and *New Scientist,* trade journals such as *Business Week* and *Europachemie,* and newspapers such as *The Financial Times* and *VDI Nachrichten* are screened for this section.

(*b*) *Foreign Patent News–Chemistry,* a publication compiled from the *Official Gazette* (U.S.A.), the *Official Journal* (U.K.), and *Patenblatt* (Federal Republic of Germany).

(*c*) *Japanese Patent Index,* an annual index to the *Japanese Patent Gazette.*

(*d*) *JICST Monthly,* originally the house organ of JICST, this publication has now established itself as the representative professional journal of documentation in Japan.

Types of service provided by the centre are:

(*a*) Photocopy Services. This is the heaviest business of the Centre aside from publication of *Current Bibliography.* In recent years more than 250 000 requests for copies of articles have been handled annually, i.e. about 5 000 a week.

(*b*) Current Content Sheet Service. "Tables of Contents" of journals as requested by subscribers are supplied in photocopy before the journals are processed for abstracting. This provides a current awareness service prior to publication of *Current Bibliography.*

(*c*) Translation Service. The centre arranges for the translation of foreign articles into Japanese and Japanese articles into English, French, German, and Russian on request. Most of the translation is done by outside help.

(*d*) Literature Search Service. Custom searches of the journal and patent literature are undertaken on request. This service does not include the fields of medicine, agriculture, and biology.

The centre is examining approaches to the mechanization of information handling with respect to the preparation of *Current Bibliography,* and with respect to the carrying out of literature searches. Computer facilities have been installed and experimental work is in hand on searching the metallurgy, chemistry, and electrical engineering sections of the literature.

The function of JICST is to facilitate the dissemination of scientific and technical information in Japan, and its activities have been expanded yearly since its creation. However, the financial status of the organization has forced it to limit its activities somewhat. JICST is not an entirely governmental institution because half its initial capital was provided by industry. Its legal status is that of a so-called "special corporation". Although it is a non-profit institution, it is expected to support itself from its business income. However, this has not yet proved possible and annual subsidies have been provided by the government to cover approximately half the operating expenses of the centre. Operations of the centre are conducted in a new four-storey building equipped with modern facilities and located near the principal government offices and the new National Diet Library. JICST also has two service branches in Osaka and Nagoya which are both important industrial areas of Japan.[55,56]

The National Diet Library

After World War II it was realized that a parliamentary library with an effective research function was of paramount importance for the deliberation of state affairs by members of the Diet. In December 1947, in response to a request made by the Diet, a U.S. Library Mission provided advice on the establishment of such a parliamentary library in close collaboration with the Committees for Library Management of both Houses of the Diet and other organs. On the basis of their recommendation, a National Diet Library Law was promulgated on February 9, 1948, and on June 15, 1948, the new National Diet Library (NDL) was opened to the public, with a staff of 182 persons and a meagre collection of 215 000 volumes, most of which had come from both Houses of the Diet. Currently, the staff of the National Diet Library numbers over 800 and the collection exceeds 4 500 000 volumes. Among the branches of the National Diet Library are two libraries noted for their remarkable collections of Chinese and other Oriental classics, i.e. the Toyo Bunko (Oriental Library) and the Seikado Library. The former Imperial Library, or Ueno Library, is also a branch library, although a large part of its collections has been transferred to the main library. The remaining branch libraries are in the executive and judicial agencies of the government and number 30 in all. The librarians of these branch libraries are appointed by the librarian of the National Diet Library. It is claimed that this system, unique in the library circles of the world, makes it possible for constituent libraries to improve more effectively their services and thus enhance the functions of the Diet, government agencies, and the Supreme Court.

First and foremost, the National Diet Library is the library for the Diet. Second, the library services the executive and judicial government agencies through the branch libraries. Third, it offers its collection for the free use of the public. Fourth, it co-operates with libraries in foreign countries in such activities as exchange of publications, international loan of books, and the exchange of scientific information. As a result of the legal deposit system, the library is building a comprehensive collection, for preservation in perpetuity, of the records of the nation's cultural achievements. It also endeavours to collect as extensively as possible foreign publications that may be helpful to Japan's progress in culture and science. The library functions as the central library of Japan, compiling the Japanese national bibliography and other bibliographies, union catalogues and periodical indexes, preparing and distributing printed catalogue cards, and co-operating with other libraries through interlibrary loan of materials and assistance in reference services. Apart from the usual types of reference service given in the main library, the NDL has set up 10 regional scientific materials centres in the important cities of Japan. These centres receive from the NDL such materials as U.S. technical reports, *Nuclear Science Abstracts*, and other reference books with which to serve the needs of local researchers. The NDL is now housed in a new building completed in July 1961. An interesting feature is the incorporation of elevators, dumbwaiters, vertical conveyers, and pneumatic tubes, which make it possible to send books speedily from the stacks to the delivery desk.[57,58,59]

Section V

FUTURE DEVELOPMENTS

V.1 Recent Foreign Assessments

In preparing the foregoing review of scientific and technical information activities in selected international organizations and foreign countries, it became apparent that not only is there widespread recognition of the information problem but also that several important reports are in preparation or have just been completed. Of those still being prepared, two have been commissioned at high levels in the respective public sectors and can be expected to result in governmental action of real significance with important ramifications throughout the countries concerned.

The first of these is the work of the President's Advisory Commission on Libraries in the United States which has now submitted its report to the President's Library Committee for assessment. A definitive statement on the future role of libraries on the United States information scene and the steps to be followed in developing this role are expected momentarily.

The second study is that being undertaken by the *ad hoc* committee set up by the Minister of Education and Science in the United Kingdom to examine the role of the major national libraries and the extent to which their services should be welded into a coherent whole in association with the other libraries in the country. Proposals which may well reshape library services in the United Kingdom can be expected from the deliberations of this committee which is due to report by the end of 1968.

Several completed reports prepared by organizations of high-ranking stature have been found to express with varying degrees of comprehensiveness, eloquence, and lucidity what the subgroup as a whole has come to accept as the present situation with respect to information handling and what in general should be done in future. These reports are:

(1) Science, Government and Information: The Responsibilities of the Technical Community and the Government in the Transfer of Information. A Report of the President's Science Advisory Committee. The White House, Washington, D.C., January 10, 1963.

(2) A National Library Agency–A Proposal. American Library Association Bulletin, March 1968, pp. 225-265.

(3) Scientific Library Services. Report of the Association's Committee on Scientific Library Services. The Library Association, London 1968.

(4) Report on Collection, Dissemination, Storage and Retrieval of Scientific and Technological Information. Parliamentary and Scientific Committee, 7 Buckingham Gate, Westminster S.W. 1, January 1968.

(5) Scientific and Technical Information Systems and Policies. Third Ministerial Meeting on Science of OECD Countries, 11th and 12th March 1968, Paris. Agenda item VII, General Report CMS(68)18, Issues and Recommendations CMS(68)19. (Restricted).

The factual material in these reports has been used in preparing Sections III and IV of this chapter. The following is a composite presentation derived from the ideas in these reports and gives a picture that has direct relevance to Canada.

In general, information of all kinds is essential for our development as individuals and the progress and survival of mankind. In particular, scientific and technical information is a prerequisite for efficiency and development in our increasingly technically based civilization. These postulates dictate that information ought to be equally accessible to all elements of the economy, wherever located, rapidly and conveniently.

The world's production of scientific and technical information has grown too large to be handled by conventional methods through the activities of libraries and other agencies which have evolved in response to a variety of local and other special needs. A change of scale has altered the dimensions of the tasks to be accomplished.

The number of research and development workers is growing rapidly with a consequent increase in the number of publications issued each year. For example, *Chemical Abstracts* produced 38 000 abstracts in 1947 and will produce about 250 000 in 1968. The number of students graduating from universities and technical colleges each year who will become potential users of information has grown substantially. The number of scientifically productive countries is steadily increasing and languages such as Russian and Japanese are becoming scientifically important. Nevertheless, the time available for reading does not expand.

Although the greater mass of the world's information is non-confidential and unclassified and hence available to all, the effort of finding whether a piece of scientific information or engineering data exists, and if so where, may absorb far too much of a scientist's time and possibly defeat the busy engineer completely. Neither local, special, nor national needs are likely to be met in an economical and realistic manner in the future by simply making adjustments for natural growth and effecting piecemeal improvements.

The systematic organization and exploitation of scientific and technical knowledge are so vital to the nation's material prosperity that government can ill afford to ignore their importance. Only government is effectively in a position to plan and finance the attainment of these objectives. There are numerous obstacles to be overcome before scientists, engineers, doctors, administrators, etc., can consult quickly relevant sections of distant stores of knowledge, updated automatically from newly published information no matter what its language of origin. To bring this about should be one of the more challenging of national commitments during the next decade.

Each country needs, at policy level within the government administration, a focus for decisions on the development of national information services. Whatever form this focus takes, it should have the responsibility and the resources for:

(1) Advising government departments and public and private institutions on all matters affecting the conduct, support for, and development of scientific and technical information activities;
(2) Taking such measures as may be necessary to encourage, facilitate, and develop a logical and co-ordinated national network of information services;
(3) Ensuring that the country develops the technical ability to interact with, contribute to, and take from the comprehensive mechanized international information services now developing, and with the relevant national services of other countries;
(4) Speaking as the authoritative national voice in international negotiations for the co-ordination of information services.

Failure to establish such a co-ordinating focus will mean:

(1) Wasteful duplication of resources;
(2) Development of internal information systems which are mutually incompatible and also incompatible with those of other countries;
(3) Inability to participate fully in international efforts to develop and exploit new technologies of information processing and documentation;
(4) Increased cost of information services with decreasing benefit from the expenditure;
(5) Reduced efficiency of research and development, tantamount to squandering the nation's technical effort;
(6) Delayed application of the results of research, and possibly non-receipt of such results;
(7) The opening of serious information gaps between countries.

The action taken by a country in this regard will determine whether it will be an active participant in the initiation and development of comprehensive international information systems or not. Countries that defer the decision to participate will find that systems design (selection of hardware and software, input and output requirements) will be fixed or selected without consideration for the non-participants. They risk, therefore, finding themselves unable to use the output effectively.

The foregoing asserts that maximum access to information is in the national interest, that present systems are inadequate, and that concerted and comprehensive planning must occur. It is evident that a national base of operations is in order.

V.2 Developments Abroad and the Implications for Canada

V.2.1 A National Focus for Information Activities

The principal industrialized nations of the world produce prodigious amounts of information. They have also created services that attempt to obtain, index, abstract, and disseminate internally generated information and varying amounts of information imported from other countries. Canada cannot attempt to be self-sufficient in terms of information and therefore must co-operate with other countries with respect to the exchange of primary information and the development and use of secondary information services, such as abstracting and indexing. Co-operative arrangements need to be executed with many different groups in other countries of the world and with the many international organizations.

This all points to the need for some agency or office to serve as the focal point for co-ordinating present and stimulating additional future Canadian dealings with other countries and international organizations. The purpose of this office should be to ensure appropriate Canadian representation (not necessarily by the office itself) when this is required. It would not be concerned with personal contacts or group contacts of a bilateral or international nature except where these involved unique services or some participation on behalf of Canada. The OECD Scientific and Technical Information Policy Group has recommended that a national focus for information activities be established in each country to facilitate the conclusion of the necessary co-operative agreements that will lead to the development of a total international exchange of scientific and technical information. The authors of this chapter endorse this recommendation in view of the needs expressed above and the developments outlined below.

Until the last decade, attempts to produce the necessary documentary collections and systematic indexes were left to the initiative of various interested groups such as the professional and technical associations, industrial institutes, libraries and library associations, and commercial organizations. This approach is now being supplemented by a more comprehensive treatment involving some central direction of national activities and the international sharing of responsibilities.

In the Eastern European countries, where state planning and control are the accepted norms, comprehensive organizational structures have been created to collect, index, and disseminate published information. These all respond to some central administrative focus charged with developing the system internally and cultivating international co-operation. In the U.S.S.R. there is the State Committee for the Co-ordination of Scientific Research; in Poland it is the Central Institute of Scientific, Technical and Economic Information; the German Democratic Republic has the Central Institute for Information and Documentation; and in Bulgaria there is the Central Institute of Scientific and Technical Information. In other parts of the world where state planning and control are far less vigorously invoked similar developments are taking place: the United States is feeling its way to some systematization of information activities through the creation and subsequent efforts of COSATI and SATCOM; the United Kingdom has taken a step in this direction with the creation of OSTI.

The trend is both obvious and logical. If a nation's information resources are to be organized in a rational manner so that unnecessary duplication is avoided and an infrastructure created that can handle information expeditiously and comprehensively in co-operation with other countries, some national focus is inevitable.

There is no such focus in Canada today. Canada should recognize this need and take appropriate action.

V.2.2 The Responsibilities of a National Focus

Canada's relations with the large information-producing countries of the world, such as the United States, the U.S.S.R., the United Kingdom, France, and Germany, for the purposes of facilitating the flow of information into Canada, are of vital importance. This must be reflected in the policies adopted by any national focus that is established to further such international exchange and co-operation. In particular, Canada must maintain as much control as possible over the channels of information distribution within the country and the use to which information is put within the country, and be free to select what information will be imported into the country.

The middle-sized countries, such as the Netherlands, Sweden, and Poland, have a role comparable to that of Canada in the production and use of information. Relations with these countries should be fostered so that mutually compatible solutions to our common problems can be evolved; if necessary independently, but preferably by co-operation and sharing of responsibilities.

Relations with countries, both large and small, that are only beginning to develop their requirements for scientific and technical information should be cultivated. Opportunities will arise for Canada to assist such countries by the provision of information and to benefit by further supplying capital, expertise, or materials directed toward utilizing such information for the improvement of the economies of the countries.

The existence of many intergovernmental organizations concerned with the co-operative management and exchange of scientific and technical information makes it abundantly clear that Canada needs a national focal point for information and reports on the work of these organizations so that federal, provincial, local, professional, and commercial organizations may be kept aware of the pertinent ongoing international programs. The role of the proposed national focus in providing such a service must be clearly underlined.

Many Canadians now participate, and often take a leading part, in the activities of the various specialized non-governmental international organizations, and there is an evident need for a continuing directory of the services that these organizations can provide for Canada. Also required is a continuing directory of organizations and individuals within Canada who are actively concerned in carrying out the programs of such international organizations.

The role that Canada will take in supplying specialized information to both non-governmental and intergovernmental bibliographical projects, such as the International Nuclear Information Service of the International Atomic Energy Agency, is one that will require careful study and planning. Participation in such projects should not be limited solely to federal government agencies in Canada, but the support of provincial, municipal, and university personnel should be enlisted as appropriate. The ability of Canada to participate in the work of French-language organizations and to supply information in French is of particular value and should be exploited to the full.

V.2.3 Library Networks

When information is requested today, it is expected within 24 hours, otherwise it will probably not be used. In this age of instant communication, the present performance of libraries in making documents available to users is inadequate. There is an urgent need for libraries to be capable of communicating among themselves readily by electronic means for the purposes of identifying, locating, requesting, and, if need be, transmitting material. The technology is available but is being adopted by what seem to the user community distressingly slow steps. Integrated library networks employing common operating procedures are required and will undoubtedly come into existence, but restrictive administrative and financial barriers will have to be overcome. Recognition of this need for effective interlibrary co-operation is implicit in the high-level examinations of the future role of libraries and library networks taking place in the United States (President's Library Committee), and the United Kingdom (Dainton committee). The U.S.S.R. has laid down management principles under which interlibrary co-operation will take place, and the Japanese have seen fit to make all the libraries of government departments an integral part of the National Diet Library. Library networks are coming into existence in the United States through the initiative of various groups, and more can be expected. If Canadian library users are to be served adequately in the future, effective library networks that enable libraries to respond to requests for documents within minutes instead of within days should be created from the resources already in existence. Other countries are on the move in this matter—Canada also must act.

V.2.4 International Co-operation in the Preparation of Secondary Sources of Information

Language differences, and to some extent geographical separation, create significant barriers to the transfer of information between countries. As a result, abstract journals have been created in most countries for the specific purpose of assisting the inhabitants of those countries to keep abreast of developments and ideas in other countries. In Western Europe and North America such journals have arisen as a result of the initiative of specific groups at different times, and a multiplicity of abstract journals and indexes covering different types of world literature to different extents is now available. In recent years, nations not speaking one of the Western European languages have realized the importance of making foreign information available to their scientists and engineers, and have created indigenous abstract journals with comprehensive coverage of world literature. Principal examples are *Referativniy Zhurnal*, in the U.S.S.R., and *Current Bibliography on Science and Technology*, in Japan.

The net result today is a large number of organizations carrying out similar work, inevitably duplicating each other's efforts in many instances, and not producing really comprehensive coverage of all significant world literature. This is unfortunate from several points of view as far as Canada is concerned. First, the absence of a limited and well-known series of fully comprehensive abstracting and indexing services means that Canadian scientists and engineers do not have the necessary bibliographic tools to enable them to maintain effective awareness of information available from foreign countries. Second, Canada cannot realistically consider the creation of a national abstracting service capable of handling the literature of the world, for the cost would be too great. Third, some of the existing abstract journals are published in languages with which the great majority of Canadian scientists and engineers cannot cope, e.g. Russian, Japanese, German.

In these circumstances, it is in Canada's own interest to promote international co-operation to ensure the gradual creation of comparable abstract journals in English and French that exhaustively cover the world's scientific and technical literature. Each country should be encouraged to accept a responsibility for providing abstracts of all significant domestic literature to either an international clearinghouse or to selected organizations producing specific journals. In the former case, it could also be the responsibility of the clearinghouse to translate abstracts from one language into each of the major languages employed for the abstract journals, e.g. English, French, German, Spanish, Russian, Japanese. Alternatively, those countries sharing a common language could co-operate in translating foreign-language abstracts into their own language. Thus, Canada could share with the other English-speaking countries the task of translating abstracts produced by non-English-speaking countries into English, and could co-operate with other French-speaking peoples in translating abstracts into French.

Some positive steps are under way to bring about degrees of international co-operation in this matter. The ICSU Abstracting Board has arranged for scientific articles or abstracts to be sent to various abstract-publishing groups before publication of the article in a journal. This has helped to reduce the time-lag between the date of publication of the article and the date of publication of an abstract in an abstract journal. The American Chemical Society is pursuing the establishment of chemical information centres in various parts of the world that would exploit the products of the Chemical Abstracts Service and would also provide national or regional input to *Chemical Abstracts*. The International Atomic Energy Agency in Vienna is working toward the establishment of an International Nuclear Information Service (INIS) whereby participating nations would provide abstracts of their own domestic literature in return for a complete file of the abstracts provided by all the nations.

Such co-operation could be a major factor in facilitating the exploitation of known information by all countries and, particularly, it could help to raise the living standards of underdeveloped countries. The vigorous interchange of ideas and information among countries will also do much to engender mutual trust and understanding among nations. For its own benefit and for these broader purposes, Canada should foster international co-operation in developing comprehensive abstracting services available to all.

V.2.5 Exploitation of Information by Industry and Commerce

Information only realizes tangible benefits to a nation when it is used to produce new, improved, or cheaper goods and services, or when it contributes to the growth of the economy. This is the prime reason for establishing effective information services, and it is interesting to observe the different approaches adopted in Eastern European countries and Western countries to accomplish this objective.

The Eastern European countries have all introduced industry-oriented information services to complement the services available to scientific institutions. Each significant sector of industry has its own information network tying together all the manufacturing establishments and research institutes involved with that particular branch of technology. By way of contrast, the Western nations have developed a much more diffuse organization of information services of value to industry. Current progress is reported in trade journals and technical periodicals associated with technical societies. Abstract journals and other current awareness publications also emanate from these sources. Documents required must be borrowed through the co-operative efforts of various libraries participating in collaborative schemes of varying degrees of formality and efficiency. Services supplying information in response to specific (but non-bibliographic) requests operate over a broad area of knowledge, e.g. the Danish Technical Information Service (DTO). The Western approach has been much more oriented toward serving the user and has relied heavily on advertising for financial support.

While no assessment can be made of the relative efficiencies of the two "systems" in providing for the needs of industrial users of information, it does appear that the Eastern European philosophy is worthy of further examination within the context of the Canadian milieu. Canada should consider bringing together the relevant components of the present diffuse system of information communication into a series of groupings devoted to satisfying the complete needs of the different industrial sectors.

Section VI

RECOMMENDATIONS

The major industrialized countries of the world are suppliers of information to Canada, and it is important for the continued growth of our economy that relations with these countries are such that the flow of information is facilitated. Either as a result of deliberate government action or of unco-ordinated activities on the part of many different groups, internal information services have developed in all countries. Co-operation in information matters is being fostered by many governmental and non-governmental international organizations. If Canada is to develop an effective internal information network which can co-operate with international and other national organizations in a manner that will contribute positively to the growth of the economy, there must be greater co-ordination and planned direction of relevant activities.

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 considered 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 of a coherent internal information network that will contribute to and make use of appropriate information services of 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.**

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PRINCIPAL ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

		Page
ACS	American Chemical Society	23
AEC	Atomic Energy Commission	21
AFAP	Association française pour l'accroissement de la productivité	34
AFNOR	Association française de normalisation	34
AIFT	American Institute of Food Technologists.	32
ANRT	Association nationale de la recherche technique	34
ASTM	American Society for Testing and Materials	33
BIOSIS	BioSciences Information Service	23
CAB	Commonwealth Agricultural Bureaux	32
CAS	Chemical Abstracts Service	23
CFSTI	Clearinghouse for Federal Scientific and Technical Information	21
CID	Centre for Information and Documentation	13
CIINTE	Central Institute for Scientific, Technical and Economic Information	44
CNRS	Centre national de la recherche scientifique	33
CODATA	Committee on Data for Science and Technology	10
CONLIS	*ad hoc* Joint Committee on National Library/Information Systems	26
COSATI	Committee on Scientific and Technical Information	18
DNA	Deutscher Normenausschuss	39
DSIR	Department of Scientific and Industrial Research	27
DTO	Danish Technical Information Service	37
EDUCOM	Interuniversity Communication Council	25
EFOR	Foundation for the Exploitation of Research Results	36
EJC	Engineers Joint Council	23
ETC	European Translations Centre	40
EURATOM	European Atomic Energy Community	13
FID	International Federation for Documentation	8
IAA	International Aerospace Abstracts	21
IAEA	International Atomic Energy Agency	11
IATUL	International Association of Technological University Libraries	58

SPECIAL STUDY
No. 8

Scientific and Technical Information in Canada Part II
Chapter 4 International Organizations and Foreign Countries

Scientific and Technical Information in Canada

Part II

Chapter 5

Techniques and Sources

Prepared for

The Science Council of Canada

SCIENTIFIC AND TECHNICAL

INFORMATION IN CANADA

PART II

CHAPTER 5

TECHNIQUES AND SOURCES

Special Study No. 8

Scientific and Technical Information in Canada

Part II

Chapter 5

Techniques and Sources

Prepared for

THE SCIENCE COUNCIL OF CANADA

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This chapter of the report

SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

is submitted by the Techniques and Sources Subgroup.

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W. C. Brown	National Research Council Ottawa
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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 Chapter 5 (Techniques and Sources) of Part II. Part I of this Special Study has already been published. The other chapters of Part II are

Chapter 1–Government Departments and Agencies
Chapter 2–Industry
Chapter 3–Universities
Chapter 4–International Organizations and Foreign Countries
Chapter 6–Libraries
Chapter 7–Economics

and will be published separately. Each of these seven separate sections contains 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

TABLE OF CONTENTS

Section I

SUMMARY

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 the 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.

Section II

INTRODUCTION

The sources of information and the information systems with which this subgroup of the Study has been concerned are those dealing with science and technology as they relate to Canadian needs. Science is taken to mean medical science, the pure and applied physical and biological sciences, including mathematics, engineering, and agricultural sciences. In addition, the Study is concerned with economic and technical data of value in industrial engineering and manufacturing.

The subgroup would wish to make clear that when the term "information" is used throughout this chapter it does not refer only to facts and data in the field of science and technology. It is the view of the subgroup that the humanist, the philosopher, and those concerned with the social sciences in Canada also require assistance in developing methods and techniques for solving current problems of information retrieval. The problems that face Canadian scientists and engineers are very little different from those that face users in all fields of knowledge. The solutions suggested for application to the problems of one field will also apply to others.

This matter has been well understood in other countries where there have been various attempts to unify planning of scientific and technical information services. In the United States, a number of the larger professional library and information associations recently indicated that the recommendations formulated by the United States Government Committee on Scientific and Technical Information (COSATI) were basically inadequate to the real needs of the situation in the United States by virtue of their limitation to science and technology.[1]

The subgroup has been more concerned with the newer and emerging forms in which information is handled and communicated – computer tapes, microforms, etc. – than with the traditional forms of printed books and periodical publications. The subgroup feels that these forms will be highly relevant to future needs, although it is clearly recognized that the older forms will coexist with the newer ones for many years. One of the basic problems to be faced is the integration of these newer forms of information with the older ones still in use. Many of the newer forms are already being utilized in Canada and are discussed in various sections of this chapter, and also given in Appendix A.

The Subgroup on Techniques and Sources was given the responsibility of outlining how modern methods used in information storage and retrieval are changing present practices in the handling of information. Among the aspects that the subgroup was asked to cover in relation to published information were indexing and abstracting, storage, retrieval, the use of computers, methods of national and regional distribution, and methods using high-speed transmission. The subgroup did not conduct extensive enquiry into the various present sources of unpublished information in Canada, though it did spend some time considering these.

A particular responsibility of the subgroup was to outline how information practices will be carried out in the future as a result of foreseeable developments in information-handling techniques. The subgroup was asked to examine the role that computers are playing and can be expected to play in the acquisition, classification, and filing of scientific and technical literature. Attention was also given to microfilming, electronic transmission of printed material and machine-readable data, and various optical and mechanical devices used in information retrieval. Particular attention was devoted to the problems which will arise when people are called upon to interact with the new information technology.

These matters are not ones which lie in the future. They are of direct concern to many thousands of Canadians today, and by 1975 will affect many thousands more. By 1980 the advanced systems of today will be commonplace, and newer information methods will have appeared which will be used by the scientist and engineer, library personnel, and industrial research workers. There are children in school in Canada today who will be in the middle years of their productive lives by the year 2000, and the world of the computer and high-speed transmission of information by communication satellites will be several decades old by then.

It is in the light of such knowledge that the subgroup has produced the following chapter. The members are all convinced that Canada can and must provide leadership in the field of information transfer. In a country that has always played a leading part in the development of long-range communication, Canadians are well equipped to handle and to benefit from the new technology being applied to information transfer.

Particular attention has been paid to the needs of the different groups of users in Canada. These groups include the large number of Canadian industries that experience great difficulty in finding up-to-date information, and the established libraries and information centres that are concerned about the proliferation of published and unpublished information in various forms. Of particular concern has been the needs of the Canadian federal and provincial governments, which are required to co-ordinate both the production and use of Canadian scientific and technical information at different levels, in both French and English.

To prepare this chapter, the subgroup considered the present state of information services in Canada and abroad. It spent some time investigating future directions in the utilization of the present information-handling technology, and considered the changes that present advanced information-handling methods may be expected to bring forth. Use was made of the information on present practices that was outlined in the briefs received by the Study Group from interested agencies and individuals in Canada.

Some attention was given to the evolution of national and international information-planning activities in North America, Europe, and Asia. To evaluate claims and descriptions of particular sources and techniques, some first-hand studies were made of a few of the significant information services in the United States, France, Germany, and Japan.

Section III

PROCESSES AND METHODS OF INFORMATION RETRIEVAL

III. 1 Formal Definition of Information

Information consists of facts, numerical data, or concepts that have utility to the user. "Utility" implies that the knowledge is new or corroborative and that it can be related to the user's current knowledge; that is, utility is directly tied to the nature of the user. Information must be at a level and in a language the user can understand, and must satisfy his current needs. Information without this specific utility to the user has no relevance to him. Although information can be stored in many forms, it still is recorded primarily in written form or text. Other packages of information include such forms as microfilms, photographs, sound recordings, computer tapes, drawings.

There are three broad classes of source information: full text, surrogate, and data. The first class is self-explanatory and is characterized by bulkiness. At the current state of the art, full text is too voluminous to be stored cheaply in computer banks and if stored as microforms is not convenient for mechanical handling. It is usually retrieved by accession number or a reference to the location of the required material in storage, after a search has narrowed down the choices.

Surrogates traditionally consist of bibliographic descriptions which may be classified or arranged by subject, and various types of abstracts or summaries that indicate or describe the contents of a document. They are more convenient for searching and can usually be stored in machine-readable forms. They occur as bibliographical lists, catalogue cards, or various forms of announcement lists. Typical items included in a surrogate are serial or classification number, shelf location, corporate or other author, date of publication, title, and abstract. The surrogate can act as a substitute for the document.

Data are narrowly defined information units such as should be available in answer to questions beginning with what? how? where? when? who? Such data, if stored in a computerized data bank associated with a command language, can easily be retrieved if the correct query terms are used. The Canada Land Inventory is an example. It contains data such as local population density, availability of river transport, and average family income of people living within a defined radius. Such data are associated with the co-ordinates of locations on the map of Canada. Numerical data that are normally published in tabular form can be more readily kept up-to-date if stored in a computerized data bank.

The key element for selecting documents that contain information required by the user is the indexing term. These terms have been called by various names – subject headings, uniterms, descriptors, keywords – depending on the system used.

The essential division is into terms that are controlled (that is, they must be in an authority list or dictionary of allowed terms), and those that are uncontrolled. When the indexing terms are taken from the text of the document itself the listing of these can be carried out by a computer, and thus the same terms will always be chosen if the same logical process for term selection is used. The terms may also be standardized by comparison with the words on the authority list. This method gives an excellent basis for transferring document surrogates from one system to another so as to avoid reprocessing material. Selection of terms by specialists from a controlled vocabulary permits more concise definition of the content of a document and thus makes for more efficient file-searching by specialists. However, it introduces a human element with the possibility of inconsistency in the selection of indexing terms.

III.2 Physical Forms in which Information is Embodied

Information is supplied in many forms – some conventional, some less conventional. Figure 1 illustrates the characteristics of three main physical forms of information. The traditional means of obtaining information (from discussion or printed material) can be expected to continue but will be supplemented by other forms. The cumulated bulk of printed material now calls for more compact forms of storage.

Figure 1. – Information – Physical Realization

Hard Copy	Microforms	Machineable Data
Printed text	Microfiche Whole text Roll film	Magnetic tape Surrogates Paper tape
Bulky to store	Most compact	Compact
Requires no equipment for reading	Equipment required	Expensive equipment required
Stored documents not suitable for browsing	With appropriate equipment, suitable for browsing	
Catalogue cards suitable for browsing		
Expensive to produce	Cheap to reproduce	
Only intellectual analysis	Limited mechanical analysis and search	Computerized analysis and search possible
Teleprocessing slow, expensive		Teleprocessing possible

Printed text (hard copy) is most favoured by the user at present. Because of its bulk and the cost of reproduction, microforms (text in photographically reduced form) are gradually replacing it for long-term storage. Among the many photographic, reproducible forms in current use, the microfiche is rapidly growing in popularity. A microfiche may contain 60 or more pages of material on a single sheet of film and hence is much cheaper to reproduce than the equivalent hard copy and more suitable for mailing. In the 1970s microfiche may be the usual form of full text for many publications.

In order that the individual can become aware of current information of interest to him, the printed material from various sources must be indexed so that he may locate it quickly and with minimum effort. Where the volume of material is large and speed of dissemination important, it has been found that computer methods are best. In the fields of science and technology, which constitute the area of this Study, speed and selectivity are essential, and modern communications, combined with computerized processing, offer an effective solution to this problem. It is possible that "soft" copy, i.e. visual display, will play an important role by 1980.

For a long time full text will be distributed by such regular means as the mails, issued by publishers, circulated by libraries and clearinghouses, but surrogates will more and more be stored and disseminated in machine-readable form. Although remote access to computerized data banks will be common by 1970, card or printed catalogues and other computer-generated indexes will continue to be valuable aids in recording and announcing new material.

In view of the above considerations, attention will be concentrated on present-day, state-of-the-art methods of information storage and retrieval using computer-based systems. It is only recently that modern technology has been able to offer practical measures to relieve the burden imposed on scientists by the steady flood of new information. The current generation of computers offers (*a*) the simultaneous use of these devices by many individuals, (*b*) economical mass storage, and (*c*) sophisticated programming methods that allow the handling of information in manageable amounts. The use of computers and modern methods of communication can prevent duplication of information handling, shorten the path between source document and potential user, and provide a means of sifting out the irrelevant material from that which is useful. It is to be expected that the whole way of thinking about the communication of information and about teaching methods will be revolutionized by new technological developments.

III.3 Formal Elements of an Information System

The elements of modern systems for the communication of information have evolved from discoveries of illustrious parentage. Almost a century ago Maxwell framed the electromagnetic equations, Boole developed symbolic logic, Babbage developed the basis for computers in the modern sense. The integration of knowledge and experience occurred in World War II when scientists left the pursuit of pure knowledge to apply scientific methods to wartime goals and thereby invented the devices and forged the mathematical techniques that made the current advances in automation possible. Modern high-speed computing devices have arisen from the experience in designing complex circuitry based on electronic tubes during this catalytic period. The further advance to solid-state circuitry, following close on the discoveries in pure research (a triumph in the rapid transfer of information from research to applied fields), gave rise to the high speeds and miniaturization that have reduced the cost of computers and made them ubiquitous. Without the appearance of the new field of operations research during the war, the potentialities of computers could hardly have been exploited.

The elements of an information system (Figure 2) are, essentially, the source, the user, and the channel of communication linking them. The term "channel" does not refer to a simple path but may involve various operations of storage, cataloguing, announcement, analysis in depth, and searching.[2] The following information organization and dissemination functions can be distinguished from the information storage functions which have been associated traditionally with libraries:

(1) Formation of surrogates (indexing);
(2) Announcement of surrogates;
(3) In-depth analysis of documents to extract the information they contain;
(4) Supply and distribution of documents (clearinghouse operations).

The first function entails indexing and abstracting, as mentioned earlier. The literature of each of the main scientific fields is abstracted and announced in special journals usually associated with learned societies. A well-known example in the field of chemistry is *Chemical Abstracts*, which processes about 250 000 abstracts annually. The printed announcements are produced using computerized typesetting, and the by-product magnetic tapes are made available to users. In other subject fields similar services are being developed.

In a typical clearinghouse operation, the user is assisted in securing the required documents. The U.S. Department of Commerce announces documents in the *United States Government Research and Development Reports.* The documents are sold directly to users, stressing speed of response and simplified accounting procedures. Adequate stocks of each document in full-size printed form (hard copy) and in microfiche are available.

The two operations described above deal with surrogates and documents respectively. They do not deal directly with the provision of information but with references to documents or the provision of documents that may contain information. The extraction of this information through analysis and the evaluation of documents are carried out at information analysis centres which will supply specific information to users in the fields covered by these centres.

Figure 2.—Elements of an Information System

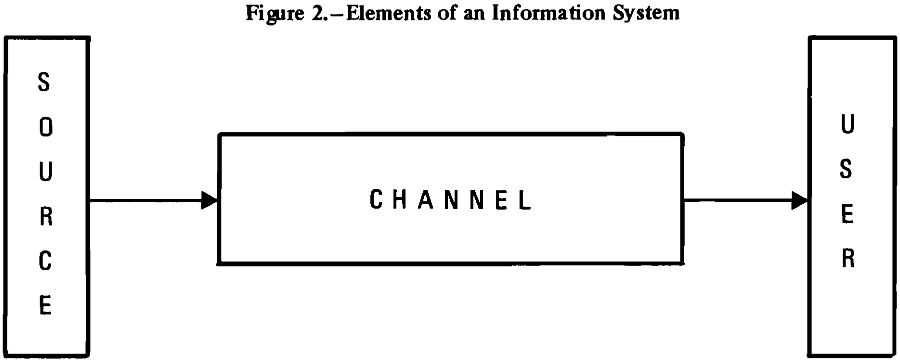
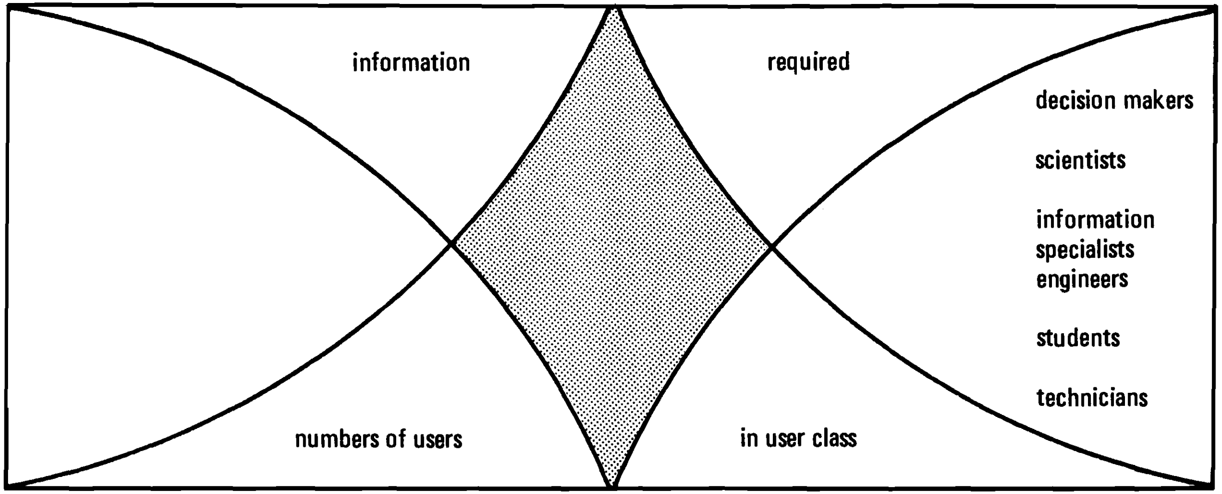


Figure 3.–Classes of Users



III.4 The User

The user is the key element in the information system, since it exists only to satisfy his needs. Types of user are shown diagrammatically in Figure 3, classified according to sophistication and the amount of information they require. We may divide the population into four broad classes:

(1) Decision makers;
(2) Scientists;
(3) Information specialists, engineers, and designers;
(4) Technicians.

The first class contains only a few people, who require information from many fields that has been refined, reviewed, and condensed. The information is obtained either from specially prepared brief reviews or by conversation with an expert in the field. The scientist, besides his need for in-depth material in his own special field, requires interdisciplinary information from many fields and may search for it himself or utilize papers or surrogates selected or prepared for him by information specialists. Engineers usually look for their material in textbooks, technical journals, reference books, and trade literature. They are more interested in data than in concepts. The technician requires predigested information which is very specific to his needs and in the language he understands. Students, although shown near the bottom of the chart, may require information in the form used by the classifications up to that of scientists, depending on the level of their education.

In general, computer techniques have most direct application in aiding the scientists and engineers. Since it is the task of these people to digest information for transfer upward and downward, it is fitting that the newer methods can help lighten their burdens. There is a hierarchy of channels by which information can be most effectively transferred to each of these classes. It is the role of the information channel to match the source to the user. Figure 4 is a schematic tabulation showing relation of user to source for various groups. Communication at top and bottom of the user pyramid is most effective when verbal – by interplay of question and answer as the problem is defined. Decision makers are advised by consultants who, in turn, are aided by reviews prepared by scientists who evaluate research carried out in their own fields.

Under the most favourable conditions, the users are kept constantly aware of current developments by selective dissemination of information (SDI) about documents which, if they appear to be of interest, can be obtained rapidly from a clearinghouse or other source. Interest profiles on which SDI is based are prepared by information specialists, who also aid the scientist in carrying out retrospective searches when the scientist is entering a new field or seeking interdisciplinary links between his own and other fields. The research scientist (or any other competent user) can bypass the information specialist and browse directly in the surrogate materials if the latter are stored in a computer provided with on-line remote terminals.

Figure 4. – Information Cycle Hierarchies

Source	Channel (media)		User type
Scientific reports			Policy framer
	Scientific adviser		Decision maker
			Research manager
	Review publications		
	Consultants		Consultant
Dissertations		SDI notes	
Monographs	Surrogates	abstract bulletins	Research scientist
		microforms	Graduate student
			R & D engineer
Learned journals			
Government reports	Clearinghouse		
			Information scientist
Patents	Reactive consoles		
			Engineer
Trade literature	Information analysis centres		
			Designer
Handbooks			
	Information specialists		
Textbooks			
	Trade representatives		
		hard cover books	Student (undergraduate)
Manuals	Special libraries	reference librarians	
		field reps.	Technician
Pamphlets	Special agencies*	information services (central)	

*Government departments, of course, supply most of the channels shown higher in the hierarchy as well as these; under this heading also come trade and professional associations.

NOTE: The correspondence between categories in neighbouring columns is indicative rather than exact.

Other methods of dissemination are possible. Material that has been reviewed and evaluated by scientists and indexed by subject specialists is published in forms suitable for designers, engineers, and technicians. Certain information specialists, such as agricultural agents, present the appropriate material to a wider audience.

Figure 5 is an elaboration of Figure 2 to show internal structure in the communication channel with the user pyramid superimposed at the right to indicate lines of communication between zones of the pyramid through an information analysis centre.

Figure 5.–Elaborated Information System

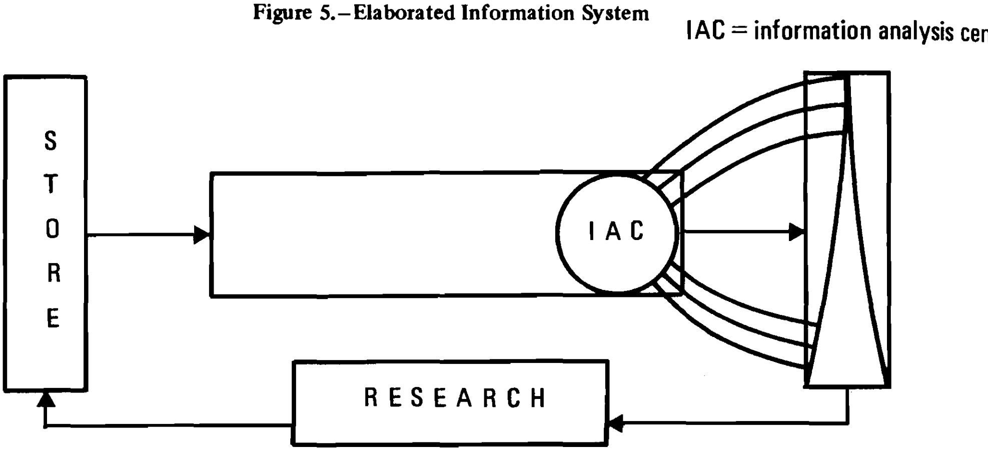


Figure 6 shows the functions of an information centre which combines all of the functions described above. The operations – surrogate processing, acquisition, access control, search and content analysis – are all carried out by scientifically trained professionals usually known as information specialists. Because of the importance to their task of knowledge of the various scientific fields treated at the information centre, they normally have degrees in pure and applied science but gain knowledge of information handling through on-the-job training. The quality of service ultimately depends on these information specialists, and this will remain true even if a considerable degree of automation is introduced into the mechanical aspects of the task. In fact, it is probable that the emphasis in information handling will then shift away from semi-mechanical aspects such as indexing to the more demanding task of content analysis and evaluation.

As an aid to the intellectual processes carried out by users in the central zone of the pyramid (Figure 2), where information is generated, classified, and evaluated, the application of computer techniques is most straightforward. Methods are already available for reducing the great mass of new material to sufficient order that it may be channelled out to users in various categories.

Figure 6

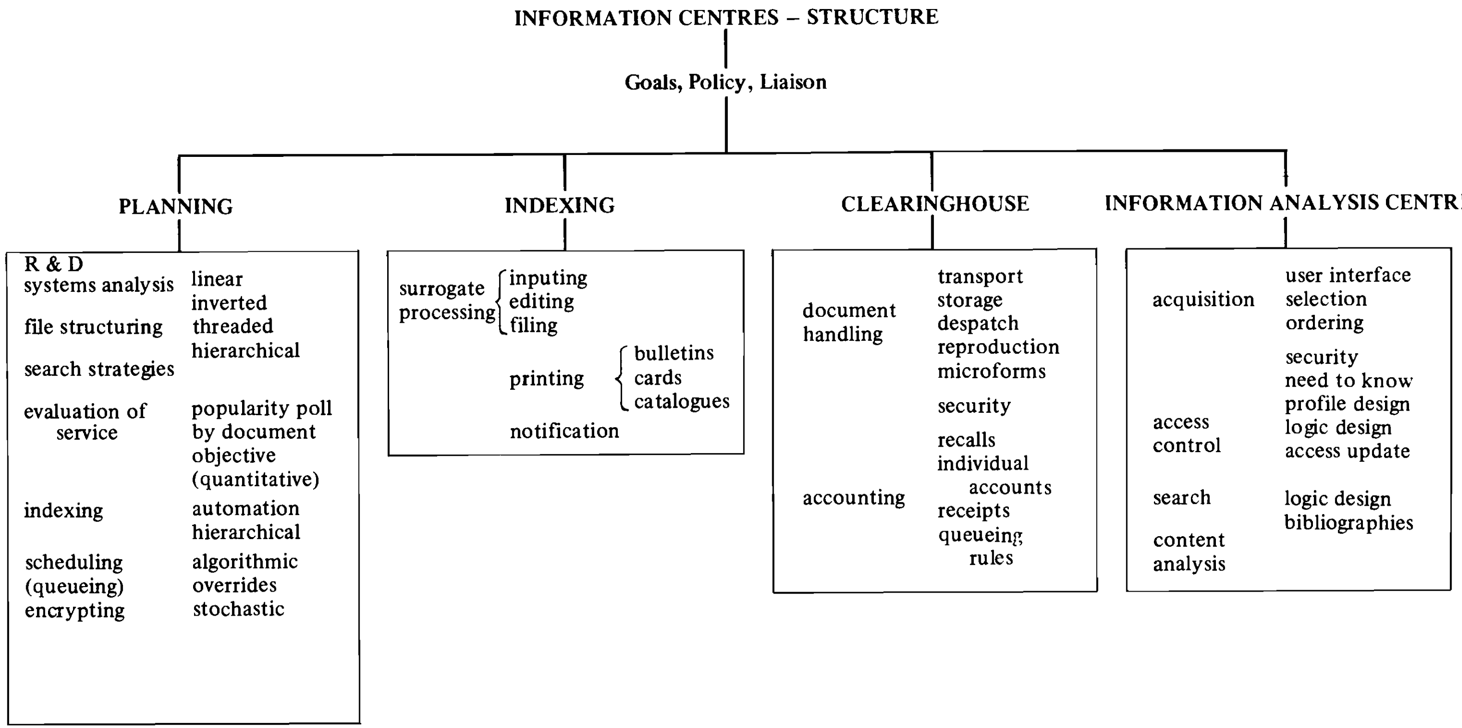

INFORMATION CENTRES – STRUCTURE
Goals, Policy, Liaison
PLANNING
INDEXING
CLEARINGHOUSE
INFORMATION ANALYSIS CENTRE
R & D
systems analysis
file structuring
search strategies
evaluation of service
indexing
scheduling (queueing)
encrypting
linear
inverted
threaded
hierarchical
popularity poll
by document
objective (quantitative)
automation
hierarchical
algorithmic
overrides
stochastic
surrogate processing
inputing
editing
filing
printing
bulletins
cards
catalogues
notification
document handling
transport
storage
despatch
reproduction
microforms
security
accounting
recalls
individual accounts
receipts
queueing rules
acquisition
user interface
selection
ordering
access control
security
need to know
profile design
logic design
access update
search
logic design
bibliographies
content analysis

Figure 7.—Information Storage

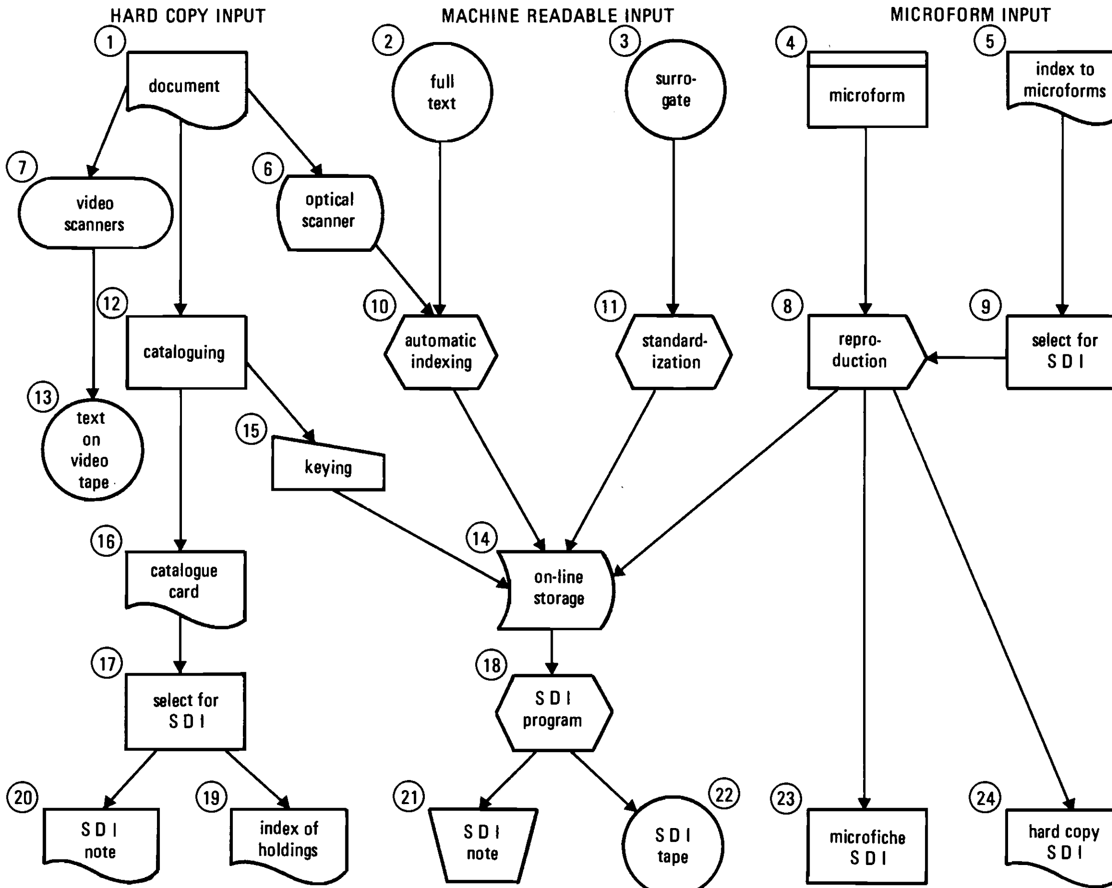
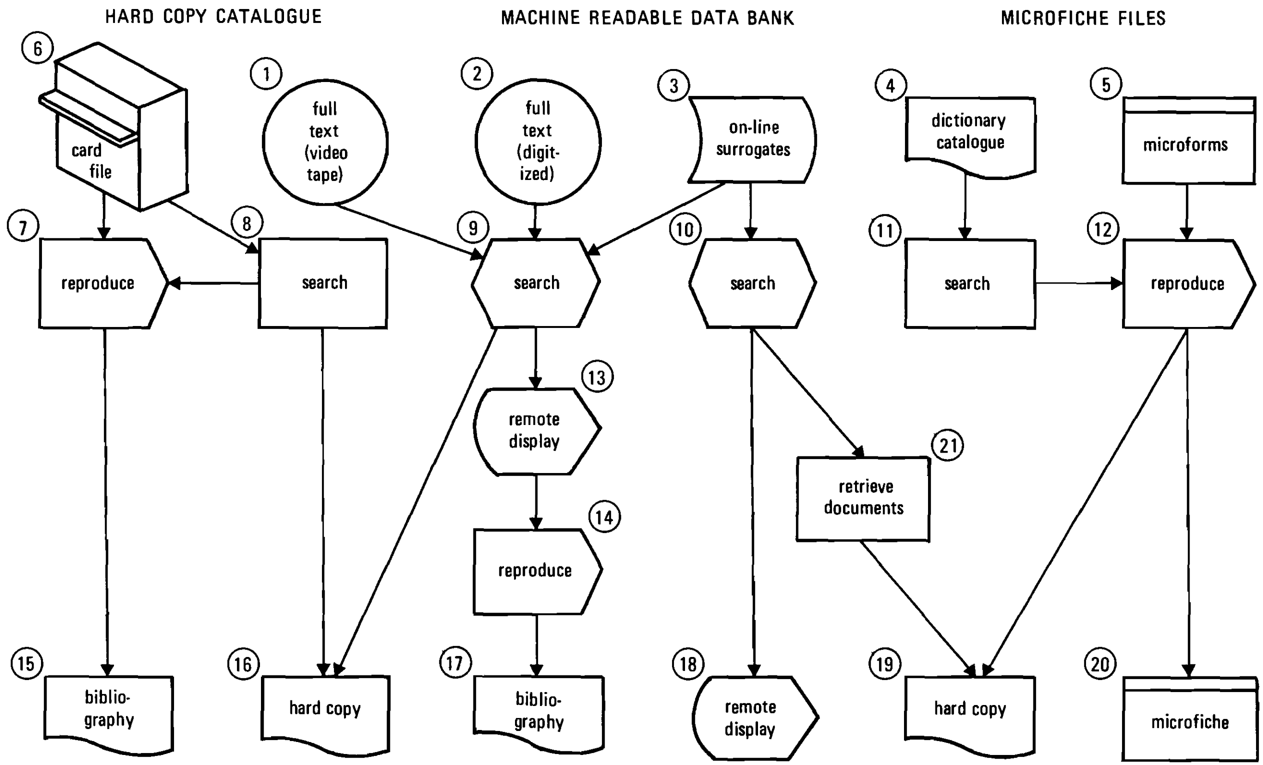


Figure 8.—Information Retrieval



III.5 Operations Involved in Producing Document Surrogates

In what follows, only state-of-the-art techniques are treated. Input and output operations involving, for example, speech recognition by computer are not treated, as their general use is at least 10 years away. Figure 7 shows parallel treatment of the three principal forms for input: hard copy, machine-readable records, and microforms. Details of each of the processes shown symbolically here are given later in the section on Techniques.

The conventional treatment of hard copy (1) is to have it catalogued, producing as the main surrogate a catalogue card (16) which may be processed by reproduction or otherwise to provide SDI notices and an index of accessions. An alternative route after cataloguing is to enter the bibliographic information into a computer (15). In this case, punched cards, paper tape, or magnetic tape may be produced directly, or the data may even be entered in a computer as by the IBM DATATEXT system (14). Still another alternative, which is currently available only for specific type faces and very good copy, is to use an optical reader (6) to convert the text of the document into machine-readable form. Alternatively, a flying spot scanner may be used to digitize the image of the text, the characters not being read individually (13). The text is then stored on tape and may be transferred by line for remote display or for remote printing.

If machine-readable data (usually magnetic tape) are available from a source, this may be a digital representation of either the full text (2) or a surrogate (3). If it consists of full text it may be automatically indexed (10) and the indexing data stored on disc (14). If it is a surrogate (3), the data can be put into standard form (11) for use by the system, and stored (14). These data may then be used for computer typesetting of indexes, computer printing of SDI notes, or the formation of inverted files for later searching (21), (22).

Microforms (4) are usually accompanied by printed indexes. SDI is performed by searching these indexes and reproducing the microform (8) or hard copy to send to the individual user (24). Microfiche is the most economical method of providing full text SDI to the user (23). Microfilm catalogues on reels, while relatively easy to search, are difficult to update because new information cannot be inserted between any pair of frames as would be required in maintaining, say, an alphabetical order.

III.6 Operations Involved in Retrieving Information from Storage (Figure 8)

Document (or photo-image) retrieval will be considered, although data retrieval is relatively easy if the data base is ordered in a sufficiently explicit way. As in previous paragraphs, which showed how the incoming information was announced and the surrogate stored, the three main divisions will be considered in parallel.

Card files may be stored in cabinets or in a motor-driven file. In the former case, the searcher walks around among the cabinets (6), pulling out the drawers to find the cards. In the latter case, the drawer comes to the searcher. Card files are, in principle, easy to update by inserting a new card in the correct order between existing cards. When the collection is very large, supervision of this operation becomes increasingly difficult and the maintenance of consistent filing sequence is expensive. If this is not done, terms under which material is indexed become extremely broad; that is, under each term there may be several thousand titles, most referring to obsolete material.

Bibliographies may be formed by reproducing individual catalogue card entries for documents considered to be pertinent. The card catalogue is still an excellent device for searching but has the disadvantage that it cannot be directly accessed remotely. Distribution of cards for individuals to generate their own catalogues provides a flexible method of forming subcatalogues but involves filing at each of the catalogues.

When full text is available in machine-readable form (2) it can be searched by computer, the results being instantly displayed to the user who can thereby modify his search strategy. There is not much of such material available at present, and in any case the method is very expensive in machine time. A cheaper method is to have surrogates on-line (3) and full text images on magnetic tape (1). The search can be conducted in terms of Boolean combinations of descriptors, and the interesting documents on tape (1) reviewed remotely (13) before deciding to order the document, reproduce it from the display (14), or transmit it (if sufficiently urgent) by line (16).

Card or book catalogues (4) are perhaps the most convenient to use and are at present the most useful product of machine processing. They are particularly valuable if the entire collection is not to be searched but rather if specific portions of the catalogue are to be analyzed, e.g. as in duplicate checking when a new document is being entered into the library system. After searching (11), either the document, a reproduction, or a microform is provided.

III.7 Trends in User Preferences

User needs studies such as those carried out for the U.S. National Aeronautics and Space Administration (NASA) and the U.S. Department of Defense (DOD) have shown that the most popular method of obtaining information is by word of mouth from a known expert. Librarians and scientists are often unaware of major sources such as government reports (the U.S. Government publishes over 200 000 a year), and have little experience as yet in using the new techniques and media available for dissemination of information, such as microfiche and display consoles connected to computerized data banks. Thus, design of new systems should not be limited to what users currently believe to be their requirements. Antagonism shown toward the use of microfiche instead of printed copies rapidly subsides when the individual finds that he can accumulate a complete library in this form in one drawer of his desk, at small cost. Light-weight microfiche readers, taking up little space and highly engineered for comfortable use, are available at a reasonable cost.

By 1970, keyboard terminals should be available in all libraries and will provide searches of remotely located data banks. At rentals of $100 a month they are economically feasible, since their use eliminates the necessity of storing large amounts of material which may not be frequently used. NASA has found that one-day service in the provision of documents or microfiche is practical on a routine basis in response to properly defined requests. A search is structured at the keyboard and transmitted to the central computerized file. The documents selected as a result of the search are then ordered at the same terminal. At a somewhat higher cost, selection can be determined by reiterated queries of the data base through the terminal.

By the late 1970s, keyboard terminals with cathode ray tube displays will probably cost no more than $500, and more effective searches by users in remote locations, who will be able to scan the full text including graphics stored in video form, will be feasible. By the early 1980s, many scientists will have such a terminal at their own desks, and the need to store hard copy or microfiche locally will be reduced substantially.

It is feasible to forecast that domestic television cables could be integrated with the telephone system during the 1980s so that the television receiver can be operated in conjunction with an electric typewriter to make use of the national information network. It will then be possible to make enquiries of the various government and commercial data banks using normal English or French language. Voice communication with the computer should be available by 1985.

Section IV

SOURCES OF SCIENTIFIC AND TECHNICAL INFORMATION

IV.1 Sources Available to the User

There are a great many sources of scientific and technical information available to the Canadian user. The problem that faces the user in Canada is how to select from the sources the information that is of most value to him. The manner in which the information is made available—whether in the form of written and printed materials, whether it is published in book form or periodical, whether it appears in reports or abstract journals, or whether it is in any of the multitude of new forms that are available—poses problems for the Canadian user. There have been estimates that as much technical knowledge will be developed in the next 15 years as has been accumulated in the entire history of mankind. A recent report to the U.S. Congress stated that in the United States approximately 25 000 technical papers are produced each week, along with 400 new books and 3 500 articles.[3]

Not only is printed and written material in conventional forms of value to the user, but a great deal of statistical and other data are being produced and constitute an important source of scientific and technical information. The user is concerned about access to such sources and expects to have them made available through procedures which will provide transfer of the information for his purposes as rapidly as possible.

It is very clear that more intensive methods for the handling and retrieval of information must now be adopted by Canadian individuals and institutions if Canada is to advance its position in the world of science and technology. The literature searching and information services that are now available do not produce satisfactory results. To carry out such searches in the most efficient manner, all the different sources of information must be more readily available.

Examples of unnecessary duplication of effort and loss of time in the retrieval of needed information were reported in a number of the briefs received by the Study Group from Canadian research workers and scientists. There were not, in every case, fully documented case histories, since few people cared to admit that their literature-searching methods are imperfect. But sufficient information was obtained from the briefs and from interviews conducted by the Study Group to see that Canadian institutions had great difficulty in making use of all the sources of available information. This matter was particularly acute in considering the offerings of the traditional library services in Canada.[4] Many private individuals also have difficulty, and one Canadian consulting geologist estimated that 15 to 20 per cent of the new work pertinent to his interest does not come to his attention for two or three years after publication.

It has been estimated that about one tenth of the United States research and development effort is spent on unsuspected duplication of work.[5] J. Martyn[6] has claimed that this amount of unintentional duplication may be as high as one fifth. There are a number of reports and examples of loss of time and money that have occurred because of such duplication. The U.S. ballistic-missile program was held up for four months by difficulty in designing reliable slow-control valves for liquid oxygen. After the work had been done, the U.S. Air Force found that one of its own men was already familiar with the problem, which had been tackled when designing valves used in high-altitude balloon flights.[7] Eugene Garfield has presented the example of a paper claiming a new method for analyzing peptides, which was published four years after the method had already been reported.[8]

In any review of the sources of information that are available in Canada, it is essential to recognize that there are serious problems which face Canadian users. The problem arises mainly when users turn to institutions which they expect might serve their needs, such as libraries, information centres, publishers, and book shops. They find that these institutions often lack the staff who should be aware of all of the sources of information. Since over 95 per cent of all published information in science and technology in Canada is derived from other countries, there are many problems in the physical location of information abroad and its rapid importation into Canada. These problems do not affect all users alike. In many cases users in large urban centres are served relatively well, but in parts of Canada that are distant from metropolitan centres the problems of access can be acute. Various other problems were reported in briefs to the Study Group. They may be summarized as follows:

(*a*) The bilingual nature of Canada means that access to information should be available for both French and English users. This does not mean that everything should be available in both languages, but that users' needs should be able to be expressed in either language.

(*b*) While a few Canadian scientific and technical periodicals are indexed in American and other foreign indexes, information on the contents of many Canadian periodicals and reports is not available. In addition, many Canadian scientists present their research results in publications issued outside of Canada. There is no general index to their output, only fragmentary sources.

(*c*) A number of restrictions and delays occur in acquiring material in Canada from abroad. Information imported as microfilm or computer tape is often considered dutiable by the Canadian Customs and delayed until the matter has been investigated. Requests to sources for information in North America from some parts of Canada may take a minimum of three weeks before material is received and, if the first source does not have it, there is often a delay of up to six weeks. Some books are not available for sale in Canada for several months after publication in the United Kingdom or the United States because of copyright or agency agreements among the publishers.

(*d*) To obtain U.S. military specifications and standards, often two to three weeks are necessary for those already held in Canada and several months for those that must be supplied from the United States via Canadian military supply channels. Different methods of awarding government contracts in Canada from those in the United States and other countries often means that there is not the same access by Canadian contractors to information available through government channels.

IV.2 Current Scientific and Technical Information

Briefs presented by over 90 per cent of respondents from all parts of Canada emphasized that current information in the fields of science and technology is a most important requirement of Canadian research workers, engineers, and manufacturers. Such current information is derived from a wide variety of sources, including suppliers of equipment, trade publications, technical reports and journals, conferences and meetings, books, directories, scientific films, correspondence, statistical information, and a host of other sources. Many of the briefs indicated that abstract services, including computerized services, bibliographies and reports from provincial and federal government agencies, indexes and patent information, standards and trade directories were important sources of additional information. Although the use was not high, a number of respondents signified that they used Canadian and foreign commercial scientific and technical information services, the provincial research foundations and councils, the National Research Council, university and public libraries, armed forces publications, technical, professional, or trade associations, as well as direct research, to secure what they required.

It is clear to many individuals in Canada that the sources for current information available to them are not the most up-to-date and do not always provide the latest information. This has led to a considerable amount of interest in acquiring machine-readable records rather than traditional printed publications. Since many of these records in machine-readable form are being produced as part of large bibliographic and cataloguing systems outside of Canada, more and more Canadians are becoming concerned with methods of access to them. At the same time, it is evident that different methods and techniques are constantly being developed and there is considerable concern in Canada about the direction of research in this field and the possibility that certain present sources will become rapidly obsolete and will be replaced by new sources.

IV.3 Primary Sources

Primary sources of information are mainly in written form, and one of the most common of these is the periodical. The scientific periodical began in France in January 1665 with the *Journal des sçavans*. It was followed three months later by *Philosophical Transactions*, and from then on the number has continued to increase.

There are at the present time over 26 000 regularly appearing periodicals in the world that record developments in the field of science and technology.[9] These are supplemented by the many hundreds of thousands of reports produced by private organizations, government departments, specialized research bodies, manufacturers of equipment, and originators of new technical processes in all countries. It is estimated that one U.S. Federal Government agency alone, NASA, produces over 40 000 reports in a year.

It is in dealing with current information that the users seem to have the greatest difficulty. Such current information is not easy to locate and in many cases is contained in journals and publications which are not immediately available in Canada.

Canada produces approximately 550 current periodical publications dealing with science and technology.[10] The term "periodical" has been interpreted rather broadly to include regularly and irregularly published government documents, trade journals, and house organs. In these three categories only the more representative and important titles have been included. Approximately 24 per cent of the Canadian scientific and technical periodicals, or 121, are produced by government departments, either federal or provincial. The rest are produced by commercial organizations, universities, research organizations, trade and professional associations, etc. Of the periodicals listed, 50 are published in the French language.

In 1967 the Toronto Public Library conducted a sample survey to estimate the relative numbers and the scope of Canadian scientific and technical periodicals received by some industries in Metropolitan Toronto. A questionnaire was sent to some 200 businesses in the Metro Toronto area asking for (*a*) a list of periodicals presently acquired by the firm as a means of securing current technical information, (*b*) a list of those maintained for reference purposes, (*c*) a list of those from which photocopies were regularly obtained.

The number of periodicals received by the 162 firms that replied to the survey ranged from 0 to 600, with only one firm receiving 600. There were 61 periodicals that were subscribed to by 7 or more of the 162 firms. Of these 61 there were 21 Canadian periodicals, 35 from the United States, and 5 from other countries. All were in the English language. There were no foreign-language periodicals and no periodicals that reported directly the scientific and technical developments of Germany, Japan, Eastern Europe, Asia, or Africa.

Of the 175 scientific and technical periodicals in the fields of architecture and building, automation, chemistry and chemical engineering, electricity and electronics, engineering, industrial and mechanical arts, metallurgy and mines, and natural resources, published annually in Canada, in this survey the following 21 were listed as being consulted most often: *Canadian Builder, Canadian Chemical Processing, Canadian Controls and Instrumentation, Canadian Electronics Engineering, Canadian Industrial Equipment News, Canadian Machinery and Metal Working, Canadian Mining Journal, Canadian Plastics, Canadian Pulp and Paper Industry, Chemistry in Canada, Design Engineering, Electrical News and Engineering, Electronics and Communications, Engineering and Contract Record, Engineering Journal, Modern Power and Engineering, Plant Administration, Plant Engineering, Professional Engineer and Engineering Digest, Progressive Plastics,* and *Pulp and Paper Magazine of Canada.* Several of these publications supply readers with specific information on products advertised. One of them, *Engineering and Contract Record,* in 1966 received 28 000 reader enquiries for such information.

The future of scientific and technical journals has been called into question many times over the past 20 years.[11] While it has been possible to devise a number of solutions to the problem of the use of periodical literature that meet the needs of individual firms and establishments, nothing on a general basis has yet been developed. Some investigations have proposed a change in the form of journal publication and distribution and have devised computer methods to deliver to each subscriber a stream of papers, abstracts, and title references specially selected to meet the subscriber's regular or perhaps frequently changing desires.[12] In the main, however, the user still struggles with a large amount of primary sources of published information that is growing larger each day.

IV.4 Main Secondary Sources

To facilitate access to the current literature in the various forms in which it appears, over 1 800 indexing and abstracting services in the fields of science and technology are produced annually in all parts of the world on a commercial or non-commercial basis. These attempt to provide bibliographic control of the literature, and most large libraries in Canada make active use of such services. The National Science Library has published a list of 365 of these services to which it subscribes.[13] Some of these sources attempt to be comprehensive but most of them are selective.

Some of the largest abstracting services that attempt to be comprehensive are to be found in the field of chemistry. Chemists depend on several international abstracting and indexing services for their knowledge of the published literature in their field. Some of these are the *Bulletin signalétique* (France), *Chemisches Zentralblatt* (Germany), *Referativniy Zhurnal* (U.S.S.R.). Another of these, *Chemical Abstracts*, is published by the Chemical Abstract Service of the American Chemical Society, Columbus, Ohio. *Chemical Abstracts*, which started in 1902, published in 1966 about a quarter of a million abstracts of journal articles and patents appearing in 12 000 periodicals from over 100 countries. The size of the operation has been growing at a rate of about 9 per cent per year for the past 20 years. This rate of growth has forced a move to more automatic processes for production of the society's publications and a program is well in hand that will see the whole operation shifted to a computer basis before 1970. This is expected to provide a decrease in the time lag between publication of the article and publication of the abstract and indexes, and at the same time reduce the unit cost of the operation. It has already resulted in additional services becoming available both in printed and magnetic tape form (Appendix B).

Chemical Titles, another publication of the American Chemical Society, lists the titles of all articles in some 650 world-wide chemical publications in alphabetical order of each of the important words of the title. In each entry the accompanying words of the title are shown. This biweekly publication uses a computer program known as KWIC (Key Word in Context). The titles are also available in magnetic tape form together with a computer program by which the tape may be searched using a "profile" of interest words tailored to the needs of the individual. The National Research Council, Ottawa, receives and utilizes this service (Appendix B).

While the largest amount of the documentation of present-day scientific innovation in the world is published in the English language, Russian, French, and

German are also important (Table 1). Such information is indexed and abstracted in many countries by national abstracting services. Since 1950 there has been extensive study of the means of reducing duplication between major world abstract journals. There are comprehensive national abstract services in Japanese, Russian, German, and French as well as English.

Table 1. – Language Breakdown of Literature Indexed in Six Major English-language Abstracting and Indexing Publications[14]

Language	Journal					
	Chemical Abstracts	*Biological Abstracts*	*Physics Abstracts*	*Engineering Index*	*Index Medicus*	*Mathematical Reviews*
	%	%	%	%	%	%
English . . .	50.3	75.0	73.0	82.3	51.2	54.8
Russian. . .	23.4	10.0	17.0	3.9	5.6	21.4
German. . .	6.4	3.0	4.0	8.6	17.2	8.7
French . . .	7.3	3.0	4.0	2.4	8.6	7.8
Japanese . .	3.6	1.0	0.5	0.1	0.9	0.7
Chinese. . .	0.5	1.0	0.1	0.0	0.4	0.2
Other. . . .	8.5	7.0	1.4	2.7	16.1	6.4

One of the principal requirements for Canadian users is an abstract or indexing service which covers all new Canadian scientific and technical information. The contents of some Canadian publications are indexed in French, British, U.S.A. and other services, but selection and coverage are dependent on the desires of the foreign user, not the Canadian. Repeated attempts have been made in the past to provide an index to Canadian technical information but they have not resulted in any continuing activity. The *Canadian Business and Technical Index* of the Toronto Public Library was carried on for four years, from 1959 to 1962, but was dropped because of lack of subscribers to make it self-supporting. The *Canadian Periodical Index,* published by the Canadian Library Association, which includes 20 Canadian technical periodicals, receives support from the Federal Government only for publication of its cumulated issues. Of 542 currently published periodicals in science and technology in Canada, only 232 (42 per cent) are indexed in any of 34 Canadian and foreign indexing and abstracting journals examined by the Canadian Library Association.[15] Some subject categories are indexed fully (botany, mathematics, psychology), but one third of the subject categories are only indexed 50 per cent and one, photography, is not indexed at all. *Chemical Abstracts* covers 98 Canadian titles; the *Bibliography of Agriculture* (U.S.A.), 68; *Bulletin signalétique* (France) (all sections), 67; *Engineering Index* (U.S.A.), 43.

IV.5 Other Secondary Sources

Further secondary sources of current information include bibliographies, handbooks, research guides, review publications, and many others. All of these forms have their special uses, but have evolved with very little joint planning or consultation. To the newcomer in the field of literature searching, these sources present a bewildering variety of approaches. It is in the face of such variety that many scientists request a more rational approach to the indexing of published materials. Many discussions have been held, on both a national and an international scale, in an attempt to rationalize the production of these guides. This effort has led to a growing amount of interest by many people in the problem. The present enquiry, limited to scientific and technical information, has received 233 briefs from all parts of Canada.

Patent literature has been the subject of considerable investigation both in Canada and abroad, since this source of information is not readily available to Canadian users but is of considerable value.[16] Improved indexing services have been developed in many countries, and international efforts are being made to develop methods for the searching of patents.

Of growing importance is scientific and technical material available through motion pictures. It has been pointed out by the National Science Film Library of the Canadian Film Institute that motion picture film is a unique medium for the transmission of certain kinds of information which will be used with increasing frequency.[17] This organization plans to publish an index of film footage currently in existence in Canada which is of primary interest as information on research projects, and establish a collection of such research films. It now maintains a title index to some 12 000 of the 30 000 to 40 000 motion picture films which have been produced in various parts of the world and contain information of interest to scientists and industrial organizations.

IV.6 National Organization of Scientific and Technical Information

Many countries since the end of World War II have developed highly successful methods for the co-ordination of the information produced in their research establishments, universities, educational institutions, manufacturing centres, agricultural stations, health and welfare establishments, and other agencies. The product of such national scientific and technical information services, when it is available in English, French, Russian, Spanish, and some other languages, generally has an international circulation as well as a national one.

In Canada there has been considerable interest in the organization of scientific and technical information. When the National Research Council, Ottawa, was established in 1916, one of its first components was a library which would gather scientific and technical reports from around the world and make them available to the scientists of the council. Other libraries were established in the major federal government departments and in the universities and colleges in all parts of Canada. With the growth of Canadian industrialization it was apparent that the addition of more and more libraries, each one working only with a particular group of users, was not the most advantageous organization for Canada.

Plans and discussions have gone on concerning the national organization of scientific and technical information in Canada, but few concrete results have been achieved. Canada, among the many industrial countries of the world, does not yet have a fully developed national organization for the dissemination and transfer of scientific and technical information to serve users in the country. One of the basic steps that must be taken is to assign functional responsibility for organizing scientific and technical information and to obtain agreement concerning the respective roles of the following Canadian agencies: industry and industrial users, the Canadian publishing services, universities, and government organizations at all levels–federal, provincial, and municipal. It is quite clear that such a plan for organizing scientific and technical information in Canada will require the clear-cut assignment of responsibilities among these various agencies.

One of the first countries to develop a national system for scientific and technical documentation after World War II was France. The *Centre national de recherche scientifique* established a documentation service in Paris after 1945 to deal with the rational distribution of information arising out of French scientific discovery, both for domestic and foreign use. The services of the *Centre de documentation*, Paris, include systematic indexing services, the publication of the monthly *Bulletin signalétique,* and a variety of other information sources, and the provision of microfilm copies of scientific documents and reports to individual scientists both in metropolitan France and overseas. The centre has a staff of 290 and in 1967 published 413 000 abstracts in its abstracting journal and provided 294 000 copies of articles, 60 per cent in the form of microfilm.[18]

In the United Kingdom, the Department of Scientific and Industrial Research after World War II established a number of information services within the various research establishments of the British Government. The Association of Special Libraries and Information Bureaux (Aslib), London, had been formed to assist the growth of specialized scientific and technical information services throughout the United Kingdom. Many industrial firms in Britain set up extensive information services. A particularly important service operated in Great Britain is the National Lending Library for Science and Technology at Boston Spa, Yorkshire. This library regularly receives many thousands of scientific and technical periodicals, reports, and monographs, and makes them available by rapid photocopying services and loans to individual users all over Great Britain. Over 3 000 items a day are sent from Boston Spa in answer to specific requests.

Other European countries active in the provision of national scientific information include the members of the Organisation for Economic Co-operation and Development (OECD) in Western Europe, as well as Poland, Hungary, Czechoslovakia, and other members of COMECON in Eastern Europe.

An important service exists in Japan. This is the Japan Information Centre for Science and Technology (JICST), Tokyo, which provides a biweekly abstract publication announcing new developments in both foreign and domestic research in many fields. In 1966, 282 000 abstracts were published. The purpose of JICST is to collect world-wide scientific information comprehensively and to process it systematically, to disseminate information rapidly and appropriately to organizations and individuals regularly and on request, and to encourage scientific information services in Japan in business and industry to solve problems in securing the information they need. The services of JICST are used by more than 400 research centres in Japan and by the universities, government departments, and private industries in all parts of the country. JICST is financed as a non-profit corporation jointly by government and industry. During 1968 the Japan Information Centre for Science and Technology will computerize the production of nine subject series of its current monthly bibliography on science and technology. The new system will serve to cut down the amount of time needed to prepare each issue from three months to one and a half months, and it will produce annual and subject indexes, which until now have taken eight months, shortly after the completion of each volume. It has been estimated that, among the industries in Japan that maintain their own large scientific and technical documentation services, the work of JICST is used to meet at least 40 per cent of the demands originating from these industries.

In the United States of America there have been many efforts to improve access to scientific and technical information. The National Science Foundation, Washington, maintains an Office of Science Information Service which in 1966 awarded 167 grants and contracts totalling $11.6 million on research and development in the field of information science.[19] Various departments of the U.S. Government, particularly the Department of Defense; the National Aeronautics and Space Administration; the Department of Health, Education and Welfare; the Department of Agriculture; and the Department of Commerce, have established networks of information services, both within the United States and abroad. The importance of information services can be seen from the amounts reported in the summary table (Table 2) for documentation, reference, and information services, and for the research and development of these services.

A principal central service that has been established in the United States is the Clearinghouse for Federal Scientific and Technical Information, in Washington (Appendix D). This clearinghouse is a distribution agency for unclassified report literature produced by federal departments and offered for sale. It deals with the output of more than 30 U.S. federal agencies. It operates a translation announcement journal and has the text of the abstracts to available government reports published on a semi-monthly basis in *U.S. Government Research and Development Reports*. Its *Fast Announcement* service provides abstracts of selected items of information and is mailed directly to subscribers.

The U.S. National Standard Reference Data System of the National Bureau of Standards consists of a group of data centres throughout the United States which produce compilations of critically evaluated data, critical reviews of the state of knowledge in specialized areas, and computations of useful functions derived from standard reference data. Many of the centres are located in Washington but some are located in universities and laboratories across the country.

The U.S. Department of Defense maintains information analysis centres that have been established to facilitate the exchange and use of scientific and technical information. These centres collect, review, digest, analyze, appraise, and summarize information and provide advisory and other services concerning available scientific and technical information to manufacturers in all parts of the United States. The department also carries on a wide range of other scientific and technical information activities.[20]

Table 2. – U.S. Federal Obligations for Scientific and Technical Information of Selected Agencies: Fiscal Year 1968 (Estimated) (Thousands of Dollars)

Agency and Subdivision	Total	Publication & Distribution	Documentation Reference & Information Service	Symposia & Audio-Visual Media	R&D in Information Science
Total, All Agencies	348 074	90 500	177 877	35 902	43 785
Selected Departments					
Dept. of Agriculture, Total	8 393	3 290	2 874	1 890	339
National Agricultural Library	2 900	422	2 130	20	328
Dept. of Commerce, Total	53 053	27 416	21 957	720	2 960
Maritime Administration	25	25	–	–	–
Patent Office	38 331	24 865	13 007	20	439
Dept. of Defence, Total	127 727	26 328	67 927	17 988	15 484
Dept. of Health, Education & Welfare, Total	68 789	5 960	44 448	7 788	10 593
Office of Education	6 532	75	5 870	87	500
Public Health Service	58 850	5 459	36 016	7 384	9 991
National Institutes of Health	17 373	2 772	5 522	3 436	5 643
National Library of Medicine	27 312	385	25 354	50	1 523
Geological Survey	6 904	4 590	1 466	197	651
Other Selected Agencies					
Atomic Energy Commission	5 783	3 130	1 694	271	688
Library of Congress	16 602	–	14 449	10	2 143
National Aeronautics & Space Administration	26 844	10 862	12 127	3 435	420
National Science Foundation	19 215	2 715	5 615	1 510	9 375
Office of Science & Technology	250	–	–	–	250
Smithsonian Institution	2 401	1 204	1 009	121	67

SOURCE: Federal Funds for Research, Development, and Other Scientific Activities, fiscal year 1968. National Science Foundation, Surveys of Science Resources Series, NSF 67-19, p. 238-239.

The U.S. National Aeronautics and Space Administration (NASA) is one of the leading agencies of the U.S. Government concerned with the dissemination of scientific and technical information to both the scientific community and industry. NASA has developed a great many specific services designed to make available information produced by government contractors working for the agency, as well as making it possible for these contractors to have access to the most recent technical results in their own and other fields. A very important part of the work of the NASA information facility is the study of methods and techniques concerned with the dissemination of scientific information to industry. As a result of these studies, a number of specialized services have been developed, some of them available to Canadian users (Appendix E). The NASA information facility has pioneered in the development of a number of important concepts and methods in information work, including the transfer of information to industry.

The U.S. Atomic Energy Commission maintains specialized information and data centres whose functions are to provide data on nuclear-level properties. The U.S. Department of Commerce, as well as operating the Clearinghouse and the Standard Reference Data System, maintains field offices whose prime object is to serve as contact points for the department in each locality in the United States. These carry out the field programs of four major agencies of the Department of Commerce: the Bureau of International Commerce, the Institute for Applied Technology, the Office of Business Economics, and the Defense Services Administration Bureau. The offices also disseminate census bureau data and serve as local information centres for other Department of Commerce agencies, including the National Bureau of Standards, the U.S. Patent Office, the U.S. Travel Service, and the Economic Development Administration.

In 1965 the U.S. Congress enacted the State Technical Services Act with the objective of promoting commerce and encouraging economic growth throughout the nation. The Act is designed to support state and interstate programs which will make the findings of science and technology available to American manufacturers. The purpose of this program is to secure wider diffusion and more effective application of science and technology in business, commerce, and industry. The Office of State Technical Services, which administers the Act, co-operates with individual state programs and provides funds to enable local authorities to carry out the reference and information services needed by local industries.

The roles of the U.S. Federal Government Committee on Scientific and Technical Information (COSATI) under the Federal Council for Science and Technology, the Resources Program staff of the Department of the Interior, the Community Development Service of the Department of Agriculture, the Science Information Exchange of the Smithsonian Institution, the National Referral Centre for Science and Technology of the Library of Congress, and the proposed national system for scientific and technical information are all carried out in relation to the program of the Office of State Technical Services so that effective relationships can be established with these several agencies without overlap or omission.[21]

The co-ordination and development of scientific and technical information in the U.S.S.R. is the responsibility of VINITI, the state scientific and technical information service located in Moscow. Other information bodies exist in various parts of the U.S.S.R. The function of VINITI is to prepare a series of major abstract journals, *Referativniy Zhurnal*, which are distributed throughout the Soviet Union and abroad. These journals list the contents of all new major scientific reports and journals, along with abstracts in the Russian language. Other functions of VINITI include the planning and organization of scientific information centres in various parts of the Soviet Union, co-ordination with the programs of existing U.S.S.R. agencies, the distribution of information to industry. A plan for the use of national computer-based information exchange systems in the U.S.S.R. operating for different levels of users and institutions has been announced.

IV.7 International Organization of Scientific and Technical Information

The growing tendency to form co-operative arrangements on an international basis for the development of various areas of science and technical investigation has given rise to a great many agencies concerned with the international organization and exchange of information in all fields. The more important government-financed operations are the various specialized agencies of the United Nations, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO); the International Labour Office (ILO); the World Health Organization (WHO); the Food and Agriculture Organization (FAO); as well as regional intergovernmental bodies in various parts of the world. In addition, there are more than a dozen specialized non-governmental international organizations which deal exclusively with the organization of scientific and technical knowledge and its international exchange. Some of the major organizations in this field are:

International Federation for Documentation (FID)
International Federation for Information Processing (IFIP)
International Federation of Library Associations (IFLA)
International Council of Scientific Unions (ICSU)
International Council for Social Sciences (ICSS)
International Federation of Translators (FIT)
International Organization for Standardization (ISO)
Committee for International Co-operation in Information Retrieval among Examining Patent Offices (ICIREPAT).

Each of these international non-governmental agencies is made up of national members. Canada has membership in most of these organizations. Within Canada, however, there is no effective means of co-ordinating Canadian participation or exchanging information on the work carried out by the national participating bodies. The Canadian National Commission for UNESCO has attempted some co-ordination since all of these bodies act in some consultative capacity to UNESCO.

Such international activity is utilized most effectively by the larger countries, since only they can afford the staff and financial expenditure that are necessary to follow in detail all the work of these international agencies. Smaller countries, such as Canada, generally experience great difficulty in being able to contribute to the work of the international bodies and take full advantage of all that is produced.

The evolution of regional international agencies has meant that certain regional groupings of countries have been able to pool their resources in scientific and technical information development and make use of the knowledge produced in each country on a co-operative basis. Canada participates in a few such regional organizations, notably OECD, as well as in certain of the large international agencies.

Examples of such work may be seen in EURATOM and the International Atomic Energy Agency (IAEA). While not international in scope, EURATOM, in co-operation with the U.S. Atomic Energy Commission, has established a sophisticated information-handling system for its member countries dealing with the peaceful uses of atomic energy.

During 1966 the major nuclear nations agreed to develop an International Nuclear Information System (INIS) with the participation of the International Atomic Energy Agency in Vienna. Under this plan, individual nations or regional groups of nations will assume responsibility for preparing abstracts and indexes of all the significant literature produced in their geographical areas dealing with the peaceful uses of atomic energy. All participants will receive a complete machine record of the total file from which computer-produced services can be prepared.

The present program of UNESCO for the improvement of scientific and technical information and documentation is based on a five-year scheme adopted by the UNESCO General Conference in 1966. A study of the "Feasibility of a World Science Information System" is in preparation jointly by UNESCO and the International Council of Scientific Unions (ICSU). The system is envisaged as a flexible international network that will co-ordinate national and regional scientific and technical information systems already in existence and those to be established in the future. In designing the system, consideration is being given to:

(1) Qualitative selection of stored information;
(2) Transferability and compatibility of information storage and retrieval techniques and equipment;
(3) Computer languages.

Computers, satellite communication broadcasting, and other sophisticated electronic and optical devices will be used extensively.[22]

Section V

TECHNIQUES FOR HANDLING INFORMATION

V.1 Introduction

Technological developments of the last 25 years have provided the means for control of the rising flow of information so that, in spite of the flood, improved information services are being developed and further major advances can be foreseen. Computers and related equipment have provided the main impetus, but developments in communication and microreproduction have contributed to systems that allow more rapid and more economical transmission, storage, and retrieval of information. Initially, computers were used to prepare printed indexes for manual use which could be sorted and printed with greater accuracy and speed and at lower cost than was previously possible. The more intellectual task of selecting and controlling indexing terminology and search of the index was done by people. Recent studies have been directed toward taking more and more of this work into the computer system.

A rapid change is taking place in the technology of printing, whereby the hot metal linotype process is being replaced by computer-controlled, photographic-type composition.[23] A by-product of this is often the provision of text in machine-readable form which is then available for information processing. Integrated systems that make use of this for automatic indexing, selection, and dissemination are in developmental stages in *Chemical Abstracts* and MEDLARS[24] and will be fully operational by 1969. This will avoid much of the present delay and cost of secondary handling, and indicates the trend in information-handling processes.

Selective dissemination of information provides the means whereby only those items pertinent to his problem area will be received by the user, eliminating much of the time now spent on the selection of information from the increasingly voluminous literature now available.

V.2 Application of Computers to Library Administrative Practice

The first area in which computers were successfully applied to library practice was in the handling of journal subscriptions where systems developed for commercial purchasing and accounting could be readily adapted. Many libraries in Canada now use journal subscription renewal systems from which listings of holdings are also prepared.

V.2.1 Circulation Control

Control of circulation of library materials accounts for a large part of the clerical effort in most libraries, hence the interest in computerized systems in this area. These are developing slowly: Université Laval, in Québec, has one of the first systems of this type in Canada. The Bell Telephone Laboratories have recently installed an integrated system, known as BELLREL, linking three of its largest libraries in Holmdel, Murray Hill, and Whipany, in New Jersey, for loans, returns, renewals, reservations, and enquiries.[25] Two IBM 1050 terminals with keyboard, printer, and card-reading facilities are located in each of three libraries. These are linked by Western Electric 103A Dataphones to the Comptroller's Division IBM System/360 model 40 computer at Murray Hill. For librarians, BELLREL offers a "real-time" (immediate response) computer system for handling library transactions. The circulation librarian can quickly determine the books already on loan to individuals or the place of a person on a waiting list. In all, 19 types of "real-time" questions or transactions can be handled. Overnight processing on a "batch" basis is used for ready-to-mail overdue notices, printed with all information including the borrower's address. This eliminates hand processing of some 60 000 notices per year. Batch processing also provides a number of records to aid library workers in determining the current status of books, journals, and other publications. Book and borrower data required for immediate retrieval are maintained in direct-access computer disc files. Also, a complete history of all transactions is recorded on magnetic tapes. These provide library supervisors with statistics and other data necessary for analyzing the flow of library materials and the patterns of borrower demand. The frequency of requests for a book or document help to determine whether it should be discarded or whether additional copies should be purchased. Another feature of the system is the automatic charge-out of any returned item to the next borrower on the waiting list. When a book is returned the computer sends a message to the librarian, instructing her where next to send the book. Because information can be recorded either directly through the typewriter console or through the use of a card-reading unit at the input terminal, the system can handle all classes of library publications with or without the use of pre-punched book cards. This flexibility also is available for recording borrower identifications, since two thirds of the Bell Telephone Laboratories library transactions are the remote kind in response to telephone or mailed requests.

V.2.2 Library Catalogues

In the past 70 years the ubiquitous card catalogue has, in spite of its faults, been virtually the only practical solution to the provision of a users' guide to the holdings of a library. The computer provides assistance in the maintenance of the card catalogue and, more important, provides alternates in the form of a printed book-type catalogue or a machine catalogue available through a computer terminal. These developments are setting the stage for major advances in providing service to users at or away from the library proper. In the preparation of library card catalogues, the University of Toronto has been one of the leaders on the American continent in the use of the MARC (Machine-Readable Catalogue) tape of the Library of Congress (Appendix C). On an experimental basis, the information required for preparation of library catalogue cards is distributed regularly to 16 participating libraries by the Library of Congress.

V.2.3 Book Catalogues

Computer-printed book catalogues have not proved satisfactory except as selective subject catalogues or in smaller industrial libraries, such as Du Pont of Canada [26] and Canadian Industries Limited.[27] The main difficulty with the larger catalogues has been the expense of reprinting to provide an up-to-date version. The use of 16-mm. microfilm prepared directly by the computer, or using automatic cameras on computer printout, appears to offer a practical solution to the problem.[28]

The time-consuming and costly part of preparing an index is the assignment of subject headings, index terms, or classification notation according to a prescribed system. The Library of Congress supplies the basic descriptive cataloguing for most of the books published in the United States and the important publishing countries of the world, but there remains much material of interest only to Canada which is needed to maintain the national character of our holdings. This, however, should not long delay the development of a computerized system for most requirements of Canadian libraries. A Canadian centre for the standardization and distribution of this material would greatly assist this development. The National Library, in Ottawa, has a cataloguing program covering much of this material and is developing a magnetic tape system. Standardization has not yet progressed to the state where the resulting record is compatible with that of the Library of Congress system.

V.3 Co-ordinate Indexing

The failure of traditional classification and subject indexing systems to handle the growing bulk of technical writing inspired the study of alternative systems for information retrieval. A leading advocate of an alternative approach was Mortimer Taube who, in 1953, published a series of texts on co-ordinate indexing.[29] This has become the basis of many of the successful retrieval systems in use today. A feature of the system is the use of a large number of word tags, often referred to as terms or descriptors, by which a document may be identified. In its simplest form, these are words selected from the text as representative of its content. The number of descriptors may vary from 5 to 100, but commonly are of the order of 15 to 25. (By way of contrast, the Library of Congress assigns, on the average, 1.6 subject headings per book.) The search system used is one of co-ordination, i.e. finding documents that have two or more terms in common. This process lends itself readily to mechanization, initially using manual system—uniterm cards, mechanical sorters, or optical coincidence cards (peek-a-boo)—but now mainly using computers to prepare manual indexes, dual dictionaries, or custom searches. Some large Canadian firms have developed systems of this type.[30,31] The computerized search may be expressed in Boolean logical statements of terms connected by *and, or* and *not.* More advanced systems use weighting of terms, which leaves much of the Boolean logic to the computer and allows the answers to be arranged in order of probable pertinence to the question. A system of this type has been developed by Canadian Industries Limited[32] for the magnetic tape index to U.S. Chemical Patents 1950-1966, published by IFI/Plenum[33] which lists 170 000 chemical patents with an average of 30 descriptors per patent—over five million references. This is one of the most advanced search programs available for any commercial file.

The choice of word tags may be limited by a guide to terminology–a thesaurus–which serves as an "authority list", defining preferred terminology and often showing the semantic relationships between terms, often referred to as "tree structures". Typical examples are published by the Engineers Joint Council,[34] the National Aeronautics and Space Administration, [35] and the American Chemical Society.[36]

V.4 Automatic Indexing

Given the abstract or full text in machine-readable form, it should be possible to develop routines for the classification of documents or the indexing of information for retrieval, using computers. This is being studied actively, and systems are in use and others are being developed that show promise. The System Development Corporation, California,[37] described one of the first successful applications of such a system. The International Business Machines (IBM) Generalized Information System (GIS) builds co-ordinate indexes automatically from text.[38]

V.5 KWIC Indexing

The first method of automatic indexing to gain wide application was Key Word In Context (KWIC) indexing developed by Luhn.[39] This system, which lists all important words in titles alphabetically in the centre of the page, is widely used in many Canadian firms, notably Air Canada which distributes to all ticket agents manuals for air traffic regulations, which must be revised frequently, based on this system. The American Chemical Society publication *Chemical Titles,* which lists titles of the articles in some 650 of the world's leading chemical journals within two weeks of their publication, was the first major index published using this form of automatic indexing. The publication *Pandex* [40], which issues a quarterly index in microfiche form of 1 600 science publications, uses a form of KWIC index which overcomes many of the limitations of the earlier systems by providing, for example, improved readability by the use of capitals and lower case, and improved machine sorting together with control of terminology to bring related concepts together in the index. This control of terminology covers foreign entries which are listed in the original language but in their place next to the English-language entries on the same aspect of the subject. A related scheme, Key Word Out of Context (KWOC), lists automatically titles or phrases from text under a keyword from the title as in a subject list of titles under subject headings. While this is more conventional in format, it loses the "in context" feature of KWIC.

Computerized systems for indexing the abstracts or full text are being widely studied. Those now in use depend on the recognition of words or phrases in the text which are used for selective dissemination according to the prescribed interest profile of a user. Large-scale tests on selective dissemination by the American Chemical Society (Appendix B) are in progress which are revealing the problem areas needing study before a widely acceptable system can be made operational. In narrow subject areas such as *Chemical Biological Activities,* which uses specially prepared abstracts, success has been better than in attempts to use regular abstracts.

V.6 Retrospective Search

Retrospective search usually involves a much larger file than current input, so that many selection systems designed for selective dissemination do not provide the necessary efficiency or discrimination needed for a large file. Since the answers tend to be voluminous, there is need for a means of ranking the output according to the probable relevance of the items to the question. This is usually accomplished by assigning weights to the terms of the enquiry and developing scores for the relevant items which become the means of ranking the output. The list of terms associated with each answer can be helpful in assessing the probable relevance of the items found.[32]

The IBM Generalized Information System (GIS)[38] constructs a file of "key words" selected automatically which are stored in a random-access file allowing search in a conversational mode using a "terminal typewriter". Such systems were pioneered in the Multiple-Access Computer (Project MAC)[41] experiment at the Massachusetts Institute of Technology. Installations capable of storing large amounts of data on-line to many terminals simultaneously are becoming widely available. Since they can use existing telephone lines for interconnection, such systems can develop rapidly. The limitation on their growth will not be the technical problems but rather the existence of a store of data to which such a connection is justified. These should develop rapidly as large abstracting and indexing organizations put in operation the large computerized systems now being introduced—National Library of Medicine (Appendix F), and American Chemical Society (Appendix B).

V.7 Input to Systems

Cost studies of systems using intellectual appreciation by trained personnel to assign indexing terms or classification show that about 80 per cent of the cost of input is accounted for in this function.[41] The Institute for Scientific Information (ISI), in Philadelphia, and the Technical Information Project (TIP), at the Massachusetts Institute of Technology, make use of the title, author, institutional sponsor, and the citations in the bibliographic references. In this way, the input becomes a purely clerical operation and thereby appreciably cheaper.

The service offered commercially by ISI covers some 1 600 journals of science, including broad coverage in medical and related subjects.[42] A selective dissemination service may be purchased from ISI, which provides each week an individual computer printout for each profile in the system. The profile can specify any author or journal which can be excluded or included, similarly a word or word combinations in the title or specific references to papers or books. All papers that match the specifications of the individual profile are listed, giving title, author, and reference. Attention is thus drawn automatically to all publications by a specific author or from a given institution or which refer to a previous specific publication. The magnetic tape records prepared for this service may be purchased for use in a private information dissemination and retrieval system. The National Science Library, Ottawa, now receives the titles and references from this system and has reformatted them so that they are compatible with the *Chemical Titles* SDI system.

This is typical of the kind of operation in the information field in which Canadians should become adept.

ISI prepares from the cumulative input a "citation index" which lists all papers that refer to a given paper. The annual volumes of this publication allow the user to follow forward in time the use being made of a specific technique or publication in a way that is not possible with the usually indexing and abstracting system.

The Technical Information Project (TIP) at the Massachusetts Institute of Technology uses a similar data base covering some 32 journals of physics. No routine publication or services are prepared but the system is "on-line" to 200 terminals in the institute. On an individual basis, the data base may be queried using a "conversational mode" approach or a stored routine which may be repeated at regular intervals. These routines may include complex logical associations and statistical methods which utilize the power of the computer to select lists of literature references with a flexibility of approach which would be virtually impossible using more conventional systems.

A major experiment at the Massachusetts Institute of Technology, Project INTREX,[43] involves the input for a library catalogue using, in addition to the normal catalogue information, such material as the table of contents and the index of the book, extracts from the preface, as well as reviews and comments of the users. The whole of this will be available for search by terminal to locate and select items from the library. This machine record is a longer and more complex description of the stored items than any previously attempted on a large scale, and indicates the growing power of computers to store and use large files of formatted and full-text information. The use of available input which can be augmented as use broadens suggests a future trend for building effective search files.

V.8 Data Banks

Present computer systems are particularly well suited for the storage and interrelation of data where the information is largely numeric in nature. Many files are being built in a wide variety of areas, including chemical constants for analysis of infra-red or X-ray diffraction, and the physical properties of many materials. The acquisition of such data files is a function of libraries and information services. In some cases, specialized data centres are set up if no library is available to handle the data files or does not wish to do so. Once the data file is secured, its operation and use is generally the function of specialized staff and research workers.[44]

V.9. Chemical Structure

The recording of chemical structure in a form suitable for manipulation in a computer has proved more difficult. Systems using both topological description and linear notations are, however, being developed which offer new means of relating chemical structure and chemical or biological activity. The more extensive analysis and correlation of data made possible by such systems greatly extend the usefulness of, and provide the motivation to build, these large data compilations in machine-readable form. A comprehensive review of this area is given by Tait in the *Second Annual Review of Information Science and Technology.*[45]

V.10 Facsimile

Copying devices have improved in quality at lower cost so that Xerox has become a word in the language in the same way that Kodak and Frigidaire were accepted a generation ago. This ability to supply copies has reduced the necessity to lend much material in the original form, providing instead a copy for individual use. As these improvements continue and their use becomes more widespread, new problems arise with regard to copyright, the economics of publication, and the compensation of the author and publisher. The reproduction of out-of-print books becomes possible at reasonable cost so that it is no longer necessary in many cases to arrange interlibrary loan or travel to consult much material of archival value. These developments have increased the flood of material available to the user who already recognizes the necessity of having some selective aids so that his time available for reading can be used more effectively.

Present equipment for facsimile transmission by wire or radio of the printed page is practical for weather maps and some drawings but is too slow and expensive to be practical for a page of printed text.[46] Improved devices are foreseen but the technical problems are not yielding as rapidly as previous forecasts had predicted. Television tubes designed for high resolutions– 2 000 lines per inch–should provide a page readable at close range in normal page size, but their use is not widespread, nor is satisfactory equipment for making copies readily available. The next decade should see marked improvements as the technical problems do not limit advancement in this area. Transmission of signals to operate an electric typewriter using conventional telephone lines is well developed. The speed of this equipment (about 6 lines per minute) is suitable for messages which include citations and abstracts but, in general, not for the transmission of the text of printed material. Using computers to send and receive the signals, speeds of 300 to 600 printed lines per minute are now possible but this is not economic for full text which is more economically supplied by air mail or printed pages, microforms or magnetic tapes in our present technical and economic circumstances.

V.11 Closed-circuit Television–Video Transmission

Equipment is now in use which allows the transmission by television of material stored on film or computer memory. Films which may include colour image and sound track are widely used in entertainment and are being used increasingly in education. With closed-circuit equipment, individual use of such services is now practical. Computer-stored files and conversational mode enquiry systems, which may include television display, allow the user to be guided to fuller use of data than is now possible with a card catalogue or printed index. We can foresee the replacement of the traditional library card catalogue by visual display terminals at the user's location.

V.12 Microform

Photographically reduced copies have been used as a means of storage and transmission of documents for many years. Improvements in the technique for preparation and reproduction have accompanied their widespread adoption by government agencies for distribution of reports. This, in turn, has promoted wider use of the technique. Microform reader-printers which allow the user to make a copy of selected items for his retention have increased "customer acceptance" which has previously limited the usefulness of microforms.

Roll films (2 400, 26-mm. frames in 100-foot reels), microfiche (60 frames in a sheet of film 48 mm. by 105 mm.), and aperture cards (1 to 8 frames in a machine-processable punched card) all have characteristics which lend themselves for particular purposes. Roll films may be placed in cassettes which can be stored conveniently and loaded automatically into readers or reader-printers. These have gained acceptance for large compilations of data or journals. *Chemical Abstracts* (1902-68) consists of some 150 volumes which are now available on a rental basis in film form. Users report more efficient search as compared to bound volumes of the same material.[47] This is particularly true if the "Miracode" type of system of automatic page location is used.[48]

Microfiche find particular application in the distribution of reports which can often be recorded on a single sheet of film. Since the cost of reproduction and mailing is low, they are well suited to the selective dissemination system used by U.S. Government agencies, of which NASA is typical (Appendix E). They are also available in this form from the U.S. Clearinghouse for Federal Scientific and Technical Information in Washington (Appendix D). The National Science Library, Ottawa, has files of this U.S. Government material on microfiche and equipment for duplication. For individual use, microjackets (which consist of strips of 16-mm. film mounted in a transparent plastic envelope) provide a convenient means of preparing micro-copy without complex equipment. One of the main attractions of these microforms is the low cost of reproduction which, in the case of film, is about two tenths of a cent a page.

Equipment for recording the output of computers on 16-mm. film is becoming more widely available. This allows printer speeds of 5 000 lines a minute–five times the speed of line printers–and can form the basis of improved systems for handling computer output. Procedures whereby binary coding can be added by the computer to such film have been developed by Eastman Kodak.[48]

Section VI

INFORMATION SYSTEMS

VI.1 Introduction

In earlier sections of this chapter the present situation with regard to the dissemination of scientific and technical information has been reviewed, the many sources of information have been explored, and modern techniques of information handling have been described. In this section a short review will be presented of information systems that are illustrative of those best suited to Canadian requirements. The intent here is to formulate system concepts emphasizing features that have been submitted to this Study in briefs and in discussions held in major Canadian centres, to explore what can now be done and what must be planned for in the near future.

The proliferation of printed information poses a major problem to users in all countries. Many users lack their own files of primary sources of information and the secondary sources of indexing and abstracting services which provide a guide to the literature produced. A wide variety of non-conventional information systems has been developed to meet the needs of specialized groups of users. Such systems have been established on a local, regional, national, or international basis, and are used by many Canadians. The Techniques and Sources Subgroup has sought to define the functions and purposes of the less conventional information systems operating both within Canada and abroad. Such systems, to be effective, must be designed to meet the actual needs of the users. For purposes of this description, it is considered that a non-conventional information system includes the following elements, among others:

(1) A body of documents, or information units, or sources;
(2) An index to it, suitable for rapid machine searching;
(3) A mechanism for producing the index;
(4) A mechanism for searching or otherwise manipulating the index;
(5) A mechanism for printing out or otherwise displaying the results of searches or other index manipulations.

Several of these information systems are described in some detail in the appendices to this chapter. Many others are concisely reviewed in *Non-Conventional Scientific and Technical Information Systems in Current Use.*

It should not be construed that mention of particular systems implies approval. Those systems mentioned, however, serve to illustrate modern techniques now employed in information handling and provide the reader with some appreciation of their aims and potential. Neither the information problem nor its solution is necessarily the same in all countries. Each country contributes differently to the store of knowledge, and the needs of science and industry can dictate highly individual solutions. Canada at this time is largely a user of information published elsewhere and hence is very dependent on abstracting, indexing, and documentation services of other countries, notably those of the United States and Europe. Canada's wide territory covers five time-zones so that real-time operation of any information network can present difficulties. Storage and retrieval problems in such an environment are not peculiar, however, to information networks; radio and television networks store and retrieve programs daily so that all Canadian families may receive them at the most convenient hours. Multilingual operation, such as EURATOM faces in its European network, must be considered in some instances. The low population density in Canada puts a premium on the efficiency of the system.

VI.2 System Concepts

One result of poor information retrieval in science and technology is the origination of new systems without adequate study of those already in existence. Often even knowledge of their existence is lacking and, in the view of many developers, it is often cheaper to start afresh than to attempt to standardize.

In the field of information services, particularly as automation increases its penetration, standardization of interchange is imperative and this will be referred to in detail later in this chapter.

From the many basic concepts that have received detailed consideration during subgroup discussions, the following have been selected as being of prime importance in the context of a national information system for Canada:

- The system should be evolutionary in concept, since the hardware and software now available are continually being improved and experience will suggest changes. It must be able to accommodate traditional library practices for some time. Flexibility is vital.
- Standardization of Canada's domestic output format with other countries would considerably simplify entry into international information banks and ensure that Canadian publications are well represented there.
- The information retrieval system must be capable of accepting information in all the formats received from co-operating countries. This implies considerable emphasis on computer programming in Canada and on support for international standardization efforts.
- The system should accept information in foreign languages having characters not found in English text. Should these be made available on tape, specialized printing equipment must be available before translation can be undertaken.
- Decentralization of information centres with national control and centralized processing appears to offer the most economical system. Centres of excellence should be fitted into this system to advantage.
- The system should be heavily user-oriented; it should ensure that a minimum of the user's time, money, and effort is expended.

- It is essential that a national system employ some form of selective dissemination of information (SDI) if it is to serve the user adequately. This will probably be on a local or regional basis.
- Industry requires critical state-of-the-art reviews in relevant fields, not simply information retrieval.
- Value and document age are generally inversely related. Timeliness of dissemination of information is vital and is one of the main driving forces behind the evolving technology.
- If information flow from document centres is to be kept within economic bounds, some method of progressively narrowing the area of search is required. In its simplest form this may involve no more than telephone conversation with a specialist, but the system should accommodate eventual extension to a conversational mode of enquiry through time-shared computer facilities and display consoles. Information requests may then progress successively from citation through abstract to text retrieval with higher relevancy and lower cost.
- The system must be human-engineered to allow the customer efficient use of an expensive resource through sophisticated programming of time-shared services. Rejection by the user is probably the greatest risk involved.
- The maximum use of off-line and local facilities should be encouraged. Unnecessary use of specialized, expensive communication links should be avoided.
- Fully automated retrieval systems offer the possibility of publication on demand only. If manuscripts are prepared using machine-readable media, publication can be achieved remotely thus avoiding the shipment of large volumes of bound material. The copyright problems that will arise require early study.
- The system must be designed to afford its users rapid access to the contents of libraries and special collections, whether centralized or regional.
- The system should allow retrieval of pictorial data as well as textual information.
- It is apparent that an information retrieval system of national scope can be of immense value in the educational field, and it may well prove more economical to combine the communication facilities required by both.

VI.3 Information Systems and Networks

For many generations libraries were able to satisfy the information needs of science and industry through archival storage, with retrieval entirely dependent on the knowledge and persistence of librarian and user. As the flow of information grew to become an uncontrolled flood, however, retrieval became increasingly difficult and traditional methods were forced to change. Scientific disciplines began to support their own aids to information retrieval, such as *Biological Abstracts, Chemical Abstracts,* and *The Engineering Index,* to mention only a few. Once they became available, computers were pressed quickly into service to reduce the human effort required, with little regard to standardization between publishers. Thus, many systems of computer-aided storage and retrieval have been developed which may become highly individualized inputs to any postulated national information system.

Many libraries – government, public, educational, and industrial – have developed information-handling systems appropriate to their needs, often with little reference to the work or requirements of others. Information systems have received much attention, information networks far too little. Networks, perhaps more than any other word, implies the hope and, in turn, the impetus for this Study. The word suggests intercommunication which, in today's technology, presupposes computer-to-computer transfer of information between geographically separated information systems using the high-speed communication channels now available for public use. Networks of this type have been used for military communications. The experience gained has laid the groundwork for solving basic problems of information transfer. The real challenge today is the integration of information retrieval systems into a single information transfer network through which the individual user may have rapid and economical access to the accumulated knowledge of the world community.

VI.3.1 Types of Information Retrieval Systems

Information handling and retrieval techniques may vary widely depending on the aims of the system, the type of information stored, and the interests of the user. Systems may be broadly classified as those utilizing batch processing and those using time-shared processing.

Information Retrieval by Batch Processing

Most systems now use batch processing for retrospective searching and the selective dissemination of information. To make most efficient use of expensive computer facilities, a large number of search requests are batched and entered into the computer system for simultaneous search. If the search requests and the resultant outputs are handled by mail with little or no contact between the user and the computer staff, it often results in long delay, inadequate communication and rather low relevance or inadequate recall of information. With sophisticated programming and the use of intercommunication networks, however, systems of this type can be made to provide excellent service to a large clientele at realistically low costs. There are far too many systems employing batch or time-shared processing, or a combination of both, to describe each in any detail, but the following are representative of such systems used for information processing.

(*a*) Chemical Abstracts Service of the American Chemical Society (Appendix B) publishes various information journals and provides individual searches on request. This service is important because of its early origin, its comprehensive coverage, and its wide use in Canadian science.

(*b*) Library of Congress Project MARC (Appendix C). A standardized, machine-readable catalogue record is available to libraries from the Library of

Congress. The record on magnetic tape has been designed to serve many purposes in addition to the basic function of producing catalogue cards or book catalogues; it is capable of acting as input for computer-controlled printing, being retrieved from a large electronic store, and of facilitating preparation of special bibliographies. This important source must be accommodated by any Canadian national information system.

(*c*) U.S. Clearinghouse for Federal Scientific and Technical Information (Appendix D). This distribution agency for unclassified reports produces an index to available government reports by computer, and makes available the text of abstracts on tape. Bibliographic searches are performed on a fee basis. The service is of significant interest to this Study because it has successfully coped with the problem of converting machine-readable records from various government agencies. This merging of tape records will be a problem of major proportions in a Canadian information system.

(*d*) U.S. National Library of Medicine (Appendix F). The computer-based MEDLARS system provides magnetic tape with indexes, augmented bibliographic citations, and keywords to articles in some 2 400 medical journals. The tapes are used to produce *Index Medicus* and to provide individual bibliographic searches on request. The system makes use of a unique photo-typesetter (GRACE) which prints in upper and lower case at the rate of 300 characters per second from a font of 226 characters. MEDLARS is significant as the largest collection of citations and abstracts in the field of medicine.

(*e*) North American Rockwell Corporation (Appendix H). The Technical Information Processing System (TIPS) is an information storage and retrieval system designed to bring together in one network the nine technical information centres and eighteen branches of the company in California, Ohio, Oklahoma, and Texas. It is particularly significant because it represents an industrial operating network of many computers which provides excellent dissemination of information and retrospective search facilities for thousands of users.

(*f*) Educational Research Information Center (ERIC). The Department of Health, Education and Welfare of the U.S. Government sponsors the use of a similar system to produce detailed indexes to educational research publications. These indexes are printed in many formats useful to research, management, and government personnel, and meet in the United States a need expressed to this Study in many briefs, namely, that of a central, computer-produced index to research activities in Canada. The low cost of the ERIC service is indicative of what can be achieved through efficient use of computer information processing.

(*g*) Institute for Scientific Information, Philadelphia. This company provides information services for science with particular reference to chemistry. Bibliographic citations covering articles appearing in 1 600 scientific and technical journals are available on magnetic tape. Other tape services include the *Science Citation Index*, which allows the user to follow the current literature in a particular area of scientific activity by the references made by subsequent authors. The *Index Chemicus* is an additional information service covering new chemical compounds and their syntheses. Searches may be performed on an individual profile basis and the service is significant in that it offers outright sale of these commercially prepared tapes for use in other computer-based systems.

(*h*) IBM Technical Information Retrieval Center, Armonk, N.Y. The IBM Current Information Selection System (CIS) provides a current awareness service for more than 3 000 technical and scientific employees of the company. Its user-interest profiles on magnetic tape are compared weekly against the full abstracts on magnetic tape of journal articles, reports, and other documents. The system is significant in that it compares the text words in the abstract with the significant words of the profiles. The text in blocks of 800 items is compared with the profiles of 120 users simultaneously in 45 seconds. Bibliographic citations and abstracts of interest to each user are printed on punched cards and mailed. Provision is made for a continual feedback of subscribers' interest through the return of a punched card supplied with each abstract. Retrospective searches for individuals are also provided in this system. The CIS system includes satellite operations in San José, California, and La Gaude, France. Documents and abstracts are regularly circulated among the three locations, frequently using broadband carrier communication facilities.

Information Retrieval by Time-sharing Conversational Mode

The availability of increasingly sophisticated computer hardware and software has encouraged information scientists during the last few years to employ time-shared processing for information retrieval. It would be totally uneconomic to allow an individual user exclusive real-time interaction with a computer information storage and retrieval system. However, by sharing the central processing unit with many users, each may be serviced adequately in sequence without apparent loss of continuity and with a resultant reduction in the cost to each individual user. Such time-shared terminals allow the user great freedom in search definition. They permit, up to a degree, the browsing operation normal in the library. Sophisticated real-time information systems employing conversational displays enable the user to evaluate the many articles retrieved at the source before asking for delivery of one or two articles that meet his requirements. Consequently, the request may be answered more meaningfully with less delay and with much higher relevancy. Time-shared processing provides superior service for retrieval at present; it can be expected to provide even better services in the future as information is indexed more deeply to allow retrieval of subject matter from stored text. The following are some typical examples.

(*a*) Lockheed Palo Alto Research Laboratory (Appendix G). This system, known as DIALOG, was developed to investigate the effectiveness of a flexible, conversational language that could be used in conjunction with on-line cathode ray tube (CRT) terminals for direct retrieval of references by the user. The thesaurus is machine-stored and may be displayed in both alphabetical and in conceptually related forms. Single-key commands control all the operations required in a search but leave the user freedom to enter operational data relevant to the search, such as keywords, search limits, and Boolean logic necessary for the retrieval operation. Experience has shown that less than one sixth of the typical search time is required for computer processing. The cost per search of $10 to $20 is realistic with the present equipment. The user receives two printed documents: a listing of the full bibliographic citation for each selected item, and a listing of the commands used. The latter can also include the document numbers of the retrieved items to allow easy ordering from a document centre. Since bibliographic citations of all documents satisfying the search strategy can be displayed on the CRT terminal, only those of real interest to the user will ultimately be on the printed list. This considerably reduces the number of citations. Such a system uses the best ability of both the user and the machine. The computer merely serves as a data-processing extension of the user, and his intelligence and experience are continuously engaged until an acceptable result is achieved.

(*b*) Massachusetts Institute of Technology. Time-shared systems owe much to the early development at the Massachusetts Institute of Technology of the Technical Information Program (TIP). MIT has now embarked on a long-range project known as INTREX which will feature the machine retrieval of information from full text comprising, in addition to the normal bibliographic citation, the table of contents and the index of a book, extracts from the preface, reviews, and users' comments. It is an ambitious project and one which may well provide experience of value in planning Canadian information systems.

(*c*) European Atomic Energy Community. EURATOM, with headquarters in Luxembourg, has a well-developed operating retrieval system with on-line facilities operated by its Centre for Information and Documentation. One of the most interesting features of the system arises from the fact that it deals with published material in many languages, and search questions may be posed in any of five languages. A system of mapping conceptually related terms in many fields of interest has been used to permit this multilingual operation. The related terms are arranged in a rectangular grid with corresponding terms in other languages occupying the same grid co-ordinate positions. A transparent overlay bearing the terminology in any language other than English may be placed over the English terminology and so effectively achieve a translation. Only the English-language terminology is used to address the retrieval system although documents are stored in their original language.

(*d*) System Development Corporation. Still another system using Bibliographic On-Line Display (BOLD) is that developed at System Development Corporation, Santa Monica, California. Of particular interest is the usefulness of this system both in a browsing mode and a search mode. It is a general-purpose vehicle for real-time citation and information retrieval, operating in a time-shared environment.

VI.4 Information Systems in Canada, Present and Proposed

Canadian interest and activity in the use of machine methods for information storage and retrieval is increasing rapidly. At the present time, however, there are relatively few systems that are fully operational, but there are a number in the process of development that are functioning on an experimental basis. Because of Canada's recent entry into this field, it would be difficult to cite three dozen papers on this subject published during the last three years. Most of the information concerning activities in this field, therefore, was obtained from briefs and visits made by members of the Study Group. The Study was far from exhaustive, but Appendix A contains a brief description of some 35 selected Canadian non-conventional information and data systems, mainly in the field of science and technology, illustrating some of the activities in the use of machine methods for information dissemination.

Although the number of new projects in Canada is increasing, most of them are relatively small for specialized services. There is, therefore, an urgent need to initiate a dozen or more projects in as many environments as possible to gain further experience in techniques and to develop typical systems which may be expanded. These projects are not inexpensive in comparison with the type of work now being carried out. The annual cost will probably be from $50 000 to $250 000 per project.

Existing libraries and information centres should be urged to undertake projects, since the important advances that are to be made are in bibliographic and indexing techniques, in information scanning and retrieval, and in timely dissemination of information to those who need it. These techniques are based on the computer handling of secondary bibliographic indexes. Individuals and organizations are not quick to modify methods, especially when they have investments in old systems. Canadian libraries should be encouraged and financially assisted to modernize their methods. In the federal and provincial government services the opportunity exists for the development of national information services in areas, such as shipbuilding, not now being covered by existing services from abroad. There is also the opportunity of developing repackaging programs to deal with the existing inputs from other countries. This is particularly important for the conversion of English-language systems to bilingual French and English systems.

The above proposals are made in the full realization that, at the present time, equipment for information retrieval is still in the exploratory stage and much of the programming needs further development. However, the older manual systems, growing obsolete rapidly, provide no solution whatever.

The terms of reference of this Study envisage national information services far removed from the traditional archival operations of many libraries. They must encompass all activities of accession, storage, retrieval by a variety of logical controls, dissemination, printing, and publishing, in addition to the normal administrative operations of cataloguing, serial and circulation listing.

If they are to be successful the systems must provide, in a national sense, services equivalent to those expected of the most advanced system serving a very large company having corporate headquarters, regional manufacturing divisions with wide research and development interests, and possibly smaller local units. This analogy is suggested because for such an industrial system to flourish it must be as economical as modern techniques allow and yet serve the scientist or engineer adequately. Also, the decentralized operation of such a system applied to a national system could be related directly to a national centre with regional information agencies covering the entire nation and with additional subsidiary units where necessitated by local conditions. Autonomous divisions of some large companies maintain their own information centres with text and graphical storage problems, fast-access requirements, redundancy of input questions. These are similar to the conditions faced in evolving a system that can link large national libraries to regional university and public libraries in an efficient network.

With this concept in mind, a search has been made for such an industrial information system now in operation serving a large number of divisions staffed with professionals of high calibre and widely diverse interests. This has led to the selection of the North American Rockwell Technical Information Processing System (Appendix H) as a possible model for an initial system that could be further developed to meet Canadian needs. Incorporation of on-line retrieval displays, time-shared among many users as in the Lockheed DIALOG system, could improve the system further.

The North American system ties together nine technical information centres and eighteen branches of the company in California, Ohio, Oklahoma, and Texas. It serves 100 000 employees of whom more than 15 000 are professional scientists and engineers. Diversity of disciplines is shown by products ranging from nuclear reactors and exotic power sources through micro-electronics, navigational instrumentation, aircraft, antennas, rocket planes, and engines for space vehicles. Additionally, the Space and Information Systems Division is prime contractor for the Apollo Project which involves all the life sciences as well as sophisticated engineering. One group in this division, Information Systems, does research and development of information systems techniques, and their experience has made possible the development of the TIPS system. Moreover, the Science Center, at Thousand Oaks, California, is a fundamental research laboratory active in the study of materials and phenomena at atomic and molecular level in four major fields: physics, chemistry, metallurgy, and mathematics.

It appears that a system such as this one, which was commercially developed and has operated successfully since 1964, has much to offer as a model. It is suggested that the best method of implementing a trial system in Canada is for an appropriate agency to contract for the design and operation of one or more pilot projects, with financing by the Government of Canada. The pilot projects could include some of the features and facilities incorporated in the North American Rockwell Corporation TIPS and the Lockheed DIALOG systems, but they would have to be designed to meet Canadian requirements for a specific region or selected group of users. They would also have to be capable of expansion.

It is the view of the subgroup that a national information service should be developed with systems in various disciplines, depending on the willingness of individual Canadian institutions to co-operate. Initially, a number of Canadian Government agencies could co-operate with each other and with industry in the design of a scientific information service backed by a clearinghouse to supply reports and information. Since universities house the best regional collections of information in Canada, proposals for making these resources available to all also merit support.

Of particular urgency is the establishment of information networks linking the main public, special, and university library services in Canada. A problem that now exists is that communication and interlibrary loan between libraries are on a permissive basis only. Although it may be known that information a user needs is available in a particular library, it may not be possible, because of a lack of administrative and organizational arrangements, for such information to be secured.

The establishment of industrial information centres which will locate information for industry is of prime concern. Many of these will be required for newly developing industries. Industries should employ information officers, trained to find information, to a greater degree than at present in Canada and they should be linked to a functional network.

Other Canadian institutions that might be included in information network planning are the public schools, the secondary schools, and the technical vocational schools. The Canadian public libraries now spend over $40 million a year in providing services to users in many Canadian communities. It has been estimated that in the larger urban centres from 10 to 20 per cent of the requests received at the public libraries are for help in technical, vocational, and home arts fields. This percentage is higher where specialized technical and scientific information resources are provided.

Section VII

STANDARDIZATION

VII.1 The Need for Standardization

It would be difficult indeed to imagine our present world without global communications. Few developments in the last 100 years can match in importance the emergence of communication utilities, first in telegraphy, then telephony, radio, and television. Now the enhancement of these existing services, together with the promise of even more sophisticated ones, is offered through the development of satellite communication channels. Despite the brilliance of these inventions, however, it is doubtful that any would have achieved world-wide use had not the problems of standardization been studied and solved. The development of advanced computer hardware and software has given us a powerful tool for the realization of international information networks. These must be viewed as a new form of information utility which, owing to their greater complexity, require a higher degree of standardization than the communication networks of the past and present. The latter could depend upon the versatility and intelligence of humans to correct errors in the system; when dealing with computers, very few errors can be tolerated without a high order of system inefficiency. To handle the vast flow of information, computer must talk to computer without difficulty, and this implies a depth of standardization in the preparation of material, hardware and software, that is unique in the field of international communication.

VII.2 Areas of Standardization

For information systems at all levels, from centres for international exchange through centres at national and provincial levels to the final user, three levels of standardization can be considered: (*a*) identical, (*b*) compatible, (*c*) convertible. It is obvious that standardization on identical equipment software and hardware and identical formats of input and output would offer the most economical information system. Except for the smallest systems, however, it is virtually impossible to achieve this level of standardization. It is likely that the compatible level of standardization, wherein systems may communicate one with the other despite the lack of identical hardware, is the best that could be achieved without an intolerable level of dictation. Even the compatible level of standardization is difficult to reach on a national scale so that most agencies striving for international standardization will, in all probability, merely attempt to achieve the convertible level. It is difficult to imagine an international exchange of information without even this minimum agreement. Countries participating in an information exchange network would be required to have facilities capable of supplying and receiving information in the format that is internationally accepted.

To ensure the development of a practical national information system with international exchange capabilities, standardization in a number of technical areas must be achieved.

(*a*) System input. Basic standards are needed to permit information to be recorded and exchanged on the accepted medium, such as magnetic tape.

(*b*) Standardization of Content Format. Standard formats are required for the key elements in bibliographic citations and such other information necessary for international identification as source, country or origin, and language. Such a format need not be used within a national system but should be the standard for information exchanged internationally.

(*c*) Standardized Indexing Terms. If many different systems are to use the same source tapes with a minimum of conversion, standards of keyword indexing and thesauri are needed, at least in the same discipline. This problem is made even more difficult by the fact that word meanings change and new words are added to the vocabulary periodically.

(*d*) Standardization of Programming Language. The use of a common, high-level programming language would ease greatly the problems of information exchange. However, it is too early to expect such a high degree of standardization while powerful languages are still undergoing development. Although admittedly expensive and inefficient, programming language differences can be accommodated. Efforts to reach the standardized language should be given priority.

(*e*) Hardware Interface Standardization. A great deal has already been accomplished in this field to allow equipment of different manufacture to function efficiently with various computers. In the early growth of such efforts, however, manufacturers played a prominent part, and international standards, although sometimes existing in these fields, have not been followed. Generation of such international standards and firm support of their use are essential if an international information network is to grow and flourish efficiently and economically.

(*f*) Influence of Hierarchical Level on Standardization. If, for purpose of illustration, a system is postulated having decentralized information centres in major cities, centralized cataloguing and indexing, and a single centre for international exchange, then standardization may vary with the level within this system. At the lowest level of the system which services the user, flexibility in hardware and software can continue to be permitted as it is vital to allow experimentation and evaluation at this level. As the degree of centralization progresses, standards must become firmer or costs and response times will increase quickly. At the international level it would seem to be essential that certain minimum standards exist.

Every effort should be made to achieve workable standards of format, content, and coding. Acceptable standards for dealing with the multiplicity of languages must also be achieved.

VII.3 Present Standardization Program

VII.3.1 International Organization for Standardization (ISO)

Various attempts are being made on both a national and an international basis to rationalize and standardize the various components of information systems. ISO, with headquarters in Geneva, Switzerland, is the leading world organization carrying out this work. Its object is:[49]

> ". . . to promote the development of standards in the world with a view to facilitating the international exchange of goods and services and to developing mutual co-operation in the sphere of intellectual, scientific, technological and economic activity."

To achieve these objects it may:

(1) Take action to facilitate co-ordination and unification of national standards and issue necessary recommendations to Member Bodies for this purpose;

(2) Set up international standards provided, in each case, no Member Body dissents;

(3) Encourage and facilitate, as occasion demands, the development of new standards having common requirements for use in the national or international sphere;

(4) Arrange for exchange of information regarding work of its Member Bodies and of its Technical Committees;

(5) Co-operate with other international organizations interested in related matters, particularly by undertaking, at their request, studies relating to standardization projects.

Of the many ISO Technical Committees now active, two have particular reference to information services and systems: ISO/TC-46 on Documentation deals with bibliographical citations, microforms, transliteration, and allied documentation matters; ISO/TC-97 on Computers and Information Processing is involved with standardization of terminology, problem description, programming languages, communication characteristics, input-output and physical (non-electrical) characteristics of computers and data-processing devices, equipments, and systems. The latter committee presently has eight subcommittees devoted to the following areas: vocabulary, character sets and coding, character recognition, input-output, programming languages, digital data transmission, problem definition and analysis, and numerical control of machine tools.

By the end of 1967, 15 ISO recommendations applicable to information systems had been published and a further 19 had achieved draft status. The subjects of these recommended international standards have included the material, content and layout of documents, abstract and microfiche standards, reference abbreviations, alphanumeric character sets for information processing, and standards for paper and magnetic tape coding. Additionally, both committees have under study a number of other important areas relating to microforms, patents, translations, numbering systems, directories and statistics, document classification, programming languages and communication characteristics of computers and data-processing devices, equipment, and systems.

Many of the basic standards required for the operation of international and national systems already exist in the program of ISO. They are recommendations only, however, and require acceptance by interested countries. It is imperative that these standards receive the support they merit.

Canada is represented in ISO by the Canadian Standards Association. Although Canada to date has not been represented at any plenary sessions, members of the CSA Specification Committee on Computers and Information Processing act as the Canadian Advisory Committee on ISO/TC-97. The CSA committee has also formed seven subcommittees corresponding closely in scope with those of the ISO/TC-97.[50]

VII.3.2 International Electrotechnical Commission (IEC)

The International Electrotechnical Commission is composed of the national standards organizations of 37 countries of the world and is also concerned with standardization in the field of computers and information processing. It has four subcommittees concerned with digital input-output equipment, digital data transmission, analog information equipment, and input-output media.

IEC Technical Committee No. 53 on Computers and Information Processing is most relevant to the work covered by this Study. Its objective is to prepare international recommendations for the electrical characteristics of computers and information-processing devices and systems including process control computers, machine-tool control computers, and others as developed.

The Canadian National Committee of the International Electrotechnical Commission (CNC/IEC) is the official channel of participation in the work of IEC by all organizations and persons in Canada, and operates under the auspices of CSA. The CSA Specification Committee on Computers and Information Processing is responsible for reviewing and approving standards issued by IEC in this area.[50,51]

VII.3.3 American Standards Association (ASA)

The American Standards Association in Washington, D.C., is a privately supported national organization acting as the clearinghouse and co-ordinating agency for voluntary standards in the United States of America. An ASA standard is a voluntary national standard, arrived at by common consent, and is available for voluntary use.

The ASA Sectional Committee X-3 on Computers and Information Processing has eight working subcommittees. They operate in such fields as optical character recognition, with tasks groups on font development, printing and applications, coded character sets and data formats. This committee has issued the American Standard Code for Information Interchange (1963). This standard presents the recommended coded character set to be used for information interchange between information-processing systems, communication systems and associated equipment, but does not define the means by which the coded set is to be recorded on any physical medium, nor does it include any redundancies. Furthermore, it does not define techniques for error control nor specify a standard collation sequence. The International Business Machines Corporation has stated that it plans to provide whatever means are practical to meet customer needs for using the standard code as soon as possible after media standardization is approved by the American Standards Association.

Further subcommittees of the ASA Sectional Committee X-3 are studying the problems of input-output media including a code for perforated tape and specifications for the physical dimensions of both one-inch and seven-sixteenths-inch perforated tape, codes for magnetic tape and punched cards, codes for both perforated and magnetic tape for numerical machine tool control, and specifications for the physical dimensions of half-inch magnetic tape and for the 80-column and 90-column punched card and edge-punched card.

Sectional Committee Z-39 of the American Standards Association covers library work and documentation. Its purpose is to develop standards for concept, definitions, terminology, letters and signs, practices, methods, supplies and equipment used in the field of library work and in the preparation and utilization of documents.[50]

VII.3.4 Canadian Standards Association (CSA)

The national clearinghouse and co-ordinating body for standardization in Canada is the Canadian Standards Association, Ottawa. Founded in 1919, it is a non-profit, non-government association of technical committees. CSA is the Member Body for Canada in IEC and in ISO.

The main function of CSA on the national level is to provide the machinery for the development of a uniform set of national standards, called Canadian Standards. In the international field, CSA's role is manifold:[51]

(1) It provides the means for establishing a representative Canadian viewpoint for international standards committee work and at other international standards meetings;
(2) It accredits Canadian delegates to ISO and IEC Technical Committee meetings through the respective Canadian National Committees on ISO or IEC;
(3) It provides administrative support and unified procedures for Canadian participation in ISO and IEC work;
(4) It provides financial support for the Canadian National Committees of ISO and IEC, neither of which has any independent source of income;
(5) It serves as a point of contact between Canadian industry and other nations in standards matters;
(6) It keeps Canadian industry informed of standards developments in other countries through its quarterly publication *CSA News Bulletin* and it maintains an extensive reference library;
(7) It keeps other countries informed on standards work in Canada.

Canada's policy and participation in ISO and IEC technical work are decided by advisory committees composed of experts who represent the industries concerned through their trade and technical groups. These are the corresponding committees operating under the CSA and Canadian Government Specifications Board (CGSB) procedure. Industry and government, therefore, decide whether

Canada will participate in an ISO or an IEC project. Through CSA they send delegates to the international meetings. These delegates keep the advisory group and CSA informed on all technical matters.

The CSA Committee most relevant to scientific and technical information handling is the Specification Committee on Computers and Information Processing,[50] which acts as the Canadian Advisory Committee on ISO/TC-97 and IEC/TC-53 as mentioned earlier. It has formed seven subcommittees to date dealing with character sets and codes, programming languages, problem definition and system analysis, French keyboard, data elements and their coded representation, punch paper tape, and remote communication. Committee members have reviewed many ISO documents and have submitted on behalf of Canada in a number of instances completed letter ballots of draft ISO/TC-97 recommendations indicating Canadian approval. The work of the committee is continuing and merits the support of the Canadian Government and of industry.

VII.4 Supporting Standardization Studies

There are many international, national, and private organizations supporting or influencing standardization studies in this field. The following are typical.

VII.4.1 Organisation for Economic Co-operation and Development (OECD)

The member nations of this organization have recently formed a working panel on Standardization for Information Transfer, and a preparatory meeting was held in Paris in December 1967. The agreed aim of this panel is to study the problems of standardization in elements of the system of information transfer in science and technology insofar as these raise issues for governments, and to recommend action to solve these problems. This will involve identifying priorities, measures for accelerating the application and establishment of standards, and anticipating the minimum technical constraints within which new systems must be designed to ensure compatibility.

VII.4.2 United Nations Educational, Scientific and Cultural Organization (UNESCO), International Congress of Scientific Unions (ICSU)

A panel has been formed co-operatively by UNESCO and ICSU to foster standards for an international scientific information system. The system envisaged may be extended to include technology. A meeting of this group was held in December 1967 in Paris, at which several committees were empowered to begin studies in critical areas of standardization.

VII.4.3 International Nuclear Information System (INIS)

This information system is organized by the International Atomic Energy Agency (IAEA), Vienna, and constitutes a very important service in the field of nuclear information. Its international stature means that the technical decisions taken in organizing this system may have a considerable effect on standardization. ISO recommendations are not followed in every instance, so that conversion to attain compatibility with other systems will be required. It must be emphasized that those responsible for planning information systems, both nationally and internationally, should take responsible action to study applicable standards to ensure compatibility of such systems with a minimum of modification and conversion programming.

VII.4.4 Library of Congress

The Library of Congress and the Committee on Automation of the Association of Research Libraries jointly sponsored in January 1965 a conference on Machine-Readable Catalogue Copy. As a result of this meeting, the Information Systems Office of the Library of Congress issued a report in June 1965 entitled "A Proposed Format for a Standard Machine-Readable Catalogue Record" (Appendix C).

Section VIII

RECOMMENDATIONS

The nation's store of information is in every sense a national asset – one of inestimable value when put to use. Information falls into several broad classes, takes many forms, and fulfills different functions, but it is universally needed at all levels of society and should be made equally accessible. It is vital to industrial growth, the life-blood of research and education, essential to government policy, and a source of pleasure and stimulation to the individual.

Population growth, higher educational standards, the increasing importance of research to national growth, and the economies produced by modern technology have all generated an ever-increasing flood of information. Traditional library methods can cope with its storage but can offer little hope of speedy retrieval without the assistance of electronic computers. As these find increasing use in the information field, an increasingly apparent relationship with educational television and computer-assisted teaching will become evident. These new methods of instruction will form part of the future systems of education and may well share common communication and terminal facilities with the systems for information retrieval. Standards must be introduced to ensure interprovincial and international compatibility without stifling desirable development.

Responsibility for Access to Information

Canada at this time is largely a user of information published elsewhere and hence is very dependent on abstracting, indexing, and documentation services produced in other countries. Existing directives of the U.S. Government are indicative that serious constraints may be placed on the present almost unlimited flow of scientific and technical information from government sources. In the interests of economy and to avoid useless duplication, only one copy of certain material will be provided to a nation by the U.S. Government in the future, and internal distribution will become the responsibility of the recipient. Centralization of intergovernmental information handling between countries will thus become inevitable and steps should be taken to prepare for its introduction. Many institutions and agencies in Canada have expressed concern and are prepared to participate in the development of national plans for more effective utilization of information. In future years the producers of information services outside of Canada will need to know to whom they should turn for the supply of the Canadian information for the specialized services they offer. It is likely that such demands will be made on Canada from the United States, Great Britain, France, U.S.S.R., China, and other major producers of information services.

Consideration by the subgroup of the important changes taking place in the techniques and sources of information available to government, industry, and education, and the growing need for common standardization and more efficient administration has led to the recommendation that:

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.

Federal Government Responsibility

To derive maximum benefit from the wealth of information within and abroad, Canada should invest considerable human and financial resources in a national system for information retrieval by electronic means. The most sophisticated information system will fail unless the material it is designed to process is coded and indexed consistently, compatibly, and in sufficient depth to satisfy all anticipated uses, both nationally and internationally. This cannot be achieved without highly effective, centralized guidance, agreed objectives, adequate financial support, and a spirit of co-operation at all levels of operation.

It is therefore recommended that 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 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.

Responsibility of Specialized Information Centres

In common with most countries, Canada has demonstrated leadership in certain areas of research and in particular fields of manufacturing and natural resource development. Often these abilities and the data banks they nourish are regional and local and could readily form a sound base of specialized information centres or centres of excellence. Some might become specialized world data centres as international information exchange develops. This would be a progressive development as needs are identified and user requirements render it feasible and economic.

It is therefore recommended that the formation of advanced 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.

Role of Computer-based Information Networks

The subgroup considers that the objective of supplying complete, relevant, and timely information to all users in Canada, with the greatest speed and the minimum cost, can best be met by the systematic introduction of modern, computer-based information handling techniques and the most efficient use of appropriate communication channels.

A single centralized information system to serve local users across Canada does not appear practical. Rather, a national information network must evolve from the linking of regional sub-networks of libraries and information centres or local systems which are highly user-oriented and have gained user acceptance. This can only be achieved efficiently through early standardization of the minimum constraints necessary for the regional, national, and international interchange of publications and their surrogates.

As yet there is little experience in Canada with computer-based information networks, although several successful applications of computers in local systems have been reported. In order to introduce the use of advanced information network practices and to encourage the training of information specialists in Canada, the subgroup recommends that:

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.

Responsibility for Access by English- and French-speaking Users

Language used within the system need not present a major problem. It would be most logical to allow the enquiry to be phrased in the language of the user's choice, but original documents should be stored in the form provided.

The subgroup recommends that special efforts be directed to the development of compatible information systems for French-language scientific and technical information to reduce to a minimum reprocessing and duplication between French and English services.

Responsibility for Establishment of Communication Services

It must be emphasized that a national computer-based information network is vitally dependent on its communication links. The transmission of information between information centres, or between libraries and users, can usually be delayed a little without serious consequences, so steps may be taken to employ communication services more efficiently than is commonly possible.

The development of educational television networks will enrich the curricula of students in schools and make possible the continuing education of adults at home. One major source of information for the educational television network and for computer-assisted teaching systems could well be the scientific and technical information network. In the same way, cable television to the home and school could become a vital link in the information network.

In the geographic region within which coaxial cable connection is feasible, the wide bandwidth available will permit larger retrieval volume so that batch processing of information enquiries may suffice. Where communication costs are high and bandwidths narrow, on-line, time-shared, interactive terminals will be necessary to permit the definition of the exact needs of the user more accurately and so avoid the high cost of transmission of unnecessary data.

International communication satellites and the related domestic cable land networks hold promise for the reception of signals of any reasonable bandwidth anywhere in Canada without cost differentials. The delay factor in satellite communication, while of some significance in voice communication, is of no consequence to the unidirectional transmission of information or educational television signals. Since educational and information retrieval applications of networks have many common features, the subgroup recommends that:

> **Consideration be given to the possibility of employing common facilities wherever practical to service both information and educational networks.**

Responsibility for Rapid Dissemination of Federal Government Information

It was made evident to the subgroup through discussions and briefs submitted by many agencies that the announcement and distribution of Canadian Government report literature and that available from other internal sources leave much to be desired.

> **It is recommended that a federal clearinghouse facility be established to undertake the announcement and distribution of government reports.**

Development of Techniques for Selective Dissemination of STI

The information needs of the research specialist in any discipline are the simplest to meet, for his field of interest is small, the number of documents of interest is limited, and he can define exactly the details of his request. The situation in industry is generally quite different. Here the range of interest encompasses many disciplines and trades, the publications are numerous and widely dispersed, and it is difficult to specify the requirement with any accuracy. The provision of an information network does not, in itself, guarantee its usefulness to the industrial user who needs it most. Scientific and technical information must be unearthed from the vast output of publications and presented in the manner most useful to the individual user. The Technical Information Service, such as the National Research Council provides, offers one answer, but this service can benefit greatly from the systematic cross-checking of all published titles and abstracts against the individual or group profiles of interest stored in a computer. Such a system of selective dissemination of information is gaining wide acceptance outside of Canada and is an essential part of the information sources and techniques considered by the subgroup. It is considered so important that the subgroup recommends that:

> **Special attention be given to the problem of providing selective dissemination of information in any national or regional information network program.**

Publication of Scientific and Technical Information

Fast retrieval and selective dissemination procedures are of little value if the initial report or journal publication is unduly delayed. Publication time can be reduced by the use of computer typesetting and photoreproduction.

> **It is recommended that experimental programs be initiated involving computer typesetting and photoreproduction of a number of Canadian scientific and technical journals.**

Copyright

The subgroup is aware of the great concern expressed by many users about the need for revision of legislation governing access to materials produced by modern photocopying processes and electronic computer duplication.

> **The subgroup recommends that the matter of copyright requires study, and early attention should be devoted to it.**

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Appendices

Appendix A

SELECTED INFORMATION AND DATA SYSTEMS AND SERVICES IN CANADA, IN-BEING OR PROPOSED

The following 35 selected Canadian non-conventional information and data systems, mainly in the fields of science and technology, have been chosen as illustrations of some of the present activities in Canada in the use of machine methods for information dissemination. They exclude systems that employ hand-sort cards, microforms, and similar non-computer-based techniques. The subgroup has not attempted to collect information on all of the computer-based scientific and technical information and data systems and services now functioning in Canada. The number of these is growing steadily. Information concerning some of them was secured from the visits made by members of the Study Group and from the briefs which were presented to it. The following outline of existing and proposed systems has been prepared as a guide for later investigation. At some future date an annual review of computer-based information systems and services operating in Canada should be made and kept up to date. A useful review of mechanization in Canadian university libraries was published in 1967.[52]

Systems Developed by the Federal Government

This list does not include projects for the computer handling of internal data files of libraries in the fields of acquisitions, serial control, cataloguing, etc. Such projects are being carried on with increasing frequency.

Department of Energy, Mines and Resources, Geological Survey Branch

An operational computerized data file (GEØDAT) is maintained which makes available results of analytical tests produced by the branch's laboratories. It is planned to make this information available to the public in a form processable by computer. A proposed National Index to Geological Data is funded by the Geological Survey Branch and utilizes such efforts as the computer-assisted information activities of Imperial Oil's Western Producing Region. Other areas in which the branch is interested are an Aeromagnetism file, a Rock Magnetism file, and a Canadian Isotopic Age Data file.

Defence Research Board

The Defence Scientific Information Services (DSIS) of the Defence Research Board provides reports dealing with research and technical innovation to the Department of National Defence (DND), the Defence Research Board (DRB), grantees and holders of contracts with DND. Thirty thousand documents were processed in 1967, of which 18 000 were microfiche, the remainder hard copy. It has set up a central document service utilizing information standards, and a machine programming language that is compatible with the various other establishments of the Defence Research Board. The information service has an accumulated holding of 350 000 documents. Descriptive bibliographic citations for documents in hard copy have been entered into the DSIS machine-readable data base since January 1, 1967; bibliographic citations and abstracts have been included since January 1, 1968. Catalogue cards for 1968 accessions are generated automatically by computer programs; documents with no restrictions on their circulation are announced in a weekly accession list containing descriptive bibliographic information in accession number order and indexed by keywords. On-line entry of bibliographic information is being planned, and the feasibility of a national defence information network is being studied. Magnetic tapes containing edited and classified bibliographic data are available for the use of qualified users as well as programs written in FORTRAN for processing the data.[53]

Department of Forestry and Rural Development

(*a*) Canada Land Inventory System.[54] The Inventory contains a description of the current use of the settled land in Canada along with evaluations of land-use potential for forestry, agriculture, wildlife, and recreation. The geographically indexed information is derived from over 30 000 interpreted map sheets. Each map, traced by expert aerial photograph interpreters, records the boundary lines that separate land areas of different usage classifications. Land areas are interpreted and traced independently for each of the general land usage categories. In 1965 a contract was awarded to IBM to develop the necessary map-scanning hardware and programming techniques, and to devise a suitable file organization. In 1967 a specially developed drum scanner was installed and the two-year task of interpreting and converting the basic map coverage of the inventory is in progress. The system is programmed for the most part in PL/1 language and operates on System/360 computers.

(*b*) International Tree Disease Register (INTREDIS). Citations from standard services, such as *Forestry Abstracts, Biological Abstracts, Review of Applied Mycology,* dealing with tree diseases, are placed in a computer store for later retrieval.

National Research Council, National Science Library

(*a*) *Union List of Scientific Serials in Canadian Libraries.* The main purpose of this computerized title store is to serve as a national reference tool for efficient interlibrary loan service. An initial printout was published in two volumes in 1967. The system provides for frequent updating and the possibility of publication of new editions, selection by individual library or region, a variety of output formats in upper and lower case, and a number of program-generated error detection methods.

(*b*) Current Awareness Program. The National Research Council's present selective dissemination of information program using *Chemical Titles* on tape will accept as input a series of terms (currently 2 500 for 70 scientists) which are matched against a master file of titles of articles, and prints those titles for which a match is found. The terms consist of authors' names, journal identification, groups of words, single words, each of which may be weighted in a logical manner. The terms are stored in groups, each of which represents a question asked about the titles in the master files. A similar service has begun for ISI tapes, and work is in progress to write programs capable of accepting other tape formats, e.g. NASA, MEDLARS.

(*c*) Serial Publications in the Library. A file of approximately 12 500 serials stored on magnetic tape is updated and listed twice a month. Added coding permits a variety of selective outputs, e.g. listing by subject (Library of Congress classification), country of origin, language, type of publication. Unlike the union list, the serials tapes may be searched for a maximum of 60 subjects in addition to the other bibliographic constraints indicated. It is intended for internal use rather than national distribution.

(*d*) The Current Periodicals Daily List informs scientists at NRC of the current issues of approximately 1 500 selected journals received by the library on the previous day. Each day, identification numbers of the journals received are put into the computer where they are matched against a store of identification numbers with titles. When a match occurs, full titles associated with the identification numbers are printed repetitively under the different subscriber addresses also stored in the computer.

Systems Proposed for Development by the Federal Government

Department of Energy, Mines and Resources, Marine Sciences Branch

A marine science information system is being developed based on Canadian oceanographic data held by the branch. Other services of the department contemplating or involved in computer-based data files are the Observatories Branch, the Surveys and Mapping Branch, and the Water Research Branch.

Provincial Government Systems

Saskatchewan Government Well Data File

This is a source of data on drilling work recorded in the province.

Saskatchewan Research Council

The literature of potash is processed using the computer-assisted Science Information Service developed by Imperial Oil Limited's Western Producing Region (see below).

Alberta Government Well Data File

The Alberta Conservation Board maintains computerized information on 30 000 wells drilled in Alberta.

Ontario Department of Mines

The department has started to compile data files on metal deposits of the province, in particular on silver. Data on 10 000 oil and gas wells are available.

Ontario Institute for Studies in Education (OISE)

A system of storing and distributing educational research information of interest to Canada, known as CEDRIC, has been begun by the institute.

Universities

As noted earlier, this Appendix does not include those computer systems that are concerned solely with the mechanical handling of a library process such as acquisition and cataloguing of documents, unless these are related to methods of retrieving information.

University of Manitoba

Bibliographic Control of Water Resources Literature. *The Water Resources Thesaurus,* a vocabulary for indexing and retrieving literature dealing with research and development on water resources, published by the Office of Water Resources Research of the U.S. Department of the Interior, was selected as a subject authority list for the project. It is designed specifically for use in the United States and most of its geographic subdivisions are American but, as work progresses, it will be possible to add Canadian geographic subdivisions. Access to the system will be by two methods: (*a*) printed list, showing all holdings, and (*b*) direct access to the data by means of a cathode ray terminal. In addition, the Computation Centre has made plans for the development of the following computer-based systems:

(1) Hospital Information System
(2) Canadian Criminal Code System
(3) Winnipeg School Board System.

University of Guelph

The library maintains a special computer-based system for organization and control of government publications and research reports. Access to the documents is through personal or corporate author, series, title, serial title, report or contract number catalogues.

University of Toronto

(*a*) An experiment of selective dissemination of information to faculty members using *Chemical Titles* on computer tape (Appendix B) was carried out in 1968.

(*b*) MARC II Project. The library was a participant in the Library of Congress MARC II Pilot Project [55] (Appendix C).

(*c*) GESTAR. This experimental system of storing and retrieving bibliographic information is being developed by the Department of Geology with the aid of research grants from the National Research Council. At present, the file contains over 1 400 items referring to minerals that include one or more alkali halides. These items in some cases date back over 75 years.

Université Laval

Documentation Centre for Automatic Location of Information, Québec. This Centre has pioneered in the development of various uses of machine systems. Laval's ASYVOL system (*Analyse synthétique par vocabulaire libre*) is used to produce *Index Analytique,* an index to 60 current periodicals in the French language beginning in January 1966. The same system has been used for *Le Devoir,* a daily index, since January 1966, *Cahiers de Géographie du Québec,* and the *Canadian Historical Review,* 1950-1964.

Industrial, Commercial, and Municipal Services

Computer-based information systems are being utilized in Canada by commercial and industrial firms and municipal services. Among such systems are the following.

Pulp and Paper Research Institute, Montreal

In March 1965, the institute prepared on computer and published the first edition of the *Thesaurus of Pulp and Paper Terms,* designed to assist individuals and organizations to maintain current files of information in this field.

Atomic Energy of Canada Limited, Chalk River

A KWIC index to technical memoranda was introduced in 1967. It is issued on a monthly basis with cumulation at six-month and one-year intervals.

Northern Electric Company Limited, Ottawa

(*a*) Index of papers and talks by staff of the research and development laboratories.

(*b*) Index of technical memoranda. This index consists of four sections covering authors, titles, departments, and numerical listing.

(*c*) Technical Report Bulletin. The computer is used to compile the KWOC (Key Word Out of Context) index for the Bulletin.

The Financial Post Data Bank, Toronto

The contents of various files of published Canadian corporation documentation are available on a computer time-sharing basis.

Imperial Oil Limited, Technical Information Services, Calgary

A machine system has been developed to produce a co-ordinate index to the literature of petroleum relevant to the company's interests.

Canadian Industries Limited, Central Research Laboratory, McMasterville

Systems have been developed for literature searching and book catalogue production.

International Nickel Limited, Metallurgical Laboratory, Falconbridge

Computer services are used to produce a KWIC index and for retrospective literature searching.

Alberta Experimental SDI Association, Edmonton

An incorporated group was formed in Edmonton to undertake a selective dissemination experiment using the *Basic Journal Abstracts* of the CAS (Appendix B).

Canadian Case Law Research Limited, Edmonton

This system has been developed by Mr. Keith Latta and deals with judgments in cases from federal and provincial Supreme Courts.

Toronto Public Library, Toronto

The Toronto Public Library is engaged in two projects in the area of information systems utilizing computers: (*a*) an investigation of the use of computers for updating and printing out locations of material held in over 65 libraries in Metropolitan Toronto, and (*b*) the use of indexes and abstracts in magnetic tape form for public reference use. The library uses *The Engineering Index* tape service, Electrical/Electronics Engineering file, in connection with the latter project.

Appendix B

AMERICAN CHEMICAL SOCIETY–CHEMICAL ABSTRACTS SERVICE, COLUMBUS, OHIO

The American Chemical Society in 1961 became concerned with the growing cost and complexity of the production methods for publishing and printing its scientific journals. The adoption of a computer-based system for the preparation of *Chemical Abstracts* has introduced difficult problems. Such problems deal with chemical symbol notation, file arrangement, etc. However, a machine production method of great complexity for the publishing of a variety of chemical journals of the society has been evolved. There are now available, in addition to the printed publications, a number of files on magnetic tape which can be used as sources of chemical information.

The following machine-readable resources are available or will be available in the future from the society, in addition to its printed publications.

(*a*) *Chemical Abstracts* on magnetic tape. These are provided in two services: *CA Condensates* and *Basic Journal Abstracts.* The former includes titles, authors' names, journal and patent references, and keywords. The latter consists of abstracts published in *Chemical Abstracts* and taken from a selected list of chemical journals. The tape series are provided every two weeks. To utilize the tapes, search programs for the IBM 1401 or Systems/360 computers are provided along with the necessary documentation. Searches may also be carried out by Chemical Abstracts Service at Columbus, Ohio, and the results supplied by mail. The present yearly subscription prices for these services are $5 000 for both *CA Condensates* and *CA Basic Journal Abstracts,* or $4 000 for either one of these alone.

(*b*) *Chemical Titles.* This is a biweekly publication listing the titles of all articles in some 650 chemical publications arranged by a computer program in alphabetical order of each of the important words of the title. In each entry the accompanying words of the title are shown. This uses a computer program known as KWIC (Key Word in Context). The titles are also available on magnetic tape together with a computer program by which the tape may be searched against a profile of interest. The National Science Library, Ottawa, and some Canadian universities are experimenting with this service.

Cost of the service is $1 500 a year, plus the cost of duplicating the data base onto tapes provided by the subscriber. Custom searches of *Chemical Titles* may be performed by Chemical Abstracts Service on each of the tapes issued during the year and the search results sent to the subscriber. The subscriber pays the cost of computer search operations in addition to the subscription fee. *Chemical Titles* one-time custom searches are provided for $200. This fee includes a search of tapes issued in 1967 and 1968. Tapes issued before 1967 may be searched for an additional fee of $50 for each year. The file dates from January 1962. The user pays the cost of computer search operations in addition to the search fee.

(*c*) *Chemical-Biological Activities (CBAC).* *CBAC* offers fast, in-depth coverage of published work concerned with the interaction of organic compounds (drugs, pesticides, etc.) with biological systems (man and other animals, plants, microorganisms, etc.). Included also are metabolism studies and studies of in vitro chemical reactions of biochemical interest. Nearly 600 journals are monitored regularly for papers to be included in *CBAC.* Many are received in proof form, thus enhancing currency. An informative digest is prepared for each paper selected, and this is printed along with the title, names of authors, and bibliographic citation. An issue of *CBAC* is published every two weeks. Each digest is indexed by subject, names of authors, and molecular formulas. The issue indexes are cumulated at the end of a six-month volume period. During 1968 approximately 18 000 papers will be covered, compared with 16 000 papers covered in 1967.

Individual scientists may subscribe to *CBAC* for $100 a year but the price for non-personal subscriptions is $1 000 per annum. Supplementary subscriptions for non-personal subscribers to the service are $35. A one-year subscription to *CBAC* on magnetic tape and in printed form costs $1 600.

All digests, titles, authors' names, and bibliographic citations published in the printed issues of *CBAC* are recorded on magnetic tape. The tapes may be searched by computer to prepare custom bibliographies for a number of scientists at one time. They can then read the digest in the printed issues of *CBAC* or go directly to the primary journals.

(*d*) *Polymer Science and Technology (POST).* This service was introduced in 1967 and provides digests of papers from 400 journals and patents from 20 countries in the polymer field. The digests are prepared by the staff of Chemical Abstracts Service and appear within two to three weeks of publication. The data are available on magnetic tape as well as printed form.

POST is published in two sections – *POST-J* (journals and reports) $1 200, and *POST-P* (patents) $1 000 a year, combined subscription $2 100. Beginning in 1968, individual scientists may subscribe to *POST-J* and *POST-P* for $100 a year and receive a copy of each biweekly issue. *POST* on magnetic tape costs $1 700 for *POST-J*, $1 500 for *POST-P*, and $3 100 for both. Each issue contains the digests plus a Keyword Subject Index, Molecular Formula Index, and Author Index. *POST-P* also contains a Numerical Patent Index. Additionally, a Keyword Index to related material (bio-polymers) abstracted in *Chemical Abstracts* is published in each issue of *POST-J* and a Patent Concordance is provided in *POST-P.* Every six months the issue indexes are cumulated, merged, and re-issued as indexes to the complete volume.

Appendix C

U.S. LIBRARY OF CONGRESS PROJECT MARC

In 1965 the desirability of a centralized distribution service for machine-readable cataloguing records was discussed at several meetings attended by representatives of research libraries in the U.S.A. It had become apparent that in a growing number of libraries computers were being utilized, each performing similar conversion operations to transform catologuing records (often identical) into machine-readable form but using different formatting schemes and system details. At these meetings, there was unanimous agreement that the Library of Congress (LC), as the largest library and the recognized centre of U.S. cataloguing activity, should take the lead in establishing standards for computerized library activities as soon as possible. The first essential step would be to decide upon a machine format.

In June 1965, a preliminary report was completed in the Information Systems Office, in which a proposed format for distributing bibliographic records was described and many of the problems presented by such a format were discussed. For long-range LC requirements the format must accommodate many other purposes in addition to the basic function of producing catalogue cards or book catalogues for use outside the Library. For example, it must be capable of handling input data suitably tagged for computer-controlled printing, of permitting retrieval of information in various ways from a large electronic store, and of facilitating preparation of special bibliographies. The objective was to serve, with a single input keying, several LC purposes as well as the distribution of cataloguing records. A preliminary general-purpose format has been created which, because it is planned for use in a large and varied environment and therefore has an "open-ended" design, should satisfy the requirements of other libraries.[56]

A grant of $130 000, approved in December 1965, covering costs of preparations and programs, as well as a study of the feasibility of a full-scale distribution service, was received from the Council on Library Resources. In February 1966 a contract with the United Aircraft Corporate Systems Centre was let, which provides for the contractor to assist staff members of the Information Systems Office in planning and programming of the MARC Pilot Project (MAchine Readable Catalogue).

The records provided by LC have covered works of the type normally reported in *Publishers Weekly.* The works catalogued were in English. The format of the MARC Record is divided into two parts: a fixed-field part and a variable-field part. In the fixed field, the location and number of characters of each entry will be constant.

Beginning in September 1966, each of 16 libraries, including that of the University of Toronto, received on a weekly basis a reel of magnetic tapes containing cataloguing records for current 1966-67 imprint monographs in English, which averaged about 600 titles weekly. The cataloguing records on each week's tape were cumulated and accompanied by name and subject cross-reference information. Participating libraries received two printed lists, one arranged by LC card number and the second by author and title to show card number. Furthermore, computer programs were furnished participating libraries enabling them to select desired data from the tapes and print lists or to generate and print catalogue cards.

An important aspect of the MARC experiment was the reports by participating libraries, which recorded their experiences under operating conditions and fowarded to LC their suggestions and comments. The experiment and separate long-range studies are expected to result in an improved MARC system providing better input procedures, expanded data selection, and possible service to a larger number of libraries. A new tape format, MARC II, based on reports from the participating libraries and the Library of Congress's own experience has been published.

In October 1968 the Library of Congress proposes to make available catalogue data in machine-readable form for English-language monographs on a subscription basis. By 1972 it is expected that all current descriptive cataloguing of literature can be produced in machine-readable form.

To develop a comprehensive systems program, the Libray of Congress is entering into arrangements with the major producers of bibliographic records in other countries. It is expected that these countries will take responsibility for the production of their own bibliographical material and provide it in a machine-readable form compatible with the MARC format developed by the Library of Congress. The Library of Congress is also attempting to secure compatibility between its format and that used by other large specialized American institutions, such as the National Agriculture Library and the National Library of Medicine. There will be certain divergencies from a single standard because of the need for each institution to relate its printed production of catalogues to its machine-produced records. However, it is expected there will be some agreement on a basic set of common programs among the major users of the MARC machine-readable format.

It is likely that other large libraries which use MARC machine-readable tapes will need to reformat and process material to meet their own needs. This same problem of reformatting is presently carried on by libraries now utilizing standard Library of Congress printed bibliographic catalogue entries. Machine processing rather than human processing may avoid the present personnel costs to each institution, which are very high. The use of the MARC tapes will ensure that any library moving towards mechanization of its entire processes has some degree of confidence that a standard bibliographic entry in machine-readable form will be available.

Early in 1965 an experiment was conducted, co-operatively between the Information Systems Office, the Government Printing Office, and the LC Data Processing Office, which demonstrated the technical feasibility of using photo-composition equipment to print LC catalogue cards from machine-readable copy prepared according to the format described in ISS Planning Memorandum No. 3. This experiment followed similar work done by Lawrence Buckland[57] under a grant from the Council on Library Resources, Incorporated, in which similar results were obtained, using different printing equipment and different computer input formats. A more complete test of this capability is planned, utilizing magnetic tapes formatted according to the latest MARC standard and newer computer-controlled printing equipment.

To produce the seventh edition of LC's *Subject Headings,* compiled by the Subject Cataloguing Division, the Government Printing Office is using machine-readable records and computer-controlled photocomposition equipment. Although the objective of this project is to expedite the production of subsequent editions of the list and its supplements, interesting by-products are expected to result from availability of the set of magnetic tapes for analysis by computer.

Appendix D

U.S. CLEARINGHOUSE FOR FEDERAL SCIENTIFIC AND TECHNICAL INFORMATION, WASHINGTON, D.C.

The U.S. Clearinghouse for Federal Scientific and Technical Information (CFSTI) is a distribution agency for unclassified reports. It produces *U.S. Government Research and Development Reports (USGRDR)* which contain abstracts of these reports. It also makes available the text of abstracts on magnetic tapes, as well as the *Government-Wide Index to Federal Research and Development Reports (USGWI),* and a translations announcement journal.

One of the main parts of the CFSTI collection is the report literature from the Defense Documentation Center (DDC), consisting of unclassified reports from military organizations and defence contractors. CFSTI acquires only scientific, technical, and engineering reports resulting from efforts supported by federal funds. Depending on the treatment given at the source agency, a report may be re-analyzed for CFSTI cataloguing, and the material provided may be reviewed or modified as appropriate to conform with CFSTI formats. Reports are available on microfiche or microfilm and as hard copy.

CFSTI distributes scientific and technical information published by the U.S. Government Printing Office (GPO) for other agencies, acting as a bookseller at the prices assigned by the GPO. CFSTI prepares bibliographies on a contract or fee basis. It also initiates certain bibliographies that may be considered to be price lists or secondary announcements of comparatively popular subject areas.

The current annual rate of translations and foreign reports received is over 2 500. CFSTI also announces and indexes over 20 000 patents per year which are of interest to industry.

USGRDR is produced by computer from machine-readable records generated by the Atomic Energy Commission (AEC), National Aeronautics and Space Administration (NASA), Defense Documentation Center, and the Clearinghouse for Federal Scientific and Technical Information. The computer programs reformat tape records previously used for the preparation of NASA's *Scientific and Technical Aerospace Reports (STAR).* The tapes are made compatible with the standard CFSTI tape format, and codes to produce upper- and lower-case text are inserted according to a set of program rules. The converted NASA records are merged with the data entered into the CFSTI system on punched paper tape, and further manipulation of the combined data produces *USGRDR* and *USGWI*. In the near future, similar computer conversion will be applied to data supplied by the Atomic Energy Commission for AEC-generated reports previously announced in *Nuclear Science Abstracts. USGRDR* is published semi-monthly by the CFSTI. The annual subscription is $30 ($37.50 foreign), and a single copy, $2.25.

With few exceptions, reports announced in *USGRDR* are available from the CFSTI or from any U.S. Department of Commerce field office. Hard copy and microfiche are supplied on request. When reports are announced as being available from an organization other than the Clearinghouse they are to be ordered from that source. All entries in *USGRDR* are indexed in the *USGWI* published semi-monthly and sold on subscription by the CFSTI at $22.50 a year ($27.50 foreign). Indexing terms from recent issues of announcement journals of the Atomic Energy Commission, National Aeronautics and Space Administration, and the Defense Documentation Center are also included in this index to provide a single reference guide to new, unclassified government-sponsored research and development in the physical sciences, engineering, and related technology.

A *Fast Announcement* Service was established in 1964. Its purpose is to inform scientists, engineers, and managers of the availability of new research and development reports having wide industrial interest and application. The reports are classified in 57 categories which may be subscribed to separately. There are 20 000 users on the mailing list.

Appendix E

U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, SCIENTIFIC AND TECHNICAL INFORMATION PROGRAM

The National Aeronautics and Space Administration (NASA) of the United States was established in 1958 under the authority of the National Aeronautics and Space Act. This Act provides for the widest practical and appropriate dissemination of information concerning NASA and the results of its work. Such dissemination is directed to research scientists on the one hand and to industry on the other.

Part of the information function is provided through two organizations: the NASA Scientific and Technical Information Facility, Washington, D.C., which has been operated by contract arrangements since 1962 under the direction of NASA's Scientific and Technical Information Division; and the American Institute of Aeronautics and Astronautics (AIAA), Washington, D.C., whose technical information service has been partly supported by NASA since 1963. Another part of the information function is the NASA Technology Utilization Program, which is specifically directed toward industry.

A variety of publications, services, and special techniques have been utilized in carrying out these programs.[58] The principal publications are the semi-monthly abstract journals *Scientific and Technical Aerospace Reports (STAR)*, and *International Aerospace Abstracts (IAA)*. The former is concerned with report literature, while the latter deals primarily with abstracts of articles in scientific and technical periodicals. Other publications for industry are *Technology Utilization Reports, Technology Utilization Compilations,* and *Tech Briefs.* The latter describes devices and techniques believed to be novel and to have potential use elsewhere in science or industry.

A further development has been the publication of *Selected Current Aerospace Notices (SCAN)* which provides users with speedy notification of the latest aerospace reports and articles on specific subjects.[59] The SCAN program is an effort to assist the individual scientist or engineer in selecting those sources of information most relevant to his interests and most likely to contribute to the progress of his work. Use of this service has been found to be more effective than use of abstract journals in some cases.

The objective of all of NASA's scientific and technical information work is to emphasize the value of information and the importance of local access. Timeliness in the acquisition, announcement, and distribution of information has high priority from the NASA services, as does co-operation with other information systems to improve services and reduce costs. Centralization of information storage and processing has been adopted only where efficiency and economy have resulted. NASA recognizes that a variety of services is necessary to meet the multiple needs of the thousands of scientists and technicians at work in this field in the United States.[60]

NASA regularly distributes reports in the form of microfiche to 200 agencies and firms, including Atomic Energy of Canada Limited, Chalk River, and the library of the National Aeronautical Establishment, Ottawa.

There are abstracts of approximately 400 000 technical reports and articles in the NASA machine-readable files at the Technical Information Facility, and this number is growing at a rate of approximately 9 500 items per month. Of these items, approximately 130 000 have been issued since 1961 in *International Aerospace Abstracts,* and a similar number in *Scientific and Technical Aerospace Reports.*

NASA's services include conventional computer searches at regional dissemination centres throughout the United States, person-to-person transfer of information with Technology Utilization Offices, and a number of experimental SDI services. In addition to handling requests for information at the Scientific and Technical Information Facility, Washington, NASA has made the computer tapes and the necessary computer programs available to a number of organizations so that they may fill regional and local requests for information as required.

The regional dissemination centres which NASA has helped to establish include the following:

Aerospace Research Applications Center (ARAC)
Indiana University Foundation
Indiana Memorial Union
Bloomington, Indiana

Western Research Application Center (WESRAC)
Graduate School of Business Administration
University of Southern California
Los Angeles, California

Knowledge Availability Systems Center (KASC)
University of Pittsburgh
Pittsburgh, Pennsylvania

Center for the Application of Science and Technology (CAST)
Wayne State University
Detroit, Michigan

New England Research Application Center (NERAC)
University of Connecticut
Storrs, Connecticut

Technology Application Center (TAC)
University of New Mexico
Albuquerque, New Mexico

Technology Use Studies Center (TUSC)
Southeastern State College
Durant, Oklahoma

North Carolina Science and Technology Research Center (NCSTRC)
Research Triangle Park
Durham, North Carolina

Project ASTRA
Midwest Research Institute (MRI)
Kansas City, Missouri.

NASA provides information directly to its own establishments and to manufacturers engaged in work for NASA. Approximately 35 000 document requests are received each month. In addition, it carries out an extensive program designed to make the results of the new engineering and design skills developed as a result of its activities available to industry. Special attention is given to identifying, documenting, and reporting on such new technology.[61]

A $200 000 contract has recently been awarded to Information Dynamics Corporation to design and install an electronic data-processing system in the technical library of the Cambridge Electronic Research Center of NASA. The first phase of the three-year project will include development of machine-readable bibliographic master records which will allow periodic production of printed reference lists. Later phases of the project will include design, installation, and operation of systems for handling acquisitions, cataloguing, circulation control, serial records control, and statistical records. The Electronic Research Center is part of a planned $60-million NASA complex being established in Cambridge, near the Massachusetts Institute of Technology.

NASA has pioneered in a number of other experimental projects designed to test newer methods of information handling. An SDI service which had 800 group-users and a relevance ratio of 72 per cent (with 95 per cent feedback from the users) was discontinued January 1, 1968. Descriptive bibliographic information for documents in the fields of interest (defined by descriptors) of the users was sent out, along with order forms for the documents. To reduce the cost, this centralized system was discontinued in favour of a broader dissemination into predetermined interest categories. NASA also experimented with on-line searching using remote display consoles in a system designed by Bunker-Ramo, California, in 1966. The system, known as NASA-RECON, was found to be very attractive to users though they had many criticisms. It was very expensive. The console displayed portions of the thesaurus to aid the user in constructing search logic, but was limited in flexibility and in the logic available. If it was discovered that the search strategy being used was unsatisfactory, it was not possible to retrace more than one step and the search had to be reinitiated. In addition, computer response was often delayed beyond the tolerance of the user and, although a search could be completed within two days using RECON against a total elapsed time of several weeks when the request had to be relayed to the centre where batched searches were carried out, this delay was found to be intolerable.

Appendix F

U.S. NATIONAL LIBRARY OF MEDICINE

Since 1964, the National Library of Medicine (NLM) has been developing a computer-based system for the processing of medical information, known as MEDLARS. MEDLARS is the acronym for the Medical Literature Analysis and Retrieval System. This system indexes all articles appearing in some 2 400 medical journals from all parts of the world (some 175 000 articles per year). It prepares machine-readable indexes from augmented bibliographic citations i.e. regular citations plus telegraphic abstracts using keywords, which are stored on magnetic tape. The tapes are used to produce the monthly *Index Medicus* and to provide demand search bibliographies to U.S. medical researchers, educators, and physicians.

The bibliographic search function of the MEDLARS system is designed to match precisely formulated questions against a literature citation file. This requires a computer programmed to process MEDLARS tapes produced and up-dated in the NLM. In Europe there are computers using MEDLARS programs in Newcastle (U.K.) and Stockholm. The cost of those facilities, including much of the cost of performing searches, is in the order of \$75 000 to \$100 000 per annum. In 1967, the NLM signed an agreement with the Australian National Health and Medical Research Council to set up a MEDLARS search centre in Australia for a trial period of three years at the University of Sydney. In return, the National Library of Australia has agreed to undertake some indexing of medical literature and to provide input for the MEDLARS service by 1970. The problem of compatibility of MEDLARS computer tapes with computers other than the Honeywell H-800 has caused extensive delays in the planned decentralization of its tape-searching activities. The extensive training necessary before search questions can be properly formed is another problem which had to be solved.

The cornerstone in the input operation is the controlled list of subject descriptors created by NLM, called MESH (Medical Subject Headings) which contains over 6 500 terms. This is the vocabulary which the indexing staff of 20 subject specialists uses to assign terms characterizing the content of some 2 400 health sciences journals. An average of eight descriptors per paper is entered into the system. Other staff transform this information into machine-readable form using punched tape typewriters for entry into the computer.

An important feature of the MEDLARS operation is its output device, namely the phototypesetter nicknamed GRACE (Graphic Arts Composing Equipment) which prints at the rate of 300 characters per second from a font of 226 characters (including upper and lower case). Data is transferred directly from the computer and composed on to positive photographic film or paper. This has permitted the more rapid publication of *Index Medicus*.

Many problems and delays have arisen with the "demand search" aspect of the operation. Three years after sending the Honeywell tapes to the University of California at Los Angeles as a pilot project in conversion to IBM tapes, that institution was still sending its search questions to the NLM at Bethesda, Maryland. The number of such searches run in 1967 was about 225, with the elapsed time between receipt of request and despatch of answer being between 11 and 30 days. One of the most promising aspects of MEDLARS is the work being done to produce selective indexes to portions of the entire medical literature in such fields as nursing and dentistry. Such subsets provide more manageable information files and can be tailored to meet the needs of specific bodies of users.

MEDLARS is not without its critics, which is to be expected with any major pioneering work in the field of information retrieval. Dr. Ralph R. Shaw, Dean of Library Activities, University of Hawaii, has said:

> "MEDLARS is, as a whole, a very interesting and desirable experiment which, if run as an experiment under controlled conditions and including objective investigation of the system as a whole and all of its parts, may well teach us much about better ways to handle the mass of scientific literature".

Appendix G

INFORMATION SCIENCES RESEARCH PROGRAM, LOCKHEED PALO ALTO RESEARCH LABORATORY, CALIFORNIA, U.S.A.

General Description

At the Palo Alto Research Laboratory, Lockheed Missiles and Space Company, Palo Alto, California, the Information Sciences Group, in co-operation with the National Aeronautics and Space Administration (NASA), has developed an advanced information retrieval language known as DIALOG. It is an on-line computer language which enables the user to browse through large collections of document descriptions on individual, time-shared, cathode ray tube displays. DIALOG was implemented in 1966 using an IBM System/360 model 30 computer with 32 000 bytes of core, together with two 2311 disc packs (7.5 million bytes each) for programs on intermediate storage, a 2321 Data Cell (415 million bytes) mass storage device for the main reference material, a 1443 off-line printer, and input-output terminals using 2260/1053 display and printer equipment. The main reference file contains more than 300 000 NASA citations.

Most existing computer-aided retrieval systems use batch techniques to perform retrospective searches and the selective dissemination of information against individual profiles. To gain efficiency, many search requests are batched and entered into the computer system, the results being separated by request and reviewed by the systems expert before being returned to the user. The physical distance between the user and the computer often results in long delay, inadequate communication, and low relevance indicating inadequate retrieval of information. High-speed computers and time-sharing programs now offer the user the same flexibility of search as a manual system but with the immense data-processing power of the computer as an aid. With this broad objective DIALOG was developed to investigate the effectiveness of a flexible, user-directed language in accomplishing reference retrieval.[62] The DIALOG retrieval system is presently in use at the Lockheed Palo Alto Research Laboratory and is being tested collaboratively with NASA headquarters in Washington, D.C., the communication channel being two conventional half-duplex telephone circuits.

The system was developed on the premise that it should:

- Provide a variety of command functions for the communication, search, and display of information from which the user can select those most appropriate to his particular problem;
- Provide the flexibility to include additional commands or other operational modes as new search techniques are developed;

- Assist the user in search definition and in the full employment of system capabilities;
- Allow intermediate user evaluation of search results with subsequent request refinement;
- Require a minimum of bookkeeping or remembering on the part of the user in the association of retrieval references with request expressions;
- Minimize the elapsed time between query and response;
- Eliminate the need for "middle-men" to interpret the request;
- Allow real-time interaction between user and system for search guidance.

Since the system is highly user-oriented, the command structure is both simple and limited. The upper-case values of the top row of keys on the keyboard provide a number of commands (begin search, expand, select, combine, limit, keep, display, type, print, and end of search). After depression of these command keys, the user may enter operational data relevant to his search, such as keywords, search limits, set and item numbers, and Boolean logic to combine descriptors or sets of descriptors in accordance with conventional logic, i.e. *and, or, not.*

A brief outline of a typical search operation will show how well the highest abilities of the user and the machine have been combined in this system.

BEGIN SEARCH: A request is displayed for entry of the search title, data, and user's name.

EXPAND: If a keyword is entered on the keyboard the stored list of descriptors alphabetically close to the entered term is displayed together with a temporary identification number for each descriptor.

SELECT: If now the identification number of the keyword required is inserted, the computer will assign it a set number, show the number of entries in the reference file under that descriptor and repeat the keyword itself. If further expansion and selection of keyword descriptors proves necessary, the EXPAND/SELECT procedure may be repeated as many times as desirable. Each time, the display indicates the number of items in the reference file and the computer records the full line of displayed data on the associated 1053 printer.

COMBINE: Once the major descriptors in the title have been expanded and selected, a decision can be made on the basis of the number of items in the file as to the proper combination of Boolean logic needed to achieve high relevance and a reasonable number of applicable references. The entry of the Boolean logic requires merely that the set numbers, indicated on the user's display, be related using the + sign for *or* and the * for *and* and – for *not.* Immediately the display and printer show the new set number assigned to this combination and the number in the set.

LIMIT: The user may refer to the set to which he wishes to apply the following limits, publication date, type code, and the range of items in the set to be displayed.

DISPLAY: If the number in the set is now small enough, the user may display the full bibliographic citation of the selected items by depressing the enter key after examining each item. The keywords for descriptors displayed with each citation may suggest additional terms that would increase the relevance of the retrieved documents. The user may revert to the expansion and selection procedure again and introduce additional sets into his Boolean logic with the full knowledge at all times of the number of items which satisfy the search expression.

KEEP: If after examining the displayed citations, the user decides to retain an item for later printing, he may depress the key KEEP to place the reference in a buffer store.

TYPE: Should the user wish to print on the 1053 printer any selected citation or document number, he may do so with the TYPE key followed by the appropriate address information. Should he wish, for instance, to retain on this printout all document numbers that constitute his final selected set, he may do so in this manner.

PRINT: Once the user has placed in buffer store all items that he wishes to have printed off-line on the line printer, depression of the PRINT key followed by the set number, a format number, and the numerical limits of the items required will result in a high-speed printout of the full bibliographic citations from the reference file.

END SEARCH: The search is completed when the user depresses this key and his display indicates that he enter comments, suggestions, or criticisms through the keyboard to allow evaluation of the system by the designers. Entry of this information causes the elapsed search time on the computer together with the user's comments to be printed on the console typewriter and then clears the computer for the next search.

The time spent on a typical search obviously depends on the complexity of that search and the user's experience. Experience indicates that a typical search occupies 30 minutes with about 5 minutes of central processor time. With the present equipment at Lockheed, this represents a machine charge of between $10 and $20 per search. The user receives two printed documents, the output of the line printer listing the full bibliographic citation for each selected document, and the listing of commands used from the typewriter printer, which can include a listing of the document numbers of the retrieved items to facilitate easy ordering from the document centre.

Input

Citations for storage in the main data cell may be inserted from tape or card in the conventional manner. Since this reference bank is not consulted during the logical operations on the data base, entries can be made serially and additional data cell units may be filled as required in a sequential manner. At appropriate intervals, new citation data is scanned from tape or card input to update the inverted file on disc which is the source of the data used during co-ordinate searches. The controlled programs are resident in the second disc store.

At this time the data base for the Lockheed DIALOG system is the NASA collection of over 300 000 citations. It is planned to include the appropriate abstracts for this collection during 1968, when computer capacity is increased by the installation of the IBM System/360 model 40. Citations from other sources can obviously be included in the system in their original form. Only the control programming to permit consistent entry of search data into the disc store need be provided, especially if the input format differs. Lockheed is currently experimenting with the use of the system for management purposes where the data base may be a collection of personnel summaries and project status reports. The larger computer will also permit an extension in the number of interactive display terminals.

Significance

The DIALOG reference retrieval system is illustrative of on-line interactive systems designed for non-specialists, the users themselves. The system has significant advantages:

- It is implemented with modest computer hardware and yet has all the advantages of an on-line operation (though with a restricted number of terminals at this time).
- Time-sharing reduces costs and increases flexibility. It has demonstrated the possibility of transcontinental access to information files while retaining an exceptional degree of user orientation.
- It accepts existing information stores without requiring their re-indexing.
- It accepts any arbitrarily complex or detailed search descriptions, the command language being independent of the particular data it searches.
- The real-time interaction between the user and system assists the user in search definition and in the full employment of the system capabilities.
- Relevance of the output can be very high as the user may examine citations and modify or refine his search accordingly. Examination of the citations and descriptors shown on the intermediate display and on the final printed output can quickly modify the interest profiles of the user so that the next search is more efficiently undertaken. The training advantages of the immediate feedback are large.
- The modular organization of the command program provides the flexibility for the later inclusion of additional commands or operational modes as new search techniques are developed.
- It minimizes the elapsed time between query and response and requires a minimum of bookkeeping or remembering on the part of the user.
- The system uses the best ability of both user and machine; the computer merely serves as a data-processing extension of the user. His intelligence and experience are continuously engaged until an acceptable result is achieved.

Appendix H

TECHNICAL INFORMATION PROCESSING SYSTEM (TIPS), NORTH AMERICAN ROCKWELL CORPORATION

North American ,Rockwell Corporation has designed and implemented an information-processing system having many of the characteristics desirable in a national system.[63,64,65,66,67] The system generates and utilizes information covering a broad range of products and subject disciplines, and a growing number of interdisciplinary tasks requiring access to both open and closed literature. A mixture of project- and profession-oriented indexing is used to meet the varied needs of a large corporation. The TIPS system ties together 9 technical information centres and 18 branches in four states: California, Ohio, Oklahoma, and Texas. These centres and branches provide information services for over 100 000 employees, with a primary user population of more than 15 000 professional-level scientists and engineers. More than 3 000 SDI notices are distributed each month.

The divisions of North American Rockwell Corporation generate approximately 8 000 technical reports a year, while the nine major libraries acquire about 52 000 external reports a year. The data base available for search comprises more than 70 000 documents originating within the company and more than 250 000 NASA documents. In all, the holdings of the 27 information centres comprise more than 90 000 books, over 700 000 technical reports, and over 3 000 different periodicals. The interface with other information communities is complex. Documents are obtained from over 3 300 different sources. These include private companies, universities, government agencies, and publishing houses.

As a result of the size and complexity of the information problem, a corporate-wide Technical Information Co-ordinating Committee recommended a program that would provide interdivisional compatibility and the potential for the corporate-wide exchange of technical and bibliographic information of all divisions' holdings to each user. The duplication of indexing effort because of the organizational and geographical separation of the company's operations received particular attention. The following general recommendations of the committee have guided the implementation of the TIPS System:

(1) The system must be user-oriented;
(2) A decentralized system with centralized processing should be used;
(3) The output should be book-type indexes and catalogues;
(4) The indexing and processing of information on technical reports is the most important;
(5) Ensure use of other available tape files and computer programs;
(6) Use existing general purpose equipment;
(7) Include abstracts in the system;

(8) Provide subject indexes through the use of descriptive terms;
(9) Implement the system with a minimum of disruption;
(10) Minimize overlap with external information services;
(11) Proceed in a three-phase plan of development, the mechanical production of indexes and catalogues, mechanization of search and selective dissemination, and the future phase based upon the experience gained in the other two, which will accent cheap mass files, improved software, and automatic input.

The TIPS is basically a document retrieval system. Its output is similar to the secondary publications of many abstracting and indexing services. Specifically these outputs are:

– An Accessions Catalogue. This contains a citation, a set of descriptive terms, and an abstract for each item received by North American Technical Information Centers and libraries. Each division has a unique series of accession numbers which make up a separate section of the catalogue. This catalogue is published monthly and contains information relative to all new internal reports and those received from outside sources.
– A Permuted Descriptive Terms Index which lists, under major terms, the identification numbers and accession numbers of relevant reports.
– An Author Index which lists by author the titles, identification numbers, and accession numbers of the collection.
– A Source (Corporate Author) Index which lists under sources the titles, identification numbers, and accession numbers appropriate to each source.
– A Number Index in which identification numbers, sources, and accession numbers are listed. The updating of an identification number master file also handles the common holdings problem by matching bibliographic entries by identification number and source. When common holdings are detected, the bibliographic entries are merged into one record which contains each of the associated accession numbers together with an automatically assigned completeness code to designate which original entry contains the most bibliographic information.
– A Contract Number Index which contains by contract number, the titles, identification numbers, and accession numbers.

In addition to the production of the catalogues and indexes, the system also includes capabilities for selective dissemination of information (SDI) and retrospective search. The computer system for index and catalogue production was implemented in the summer of 1964, while the SDI and retrospective search programs were implemented in the summer of 1965. The TIPS is divided into two levels of processing: a Division Level System and a Corporate Level System. The Division Level System includes cataloguing, indexing, and the preparation of abstracts (if necessary). After the information is translated to either punched cards or punched paper tape, an IBM 1401 computer is used to convert the paper tape or cards to magnetic tape, to perform audit and edit functions, and to create and update a division master file which contains all the accessions for a division. This division level output includes a shelf list and an option for printing 3 X 5 cards. Once a month a tape containing a month's accessions is generated for input to the Corporate Level System. This is then sent by microwave or telephone line transmission to the Corporate Data Processing Center.

The Corporate Level System utilizes an IBM computer of larger size with a combination of random access discs and magnetic tapes for processing. Four major programs are used to update the corporate master file by merging the input from the nine division level systems. The programs detect common holdings, prepare permuted index and inverted term files, prepare all catalogues, identification number indexes, author, source, and contract number indexes. The output of all programs is a magnetic tape in a coded format consistent with an SC 4020 Microfilm Recorder. This recorder prints the indexes and catalogues on film at the rate of 6 000 lines per minute. The film is then used to create directly offset masters by the use of Xerox Copyflo. The published indexes and catalogues are then printed using normal offset printing procedures. Output options include the automatic preparation of microfiche from the film so as to reduce the hard-copy printing costs for those divisions which have the necessary reader-printers.

To utilize the large files created by the TIPS, North American Rockwell Corporation has created a series of programs to provide selective dissemination of information and retrospective search. Basically, the difference between the two is the relevant quantity of search questions or profiles versus the size of the file searched. SDI and retrospective search are treated as one problem, whether performed at a division or corporate level. Thus, the same basic programs are used for all retrieval applications and a single input form is used for preparing an interest profile for SDI or a search question. Only an indicator is entered to differentiate between the type of question and the file to be used. To limit the search output, the retrospective search questions are more tightly controlled than the SDI profiles. Search questions for both SDI and retrospective search are stated as a series of limits, the most important limit being a set of weighted descriptive terms with an associated "Hit Level". Further restriction of the question is possible by accession number prefix limit, document type limit, publication year limit, input year limit, author limit, source limit, and contract number limit. Although the descriptive terms limit is normally always used, it is possible to formulate a question using any combination of the limits. More complex weighting techniques are available to simulate Boolean type questions. The search approach adopted uses both linear files and inverted files. More extensive use of random access storage is expected as the cost is reduced. The SDI system is achieving about 70 per cent relevance in its retrieval, and requests for documents approach 30 per cent. North American Rockwell Corporation believes that the documents associated with the SDI operation should be made available to the user with a minimum delay. In fact, the provision of microfiche with the SDI notice for each article retrieved has been tried on an experimental basis. The response has been enthusiastic. The use of group profiles on a mission-oriented basis is being considered.

North American Rockwell Corporation is actively considering more extensive use of the present system taking advantage of new software and new storage hardware. At the present time, retrospective search and SDI based on the complete corporate bibliographic collection must be performed at the general offices. When the volume or urgency of requests provides sufficient justification, it will be relatively simple to duplicate the corporate collection and supply each division with duplicate master files. Each information centre would then be able to perform retrospective searches of the total corporate collection with minimum delay. The ideal system would include the use of real-time teleprocessing and reactive typewriters. To make such a real-time system feasible, it must be operated on a time-shared basis with other systems, e.g. inventory control. It is anticipated that a real-time information system will be placed in operation when economically justifiable.

The company is developing a low-cost, high-density mass file that will be cheap enough to allow transfer of whole files from centre to centre without worrying about sophisticated long-range transmission systems. Research on software suitable for the automatic indexing of raw text is being continued and a prototype software system of this type is operational. The Space and Information Systems Division is using another system named EDICT to provide the company's engineers with design data by voice response equipment. Data from more than 75 000 engineering drawings are available from any of the company's 42 000 telephones through the use of an IBM 7770 voice response unit, which has a vocabulary of 128 words.

The corporate approach taken in the development of the TIPS has led to the inclusion of many features that are of significance in a national system, among them:

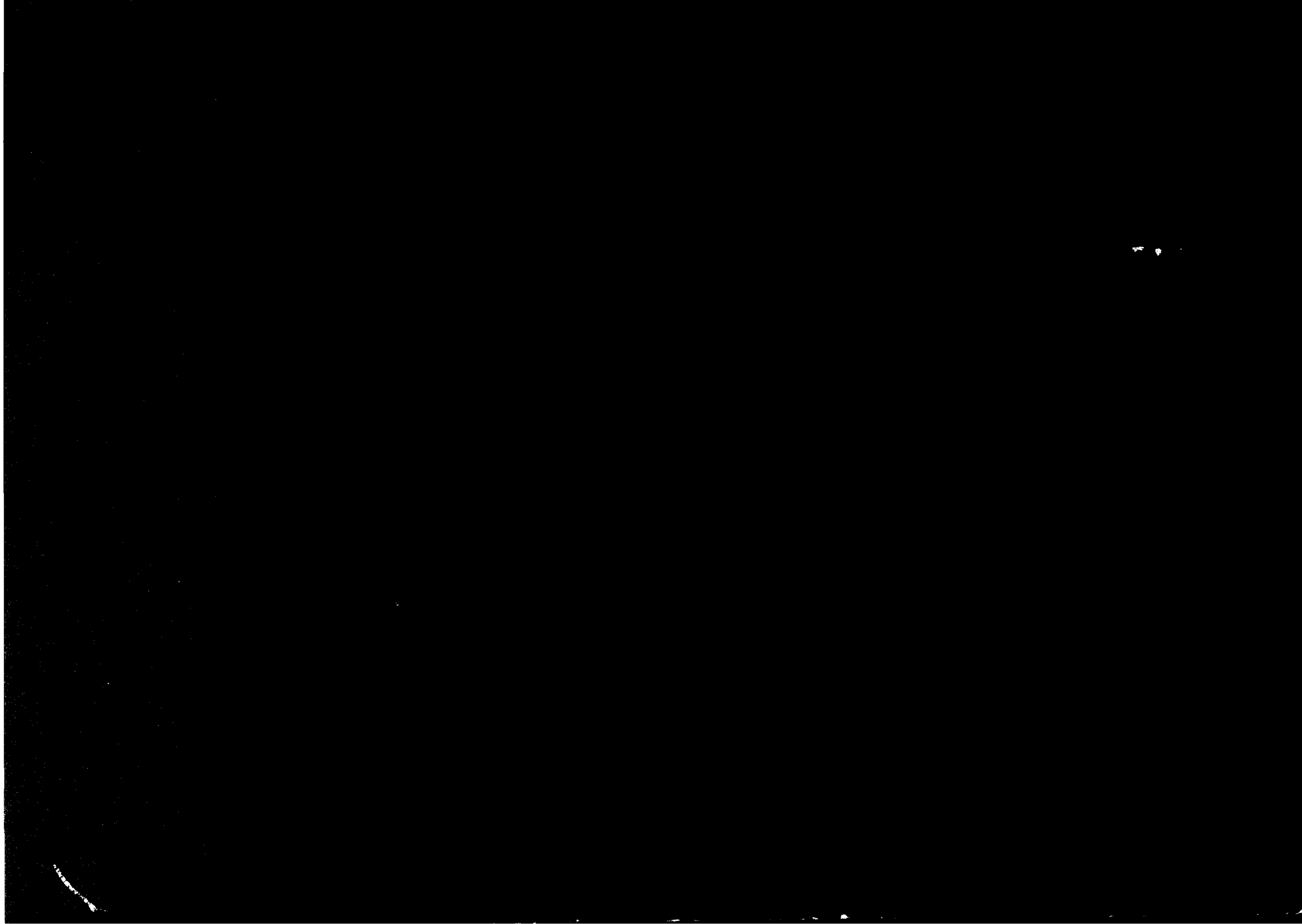
- Wide diversity in regional divisions that was successfully coped with;
- Retention of overlapping entries with different levels of bibliographic scope and the automatic indication of location of best coverage;
- High degree of user-orientation;
- Maintenance by computer of corporate level files on a monthly basis producing a master source for all divisions;
- Efficient production of accession lists and indexes as required;
- Emphasis placed on technical reports because of quantity and timeliness of information therein;
- Objective of using tape inputs in different formats from NASA, DDC, and others which relate well to Canadian requirements;
- Use of existing computers wherever possible;
- Inclusion of abstracts in the system to reduce communication costs and document handling;
- Evolutionary nature of the system to avoid disruption;
- Use within the system of adequate outputs from other services such as *Nuclear Science Abstracts*;
- Provision of both division and corporate level search capabilities;
- Efficient solution to the common holdings problem;
- Use of one form for all bibliographic purposes;

- Treatment of retrospective search and SDI as a single problem employing weight techniques in the same programs with a minor code change thus lowering costs considerably;
- Inclusion of evaluation of the service in the system;
- Provision for decentralizing more search activities in the future;
- Provision in the present system for including real-time teleprocessing and reactive typewriters.

Many of the problem areas successfully coped with in the development of the TIPS are common to those in any national and regional network. In fact, the U.S. Office of Education has adapted this system for the Educational Research Information Centers (ERIC) which collect, index, and provide ERIC Central with full abstracts of papers in their fields on machine-readable tape. North American Rockwell Corporation prepares camera-ready copy for the Government Printing Office each month. The U.S. Atomic Energy Commission also utilizes the same programs.

No. 8

Chapter 5 Techniques and Sources



Scientific and Technical Information in Canada

Part II

Chapter 6

Libraries

Prepared for
The Science Council of Canada

SCIENTIFIC AND TECHNICAL

INFORMATION IN CANADA

PART II

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LIBRARIES

Special Study No. 8

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This chapter of the report

SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

is submitted by the Libraries Subgroup.

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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 Chapter 6 (Libraries) of Part II. Part I of this Special Study has already been published. The other chapters of Part II are

Chapter 1 – Government Departments and Agencies
Chapter 2 – Industry
Chapter 3 – Universities
Chapter 4 – International Organizations and Foreign Countries
Chapter 5 – Techniques and Sources
Chapter 7 – Economics

and will be published separately. Each of these seven separate sections contains 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

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Section I

SUMMARY

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 opera-

tions 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 will 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.

Section II

STATEMENT OF THE PROBLEM

II.1 Introduction

Over the past 50 years, the communication of information in social relationships and in all institutions has increasingly become one of the single most important tasks of civilized man. Business, industry, university, and government—each is concerned with a world encompassing more and more relationships, and each is becoming more deeply involved in the process of decision making. Information is the basic ingredient in the process so that, as the amount of information increases, the processes of selecting, obtaining, processing, and examining the particular information needed for decision making become matters of supreme importance.

The needs for information have become especially pressing, because this is an age of crisis and change, of challenges and unprecedented situations, an age that is forcing almost all institutions to undergo profound transformations. No institution has been spared and all have shown evidence of strain. Some have assumed new forms and adopted far-reaching innovations while others, unable to meet the challenge, have gradually become less effective. During this period, no institution has felt the direct effects of our changing times as dramatically as the library. It stands at the centre of the information explosion and communications revolution. It has a vital role to play in the development of a national network for scientific and technical information.

II.2 Scientific and Technical Information

The information explosion and the revolution in communications are best illustrated in the fields of science and technology. Since the 17th century there has been an annual growth in scientific literature of 7 per cent—a growth factor of 10 for each half century. This year, 3 000 000* articles in some 35 000 journals are being published in more than 60 languages.[1]

There is no sign that the annual literature growth rate will slacken in the foreseeable future. Most scientists who have ever lived are active today, and 50 per cent of them have been produced during the last 10 years.[2] This may be illustrated in another way. An estimated 1 200 000 significant scientific documents will be generated each year by 1970. In biology, chemistry, and engineering (each about one quarter of the total), keeping up with all developments will require studying 1 000 articles a day.[3] The day of the general scientist has ended! The causative forces are worth underscoring.

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*This published figure is considered to be on the high side but is quoted to illustrate the magnitude of the problem.

(*a*) A scientific revolution, funded by government agencies that are mission-oriented, is causing the emergence and rapid development of inter-disciplinary sciences that are displacing the older scientific disciplines. This phenomenon is being exacerbated by the scientists themselves and is causing major stresses on the institutional forms through which science is conducted, i.e. universities, industry, government, and the institutions of primary and secondary publication.[4]

(*b*) A communications revolution, stimulated and supported by the proliferation of information, has rapidly outpaced the efforts and capacity of traditional institutions designed to provide storage and access. More important, new technology for the storage and transmission of information has overtaken traditional institutional capacity for the control of information, resulting in physical, operational, and intellectual crises in scientific information handling.

II.3 The Critical Problems

Over the years, studies have shown that the scientist, engineer, or other user needs information, whether from print or from other sources, in three identifiable areas.

(1) Current information. The need to know what others have recently done or are doing, both in the specific field in which he is working and in a broader area—knowledge that is necessary to give meaning to his work.
(2) Specific information. Everyday need for information essential to his work or better understanding of that work. This need is directly connected with a research or operational problem at hand, the need for a bit of data, a method, the construction of a piece of apparatus, an equation, or an explanation of a phenomenon.
(3) Exhaustive information. The need to check through all relevant information existing on a subject, usually the specific subject upon which the scientist or engineer is working. This need arises at the start of work on new research or when the results of investigations are ready to be reported.[5]

The problems in providing these information services to science and technology have taken three forms.

(1) A physical crisis, resulting from the sheer bulk of the material generated each year, has led to limited coverage by secondary sources (about half the useful articles are not abstracted, and of those that are abstracted, many are repeated in as many as three abstracting services)[6]; time lags (it has been estimated that the average time it takes to get an article published in a refereed journal is between one and two years); gaps in publication; difficulty in determining who is doing research and how far the research has progressed; and difficulty in finding and identifying the thousands of products invented that have been marketed and produced.
(2) An operational crisis, resulting from the exorbitant cost in both time and money needed to make each item readily available to the growing

number of users, has led to poverty in many local collections, lack of trained personnel to service user needs, difficulty of access to the information in storage, and difficulty in handling new forms for the transmission of information (including magnetic tapes, microtexts, and film).

(3) An intellectual crisis, resulting from our inability to describe an item by words or numbers that will make it retrievable, is exemplified by interdisciplinary complications arising from the interdependence of knowledge and the growth of mission-oriented research; by the publication of 50 per cent of all scientific and technical publications in languages other than English[7]; and by our lack of understanding of the processes of distribution, dissemination, and storage of messages in great quantities for easy access. Most difficult of all is to make the final connection between great stores of messages and the unknown minds to whom they are not addressed but for whom they were intended. The mental process involved in the interpretation of meaning once the message has been transmitted remains controversial in theory and is effectively unknown.

In addition, there are at least two constraints within which any improvements or evaluation of scientific services must take place. The first involves the rate of input and output of information to the human brain. The simple fact seems to be that, regardless of the rate at which recorded knowledge is accumulated through the years, the rate at which we read remains constant.[8] The second constraint arises from a characteristic inertia. This is exemplified by the fact that users do not exploit libraries and information centres. We must design new, active services requiring minimum effort on the part of the user.[9]

Something must be done and the approach must be on several fronts. What we need is a new mechanism for the better utilization of our technology—new techniques, improved and more sophisticated tools, and a much clearer understanding of the fundamental nature of communication and its uses. For, as W. O. Baker has pointed out:[10]

"... unlike material consumption of food, clothing, housing—even, perhaps, of automobiles—there is probably no limit to human needs for knowledge."

II. 4 The Need for a Network

The answer is a national information network composed of service units—including libraries, information centres, and other agencies for information transfer—and able to provide the following facilities and services for meeting the needs of users.

(*a*) Browsing. Users will always need to handle and examine books, journals, etc.

(*b*) Document Retrieval Services. This is a relatively new development in library service. Along the lines of interlibrary lending, it is best represented by the National Lending Library for Science and Technology, in England. The Clearinghouse for Federal Scientific and Technical Information, in Washington, offers a somewhat similar service with the exception that it handles only U.S. Government reports, which it sells rather than lends. Both are fast and inexpensive services, but the user must know exactly what he wants.

(*c*) Reference Retrieval Services. This level is best characterized by the work of special libraries, although some large research and public libraries have become involved. The user is not expected to know how to find what he wishes and is given help on the bibliographic identification level. The output is generally an abstract or other reference to published information.

(*d*) Data Bank Services. This level has not been provided in Canada on a systematic basis. It would provide in-depth information on a subject. It would require the extensive use of machines and the development of new approaches to subject indexing and retrieval. Much experimental work is being done in this area.

(*e*) Information Analysis Services. Only marginal services of this type are available in Canada. This would be a centre that would reduce and analyze masses of information on a variety of subjects, making useful evaluations and interpretations. The results would be precise summaries of the state of the art on specific problems.

Obviously, the above categories are not mutually exclusive. There are many overlappings, reflecting the complexity of the information and communication problem.

What is needed is a scheme combining the strengths of existing collections and services with a mechanism that can organize and manipulate them into a cohesive, co-ordinated working network, accessible to any user regardless of economic status or geographical location. This should be accomplished within existing Canadian systems, and it should be done with a full understanding of the way scientists, engineers, and other technical workers use information.

II. 5 Summary of Network Issues

A national scientific and technical information network should:

- Include and interface with most current information systems in the country, including libraries, on a voluntary basis. Such an assumption does not preclude some centralized control. The National Science Library must play a key role in any national information system.
- Engage in co-operative acquisitions, storage, and dissemination of information in a manner that will reduce unnecessary duplication and improve convenience of access according to demand.
- Engage in the acquisition, storage, and dissemination of information in forms not hitherto normally acquired and processed by conventional libraries, including unpublished and nonprint materials in various forms.
- Process materials in this wide variety of forms at greater depth than conventional libraries have done traditionally, not as bibliographic units but with regard to the information content.
- Go beyond the provision of access to information, as such, to include access to artifacts, tapes, films, etc.
- Include an alerting function or current awareness service (one for which users would be willing to pay).

–Provide information as an output of the system in at least three forms: references and bibliographies, books and documents or hard copy, facts or answers to specific questions.
–Give the user assurance that needed information or material will be in the national network or, if it is not, that the network can obtain it.
–Acquire material of possible importance to a Canadian user that is not otherwise likely to be acquired by any individual Canadian library or information service. Interlibrary lending based on unco-ordinated individual library development is inadequate.
–Conform to the law of the land. This will require both federal and provincial legislation.
–Have sound financing on a permanent basis. Tax support would be the most suitable means for initial financing.
–Have an administrative structure that will be able to keep a working control over local and private interests, while protecting the rights of libraries and information services whose parent organizations have already a considerable investment in their collections and services.
–Be based on regional systems of decentralized service. This will require a very sophisticated communications network to be effective.
–Include provision for compatibility with any international networks that may be developed.
–Develop comprehensive feedback strategies to ensure that changing user needs cause appropriate changes in the services provided.
–Be staffed by appropriate technical personnel on all levels, including administrators, systems design planners, subject specialists, librarians, educators, information scientists, information technicians, library technicians, public relations personnel.
–Develop training centres with appropriate instructors who will help to train the user in utilizing existing information services and in preparing information that will ultimately be placed in the network.
–Provide training programs for the continuing education of the personnel who design and operate the national network.
–Generate a comprehensive public relations campaign to educate the public on the cost, value, and use of information.

Section III

A NATIONAL SCIENTIFIC AND TECHNICAL INFORMATION NETWORK

III.1 Objectives and Requirements

A complete set of objectives for a national scientific and technical information system for Canada remains to be formulated, but it is possible to develop a preliminary set of objectives that will be consistent with future developments.

The basic objective is the accessibility of all existing scientific and technical information (STI) to all interested users. In short, the emphasis must be on providing maximum convenience to the user, promptness of service, and maximum efficiency in the transfer process. Maximizing convenience implies:

(1) New packaging of information while increasing the effectiveness of informal communication channels;
(2) Provision of access to peer groups;
(3) Increased educational programs.

Promptness of service implies:

(1) Better communication throughout the network;
(2) Use of more advanced communications devices to support those currently in use;
(3) Establishment of sophisticated switching within the network;
(4) Removal of as many middlemen as possible from between the user and the information source.

Maximizing efficiency of the transfer process implies:

(1) The design of a delicate balance matching user convenience and promptness with the diversity of services tailored to the user;
(2) Close control and co-ordination of processing operations;
(3) Effective allocation of personnel and equipment;
(4) Utilization of modern management and operating techniques wherever feasible.

III. 2 The Components

Satisfying such objectives requires the integration of a variety of institutional components–both now existing and to be added–into a single network. Some of these components will provide for internal communication within projects with specific missions; some of them will provide for inter-project communication on a point-to-point basis; some will provide access to means of broadcasting information in the form of reports, journal articles, and books. These different levels of accessibility satisfy correspondingly different requirements for speed of access, selectivity and quality, level of analysis and evaluation, and size of audience.

The institutional components include the following.

(*a*) Research Libraries. These are the institutions that provide access to the largest existing collections of published material. They also provide the organization, procedures, and manpower required for the essential work of acquisition, general description, storage, and retrieval of such material. In the past, libraries have concentrated their attention on material published in printed form with sufficiently high standards of quality to warrant the investment required, i.e. books and journals. Increasingly, however, they are including material of a more transitory nature—reports, documents, microforms, magnetic tapes, etc. Such libraries will form the core for any future STI network in Canada. They constitute the largest existing information system in Canada. Taken together, their collections form the largest source of recorded information. Information services in science and technology will be heavily dependent on access to retrospective collections of information, likely to be located in these library collections, since state-of-the-art surveys and specialized bibliographies will involve searching the retrospective literature.

(*b*) Special Libraries. Subject delineation is common among special libraries. In many instances entire special libraries with scientific and technical collections could be fully absorbed into the network. University libraries are traditionally divided into departmental science collections. These could be adapted to the requirements of the network.

(*c*) Information Centres (interpreted in the sense of "information analysis centres"). A scientific and technical information system implies the generation of new syntheses of information by subject disciplines. This straightforward statement is very difficult to put into practice. Science and technology have become diffuse. Division of subjects is now common, and interdisciplinary endeavours are the rule. Although it is possible to define the traditional core of scientific and technical subjects, deeper analysis requires expertise in these new subject areas. Information centres are the institutions that provide for substantive research in specific subject fields based upon the published literature. They develop state-of-the-art reports, critical reviews, specialized bibliographies, and other analyses to evaluate the relevancy, value, and import of published information. Their primary staff are specialists in the subject discipline. They may be supported by indexers, abstractors, and computer-based services. They may have specialized collections of material, but they will also depend upon the collection and services of a research library or special library with which they are affiliated.

(*d*) Document Distribution Centres. The increasing proliferation of reports and documents has led to the creation of institutions that serve, for transitory material, the same functions provided by commercial distributors of books and journals. Many of them are designed to serve the needs of specific, mission-oriented agencies.

(*e*) Professional Societies and Commercial Publishers. These are the institutions that publish primary journals and books. Their emphasis is on the quality and value of their content, which their referee procedures are designed to maintain.

(*f*) Secondary Journal Publishers. These are the institutions for publication of the abstracts and indexes for intellectual access to published material of all kinds.

Some of them emphasize books, others journals, and a few, reports and documents. Some commercial publishers are indexing vendor catalogues and other lists of manufactured products.

(*g*) Mission-oriented Agencies. These are the institutions providing one of the primary sources of published material, and are one of the primary consumers of the content, as well.

(*h*) Commercial Information Services. The self-evident economic value of certain kinds of information has produced a market that can be readily exploited by commercial organizations. They can be the institutions for specialized repackaging of data with high utility, immediacy of value, specialized use, and marketability.

The major obstacle to the development of the network will be identifying the proper participants from among this set of components. It will probably be necessary to restrict participation to a single discipline, perhaps that which will both contribute the most to and derive the most from an integrated network. However, the goal of the network should be providing information to and for any user who needs it, and therefore once a functioning network has been tested as a pilot project, others should be invited to join. In this way a national STI network will evolve that ultimately will include all disciplines. Such evolution should be anticipated and designed for at the outset. There must be ample provision for expansion, flexibility, and compatibility for adaptation to other disciplines.

From an examination of the present situation, it should be clear that a national STI network must include the concept of integrating library services with other relevant scientific and technical information activities within the country. A major effort will be required to ensure that the objectives of each component are consistent with those of any proposed national network. Attention to the problem of costs is an important consideration, but sub-optimization detrimental to the entire system must be prevented. This means that functions must be properly and economically assigned to various component activities and that resources must be shared to the maximum extent possible. In essence, the implementation schedule for the service units should clearly define:

(1) Those services and resources present in the subsystems;

(2) Those services and resources that are closely related to library operations and may be easily established in close proximity as part of the service unit;

(3) Those services and resources that may more effectively be provided separately from the subsystems.

III.3 The Functions

Accepting the main goal of the STI network as the collection, organization, preservation, and retrieval of information for distribution, it is necessary to examine the non-substantive processing functions to be performed by each agency in it, including:

(1) Input–evaluation, selection, and acquisition of materials;

(2) Processing–receiving, cataloguing, subject analysis and announcement of materials;

(3) Storage–materials management, physical preparation and organization of materials;
(4) Output–reference services, circulation, and inventory control of materials;
(5) Control–administration, management and organization of the processing functions.

These processing functions reflect the typical goals of libraries and other generalized information systems. Consequently, libraries should at least concentrate on performing the following:

(1) Physical description of the material;
(2) Physical retrieval of the material;
(3) Identification of the item given categorized surrogates such as author, title, report number, originating agency.

One function, in particular, is performed adequately by libraries–the physical retrieval of an item after the complete citation required is known. Although significant delays may still often be a problem, physical retrieval and inventory control have been refined to the point of successfully providing accessibility after the material is acquired.

The function of identification of all available citations for items needed by users suffers from inadequacy of subject approaches. The problem of fulfilling the users' subject requests revolves around the unpredictability of the way in which users will approach the subject. However, serious reconsideration of methods has begun to take hold, resulting from the potential made available through "new machines".

An active area of research concerns the behaviour of controlled vocabulary, i.e. subject headings, to act as intermediate buffers in this process. Complex systems of indexing range from uncontrolled "free indexing" to highly rigid hierarchical classification. Experiments clearly indicate that no two persons will index a document consistently, even in a highly structured and highly rigid system. Further, the same indexer will often use different subject categorization at different times for the same item. This uncertainty extending to the content analysis necessary for subject access has been an important factor in economically justifying the lack of "depth" indexing in libraries. Solving this problem is essential to efficient information transfer, as most users approach their research from a subject bias.

III. 4 The Library System

The resources of libraries will form the major part of the STI resources in the network. The individual strength of existing library service units must be retained and expanded, with improvement on a consistent and systematic basis. Building on present strengths will achieve the greatest benefits for the least investment. Supplementary and complementary services and resource collections must be developed and closely interleaved with present library services to increase further what is available to the user. For example, inventory files relating to referral services should be added to the services maintained by existing libraries. Users approaching the STI systems through their local service units should be able to use this service.

Most resources, including the people needed to form the nucleus of a national STI network, are available. They would include the staff and collections of many university libraries and the government libraries in the Ottawa area, with some help from several of the larger public and special libraries. Unfortunately, few of the small public libraries and school libraries contain personnel or materials of interest.

The scientific and technical literature resources in Canada have been studied intensively and a summary of library resources is shown in Table 1.

Table 1. – Estimated Library Resources in Canada

Libraries	Number	Holdings	Operating Payments	Circulation
			$	
Public[a]	910	21 219 284[b]	30 023 404	78 794 229[c]
University and College[a]	226	12 278 519[b]	19 752 384	6 779 586
School	2 595	7 585 163	4 132 759[e]	–[f]
Government and Special[g]	580	8 845 191	–[f]	–[f]
Total	4 311	49 928 157	58 378 033	85 573 815

SOURCE: Dominion Bureau of Statistics, Education Division, Survey of Libraries, Part 1, Public Libraries 1965; Part 2, Academic Libraries 1964-65. Ottawa, 1967.

[a] Includes regional public libraries and provincial public library services.

[b] Includes volumes of books, titles of periodicals, pamphlets, films, filmstrips, sound recordings, microfilm, and microtext.

[c] Reported circulation for all materials (not only scientific and technical).

[d] Includes technical institutes and provincial trade schools and teachers' colleges.

[e] Materials only.

[f] Figures unavailable (see Chapter 1 for estimated government expenditures on libraries).

[g] Dominion Bureau of Statistics, Education Division, Survey of Libraries, Part 1, p. 40. *Based on* Anthony T. Kruzas, Directory of special libraries and information centres. (Detroit, Gale Research, 1963) pp. 641-695. (1961 figures).

These figures can be considered only as estimates. There is a lack of consistency in reporting statistics on a yearly basis which renders comparison impossible; indeed, this is true within any single year. Attempts at clarification from DBS elicited the following responses:

(1) Urban and regional public libraries are separate categories with several exceptions.

(2) The summary for all public libraries includes their collections and circulation without duplication.

(3) Collections of supplementary material (non-book) for urban and regional public libraries are included in the total with the exception of "Microtext Units" and "Films".

(4) Total figures for supplementary material can only be obtained by adding urban, regional, and provincial library figures which, in turn, reintroduce duplication.

In effect, it is impossible to obtain a comprehensive figure for the total holdings regardless of form of material.

Numerical strength only is indicated by this total; there is no indication of duplication, subject overlapping, or of language. Concentration has been on printed literature, even though other resources are scattered throughout the country, often in small collections that are not necessarily recognized as libraries or information sources. These collections of nonprint information resources, such as computer programs, audio tapes and video tapes, films, photographs, data and experimental observations, may ultimately be as extensive as the printed literature and should be considered as valuable information resources. Nevertheless, viewed in totality, there can be little doubt that most of Canada's STI does reside primarily in the nation's libraries, ranging from the large institutional library to the small collection in a scientific office or laboratory. While the methodology employed in the information transfer process has received far less attention than the nature and extent of the resources, libraries constitute the only major channel of distribution of this information with any degree of formalized organization for access.

Some statistics from the annual reports of the National Librarian give a further indication of the information resources in the country. The 1965 report shows that the National Union Catalogue had 5.9 million entries, representing about 9.5 million volumes; the 1966 report shows 7 million and 10 million respectively. The 1966 figures are for the holdings of the 242 libraries reporting to the National Union Catalogue. In addition, the National Science Library had, according to their 1967-68 annual report, a collection of 725 400 books, bound periodicals, pamphlets, and technical reports.

The need for an information network with the goals stated is not new for Canada. Many surveys performed for Canada by external consultants have recommended it. There have been seven major studies of Canadian libraries:[11] Bonn, Williams, Simon, Bladen, Spinks, St. John, and Downs. Each of them has investigated some or all Canadian libraries and their very similar conclusions and recommendations have been repeated and supported by most librarians who submitted briefs to this Study Group.

Their recommendations and suggestions may be summarized as follows:

(1) More money for collections and buildings;
(2) More and better trained library personnel on all levels;
(3) More and better instruction for all library users;
(4) Better training for contributors to the system in report writing;
(5) Co-operation among libraries to:
  –ensure minimum duplication,
  –reduce processing costs,
  –share technological advances,
  –increase availability of services on a permanent basis, e.g. interlibrary loans,
  –share bibliographic resources,
  –create administrative structures to overcome legal barriers limiting co-operation among libraries;
(6) Introduction of a dialogue among scientists, librarians, and information and communication specialists;
(7) Establishment of a national agency and network that could implement much of the above.

The 1965 St. John report on all libraries of Ontario recommended regionalism and integration of resources. The Spinks report on the development of graduate programs in Ontario universities recommended the sharing of library resources with the main concentration under the aegis of the University of Toronto. The Vainstein report on public libraries in British Columbia recommended regional development through the integration of public libraries into a network.[12] The Saskatchewan Education Council's library conference in 1964 recommended greater co-operation in school system libraries.[13] The Bonn report of 1965 recommended a proposed "science-service" library network, built on a voluntary basis to ensure that the needs of every populated region of Canada for scientific and technical information be covered. The most recent and exhaustive survey of college and university libraries by Downs recommended enormous additional expenditures for books, buildings, and equipment to raise Canadian university libraries to acceptable quality standards. Yet it warns of the problems of duplication and the waste of money and time owing to everyone's buying esoteric and little-used research material, and urges universities to develop co-operative schemes for sharing resources.

III.5 The Need for Interlibrary Co-operation

The problem now is implementation. Each of these reports has enunciated an awareness of the need for joining library information resources together, and their recommendations could, if allowed to develop, evolve into an information system. There is one danger: groups limiting themselves to geographic or interest-oriented development could construct information systems that duplicate the work of other groups or are incompatible with other systems being developed. Each system would then be restricted to its own resources according to its own financial capabilities. There has already been too much fragmentation.

Co-ordination and integration of libraries at a national level for closer communication are not only feasible but necessary. The concept of library service must be extended beyond the immediate user population. Focal points of co-operation revolve around centralized processing that may involve the use of new and expensive equipment such as computers, and decentralized switching units for routing requests of all types to the appropriate library when the local servicing library is unable to satisfy the request. Costs associated with these areas are recognized as large expenditures requiring assistance from all participating libraries, both financially and materially. The problems that plague all libraries–overcrowded facilities, limited finances, and lack of appropriate personnel–can only be resolved if wholehearted support and assistance are forthcoming from every library quarter.

In particular, the processes involved in the selection of materials reflect localized user needs, as illustrated by the development of different types of libraries–public, university, school, and special libraries–to service varying needs. However, this has produced major communications problems. Autonomy and political pressure from their user groups have forced librarians to adopt policies conducive to furthering the individual library's immediate objectives at the expense of much needed co-operation. Each regards itself as primarily serving its immediate user group with co-operation extended to other users a secondary consideration. In addition, since each library regards itself as unique, with a unique clientele and unique services, there is little recognition of the responsibility of one library to the user community as a whole. Indeed, in public libraries there is recognized a clear mandate to restrict service to those users within the municipality, other users being charged a token fee as compensation for the lack of support of library service through payment of taxes. University libraries adopt a similar posture.

Differentiation of service is also apparent in the public library community, as it overlaps the school and university library communities, but many public libraries have decried the use of facilities by students, feeling that the school and university libraries should be providing this service.

Public libraries have developed an expertise in establishing and maintaining decentralized collections and service centres in the form of branch libraries and in maintaining mobile collections. Integration of public libraries into county and regional systems for co-ordination and centralizing of processing functions to a limited extent are developments analogous to the establishment of regional school library systems. Closer co-operation in systematic evolution of school and public library systems with complementing collections and services is a progressive future development to be followed with interest.

University libraries have a highly developed and rapid internal communications system analogous to the "invisible college" associated with the scientific community. Common recognition and knowledge of specialized collections of research materials permit rapid informal interchange of information, but formalized co-ordination outside provincial boundaries suffers from economic and legislative barriers. The political autonomy of universities also constitutes a major counteracting force in achieving co-operative regional systems. Differences between university libraries beyond the undergraduate level are emphasized in the directed growth of collections to the local on-site research programs.

Special libraries suffer most in the "co-operation" squeeze as they are the most vulnerable. Since special libraries are established to support the development of a product or service of a company, organization, or institution, they must work within a narrowly defined limit of both responsibility and authority. This limitation aids in defining the level at which co-operation may be obtained or given to the special library and ensures their dependence on external information resources and on co-operation with other libraries, whether special, university, or public. Only in large organizations or in very narrow subject fields can the special library be said to be independent of outside resources. Consequently, the greater awareness of the necessity for co-operation has frequently encouraged the growth of sophisticated subject-oriented networks. Such co-operation is found at both the regional and national levels, with the government special libraries recognized as principal co-ordinating influences when they are within the subject scope of the network.

Co-ordination and co-operation are virtually non-existent among libraries of varying user-group orientation except on a superficial basis. Co-ordination and co-operation, while valid in principle and recognized as such by everyone, involve unacceptable compromises and are frequently viewed as threatening developments. University libraries are reluctant to lend material outside the academic environment; public libraries are not inclined to provide services to education-oriented users; and special libraries frequently will lend materials to outside users only through requests from other libraries. Leadership is lacking, but even if it were forthcoming it would have to overcome political pressure, rigid administrative organizations, and fear of compromises affecting the reliability of information in accepting work performed in other libraries.

Dependence on leadership results in the unilateral establishment of operational standards by the first library to solve a particular problem. The lack of initiative on the part of individual libraries results in accepting through necessity the system that is developed first in the field. This attitude, a tendency to ignore problems until they go away or someone else solves them, is especially apparent in the application of scientific methodology to the processing operations. An obvious example is the field of data processing. Arguing that a library's economic support is not sufficient to cover experimenting or research into the use of data-processing equipment in their operations, a number of librarians are waiting for "the other fellow" to perfect his operation, with the expectation of adapting his system to their own operations. This has resulted in many libraries concentrating on specific aspects of processing without any overall co-ordination. More important, many of these systems are not transferable to other library situations.[14]

Since ends should determine means, it is essential to determine the goals of such a library system. Simply stated, they should be:

(1) To promote the increased sharing of resources, particularly among agencies of different kinds, in different areas, and with different jurisdictions;

(2) To use modern technology in an appropriate, economic manner to facilitate the sharing of resources and reduce the costs necessary for developing and processing these resources;

(3) To expand the availability of information to every user and potential user in the country;

(4) To ensure continuing assessment of the resources within the network so that provision can be made for identifying and filling gap areas as required.

The intent implies many added goals:

–A degree of "democratization of information", in which all information is made as uniformly available as feasible. In doing so, there would be no levelling of resources; rather, a formal mechanism would be created by which major resources are protected and yet made readily available.

–A steady increase in the ability to serve all points of service. This means the building up of appropriate local collections to meet immediate needs as well as to provide the ability to draw on larger resources.

–Co-operative sharing among libraries, independent of their administrative base, be it municipality, school district, industrial concern, or institution of higher learning.

–A division of function based upon efficient utilization of the co-operative system and not upon administrative boundaries. Thus, delivery of materials is made through the most convenient local agency and not through some administrative hierarchy. The channels that deliver material will not necessarily be the same as those that requested it.

–An increasing degree of specialization in the collections and interests of individual libraries, so that intellectual and financial resources are not dissipated through duplicating more broadly available material.

–A sense of responsibility by the individual library to more than its own constituency, including a willingness to serve others and to support the costs of operating larger collections on which it may draw.

–An increasing concentration of equipment, for data processing and communication, at clearly defined points, thus providing a rationale for installation of specific levels of equipment.

–Willingness on the part of libraries to co-operate in a voluntary but responsible manner, including a willingness to accept certain common standards of acquisitions, cataloguing, and methods of operation.

–Finally, but in some ways most importantly, it implies the creation of a new view of the library–on the part of librarians and users–as the place to go for information service of all kinds.[15]

III.6 The Relationship to the User

A major change in attitude within the field of librarianship has been occurring during the past decade. It is reflected in the library's attempt to involve itself in a more active service role. The view of libraries as passive "storehouses" of knowledge, i.e. giant warehouses which stored books, staffed by personnel who acted as "protectors" of the book rather than service personnel to the user, is no longer valid. The concept of active service, i.e. not waiting for the user to come to the library and not ignoring him once he arrives, increasingly has infused the planning of library services in public, academic, and school communities.

Special libraries, with their limited collections and limited services, have long recognized the need for user orientation as a pervasive factor in providing information to their clientele. Team approaches to library research problems and extensive training programs for new employees have been organized with skill and effect. Special libraries, often in co-operation with professional associations, have pioneered in such areas as:

(1) Identifying the user's needs;
(2) Developing methods of reaching their clientele;
(3) Simplifying the processing operations;
(4) Developing increased depth of subject access and information service in very narrow specialized fields.

The most comprehensive study of the characteristics of library use and users remains that of Berelson.[16] Use factors identified as relevant for this Study can be summarized as follows:

(*a*) Printed and published information constitutes a minor source of information for the user. Oral communication is by far the most frequently used source, with libraries and information centres ranking about 8 to 10 on a scale of 1 to 12 as sources of information.[17]

(*b*) The distribution of use forms a Poisson distribution with a small "communications élite" accounting for an unusually large amount of use. Library users generally have more extensive personal files, listen to more radio, watch more television, see more films, and buy more books than the general population average.[16]

(*c*) Convenience of access appears to be the primary factor governing library and information centre use. Colleagues, personal files, and local sources of information are consulted before attempting to obtain information from formal sources.[18] Proximity, ease of use of the material, and successful experience in obtaining information further influence the sources approached for task-oriented information.

Studies of what the needs and wants of users are constitute two aspects of the same problem. Opinion-sampling does provide some indication as to the desirable services, but is limited by the experience of the respondents. Users who have not worked with a specialist knowledgeable in information sources may not realize the potentials and may consider their own limited efforts adequate. Extrapolation of present user characteristics has, historically, been the most secure statistical method for planning and adapting to defined user requirements. However, little is known of the relevance of services provided to the user's interests and the use of libraries. Except in isolated case studies, there is little investigation of the way in which scientists and engineers utilize information. The basic assumption of such studies is that, by relieving the scientist of the burden of searching for and obtaining information, the time so saved on his part will be put to increasingly productive use. There has been little substantive investigation that either affirms or negates this assumption.[19]

Three concepts are appropriate in describing the link between the use of materials and the user:

(1) relevance,
(2) accuracy,
(3) availability.

Information that is not relevant to the user's needs is of no concern; information that is relevant requires accuracy both in content and description of content; information that is both relevant and accurate must then be available to be of use. The concept of relevance lies with the user. The concept of accuracy is dependent on both the originator of information and the processor. The former can only be judged accurately by the user, while the latter must become the principal responsibility of information entrepreneurs, particularly the librarian. Availability is primarily the responsibility of the information entrepreneur, but in too many cases this responsibility has been passed on to the user.

Libraries have been unable or unwilling to recruit or train appropriate subject specialists in numbers large enough to relieve the user of this added burden. The main thrust of contemporary library service has been to provide the tools by which the user may determine relevance, and to provide the information itself when demanded. This provides indicative service, i.e. pointing to where the information might be found, and represents the primary type of service now available in libraries. However, it does not satisfy the aspect of user needs which requires informative service, i.e. actually moving the information to the user in sufficiently digestible chunks upon which judgment might be rendered.

The reaction of scientists and engineers to increased volumes of information has been a deeper specialization in narrower fields. They have developed their specialties in greater and greater depth to the extent that a new type of specialization, dependent on the ability to interconnect and relate narrow fields, exists as a valid area of scientific endeavour in itself. The specialization of interdisciplinary subjects, often referred to as mission-oriented, such as urban planning, transportation, natural resources, and space travel, has cut across many disciplines, restructuring them in such a way as to render obsolete traditional methods of organizing the subject content by discipline.

The correlation of library use with educational achievement of users is well known in the library field. The tradition of service for adult self-education has been a bulwark for the support of libraries for many years. However, the main role played by libraries in adult education has been the provision of accessibility to materials.

In science and technology, many users feel libraries provide adequate service (27 per cent in the DOD User Needs Study),[21] but still others distrust the librarian as an intermediary in their search for information. Some scientists in highly specialized subject fields prefer to do their own information searching. Dependence on libraries or any other agency is viewed with suspicion. This factor will not conceivably be greatly altered by the provision of a scientific and technical information system. The main reason for this suspicion on the part of the scientist is the strait jacket imposed on him by the cataloguing rules and the list of subject headings. The scientist is forced to search for his documentation according to the way of thinking of the cataloguer, who in many instances is not a specialist in the discipline. The author approach for corporate entries is no better. Previous experience with library services undoubtedly contributes to the lack of confidence on the part of scientists leading to their self-service approach. On the other hand, technical and scientific personnel are not necessarily aware of or able to use many of the services, bibliographic tools, and resources available to them through library facilities.

For example, patent literature, government documents, and technical reports form important sources of information that appear disorganized to the user, but are in fact highly organized. Knowledge of the tools that are available and that provide access is not given to the users in their normal educational programs. Consequently, most self-service-oriented users tend to particularize and depend on sources found in the past to contain material relevant to their needs. Responsibility for acquainting these users with the tools available—an educational function—is too often ignored by librarians.

The use of both a scientific information system and the library will likely remain the same until sufficient education of users takes place. Once the user has been educated to utilize increased service, his demands change and the characteristics of his use change as well. It is impossible at this time to predict the nature of these changes.

Section IV

SPECIFIC ISSUES

IV.1 Organization

The most important factor governing the establishment of a national scientific and technical information network will be the solution of the problem of centralization. Both the degree and the type of centralization influence any interface among components that will make up the system.

Canada is a geographically large country with a very small population, scattered over a wide area, that is rapidly urbanizing, with strong regional loyalties, two official and many unofficial languages. Its information stores reflect this pattern. They too are widely scattered, with the user population concentrated in well-defined industrial centres and with a strong regional bias in the development of collections. In such a country any national STI network will probably have to be organized on a regional basis if it is to be acceptable and effective.

The degree of network centralization within regions will vary, but the establishment of regional centres should be based on the density and location of present information stores and on user patterns that indicate a sufficiently high volume of use to ensure an effective operational unit. More important, such designations will allow the network to be built on the strength of the country's existing resources rather than along arbitrary geographic lines. This, though, should not eliminate geographic considerations as one criterion in the selection process.

Some efforts toward regional units of co-operation are already under way and could easily furnish the nucleus for regional centres in their areas.[14]

The functions of regional centres include:

(1) Inventory control of materials;
(2) Intra-regional reference referral service;
(3) Inter-regional message switching for requests that cannot be satisfied within the centre;
(4) Rapid intra-regional and inter-regional delivery service of materials that cannot be delivered electronically;

and, in later stages:

(5) Co-ordination of acquisitions and processing;
(6) Centralized storage of certain little-used information;
(7) Provision for subject-oriented and other specialized information services;
(8) Provision for systems design and programming services for specialized projects based on user needs.

The nature of regional centralization will differ in different regions. Centralization can be based on type of user, subject field, or applied research development. In any case, the design of one regional centre should be sufficiently flexible to accommodate different approaches and should be compatible with other regional centres across the country. In this way, the accumulation of functions at the regional centre is dependent upon the approach of the local libraries which, in turn, are dependent on the needs of the local users. Since in practice a combination of approaches will probably be necessary, regional centres will have different functions depending on user needs. This will generate "in-depth" specialties among the regions, both in services to users and in techniques used by service units to do their work. These should be encouraged but not duplicated, as they can be used by other regional centres. Co-ordination in establishing designations and priorities is necessary and will have to be done by an agency with suitable jurisdiction.

A key role in the library system should be played by the National Science Library: it now acts as a back-up central store for the present informal arrangement among libraries. Telecommunication channels connect the major libraries with the National Science Library and with each other. This represents a first step toward the establishment of a communications network. The leadership capability and participation of the National Science Library in a national scientific and technical information network is a necessity and must be expanded. This will require funds and perhaps new legislation. The National Science Library should act as a central message-switching and processing centre during the development stages of a national network. The fact that it has not already taken a more active role in such development is disappointing and should be examined critically. The role of the National Science Library is so vital to the success of the system, particularly in the development and design stages, that no more time should be wasted. There is no point in sinking funds into this central store unless it recognizes its responsibility to the entire nation. Duplicating this resource would be an expensive and wasteful undertaking that Canada cannot afford.

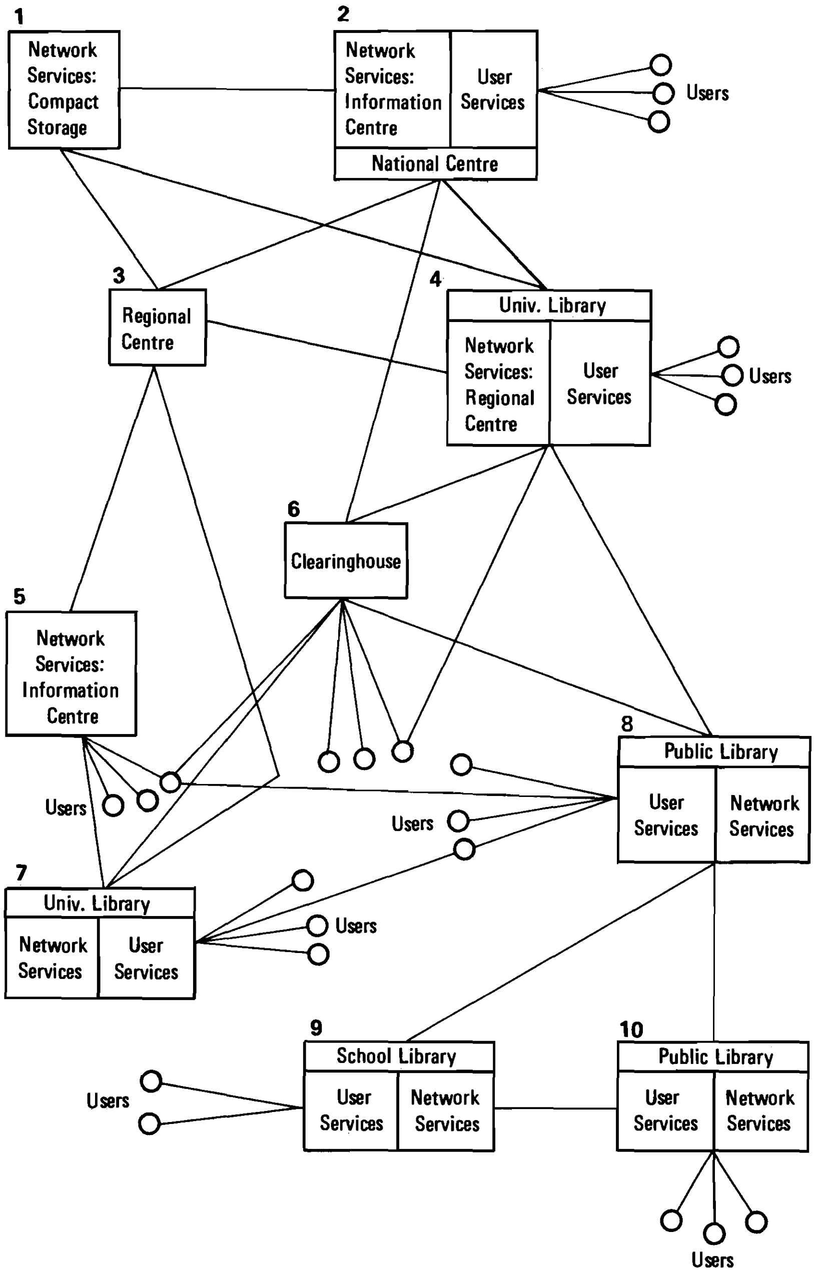
In terms of functions, the national scientific and technical information network will consist of three quasi-hierarchical units:

(1) Centralized national network services, including information storage and switching functions;
(2) Regional centres;
(3) Service units.

All units will have some degree of dual functions in user services (servicing all information needs of local users) and network services (servicing network needs at other nodes of the network). Some service units may be designed entirely on the basis of providing network services with little or no direct user contact, e.g. a clearinghouse for technical reports, some on the basis of providing direct user contact, restricting the provision of network services to the minimum contracted for participation. The degree of concentration on the dual functions will depend on the local situation.

The library system consists of those nodes based in libraries that will now have the added function of servicing network requirements at other nodes. They already have the function of providing local user services. Part of the added function will involve responsibilities associated with operation as a regional centre,

Figure 1. — National Scientific and Technical Information Network



an information centre in a subject field, a local compact storage centre, a local area message-switching station, or a combination of these. All service units, regional centres, and national units compose the national STI network.

The permutations possible within the network concept are immense. Some degree of the complexity involved is illustrated in Figure 1. Points to be noted are:

- 1, 2, and 6 are components at a national level, i.e. they provide service to the entire system although they need not be located physically on one site.
- 3 and 4 are regional centres–3 a unit designed specifically to function as a regional centre, 4 as an addition to local user services provided by an existing library.
- 4, 7, 8, 9, and 10 constitute the library system. Some users may overlap, although this tendency will decrease since any single service unit provides access to the entire system.
- 5 is a subject-oriented information centre servicing users who may also be served by a local library.

Certain other guidelines must be considered in developing the organizational structure:

(1) Regional centres must be compatible with existing services;
(2) No system will be acceptable if its resources are less accessible than at present;
(3) Some duplication of frequently used information will be necessary;
(4) All services of the entire system should be available at the local service unit;
(5) A cost for the service will have to be levied;
(6) Control, both legal and administrative, must be exercised at both national and regional levels.

IV.2 Communication

The entire concept of systems created from service units is founded on a highly sophisticated communications facility linking all libraries and service units in the system. A communications facility superimposed on the present disconnected information stores in libraries will go a long way toward improving present services while illuminating problems implicit in recording standards, processing techniques, and service performance. Superimposition of a communications facility must be co-ordinated and systematically phased into an operational system with clearly defined procedures.

Since the implication of an STI network includes provision of service to all users wherever they may be located, it should be possible for any one service unit to communicate with any other service unit, whatever the location. Because of the geographical factors involved, the communications facility will be expensive to establish, but operating costs will decrease as communications technology advances and as volume of use increases. Volume of service, priority of needs, and speed of service are factors influencing the nature of the communications mechanism for local service units.

Eventually, the communications facility will include electronic message-switching centres routing both requests for information and replies at electronic speeds, including oral messages through the telephone, visual messages through television, telefacsimile through devices similar to long-distance Xerography, and digital form through computers.

Two types of messages may be readily identified: (*a*) those having an explicitly defined situation, (*b*) those having an implicitly defined destination. The former are the easier to handle since they need only be routed to the appropriate destination. The latter may require the development of extensive internal reference files for selecting and routing the message to the most appropriate destination, namely, those service units that have the greatest probability of responding to the message. The latter may require development of directories to aid switching centres. A "shot-gun" approach, routing implicit destination messages to all service units, may be the only economic alternative in the initial stages of development.

The method used to return information to the user is again a matter of economics. As has already been indicated, many possibilities are open, but special arrangements with postal services should not be discounted as an economical, effective, and efficient means of transmission between service units, particularly where high-volume, low-time-priority information is requested.

Geography probably dictates regional development in a hierarchical order with increasing diversity of message-handling capability as the message is switched from local service units upward through the hierarchy to a regional switching centre which, in turn, communicates with other regional centres or a national centre. Such a communications network can only be effective if the switching is accomplished at high speeds with a minimum of human intervention. Economics will determine the mode of transmission, but the following are likely possibilities:

(1) Telephone transmission to a regional level for high-priority, low-volume messages;
(2) Teletype transmission for medium-volume messages;
(3) Broadband transmission for high-volume, high-priority messages;
(4) Postal services as an alternative for low-priority, high-volume and low-volume messages.

The user should be kept informed of the relative promptness available in servicing his information requirements so that he may establish priorities. Since fees in some form will be involved, the user should understand his options and set his own timetable.

The communications network should carry, in addition to the STI necessary to satisfy user demands, administrative reporting information, including statistics on the use of the communications channels. The management information necessary to continually evaluate the network's effectiveness and costs must be a built-in capability.

Management should also be able to initiate studies on peripheral problems that are introducing noise into the system. Consider the following. One of the more crucial problems involves the scientific paper. Over the years, the primary means of communication developed by the scientist was the scientific paper. It has been his most effective device. Because of the pressure to publish and the lack of qualified referees, information by scientists and pseudo-scientists, the competent and the incompetent, responsible and irresponsible, is being produced and stored at an alarming rate. All of it, whether it be useful, irrelevant, or scrap, is being accorded the same treatment when acquired for permanent storage. What can be done? Who is to police the scientists? Answers to these pressing questions must be found soon if the traditional system of reporting new findings through research papers is to survive.

IV.3 Network Access Tools

Another implication for the system under discussion is that all STI resources will be available to any service point in the system. This, in turn, implies an inventory control subsystem and a delivery subsystem to meet this objective.

Knowledge of all resources available must be transferred to the user through some communications mechanism. Ideally, the user should expect that whatever information he requires is included in the system, and the system should report only when the information is not in the system. Such an "exception" is an ideal objective and may not be feasible. Even a national STI network cannot hope to have at its disposal all information from all sources. The sheer magnitude of the world's yearly output of information is prohibitive, but goals must be set and priorities established. To offset this shortcoming, it may be necessary to identify and communicate to the user some description of the resources available. An inventory record file should be required, indicating the location of resources. Both university and public libraries are actively engaged in experimentally developing machine-readable inventory records.

The Library of Congress *de facto* MARC II bibliographic recording format will probably become the most prevalent standard in both Canada and the United States. This standard may be adopted as the initial system standard for bibliographic recording in machine-readable form. Instructions should be given to all libraries considering records conversion to adhere to this standard bibliographic format so that programs for manipulating information developed within the system will be compatible. Since voluntary acceptance of co-operation in the library field has thus far failed, enforcement of standards can only be accomplished through agencies with broad supervisory jurisdiction and power.

Inventory control information of a different type must also be available to the user, including:

(1) Information services available;
(2) Research and development projects in progress;
(3) Scientific and technical personnel engaged in similar research;
(4) Development areas being considered for research;
(5) Knowledge of the location of specialized equipment installations.

Such supplementary inventory files for secondary referral are required to enhance informal communication between scientists and engineers. A start on secondary files could be made by improving the descriptions of research projects in science and engineering carried out by graduate students at Canadian universities, as presently reported by the National Research Council of Canada. Requirements for including project descriptions, biographical information, and reporting project results could be included in the terms of government research grants.

Descriptions of the types of information services available to the user through the network must be made known to him. This can best be done through the service units and independent announcement in journals and newsletters. The co-operation of professional societies and associations is also needed as they are both contributors of information and announcement vehicles for information.

Collections of copies of machine-readable files integrated into a single inventory file could form the nucleus of the central inventory control file of the entire system. Incentives in the form of funds and programming support could very readily cause the initial establishment of this centralized inventory file. The complete inventory file would then be accessible to the user through some off-line printing device or some other electronic equipment. Computer facilities could utilize the machine-readable records through on-line interrogation or whatever means proves feasible.

In the early stages, only the larger service units would be provided with a printed copy. Photographic preparation of the inventory files in hard copy or microform for wider distribution is also possible, but this concept suffers from the difficulty in updating and from the greater expense of the project as the file size increases. Recording bibliographic information is time-consuming and costly, but once the initial system is in operation contributing service units need only convert to machine-readable form those records not already in the file.

The identification and inclusion of information from those system components without access to data-processing equipment must be accomplished on a systematic basis. This will be an expense which will require subsidization. Arrangements for inclusion of a library as a service unit in the system could include the submission of a plan for inventory recording of the local resources as a condition for acceptance, since these smaller libraries usually will gain more from participation in the system than they will contribute.

With the history and location of all resources available, the information itself must be accessible to all service units in the system. A delivery subsystem must be established that will move the information efficiently and promptly either to the user directly, with notification to the local service unit when appropriate, or through the service unit to the user. Standards of performance for the delivery system must be defined for:

(1) Local provision of information from locally available resources;

(2) Local provision of information from the closest available source.

Standards may vary according to factors such as (*a*) type of information, (*b*) urgency of request, (*c*) location of requester, (*d*) type of transmission, (*e*) type of receiver, (*f*) costs.

A graduated scale of charges should be developed that will enable evaluation of all the variables and determine the type of delivery service required and the cost. It is obvious that a minimum but no maximum cost can be developed. The overall goal of the delivery system is to provide the user with the information required as quickly and cheaply as possible. Economic support will influence the establishment of minimum cost standards, but need and user resources should override economic policies that would penalize poorer users.

The option to establish the form in which the information is desired and the speed of response required should be left to the user. The graduated charge basis should be imposed only for excessive and consistent demand for delivery performance in excess of the minimum standards. All users should have a high-priority option for a small percentage of their total requests. Co-operation through communications services provided to users, possibly including computer service as a public utility concept, should be explored. This may involve linking service units with computer centres or service bureaus through some message-switching subsystem and, at least initially, would only be feasible for low-volume, high-priority information.

IV.4 Legal Problems

Legislation is needed to encourage the formation and implementation of a national STI network. With the exception of special libraries, all other libraries that should become a part of the network are traditionally allied to education, a provincial responsibility. Public libraries are so enmeshed in restrictive provincial legislation with initiation and control by municipalities that only informal co-operation on a limited basis can be justified without enactment of legislation that will permit a sharing of resources. It is reasonably certain that such action would be coupled with the request that a management reporting system, to protect the sovereignty yet ensure the rights of service units within the system, be an integral part of the national information network.

Assuming the availability of funds, legislation will also be required to ensure the transfer of funds to participants for the support of information services and resources involved in the network. One approach is to provide direct qualifying contracts to participants upon their entrance into the national network, with some legislative mechanism ensuring adequate provincial support for later maintenance as local service units. The barrier of restricting services to local taxpayers must be overcome so that public library participation can be assured. All service units must be accessible to all prospective users.

The legislative problems are not so severe for university libraries. Many universities are provincially supported and are already tending to provincial regionalization. Resources and services are shared within provinces under these arrangements.

School libraries, which are under the direct control of school boards, face the most severe legislative problem. Here, too, a movement toward regional systems is under way but is in its infancy.

Special industrial libraries and information systems are regulated by company policy. They face almost no legislative problems and can be expected to co-operate.

Tax support and other funding for the library system are intimately associated with legislation. Funds must be available at a federal level for overall co-ordination of the network, and at a regional level for regional co-ordination. Some form of internal, interprovincial, financial compensation mechanism must be developed and accepted by all participants.

Incentives in the form of economic support must be available as a motivating force to the larger libraries. They must be encouraged to develop their facilities for participation in a national STI network where their initial roles will be greater as contributors than as users. It is unlikely that any library will participate in the network without either financial incentive or legislation requiring participation, or both. The experience of present efforts at developing regional systems bears out this theory. Few libraries are willing to decrease voluntarily their local development by contributing funds or material support to the regional system.

The greatest incentive would be provided by joint provincial and federal legislation establishing participation commitments as part of the requirement for accepting federal funds in support of information services. This would ensure that libraries would obtain federally allocated funds in support of their collections and for their service. For special libraries, some form of contract or funding involving participation commitments may be the only effective measure to ensure co-ordination of resources and services. In all cases, funding would be based on the contribution expected of the participating service unit. For this reason, contracting for services may be the simplest and most manageable approach.

Budgeting mechanisms and management reporting systems will be required to ensure that the funds allocated are in fact used for the purpose of integrating local resources and services into the library system. In the early stages, special funding mechanisms will be required for:

(1) Conversion of participating libraries into service units;
(2) Continued development of "centres of excellence" based on local collections or specialties;
(3) Unusually expensive equipment;
(4) Supplementary support of message-switching centres;
(5) Large, more active local service units.

An economic problem may be resolved at the federal level by subsidizing certain levels of the communication costs throughout the network so that the obvious factor of distance does not become prohibitive to areas that need this service most. Financial support for training local library personnel or employing special staff in procedures associated with system participation, particularly for service units conducting user training programs, must also be considered, as no mechanism exists at this time for these purposes.

The administrative structure of the network has the difficult objective of maintaining a delicate balance between sufficient control over local and private interests while protecting the rights of participants who already have a considerable investment in resources and services. It is clear that a central administrative body will be required to ensure development consistent with all the objectives of the scientific and technical information network.

The central administration will have five functions:

(1) Co-ordinating the development of the system, including setting standards of performance;
(2) Establishing priorities in meeting objectives;
(3) Constantly monitoring the progress of all parts of the system with the

power to adjust priorities accordingly;

(4) Advising on the distribution of funds for maintaining system operation, system development, and special funding according to priorities;

(5) Developing and monitoring long-range planning for the evolution of the network.

The central body should not be unwieldy in size and should be supported by an advisory committee of regional representatives. This committee would make suggestions on planning requirements and indicate areas requiring attention.

Regional administrative bodies will also be required for examining problems at that level. All participating service units should have a designated representative to the regional system whose responsibilities include liaison with the regional administration. In effect, the representatives should have the responsibility and authority to speak for their service units on operational problems, policy and development of their local service units that participate in the national network. It is important to ensure adequate communication between the local service unit, the regional administration, and the central administrative body. Decisions affecting the design, performance, and resources of local service units should be made in tandem with local network representatives.

The administrative structure suggested would have to be responsive to and aware of user needs on the local level. Decisions would require consultation with operating personnel concerned since they deal directly with users. Finally, if an operational administration for complementary services such as network design and implementation is required, it should be part of the network and not a separate unit.

IV.5 System Evaluation

A system's effectiveness depends on the quality control built into the system and the feedback from the users. Statistics on the use of every aspect of the system should be maintained until reliable and meaningful measures of performance can be used in evaluating system effectiveness. This will help develop a variety of policies, including those relating to discarding, which must eventually become a necessity. The degree of user responsiveness must be considerably higher than that presently achieved in libraries. Measuring system effectiveness will involve:

(1) A reporting procedure;

(2) Monitoring of system use;

(3) Personal contact with users;

(4) A management reporting system at local, regional, and national levels.

Other useful criteria for which measurements should be developed and maintained include quality of response, response time, user satisfaction, and economic cost effectiveness. Since volume of use is, in most cases, an inadequate measure of use or its value, associated strategies must be developed to help determine the strengths and weaknesses of the system. Singularly important in this respect is system integrity. Users must be assured that they are receiving the full attention of the system in response to their needs and that their requests, if desired, will remain confidential. Only these guarantees will assure participation of competitive industrial firms and some government agencies.

IV.6 Financial Issues

Fulfilling the criteria listed above is expensive, but economic considerations must be balanced against consideration for user convenience, promptness, and efficiency, all of which are based on user need. Information is expensive, so users must appreciate that there is no such thing as free service. Since accurate and appropriate information saves time and money, users can be expected to react favourably to reasonable charges for reasonable services they believe will benefit them. It is reasonable to expect the Federal Government to ensure the availability of the "raw" information, but it is unreasonable to expect it to provide packaging to fulfill everyone's needs. The costs incurred in packaging the information must be defrayed by the user.

The point to be made is simple: users must pay for the operating costs of specialized services possible in a national STI network. The initial capital outlays that would be needed to establish and implement these services should be provided by government grants in stages as the network is developed. It is obvious that a minimum level of convenience and promptness may be defined for each service. However, greater sophistication and increased speed of service should also be made available to those users willing and able to pay for them.

The efficiency of the transfer process is the most important variable in relation to economics, but it must be balanced particularly within the processing operations. For example, it is well known that the more time spent on analysis, the less time is required for retrieval. Since time spent by personnel within the system correlates closely and directly with processing cost, a balance must be established that takes into account:

(1) volume of input,
(2) value of input,
(3) effectiveness of retrieval,
(4) frequency of retrieval requests,
(5) value of output.

Because of uncertainty concerning the nature of users' requests, specialized analysis and retrieval techniques will be required for particular users, which again will have to be supported on a fee basis from the user. A good example of this service would be an in-depth subject analysis on behalf of the patent department of a chemical industrial firm. To perform such a function promptly, service units must have an established minimum level of convenience, promptness, and efficiency. They must also have a minimum level of economic support large enough to meet changing overall conditions and sufficiently flexible to adjust to specific user needs on a demand basis.

The whole question of compensation for development through finances, processing contributions, or personnel services remains unresolved. The library, developing new methods for a specific aspect, feels that it has a vested interest in its programs and data base, while the requesting library feels that it has every right, as a fellow member of the library community, to obtain the programs and data bases developed. Although undeclared, an "every man for himself" attitude is prevalent and is inhibiting the exchange of data and programs. Apart from the program initiated by the Canadian Association of College and University Libraries, there has been no voluntary consolidated effort on the part of the smaller libraries to band together to support systems development applicable to their operations.

IV.7 Network Personnel

To develop and then implement a national scientific and technical information network, good people will be required. Finding them will not be easy, for they must be recruited from disciplines with existing shortages. The jobs to be filled fall into three major categories:

(1) The network systems design phase, which would include input and output specifications;

(2) The administrative and legal liaison organizing phase with the municipal, regional, and national units within the network;

(3) The operating phase, which services user requests.

Ten groupings seem relevant to this discussion of network personnel. These groupings are neither logic-tight nor mutually exclusive, but do seem to encompass the requirements needed to satisfy heretofore identified user needs.

(*a*) Administrators. Many of these will come from existing libraries and information systems that will constitute much of the network. However, a whole new group will be needed to assume overall direction of the project. To demand imagination and intelligence as a requisite to appointment on this level will not be enough, for these individuals must understand the potential and relationships of all the components that will be introduced into the new network. Good organizers and administrators will be useless unless they know something about systems planning, information handling, and electronic equipment performance.

(*b*) Engineers and Systems Design Planners. This group must come from computer science, linguistics, philosophy, engineering, mathematics, psychology, or library science departments, and from technical and business schools. Initially, many will have to be trained in the complexities of information handling since they will not be familiar with the systems problems they will have to overcome.

(*c*) Subject Specialists. Most will have to come from the ranks of the scientists and engineers who are sufficiently information conscious to be willing to spend part of their time away from laboratory work. Strong incentives will be needed to entice them, as such work on this continent is at present considered second-rate. Some librarians will qualify in this category, but most lack the necessary scientific and engineering background. The work of this group is critical and will help to determine the input into the system, including the development of better abstracts, faster translations, and the improvement of indexing, subject analysis techniques, and critical reviews of the literature. This group will be the most difficult to recruit, yet the Russians have been moderately successful because they have been willing to employ older, retired scientists and engineers.

(*d*) Literature Specialists. These, too, must be recruited from the sciences. The ideal individuals are represented by scientists and engineers with degrees or experience in research and development, experts in the literature of the subject field, as opposed to research and development activity, who are willing to contribute their knowledge of the literature to developing collections and improving reference techniques.

(*e*) Librarians. Indicative reference and bibliographic service will always be needed. Someone will have to help users locate material in books, in machines or in buildings as well as train them for future library use and, on certain levels, advise them of the appropriateness of material sought. This work will not provide enough incentive for many of today's librarians. Some are experienced in handling and organizing information, and can be effectively retrained with a systems orientation and utilized in other areas of the network.

(*f*) Educators. This group will be the most important. A new curriculum must be developed, and educators must fully recognize and be able to utilize its potential. Among the responsibilities of such educators would be the development of:

- –Continuing education programs for librarians, information and communications specialists, and indexers, i.e. the operational personnel;
- –Orientation programs to train scientists and engineers in the use of information systems and in the preparation of scientific information.

(*g*) Information Scientists. These are interdisciplinary personnel who have been educated in all aspects of systems design potential, documentation, linguistics, and the many disciplines contributing to the handling of information. They will contribute their knowledge to the design and development of the network, particularly with respect to adapting intellectual requirements to the limitations of existing electronic devices.

(*h*) Information Technicians. These technicians will undertake routine implementation of electronic communication switching functions and will ensure the continued effectiveness of the machine operation of the network.

(*i*) Library Technicians. This group will be trained in the mechanics of library operation procedures and will effectively undertake the implementation of routine clerical decisions and procedures throughout the various service units.

(*j*) Public Relations Personnel. The job of these people is not an easy one as they must educate the public about the value, cost, and use of information. The concept of "public" used here means all users, regardless of position, educational background, or geographical location. We should not assume that government officials are better informed on the information question than doctors or cab drivers. This is a national problem involving all of us. In the future, information will be as important to society as labour and capital, yet many remain unaware and uninterested. The task of educating the public and keeping them informed should be undertaken on a full-time basis. Information costs and makes money. The public should be shown how and why.

All personnel within the network must recognize that major success will only be achieved by the network if it is sufficiently adaptive to the users. Despite good educational programs for users, and excellent systems personnel, the network will be of no value unless it is used. It will be necessary for the system to anticipate user needs and act on changes. A high degree of personal contact between the user and network personnel is implied. The possibility of mobile teams of specialists, aiding and advising users with particular needs, should be explored. In areas where there is a sufficient concentration to warrant the establishment of a subject-oriented analysis centre, it should be done. In fact, anywhere there is sufficient concentration of need, experts should be available. The regional centre must not be a refuge as the library once was for avoiding user contact by referral to less qualified personnel. The user must have convenient access to competent professional advice without "wading" through a hierarchy of clerks and part-time student assistants.

Training will be a crucial element in all future systems planning. What is needed is a program for training personnel, according to ability and educational background, who can fit wherever they are needed. The information network will provide an incredible variety of opportunities. The pressure on library schools to prepare students for immediately useful vocational training cannot be ignored, but to respond solely to this demand may well lead to a state of intellectual bankruptcy within the profession.

Directors of library schools recognize the need for librarians with advanced degree training, and are reviewing their curricula in the hope of developing programs that will meet the needs of the future. Professor Land, Director of the University of Toronto's School of Library Science, has summarized this position very appropriately:[22]

> "There is a need for librarians competent to engage in theoretical and empirical research on the implications of the information explosion and to assist in the development of information retrieval systems.
>
> "There is a need for librarians who have undertaken advanced study in subject analysis and computer science to direct the automation of library processes in large public, university and special libraries in Canada.
>
> "There is a need for librarians with a background in library systems management to plan and direct the organization of regional library units now being formed in Ontario and certain other provinces.
>
> "Librarians who have completed advanced studies in the bibliography of particular subject fields are required to direct the building of book collections in large libraries in subject fields ranging from African Studies to Zoology.
>
> "Librarians with a knowledge of educational theory and methods are needed to correlate library service with all levels of educational activity.
>
> "There is a great need for librarians with graduate degrees to staff existing and proposed library schools in Canada. Shortage of qualified faculty has inhibited the expansion of existing graduate programs in library science."

Our motivation for dealing with problems of training information scientists and librarians, including undergraduate and continuing-education programs, library technician and library clerical programs, is to emphasize two main points:

(1) Proper training is decisive to good service;

(2) New ways must be found to train future librarians, since traditional methods have not met the current requirements of the scientific community.

Section V

RECOMMENDATIONS

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.**

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Appendix

Appendix

A REGIONAL SCIENTIFIC AND TECHNICAL INFORMATION PROPOSAL

Introduction to Proposal

What follows is an interesting example of a proposal for the development of a Regional Scientific and Technical Information Centre. It is deliberately brief and is not intended to be either definitive or the model on which other proposals should be based. What is intended is to illustrate some valid concepts and principles at work:

(1) Support of top administrators in the region;
(2) Definition of services and functions of the Centre;
(3) A plan for development and co-operation;
(4) Definition of the scope of the user population;
(5) Relationship of regional system components;
(6) Survey of present resources;
(7) Projected implementation schedule.

These considerations are perhaps minimal requirements for voluntary co-operation within a region. A second proposal for subjects other than science and technology is being developed by another group within the area, the Nova Scotia Council for Library Resources.

PROPOSAL FOR A REGIONAL SCIENTIFIC AND TECHNICAL INFORMATION CENTRE IN THE HALIFAX-DARTMOUTH AREA

The undersigned endorse in principle the following concepts for the development of a Regional Scientific and Technical Information Centre.

Dr. Wm. L. Ford	Director, Bedford Institute of Oceanography
Dr. L. M. Dickie	Director, Marine Ecology Laboratory, Fisheries Research Board of Canada
Dr. H. Labelle	President, St. Mary's University
Dr. H. D. Hicks	President, Dalhousie University
Dr. A. C. Neish	Director, Atlantic Regional Laboratory, National Research Council of Canada
Dr. J. G. Retallack	Director-General, Defence Research Establishment (Atlantic)
Dr. G. W. Holbrook	President, Nova Scotia Technical College
Dr. J. E. Blanchard	Vice-President, Nova Scotia Research Foundation
Dr. O. F. Matthews	Industrial Research Officer, Industrial Estates Limited

(1) Introduction

During the past two years, it has become apparent to the scientific community in the area (principally those engaged in marine science studies) that a regional scientific information centre and library is advantageous to continued development. To this end, representatives of the six agencies especially concerned with various aspects of marine research met twice last winter to discuss how best to tackle the problem. While no firm conclusions were reached on *how* to go about creating such a centre, all the representatives agreed that such a centre would produce desirable results. Study of the project lapsed during the spring and summer pending availability of full-time staff to handle it, but interest was renewed this autumn. The visit on November 23, 1967, by several members of the Study Group on Scientific Information in Canada generated further discussions and new stimuli. An enlarged group, more representative of the scientific, engineering, and industrial community, has now studied the problem and produced this brief.

The problems concerning scientific and technical information are not by any means unique to this area. In fact, the U.S. President's Science Advisory Committee stated most of these in its report *Science, Government, and Information* put out in 1963. The report begins with the statement:

> "Transfer of information is an inseparable part of research and development. All those concerned with research and development–individual scientists and engineers, industrial and academic research establishments, technical societies, government agencies–must accept responsibility for the transfer of information in the same degree and spirit that they accept responsibility for research and development itself."

The report expands on this considerably and makes a number of recommendations. Of these, two are particularly pertinent to our situation:

> "The technical community must recognize that handling of technical information is a worthy and integral part of science."

> "The technical community must explore and exploit new switching methods, i.e. Specialized Information Centres."

The scientific and technical community in this area *have* seen the need for more efficient handling of technical information and *have* thought of ways and means to do it. This has resulted in a proposal for a regional scientific information centre ("a specialized information centre").

(2) A Scientific Information Network in the Halifax-Dartmouth Area

A diagram showing the groups and laboratories with an interest in any proposed regional scientific information network in the Halifax-Dartmouth area is included as Figure 1. It is envisioned that a network involving them would be a two-way street, in that information would be both generated and requested at the local level. In this way a regional centre could act, where appropriate, both as a referral agent and as the holder of a great mass of marginal published information (books and journals). In this case, marginal means in reference to the current needs at the local level. Where appropriate, the local research establishments would be considered as "centres of excellence" for particular scientific disciplines and so

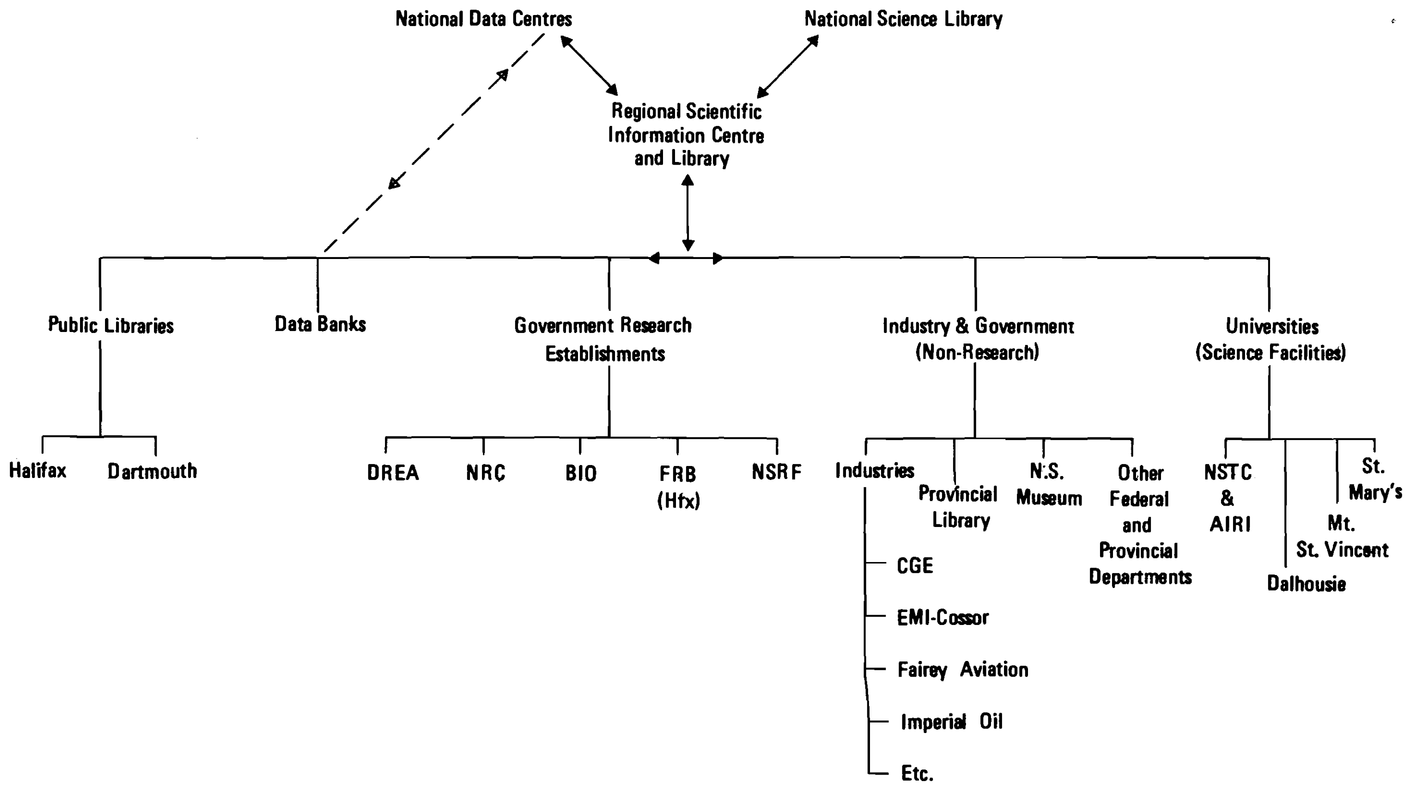

Figure 1. – Diagram of proposed scientific and technical information network in the Halifax-Dartmouth area, embodying a Regional Scientific Information Centre and Library

become repositories for information in that field. For instance, the Bedford Institute of Oceanography could become a repository for information on the marine sciences, in view of the wide scope of marine research activities carried out there.

(3) Services and Functions of a Centre

(a) Output from Centre

It is desirable that, in the early stages of development of a Centre, material requested by the local level unit should be supplied by the Centre in the form of either the original document or a photocopy. In time, as more sophisticated copy, supply and transmission methods become more widely used and available, other formats (such as microfilm, microform, computer tape, cathode ray display) could be used. Considerable research along these lines could be carried out at the Centre, in conjunction with the large pool of scientific talent in the area.

(b) Acceptable Delivery Time from Centre

When the material is available in the Centre or its associated working repositories, a delivery time of no more than 24 hours should be the goal. In other cases, the shortest possible time is, of course, desirable. If the Regional Centre is tied into a national network, or at least to the National Science Library, this time should be brought to a minimum. With the local network, a daily or twice-daily truck delivery would be necessary initially.

(c) Input to Centre

Information lodged in the Centre will come through purchases on its own initiative, especially in fringe-interest journals, abstracting and information services and translations, purchases made by the local establishments and sent in, and information generated in the local establishments and submitted in the form of published or unpublished reports. It is anticipated that the Regional Centre would eventually house sets of periodicals to complement those held by participating units and subscribe to many that are not being taken by the local establishments. Each local establishment would subscribe to the periodicals it felt were necessary to carry out the current research programs. The same principle would apply to book acquisition. Some degree of co-ordination, perhaps to the extent of centralized purchasing, may be desirable to prevent undue duplication. A central index or catalogue of the holdings in the Regional Centre and in the local establishments would be assembled at an early stage. This would be held in the Regional Centre and, in whole or in part, by the participating units.

(4) Development and Operation of a Centre

(a) Location and Housing

It is logical that a Centre would be established at or in conjunction with the best-developed local library facility. This is now Dalhousie University, and initial development of the Centre would benefit by close co-operation and association with the Dalhousie Library. This policy agrees with the statement on page 6 of the Annual Report (1966-67) of the Dalhousie Library: " . . . Dalhousie is to become the major research and referral centre for Nova Scotia and perhaps the Maritimes."

However, it remains to be established that the research information service can develop in parallel with and based on the same facilities as are required for the different university functions. The extremely rapid rate of growth of university, research institute, and industry needs must inevitably place heavy demands on any single facility. To meet such pressures without succumbing to the special rules or requirements of any one unit will require great care in administrative organization. The possible eventual need to physically separate the university study and research information functions should be recognized.

At the beginning (mid-1969), the Centre could be housed with the Killam Library at Dalhousie. Before that date, co-operative projects requiring little space (such as the catalogue of all holdings in the area) could be started. As the Centre grows it will likely outgrow its quarters in the Killam Library, a stage which may be reached by 1972 or 1973. Table 2 shows a tentative timetable for the development of the Centre. A separate physical plant which will have to be provided by that time should be planned now in association with major capital projects at either the government laboratories or the universities. The FRB is currently planning major new facilities at BIO, and tentative reservation for information centre services should be made in their plans.

(b) Finance

The bulk of the capital financing necessary for a Centre would have to be supplied by the federal and (or) provincial governments in association with new laboratory or library facilities. Part, at least, of the operating costs might be supplied by the local establishments. The estimated cost of running such a Centre according to the Bonn Report to the National Research Council of Canada (1966) is approximately 3 to 5 per cent of the combined annual research budgets of the co-operating establishments, or about $750 per year per user. The total cost will be especially high in the first year or two of full operation, to provide for acquisition of special equipment. Table 1 shows the number of users of the libraries in many of the co-operating establishments, which provides a guide to the likely division of operating cost responsibilities.

(c) Staff

The proposed Centre will eventually need a considerable staff, both clerical and professional, if it is to do its job efficiently. The professional staff will have to consist of both librarians and information scientists, the latter having their major training in a basic science with further training or experience in information handling or library work.

Initially the staff would be very small, probably none, because the co-operative projects could be handled by the staff of the existing facilities. Some time in 1969 the Centre should have a staff of, say, three professionals (two librarians and one information scientist-administrator) and six clericals. This should rise fairly rapidly so that by 1972 or 1973 the staff would consist of at least ten professionals with clerical support in the ratio of two to three to one (as it is in the National Science Library). A complement of some 30 to 50 professionals, with the requisite clerical support, will be necessary in a fully developed Centre because, in addition to the normal library work, considerable emphasis will be placed on the research, development, and improvement of automated information-handling techniques.

(5) Usage, Other than Research and University

In addition to information requirements of the research establishments and the universities, there is a demand for technical information by federal and provincial agencies and industry. There are a number of different types of industry, each with its own requirements. For example, the pulp and paper industry presently gets most of its information from the Pulp and Paper Institute. Imperial Oil Limited now obtains its technical information from company sources in Ontario and the United States. E. M. I. Cossor Limited maintains a small library and depends on the other libraries in the area for general information. With the exception of the above, most of industry and other non-research groups largely enlist the technical advice of research organizations such as the Nova Scotia Research Foundation, the Nova Scotia Technical College, the Bedford Institute of Oceanography, or Defence Research Establishment who carry out the library research required. Through its field officers in Nova Scotia and Newfoundland, the Research Foundation provides a Technical Information Service to secondary industry on behalf of the National Research Council of Canada. The use of this service by industry has shown a steady annual increase. When the Centre and Network are established and working so that information flows efficiently, with local industry tied into the system, the direct benefits to industry could be extremely significant in ensuring full independent coverage of their information requirements.

(6) Data

Although data are part of the scientific information problem, they are at present considered differently and, to a certain extent, handled differently. There are already several national and international data-storing agencies which will almost certainly continue to function. The problem of whether data should be funneled directly from the local level to the national level, or whether they should go through the Regional Centre, remains to be resolved as national policy develops in the whole area of information and library service.

(7) Conclusion

The Halifax-Dartmouth area is ideal for the establishment of an experimental Regional Scientific Information Centre and Library. Not only is a wide spectrum of scientific activities present (contained in a manageable number of units), but there are several "centres of excellence" which require a specialized scientific information centre.

It is the intention of this submission to acquaint the senior levels of government, through the Study Group on Scientific Information in Canada, with our needs. Although the major effort must come from within the local scientific community, it cannot work in a vacuum. There must be early planning for the provision of funds to implement this proposal, to permit the most efficient progress at the local level. Any equipment acquired or schemes developed in the near future should be compatible with national programs. The first major commitment of funds to provide a building and extra major equipment by 1972 or 1973 should probably be by 1971.

Table 1. – Holdings, Potential Users (Internal), and Approximate Expenditures of Some Science Libraries in the Halifax-Dartmouth Area

Library Location		Holdings		Expenditures	
	Users (Internal)	Bound Volumes (Books & Periodicals)	Current Subscriptions	Books & Periodicals Binding	Salaries, Other
National Research Council (Atlantic Region), Halifax	50	8 800	250	28 000	Not Available
Nova Scotia Research Foundation, Halifax	16	10 000	250	32 500	Not Available
Fisheries Research Board of Canada, Technological Research Laboratory, Halifax	60	12 000	180	18 000	Not Available
Defence Research Establishment (Atlantic), Dartmouth	150	8 500	162	15 000	Not Available
Nova Scotia Museum, Halifax	30	10 000	95	3 000	Not Available
Nova Scotia Technical College, Halifax	ca. 700 (includes undergraduates)	35 577	836	35 000	50 000
Dalhousie University (Science and Medicine), Halifax		43 257	2 100	125 000	70 000
Bedford Institute of Oceanography, Dartmouth-Library jointly operated by the Dept. of Energy, Mines & Resources, Marine Sciences Branch and the Fisheries Research Board of Canada, Dartmouth Station	200	6 500	275	30 000	24 000

In all cases, the holdings are as of December 15, 1967 and the expenditures are for the fiscal year 1967-68.

Table 2. – Proposed Timetable for Development of a Regional Scientific Information Centre in the Halifax-Dartmouth Area

Time	Special Funding	Assigned Staff	Housing	Remarks
1968-end 1969 . .	None	None	None	Period of intensive planning and start of co-operative projects, such as catalogues of all holdings by units in the area
1970-1972/3 . . .	Proportionate contributions from budgets of co-operating agencies to cover operating costs	1 information scientist/ administrator 2 librarians 6 clerical support *rising to* 10 professionals 25 clerical support	Space in the Killam Memorial Library, Dalhousie University	The Centre begins operations on a small scale, which probably will grow rapidly. Further intensive planning for full-scale operations and new building. Gradual extension of services. Acquisition of equipment
1972/1973–. . . .	Major contributions from senior levels of government for capital expenditure. Increased contributions from local agencies for operations	*Rising to* 30-50 professionals 80 clerical support	Own building	Intensive research into information transfer methods; implementation of these where useful. The Centre should be in full-scale operation one year after the move into its own building

Scientific and Technical Information in Canada

Part II

Chapter 7

Economics

Prepared for
The Science Council of Canada

SCIENTIFIC AND TECHNICAL

INFORMATION IN CANADA

PART II

CHAPTER 7

ECONOMICS

Special Study No. 8

Scientific and Technical Information in Canada

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Economics

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THE SCIENCE COUNCIL OF CANADA

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SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

is submitted by the Economics Subgroup.

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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 Chapter 7 (Economics) of Part II. Part I of this Special Study has already been published. The other chapters of Part II are:

Chapter 1 – Government Departments and Agencies
Chapter 2 – Industry
Chapter 3 – Universities
Chapter 4 – International Organizations and Foreign Countries
Chapter 5 – Techniques and Sources
Chapter 6 – Libraries

and will be published separately. Each of these seven separate sections contains 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

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Section I

SUMMARY

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.

Section II

GENERAL AND SPECIFIC NATURE OF INFORMATION

In our daily lives we are immersed in an abundance of scientific and technical information. News media, books, schools, advertising, conversation–all contribute day by day to the spreading of knowledge, the dissemination of the latest discoveries, inventions, and ideas. Information is at the same time in plentiful supply and vital to the conduct of our lives. The fruits of scientific and technical endeavour are omnipresent and their utilization requires both knowledge and skill. Information is like air and water–we take its availability for granted, its abundance as essential to our society. Its total value is great and its total usefulness grows as there is more and more of it. Yet the more we have of it, the less we are prepared to pay: its "free" dissemination is accepted without question.

That, however, is only one aspect of information, an aspect from which all units of information are treated as interchangeable, as though the addition of some bit of news, for example on a biological subject, is just as "valuable" as a bit of news in another field, for example in aeronautics. This may be so on the broad educational level and in the widest context of our present technological culture. But it is by no means so when it comes to the use of information for decision making or problem solving. Then, all of a sudden, from the abundance of information a number of sharply defined elements of specific knowledge must be singled out as they are needed for a specific task. The demand on information becomes mission-oriented and a specific piece of information, already in existence, may gain extreme value when put at the right time into the hands of the right user. Thus, the value of specific information depends critically on not only its content but also on the time at which it reaches the user.

It is also important to recognize that the criterion of being "specific" in a particular case transcends all borders of disciplines or subject fields–there is hardly an innovation that has not required the combined ideas from widely different fields of science and technology. This aspect of the highly individual character of each piece of information in content and time, its uniqueness as related to a specific user's task, affects drastically its economic value and, therefore, the direct or indirect price the user is prepared to pay. From the plea for "free information" we swing to the opposite attitude, common to most users who state that a good and even a high price for information would be quite acceptable if only the information supply could be so arranged that meaningful answers were available to the user at the right time. Expressed in another way, it frequently becomes so costly for users to be without the right information at the right time that the great need would justify a high price.

It is on these aspects of dissemination and retrieval of specific knowledge that severe problems have arisen in recent years. It is no longer sufficient merely to increase information nor to have the system force a flood of information on the user. Rather, he should be given the opportunity to select and choose from a wide variety of informational products and services, according to his needs and in relation to the value of the information to him. In short, it is necessary to manage the supply of information rather than just produce and distribute it.

Management of information as a resource, a commodity, and a tool to aid economic progress is the concept on which this report is based.

Section III

CATEGORIES OF INFORMATION FOR DECISION MAKING AND PROBLEM SOLVING

Decision making and problem solving are impossible without a great variety of knowledge and information at different levels. With the growing dependence of the functioning of our society on information, modern management consists of knowing where to get the proper information, how to collect it, how to store it, and then how to use it and direct it to the right and relevant places. Information can be obtained from publicly available sources, or bought in the form of proprietary rights, or produced by investigation, research, and development. The choice of these alternatives depends on assessments which, in turn, require information as an essential input. In this multiplicity of forms and levels we can distinguish some typical though somewhat overlapping categories which may be characterized as follows.

First, in any organization—small or large, academic, industrial, or governmental—there is the internal housekeeping and managerial information on personnel, pay, inventories, financing, etc. With the increasing complexity of organizations, this category is often handled by internal management information systems with varying degrees of automation of file access and data retrieval. Here the apparently high costs of automation are justified by speed of reaction and volume of accessible data, as compared with conventional methods. These systems show all the typical characteristics of modern data retrieval techniques and make use of the same type of hardware as the other data systems described below.

Then there is the vast amount of information on economic and operational matters dealing with the current environmental situation external to the organization yet needed for day-to-day decisions. Within the very few last years, a whole industry has sprung up providing information service to customers by what is sometimes called "information utilities". By teletypewriter or telephone access, the subscriber can receive current information on market conditions, stock values, warehouse inventories, on weather, news, and things like airline reservations, transportation and shipping schedules. This is done through the services of a data bank operator who receives raw data from a multiplicity of sources; he then processes and stores them to disseminate them to his customers on request. The reason for the rapid emergence of this industry is not so much the availability of new technology to deal with the vast quantity of data but, rather, the rapidly decreasing cost of service owing to computer time sharing and other common user techniques, which make it more attractive to the user to avail himself of the services of a middleman rather than to process the incoming raw data himself.

These information utilities have already gained a substantial market in the United States—estimated to reach the billion-dollar level in a few years—and are beginning to appear in Canada. They have all the hardware characteristics of data retrieval systems and are particularly flexible. Most of the data handled are ephemeral in their value (airline reservations, stock market values, etc.). Technologically, these systems offer a bewildering variety of methods which will make future integration into a more common information service increasingly difficult. Though not the immediate subject of this Study, it should be emphasized that a certain regularization of these services would be of great benefit to the users by enabling them at a later stage to integrate a variety of services without unnecessary and costly duplication of terminal facilities. A case in point, in a different field, is the simultaneous existence in Canada of two teletypewriter services, Telex and TWX, which force the users either to subscribe to both services, installing both machines, or to restrict their teletype communications to those other users who happen to be subscribers to the same service.

Next, there is the vast field generally described by the expression "scientific and technical information" (STI), which covers the whole pool of accessible knowledge in science and technology as documented in books, journals, patents, reports, films, tapes, recordings—including the information on the sources of STI itself. Often ephemeral data of the kind previously described are at first of interest to a certain class of users in their current "real time" content, and may then become significant later as STI in a statistical or scientific sense and thereby, over a period of time, serve entirely different sets of users. (For example, weather data first of interest to people concerned with travel:—transport, farming, commercial sports—later to meteorologists; or stock market values, first of interest to investors, then to economists.) Also in this category is the vast amount of technical information that is produced and disseminated by industry as part of their public relations, advertising, and business promotion activities.

No hard lines can be drawn between the various types of scientific and technical documentation, and there are no simple criteria to decide on the relative importance or value of a particular publication. Since some percentage of generated information output is inevitably worthless because of inaccuracies, or even misleading, the problem of controlling the "information explosion", besides being one of selective dissemination to users, is also one of increased selectivity in production—a function that falls into the area of responsibilities of professional and trade associations and commercial publishers who, by pre-publication screening and reviewing, play an increasingly important function in the information transfer process.

Lastly, there is a category of information of extreme importance to industrial users, in the form of direct transfer of technological know-how between firms within a country or across borders. This transfer is usually compensated for by licence fees, patent royalties, or other agreements which provide for payment of money by one group in exchange for the proprietary results of research and development performed by another group. Internationally, this kind of trade has had a strong influence on the rapid postwar growth of the economies of countries like Japan, Germany, and Italy by the importation of predominantly United States technology and the build-up of a strong industry without incurring the costs and time delays of self-sponsored research and development programs. Canada has also benefited greatly by importing technology for the rapid growth of her secondary industries. Some figures for this exchange are given in Section IV.2, and Section VI.4 will deal with the more general aspects of the economics of the technology trade.

Technology transfer is not tied to any particular system, network, or hardware concept. It is a matter of agreement between organizations, and its quantitative volume can be measured much more easily than the volume of scientific and technical information transfer, since the payment of licence fees is a better indicator for produced or acquired knowledge than the intangible consideration of books, journals, and reports.

Section IV

ECONOMIC VALUE AND BENEFITS OF INFORMATION TRANSFER

The quantitative formulation of economic value and benefit of information transfer has remained elusive and subject to divergent arguments, despite a great amount of effort spent on attempts to arrive at meaningful guidelines for national and international policy development. Mathematical models have been studied to demonstrate the influence of various degrees of information dissemination on the effectiveness of a user community; pilot systems have been physically implemented at great cost—some with considerable success, others only to be discarded after having proved uneconomical and ineffective; user studies have been undertaken to establish typical patterns of information consumption; and cost studies have been performed or are presently in progress to help to inspire the confidence of prospective supporters and providers of funds for the introduction of improved systems.

The relationship between value and cost is complex—the costs of a particular retrieval operation may be very high but its value to the user and to society could be high or low, depending entirely on the satisfaction it can provide to the particular user and the benefits that accrue from the user's activity. It is obviously pointless to invest in a system when those who are supposed to use it are not aware of its potential benefits, or when the conditions of access are such that other more conventional means lead to satisfactory results even though at a somewhat lower speed or in a less convenient form. Thus, the economic value of a particular system manifests itself largely by the extent of its use and the direct or indirect price the users are prepared to pay for it. No two user communities are alike in this respect, no two individual users are exactly the same; further, the demand patterns change with time as the user learns more and more about his field, or the emphasis on particular points of interest changes. There is obviously no single answer that simultaneously fits all the diversified needs.

If the value of information transfer is discussed in terms of usage of a particular system and the price the user is prepared to pay, it must be kept in mind that usage is very dependent on the available choice of alternatives for satisfying particular needs, so that high usage of a certain type of service does not necessarily indicate its higher beneficial value compared to another service for which the conditions of availability are less favourable. A case in point is the demonstrated profitability of a growing number of commercial information services in the United States in certain specialized fields of information retrieval. As a result of present-day retrieval technology, there are certain types of service, such as current awareness notification on known user profiles (covering the literature over the last few weeks), whose cost of provision is low enough to allow attractive price schedules for a large number of customers. It appears that although commercial marketing of information may provide an excellent mechanism for the adaptation of services to changing user needs, and as a measure of short term value to the user and society, its failure or success should be interpreted with caution as an indicator for the long-term economic value of present types of information transfer. There are still too many areas in which technology is not yet advanced enough to allow commercial exploitation and which may require government support if found of sufficient national importance. But the technological advance is rapid, and what is uneconomical and little used today may well become commercially attractive and highly used within a few years.

In this situation of difficulties in defining the criteria for economic value, we present the following facts on present-day levels of expenditure on information transfer in various user communities.

IV.1 Information Transfer At The User Level

A substantial portion of the time of people working in the fields of research, development, engineering, management, and planning is spent on the acquisition of knowledge through reading, attending conferences, conversing, and other learning processes. During the course of the Study a survey was conducted to find out how much effort goes into information acquisition in typical Canadian user communities in industry, government, and universities. The questions asked are shown in the questionnaire reproduced in Appendix A. From about 3 000 enquiries, 1 564 replies were received and analyzed as detailed in Appendix B. The survey demonstrated clearly the general awareness for STI throughout governments, industry, and educational institutions.

Half of all users reported 15 per cent or more of their time spent in procuring scientific and technical information, and the average cost of user salary corresponding to the reported percentages of time was $1 879 per year. There appears to be little difference between the institutional sectors of education, industry, and government, and also between the various occupations except that technicians reported markedly less involvement in STI activities than did engineers, scientists, administrators, and teachers.

One part of the process of information acquisition serves the purpose of user education, i.e. the increase of the user's knowledge in particular fields through a continuing learning process. The easier the access to information, and the more responsive an information system is to the user's particular interests and his particular way of learning, the more effective is the learning process. Since the user's own motivation is the driving force for further enquiry, this form of education can be the most profitable form of adult education—provided that the user's attempts are not frustrated by lack or ineffectiveness of the responses of the information system. This part of the information transfer process may be considered as an investment toward future productivity of the user.

The other part of information acquisition serves the specific purpose of problem solving and decision making in the particular field of the user's current work. Typical examples are engineering data, mathematical tools, published experimental results. The time and costs of acquiring this information may be considered as an operational expense directly tied to the costs of a particular operation.

The effect of alternatives in the type of information system available to the user cannot be generally determined: if education is the main goal, one type of system may be preferable; if cost effectiveness of production is the goal, another type may be required. However, it can be said without qualification that improved ease of access to, and improved response of, an information system will enhance the user's general effectiveness—whether by improving his overall competence or by improving the cost effectiveness of his operation.

Studies in the United States and the United Kingdom show that a significant portion of research work is unnecessary because of duplication of effort that could have been saved by better literature search. Figures of between 10 and 85 per cent have been quoted, and the effect on the overall cost of research has been estimated to amount to a loss of several per cent of the total R & D budget. The cost of improved access to information would then be offset by substantial savings in R & D work. In addition, as shown above, the average research worker spends a considerable portion of his time in searching for sources of information—part of which time could be spent more productively if information retrieval were made easier by improved machinery and information analysis services. The costs of such improvements could then be justified in the light of the higher productivity of the scientists, although proof of this is not easy to demonstrate. The validity of the argument probably depends much on the actual situation: a practising engineer, for example, will gain more from being relieved of searching the literature than a scientist working in fundamental research.

The foregoing discussion of information transfer at the user level demonstrates the fact that we are dealing with an overall expenditure of, say 15 per cent of the user's time which—with a total of some 120 000 users in the scientific and technical fields in Canada and a user salary plus overhead costs of $25 000 per annum—amounts to $450 million a year. Even a small increase in the effectiveness of such an investment, by improvements in the mechanisms of information transfer, would justify the spending of substantial funds.

However, before this could be implemented, definite management policies must be accepted to overcome certain common obstacles still observable in user communities. The situation is best described by the following quotation dealing with the financial implications of literature searches in scientific work:[1]

> "Satisfaction with one's own performance is a reward that motivates a large segment of the scientific population. The competition from his peers provides one of the strongest incentives for excellence to which a scientist responds. Accordingly, he spends a fairly large fraction of his time using all available modes of technical communication to maintain an active, and highly personal, intelligence network in the field of his specialty. The scientist wants to avoid repeating work completed by others, but he also wants to know enough details about the successes and failures of the others so that he can build upon them with his own knowledge and competence. The requirements are for high specificity, for a very short time between a technical event and the circulation of data about it, and for two-way oral communication whenever possible.

"While these are strong incentives, they lack one of the better known ingredients–money. When we look at the situations where money enters, the incentives are less favourable to extensive use of the available information.

"Project cost controls are a good example of the situations in which penalties operate to inhibit the acquisition of information. Since information is not recognized specifically as a resource, neither its acquisition nor its dissemination appears as a project cost item. Under these circumstances, the scientist who invokes the use of new or specialized literature services finds that he is under pressure to conserve project funds by cutting down on expenses not covered by the project estimate. When he has the choice of reducing his own man-hours on the project to pay for the otherwise unbudgeted literature services, the scientist reacts to such a penalty in his own self-interest, and he tends to conserve project dollars to cover his own salary."

It is up to the management policies in R & D to recognize these conditions where they exist, and to create an environment in which STI can fully play its potential role.

IV.2 Present Spending in Canadian Industry on STI

Manufacturing and service industries allocate substantial resources to both the production and acquisition of scientific and technical information.

IV.2.1 Sales Literature, Public Relations, or Advertising

Large sums are spent on the generation of product information and technical data for distribution to professionals, trade organizations, customers, and the public at large–information which can be classified in part as "sales literature", "public relations", or "advertising", and in part as trade information of general interest. In the process of increasing specialization, the dividing lines between trade information and the more orthodox forms of scientific and technical documentation are becoming less distinct; often freely distributed sales literature shows a depth of scientific treatment comparable to any other form of scientific publication and, vice versa, scientific papers published by industrial personnel are often inspired by advertising and public relations motivation. The actual expenditures in this category can be estimated only as a percentage of total business volume–3 per cent has been quoted in one sector of industry. In total, they run in the hundreds of millions of dollars annually. It appears that the benefits of the scientific and technical contents of this particular industrial information output transcend by far the specific business promotion purposes which may have stimulated their generation. The whole level of technical knowledge in our society is, without doubt, strongly affected by the free flow of this information–a factor that must be recognized in the assessment of the national information complex.

IV.2.2 Scientific and Technical Information

Scientific and technical information in the form of scientific publications is produced and disseminated by industry as a product of research and development work. The results of this work may also be reflected in the above-mentioned promulgation of sales information, but even without leading to saleable products, the fruits of R & D activities are reported in documentation, at conventions, and in public. Either explicitly, for example, in the form covered in National Aeronautics and Space Administration (NASA) contracts under the Technology Utilization

Program, or implicitly, the expenditures for publication of new findings are directly related to the spending of R & D funds. (In the example of the NASA Technology Utilization Program, R & D contractors can charge one half of 1 per cent of the contract value for mandatory reporting of new technology which is then collected, screened, and published by the Technology Utilization Division.)

IV.2.3 Management Information

On the information "consumption" side, industry requires a great amount of management information as defined above. Although much of this is in the sectors of operational and environmental data, there is no sharp dividing line from scientific and technical information. As the art of modern management utilizes mathematical tools, computer simulation methods, and other scientific procedures, the role of management is becoming more and more scientific-technical, thus relying increasingly on the sources of scientific-technical know-how. Therefore, management personnel represent a substantial portion of the user population of scientific-technical information systems.

IV.2.4 World Scientific and Technical Information

Industry's scientists, engineers, and technologists depend in their research and development work to a large extent on the store of world-wide STI. Briefs submitted by industry in the course of this Study have shown that industry, either as individual firms or collectively in associations, is prepared to spend substantial sums on the acquisition of published, specialized information. Expenditures of tens of thousands of dollars per annum are not uncommon and, apart from annually repetitive costs, initial fees to join in a co-operative information retrieval venture have been reported as high as $100 000. Industrially sponsored research organizations spend a substantial percentage of their budgets on information, in one case $270 000, corresponding to 7 per cent. Evidently, the more specific the information is, particularly in the form of data on things like oil wells, forest and geological information, drugs and chemicals, the higher is the price that is paid, quite apart from spendings on conventional libraries and professional literature collections. Average spending by firms performing R & D ranges from $3 000 to $4 000 a year by medium-sized companies to $200 000 and more by large ones. It is impossible to establish precisely the total expenditures by Canadian industry, but a rough extrapolation based on the number of some 600 companies performing R & D and on the above-mentioned averages leads to an annual total of about $15 million for the library and information services in connection with industrial R & D work, and some $30 million for scientific and technical literature acquired by the thousands of manufacturing and industrial establishments throughout Canada. Further details supporting these expenditures are included in the Industry report, Chapter 2.

Figure 1 shows the expenditures by a selected group of companies performing R & D on scientific and technical documentation services versus the number of personnel, and Figure 2 gives the same expenditures versus R & D funds. The remarkable result is that the expenditures on a per user basis (Figure 1) do not seem

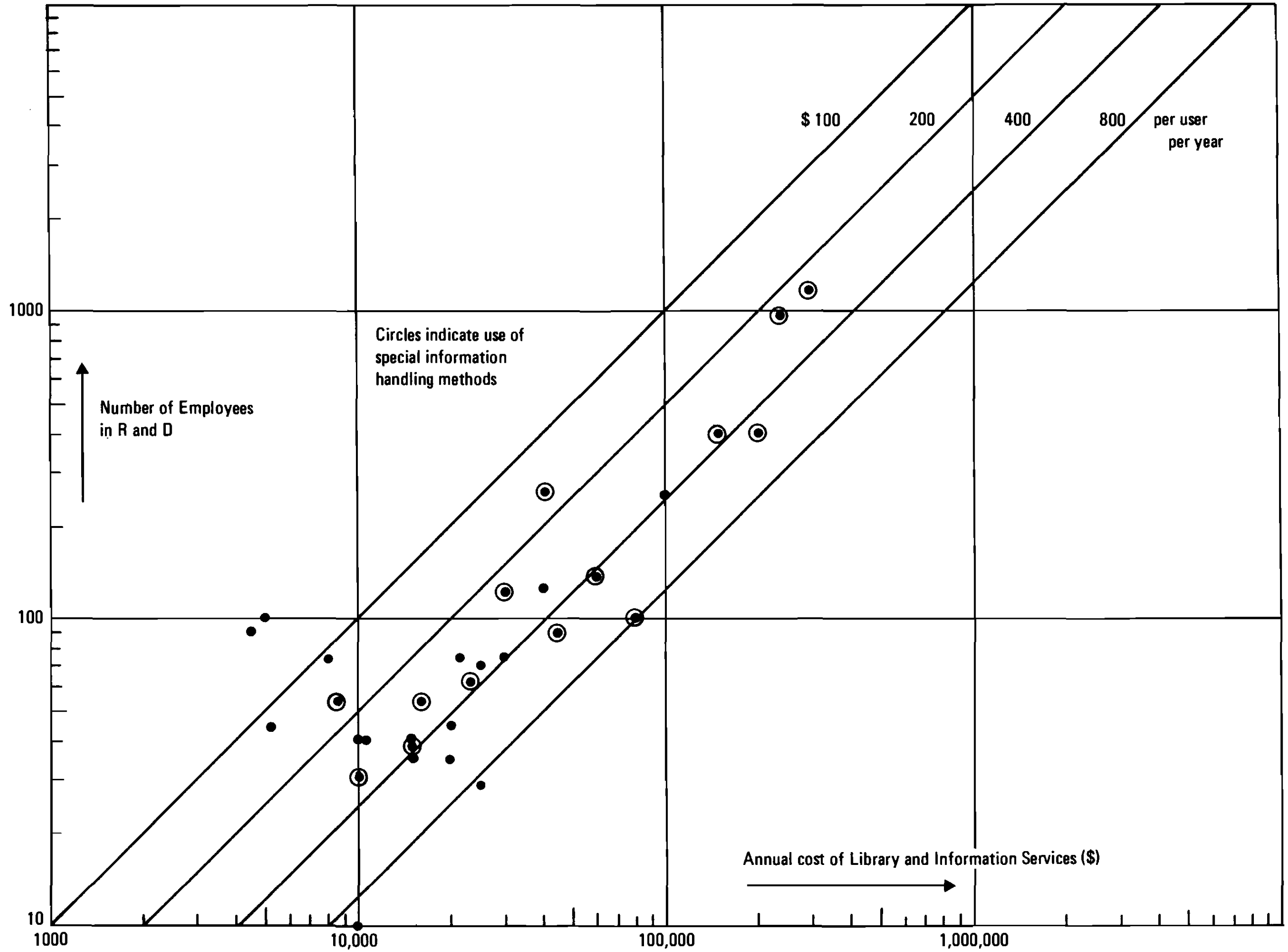


Figure 1.—Sample of R and D performing Industries. Information Service Expenditures versus scientific technical manpower

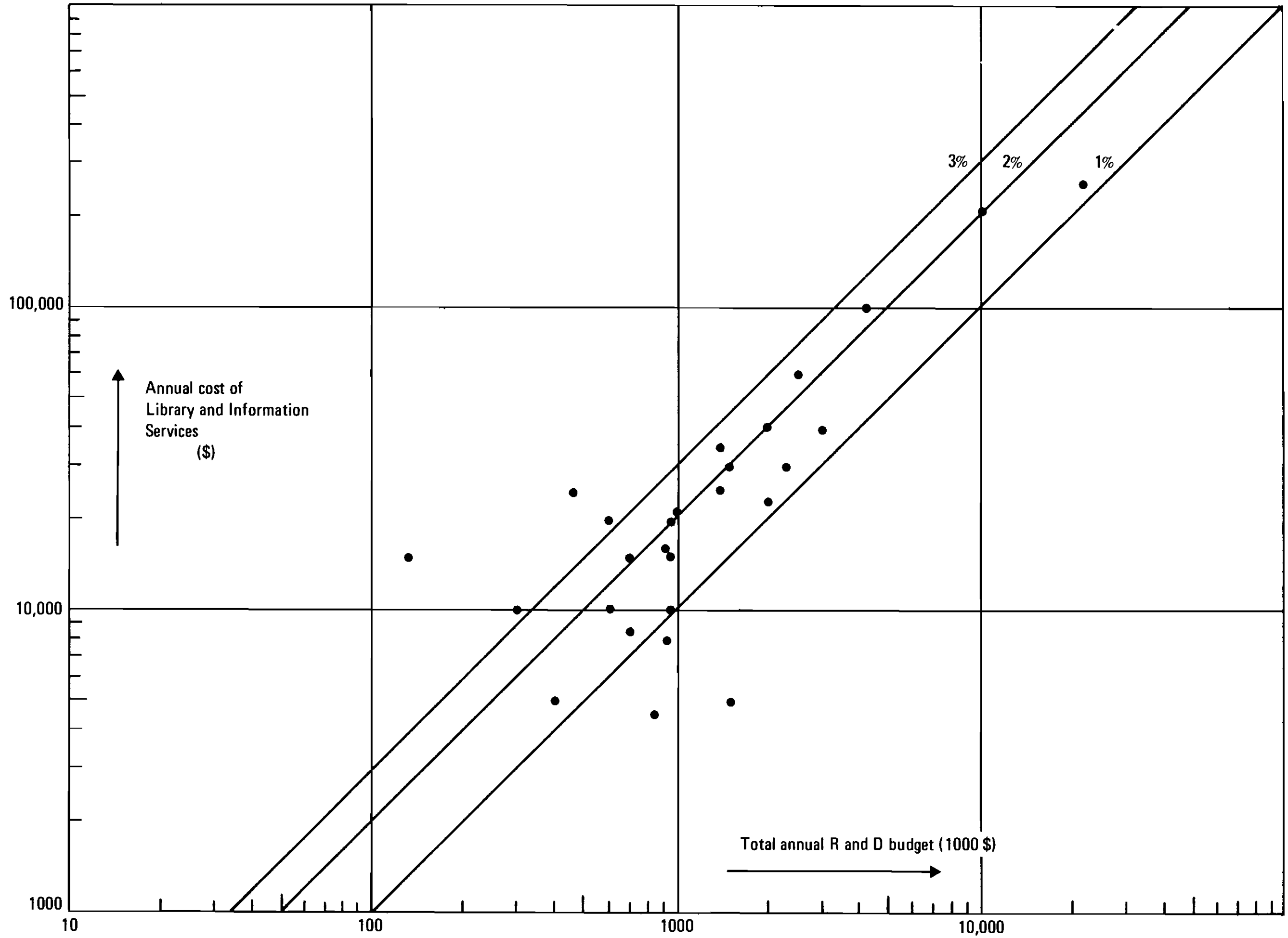


Figure 2.—Sample of R and D performing Industries. Information Service Expenditures versus total R and D budget (1966)

to depend critically on the size of the company, remaining consistently between $250 and $500 per user per year. It is further noteworthy that a majority of companies spending more than about $30 000 per annum on their information service also report that they use "special methods", i.e. data-processing equipment and computers. Obviously, the large size of the user population in these companies compensates for the larger costs of the "special methods", thus demonstrating the point that the economics of scale and speed of modern computer technology keep the cost of service per user down at levels not higher than those encountered in smaller organizations using conventional manual methods.

Practically all briefs submitted by industry stress the great importance attributed to the information function and the desirability of a substantial improvement in access and dissemination, and also the willingness of industry to pay for information services received once a national system is established.

IV.2.5 Purchase of Foreign Technology

Finally, industry spends considerable sums for the use of foreign technology as described in Section III. This transfer of technological know-how as a specific variety of scientific and technical information transfer is usually based on licensing agreements between firms or countries. Without doubt, this transfer is of great importance to national economies, and recently published statistics of the Organisation for Economic Co-operation and Development (OECD) tend to support the argument that increased manufacturing exports of some OECD member countries, including Canada, have been associated with an increased inflow of technology, predominantly from the United States. According to OECD statistics, Canadian payments on technology imports from the United States, including payments made by Canadian subsidiaries to their parent firms in the United States, amounted in 1964 to $121 million, i.e. 22 per cent of the reported total of $550 million of United States receipts. Such an inflow of technology, valued at a quarter of the $500 million spent on Canadian R & D that year, must have constituted an important factor in the rapid development of Canadian exports in the science-intensive product groups. On the other hand, Canadian exports of technology licences amounted in 1964 to only $37 million to the United States and an additional $4 million to all other countries. The economic implications of this imbalance in trade in technology are further discussed in Section VI.4.

IV.3 Government Involvement in STI Transfer

Governments at all levels—federal, provincial, and municipal—are large-scale producers and users of information in their multiple roles as operating, regulatory, policy-making, and funding agencies.

IV.3.1 Production and Distribution of Information

The production and distribution of information by governments are based mainly on statutory obligations to provide specialized information to the public in such fields as agriculture, health, and national resources. The production results from governmental activities in planning and R & D, which in turn demand the acquisition of information from world-wide sources, for internal distribution. This has led to the emergence of widely scattered information operations by governmental libraries, conventions, and field services. Originally all this was considered part of the particular field of activity, and expenditures were accounted for in the operational and administrative accounts of the respective departments. It is only lately that stimulation of information acquisition and dissemination, *per se,* has begun to be recognized as a governmental responsibility regardless of its field or discipline. And it is also fairly recently that governmental responsibilities to the public in the operation of STI centres such as the National Science Library have been recognized.

In this situation it is not surprising that any attempt at a realistic appraisal of government spendings in the field of STI is frustrated by the impossibility of identifying STI expenditures buried in the general administrative and overhead accounts. For the Federal Government, the Dominion Bureau of Statistics publishes annual figures for spendings on scientific information covering "Costs of library operations, translations, procurement and publication services in connection with information required in, or resulting from, scientific activities . . . ", but excluding information systems considered as an integral part of the R & D activities of departments. The published figure for 1965-66 was $14.5 million.[2] The corresponding estimate for 1967-68 is around $20 million. These expenditures are divided roughly into 50 per cent for salaries of library personnel, 25 per cent for production of publications, and 25 per cent for library acquisitions and handling.

However, to arrive at an estimate for the total expenditures by the Government in the field of scientific and technical information, a substantial amount must be added to account for the numerous cases where the STI function is covered under R & D costs or departmental administration and overhead costs. Also, the quoted expenditures should not be related exclusively to government research and development spendings; they cover a variety of needs, of which not the least is the present concept of multitudes of small, decentralized departmental libraries and information services with their inherent inefficiency owing to duplication of acquisition, personnel, and overhead costs.

More precise accounting is, of course, available from specialized operations such as the National Science Library, but even here a breakdown in various functions is hard to obtain. The National Science Library provides, for example, service both internally, to National Research Council personnel, and externally, to the public across the country. Whether the service to the public is effective in relation to costs cannot be decided because no cost separation is available.

Governmental agencies are rapidly becoming more aware of the importance of improved information retrieval for their day-to-day operations; this, of course, extends beyond scientific and technical disciplines and applies to a multitude of missions in the administration of law, health and welfare, transportation, housing, pollution control. Within the last few years several states in the United States have decided to reorganize and radically modernize their information systems, making use of large-scale computer operations. The trend has not yet become noticeable in Canada, but mounting problems of municipal, provincial, and federal administrations will soon require similar concerted efforts. Information utilities covering widely different subject fields but organized under a co-ordinated plan are bound to emerge—the better they are planned toward adaptability, flexibility, and augmentation, the more efficient they will be. The handling of STI is one important aspect of it.

IV.3.2 Government Policies and Programs

In the field of policy making and in funding of R & D, governments have become increasingly cognizant of the effect of information transfer on national economic and social progress and the responsibilities arising out of it. Two quotations suffice at this point to illustrate.

(1) OECD Ministerial Meeting, March 1968 (CMS (68) 18)

> "During the past decade all OECD member countries have increased their investment in research and development. To plan this research efficiently, and to apply its results, requires access to the common reservoir of scientific and technical information and data generated throughout the world. The effective communication of this information to the scientists and engineers in government, industry and the universities, and the policy makers, planners and managers in government and industry, is a key factor in technological advance and in economic and social progress."

(2) U.S. State Technical Services Act 1965 (Public Law 89-182)

> "Section 1. That Congress finds that wider diffusion and more effective application of science and technology in business, commerce and industry are essential to the growth of the economy, to higher levels of employment, and to the competitive position of United States products in world markets. The Congress also finds that the benefits of federally financed research, as well as other research, must be placed more effectively in the hands of American business, commerce, and industrial establishments. The Congress further finds that the several States, through co-operation with universities, communities and industries, can contribute significantly to these purposes by providing technical services designed to encourage a more effective application of science and technology to both new and established business, commerce, and industrial establishments. The Congress, therefore, declares that the purpose of this Act is to provide a national program of incentives and support for the several States individually and in co-operation with each other in their establishing and maintaining State and interstate technical service programs designed to achieve these ends."

In some countries national centres for information dissemination have been established, some entirely funded by the government, some on the basis of co-operation between government and private industry. They are described in greater detail in other subgroup reports and are mentioned here only to illustrate the increasing government recognition of the value of STI transfer. It appears that these specialized STI centres will eventually form part of, and will have to be integrated with, the more general utility system that represents the nation's store of information.

IV.4 University and College Budgets

Information transfer is one of the main purposes of universities, colleges, and other schools of higher learning. Therefore, much of the budgets of these institutions could well be classified as devoted to information transfer. However, since it is unlikely that the basic structure of universities and colleges will be changed in the near future by the emergence of a new information transfer mechanism proposed by this Study Group, we restrict our attention to the field of more immediate interest, the university libraries, neglecting all non-document-oriented activities. The problems of universities in general, and university libraries in particular, are extensively described in other subgroup reports. It remains here to state the level of expenditures that applies to the transfer of scientific and technical information at academic institutions.

University libraries' expenditures have been published, for example, in the Downs report[3] with reference to both the overall university expenditures and the student enrolment. The spendings for library services in Canadian universities and colleges for 1965-66 rose to 7.1 per cent of the total institutional expenditures from an average of 6.4 per cent for the five-year period 1961 to 1966. The Canadian Library Association has recommended that 10 per cent be considered a minimum during the next 10 years for universities with well-established curricula. New institutions should raise their library budgets to considerably more than 10 per cent.

In total, the expenditures at all schools covered by the Downs report, and for all disciplines, were around \$25 million in 1965-66, rising to \$32 million in 1966-67, and estimated to reach over \$40 million in 1967-68. This would correspond to a growth rate of around 8 per cent, which is not too different from the growth rate of the student enrolment (Figure 4). However, for the future a much higher rate of increase of expenditure is estimated, as shown in the future projections of university libraries quoted in the Downs report.

On a student enrolment basis, the Downs report gives the figures (1965-66) shown in Figure 3, with an average of \$152 per student per year for library services, not counting space and overhead costs. The graph of Figure 3 is presented here to bring out the fact—already shown for industry in Figure 1—that information service costs, when expressed in dollars per user per year, appear to be fairly independent of the overall size of the institution. (The two exceptions in Figure 3 which indicate higher than average costs refer to two small institutions that had just been established.)

Making the conservative assumption that science and engineering students (graduate and undergraduate in total) require the same amount of library service as students of other faculties, we can apply the above-quoted average library costs of \$152 per student per year to the number of science and engineering students reported by Levine[4], as shown in Figure 4. (These figures are higher than enrolment figures reported by the Dominion Bureau of Statistics. The difference is due to the definition of disciplines counted under the term "science".) We then arrive at expenditures of some \$13 million per annum in 1966 and some \$16 million in 1968 for scientific and technical library services at universities and colleges. According to the Canadian Association of University and College Libraries (as quoted in the Downs report), the library services provided to graduate students should be budgeted at about eight times the amount per student budgeted for undergraduates. Since, according to Figure 4, the ratio of the numbers of undergraduates to graduates is also around eight, it follows that the total library costs can be apportioned in equal amounts to these two groups. On this basis, we

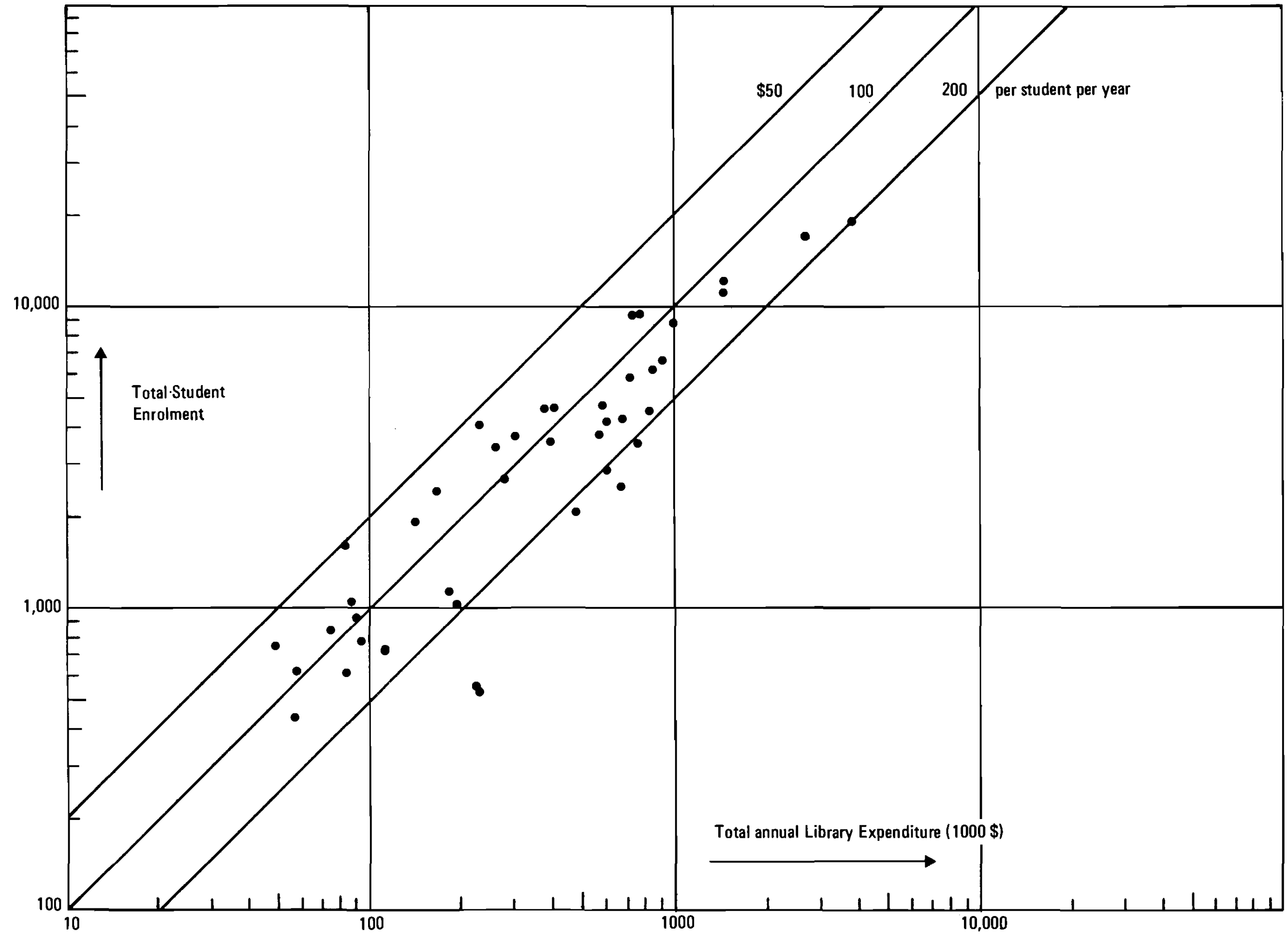
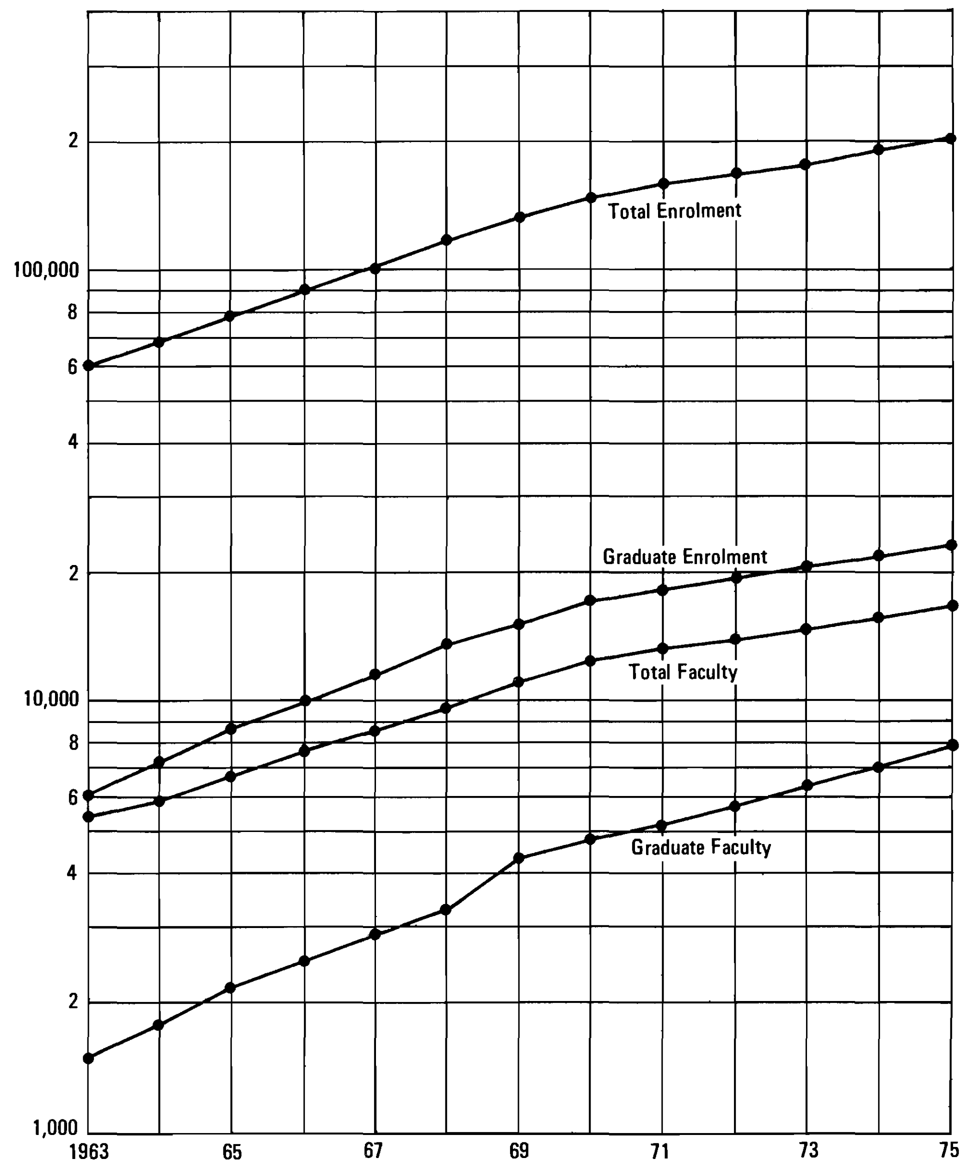


Figure 3.—University and College Library Budgets (1966) (Downs Report)

can divide the average of $152 per student per year into two parts: $85 per undergraduate per year, and $680 per graduate per year. The latter amount is similar to the expenditures for library services in research laboratories of industry shown in Figure 1.

Figure 4.—University and College Enrolment and Faculty in Science and Engineering



(Source NRC Publication No. 9197)

Section V

COSTS OF INFORMATION TRANSFER

After having discussed the value of information transfer as seen from the point of view of individual users, industry, universities, and government, it remains now to look at the costs of the various elements of the information transfer process. The main difficulty in cost assessment of existing facilities lies in the fact that expenditures for staff, libraries, books, subscriptions, conventions, etc. are often treated as administrative overhead costs and therefore remain hidden. It is only when special systems are introduced using computers, data-processing equipment, specialist personnel, etc., or in the case of arrangements for cost recovery by a system of user charges, that the associated expenditures are clearly identified as a distinct cost category. As mentioned in the preceding discussion of government spending, this comment applies particularly to the interpretation of official statistical tabulations which often fall far short of reflecting the true situation.

To overcome these difficulties and arrive at meaningful figures on an international basis, a special study group[5] has been sponsored by the Organisation for Economic Co-operation and Development, which is presently in the process of identifying distinct cost categories for the information transfer process and formulating questionnaires which are to serve as a tool for the measurement of the national expenditures in the information field. Extensive draft proposals for such enquiries on a national scale are presently up for review by the OECD Panel on the Economics of Information.

In general, the information transfer process has three distinct parts, the costs of which can be treated almost independently: input of information into the system, the transformation of information into the many forms desired by users, and output from storage to the user. A specific piece of information does not have to be entered into a particular system more than once but may be retrieved in many different forms, with or without secondary processing, serving totally different user demands at different locations and different times. This is of particular interest when the economics of self-support of information systems by user charges in large user communities are considered. The input and processing costs are then distributed over a multitude of users and, therefore, the scale of user charges can be arranged to reflect the costs of different output options much more closely than in a small community where the share of input costs per user represents a higher percentage of the charge. This means that even a highly sophisticated system can be made available to unsophisticated users at low cost because the high input and processing costs are borne by the whole user community. This benefit of the "sharing" aspect of information systems has been mentioned before in Section III as a main factor in the emergence of "information utility" services.

On a broader basis, this consideration also emphasizes the benefits of a certain centralization of the input function, i.e. the desirability, from an economic point of view, of avoiding situations where the same piece of information is entered into the system many times or at many locations, thus unnecessarily escalating the input costs. The simplest example is the multiplicity of cataloguing, indexing, abstracting, translating, and storing efforts for the same book or journal in a completely decentralized system of libraries. The other extreme is a centralized documentation system in which a book or journal is entered only once in a number of files, say a bibliographic file, an abstract file, and a full-text file, and where all user demands are satisfied from the one information bank. The degree of centralization of the input function giving the highest degree of user satisfaction at the lowest total cost depends entirely on the type of user community. The more mission-oriented a particular operation, the easier it is to find the best compromise between user needs and costs, although even here adaptability to change presents difficult problems. A complex system embracing a wide variety of user communities can be developed only on an evolutionary basis, by gradual elimination of unnecessary duplication, centralization of functions where technically, organizationally, and economically warranted, and by a conscious policy to exploit the available information resources to the benefit of the whole society.

Cost allocations to various functions of STI transfer are described in greater detail in the following paragraphs.

V.1 Costs of Computer-based Information Centres

To compare with a conventional library, a computer-based information retrieval system must be able to provide great flexibility in its response to widely varying demands. It must enable the user to obtain current awareness services, i.e. notification of new documents in selected fields; it must enable the user to perform retroactive searches in related fields; and it must facilitate what M. Kochen[6] calls tutorial service based on evaluation and synthesis by experts, i.e. information services for users who want a clear survey in a particular field of interest. A computer-based system which is able to perform these functions must have a number of distinct components, each representing a distinct cost element. These cost elements may be classified as follows, expressed in monthly charges typical for today's commercial situation and assuming direct on-line access for simple enquiries and batch processing for complex enquiries:

(1) Cost of using a central processing unit, including its built-in core memory for internal processing;

(2) Cost of using high-speed large storage for machine-readable coded information (usually magnetic disc memory);

(3) Cost of using lesser-speed very large storage for information that can be displayed in clear language rather than code (data cell, RACE), plus peripheral storage devices for historical documents (magnetic tape);

(4) Cost of user access terminals, of being on-line, of local and remote transmission facilities, of access terminals for data entry, file maintenance, and local enquiry.

The actual prices in these categories depend, of course, on the capacity, reaction time, number of terminals, and number of jobs to be processed at the same time. A typical example for a computer centre augmenting existing library and information processing services may illustrate this.

We assume a central information unit for on-line storage holding the equivalent of one million pages of information. This would cover bibliographic data, summaries, and abstracts, whereas the documents themselves would be retrievable off-line from existing libraries or document storage centres, probably as microform, photocopy, or similar device. With 2 000 characters per page, the total on-line storage would amount to two billion characters. (One hundred man-years are needed to convert such a document text into machine-readable form.) Of the two billion characters, 250 million would be stored in the high-speed storage category, the balance in the lesser-speed storage category. Typewriter terminals and visual display stations are assumed for remote and local access, for both users and operators. Updating is assumed to be done continuously, with a document growth rate of about 10 per cent per year.

On this basis the following monthly rental figures would apply:

Central processor and control units	$30 000
On-line storage (high-speed)	6 500
Lesser-speed storage (large-volume)	16 500
Peripheral storage	5 000
24 administrative terminals with display units	4 000
4 document-processing units	2 000
2 high-speed printers	2 400
30 remote access terminals	3 600
Total monthly equipment rental	$70 000

The initial cost (non-recurring) for programming and data entry at 100 man-years will be approximately $2 million. The annual operating cost will be approximately $2.5 million. This is about three times the actual machine rental in order to provide for operating and updating personnel, access line charges, space, and other overheads. It is estimated that such a system would meet the requirements of a specialized technologically oriented information centre for industry or a number of libraries forming a network in a selected region. Such a computer centre would supplement but not replace existing libraries, but should slow down the expansion of the holdings in each library by eliminating unnecessary duplication.

One feature that distinguishes the computer-based retrieval centre from the conventional library is, of course, speed of service. Whereas a retrospective search in a conventional library may take days, the computer centre may provide an answer within less than half a minute. M. Kochen[6] has estimated (based on certain assumptions on time and equipment sharing) that retrospective search, available from existing institutions for $50 in two weeks, can be provided for some $180 by the computer centre within 10 seconds. Reducing the speed would allow batch processing and reduce costs to $50 or less. However, retrospective search is only one aspect of information service and should not be used as the only measure of comparison between conventional and computer-based operations. Much greater advantages are obtained through increased speed, flexibility, and ease of access for tutorial, bibliographical, and current awareness services, and for simple on-line queries.

V.2 Costs of Network Operations

Once a computer-based information retrieval centre is established, the information is available electronically in digital form so that access for input as well as output can be obtained by electrical means regardless of distance or location. This opens the way to network operations where geographically separated centres may be interconnected to form an operating entity. The costs of interconnection are mainly those of the operation of transmission facilities which are usually available on lease from common carrier organizations. Since the economics of long-distance transmission are entirely determined by factors of scale and utilization, the availability of particular types of service and their costs are entirely dependent on the demand. This has led to a dynamic situation in which the common carriers expand their transmission plant and adjust their tariffs in close adaptation to the changing patterns of traffic, in particular to the growing data transmission traffic for computer-to-computer communication.

The costs of transmission depend on:

(1) Type of input-output device (teletypewriter, CRT, printer);
(2) Speed of operation (bits per second);
(3) Mode of operation (duplex or simple, i.e. transmit and receive either simultaneously or sequentially);
(4) Distance;
(5) Time and duration of transmission (full-time, off-peak hours, on demand).

In particular, the last factor has recently led to substantial decreases in the cost of night-time long-distance calls, wide area bulk rates, data transfer rates during off-peak hours, and many other tariff arrangements.

In general, there is a direct relationship between transmission time, frequency bandwidth, and costs of transmission. Computer-to-computer communications are conducted at the highest possible digital data speed under conditions where the available transmission medium is efficiently utilized. This is not the case when, instead of direct digital transmission, some other form of transmission (such as low-speed printer or facsimile operation) is needed. The difference is expressed directly in transmission time which is directly related to costs. As an example, the following table shows the transmission time for one page of typed copy, assuming 40 lines per page, 64 characters per line, 6.4 characters per word, and 7 binary digits per character, i.e. 18 kilobits per page.

Type of Channel and Terminal Equipment	Time Required for Transmission of One Page of Printed Copy
Teletype Channel (300 Hz, 100 w/min., 75 bits/sec.)	4 min.
Voice channel (3 KHz, 1 800 bits/sec.)	
Full data speed (high-speed printer)	10 sec.
Facsimile (commercial, analog)	5 min.
Video file (magnetic tape)	80 sec.
Special voice channel (4 KHz, 2 400 bits/sec.)	
Full data speed (high-speed printer)	7.5 sec.
Facsimile (commercial, analog)	3.5 min.
Telpak A (48 KHz, 50 K bits/sec.)	
Full data speed (computer-to-computer)	1/3 sec.
Xerox LDX (135 lines/inch)	36 sec.
Video file (magnetic tape)	6 sec.
Telpak C (240 KHz)	
Electrostatic printer (Xerox, Dick)	6 sec.
Video file (magnetic tape)	1 sec.
Video (6 MHz)	
Conventional television	30 milli sec.

At present the costs of transmission for large quantities of printed information, in the form of either facsimile or teletype transmission, are prohibitive as compared to the cost of ordinary mail services, unless the reduction of transmission delay justifies the extra expense. The main reason for these costs is the present rate structure for an input-output technology which does not allow a more effective bandwidth utilization. The substantial improvements to be expected in the near future will be described later.

If network operation of a number of information centres is considered, the interconnection costs based on presently available telecommunication services are substantial. A good example is shown in the recently published EDUNET study[7] in which cost estimates are worked out for a network interconnecting regional university centres in the United States Northeast, Mideast, Southeast, Midwest, Southwest, Mountain States, Pacific Northwest, Pacific Midwest, and Pacific Southwest with a National EDUCOM Centre in the Midwest and institutional branch connections from each of the centres to surrounding universities. With a main east-west trunk line of 24 voice channels, other interconnecting trunks of 12 voice channels, and branch lines of single channels, the total rental costs are estimated at around $100 000 per month (U.S. tariff rates). With a somewhat larger voice channel capacity, and augmented by two-way video channels for wideband and TV type transmission, the costs rise to $1 million per month.

V.3 Future Trends in Transmission Costs

As mentioned above, the high costs of today's transmission of printed information are caused by the limitations of the present input-output station technology. When higher-speed teleprinters are introduced, as expected in the near future, transmission costs per page of printed material over the switched telephone network will drop to a fraction of today's costs. Beyond that, it may be expected that transmission costs in the early 1970s, not counting terminal equipment rental costs, could drop to about one cent per page anywhere in Canada, provided that by that time:

(1) A broadband transmission facility is available to information users on a switched basis;
(2) High-speed optical readers are available;
(3) High-speed teleprinters are available;
(4) Users can accept information in a form capable of being printed by a high-speed printer, and the information can be stored in a form capable of being read by an optical reader;
(5) The volume of traffic is high enough and the pattern of usage such that the information can be stored in buffers and transmitted between the point of origin and the destination in batches.

The dramatic reduction to one cent per page is totally dependent on high-speed readers and printers in the 10 000 wpm category. This information, when stored, is capable of transmission on a broadband network at rates up to 108 kilobits per second, corresponding to the transmitting of 144 000 words per minute. A further reduction in cost per printed page would follow the development of readers that would recognize redundancy and include character recognition for material printed in standard formats. It is apparent that the cost of the transfer of printed information is mainly limited by the capability of the terminal devices and not by transmission capability.

If the same bit rate is used for digital facsimile transmission of sketches, signatures, etc., the transmission time per page would be around 6 seconds for low resolution pictures and correspondingly more for higher resolution pictures. The much higher costs of transmission then represent the premium to be paid for that type of highly redundant information.

Finally, if the same bit rate is used for direct computer-to-computer communications, costs can be kept low if batch operation and connection on a switched basis are possible. At a rate of 100 000 bits per second, most computer interactions can be completed within a few minutes.

Section VI

CANADA'S NEED FOR SCIENTIFIC AND TECHNICAL INFORMATION

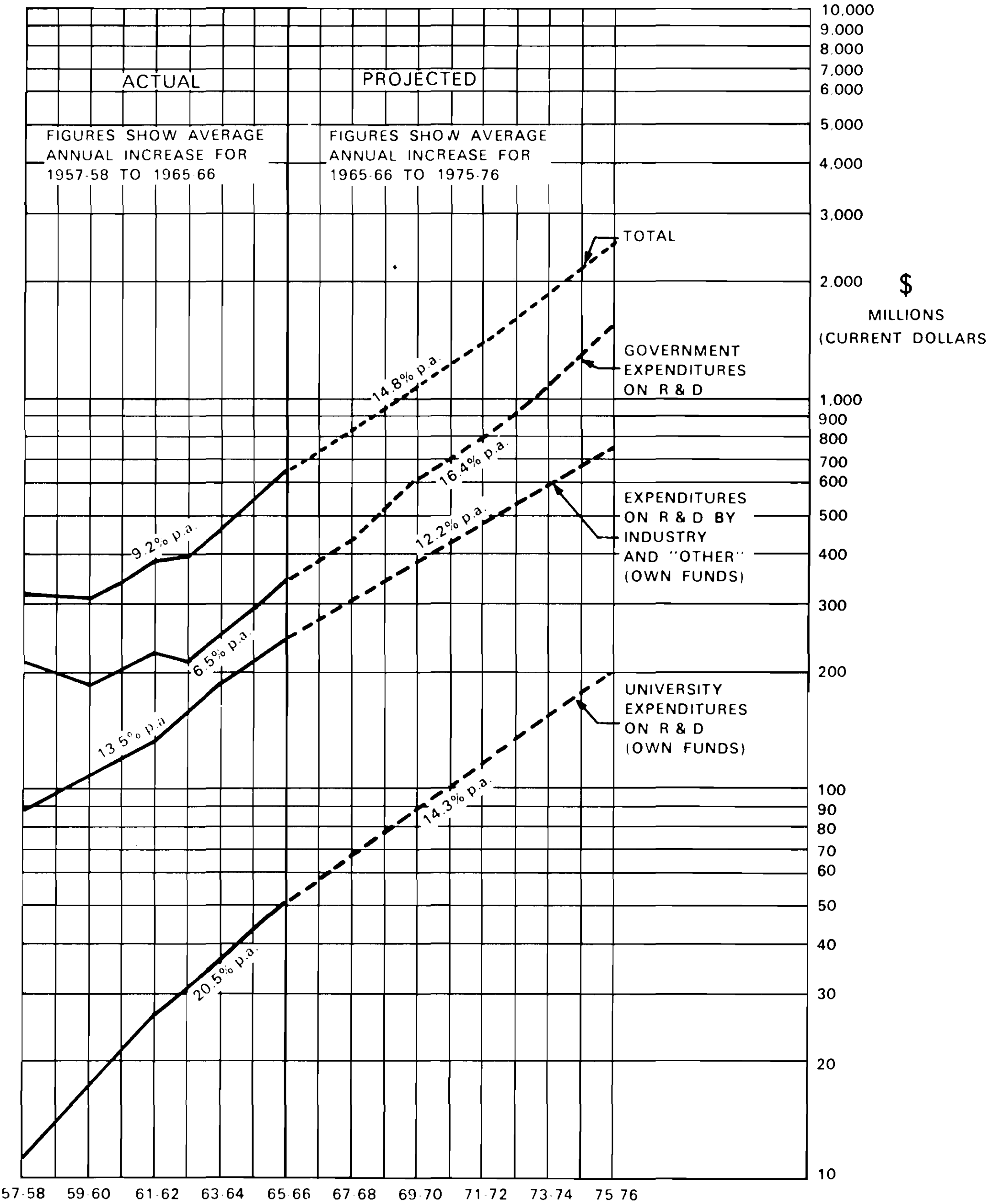
Depending on geographical, sociological, political, and historical conditions, different countries vary considerably in their need for a national policy on information transfer. Owing to a number of circumstances, Canada appears to be in a phase of her development characterized by a coincidence of factors, all emphasizing the great importance of a consolidated approach in the handling of the resources of scientific and technical information.

We present some of these factors in an arbitrary sequence which should not reflect their order of importance. Some of the factors have been stressed and described in greater detail in other subgroup reports, some are specifically related to national economic development and are presented here as general arguments rather than specific proof for any particular course of action.

VI.1 STI as Part of Research and Development

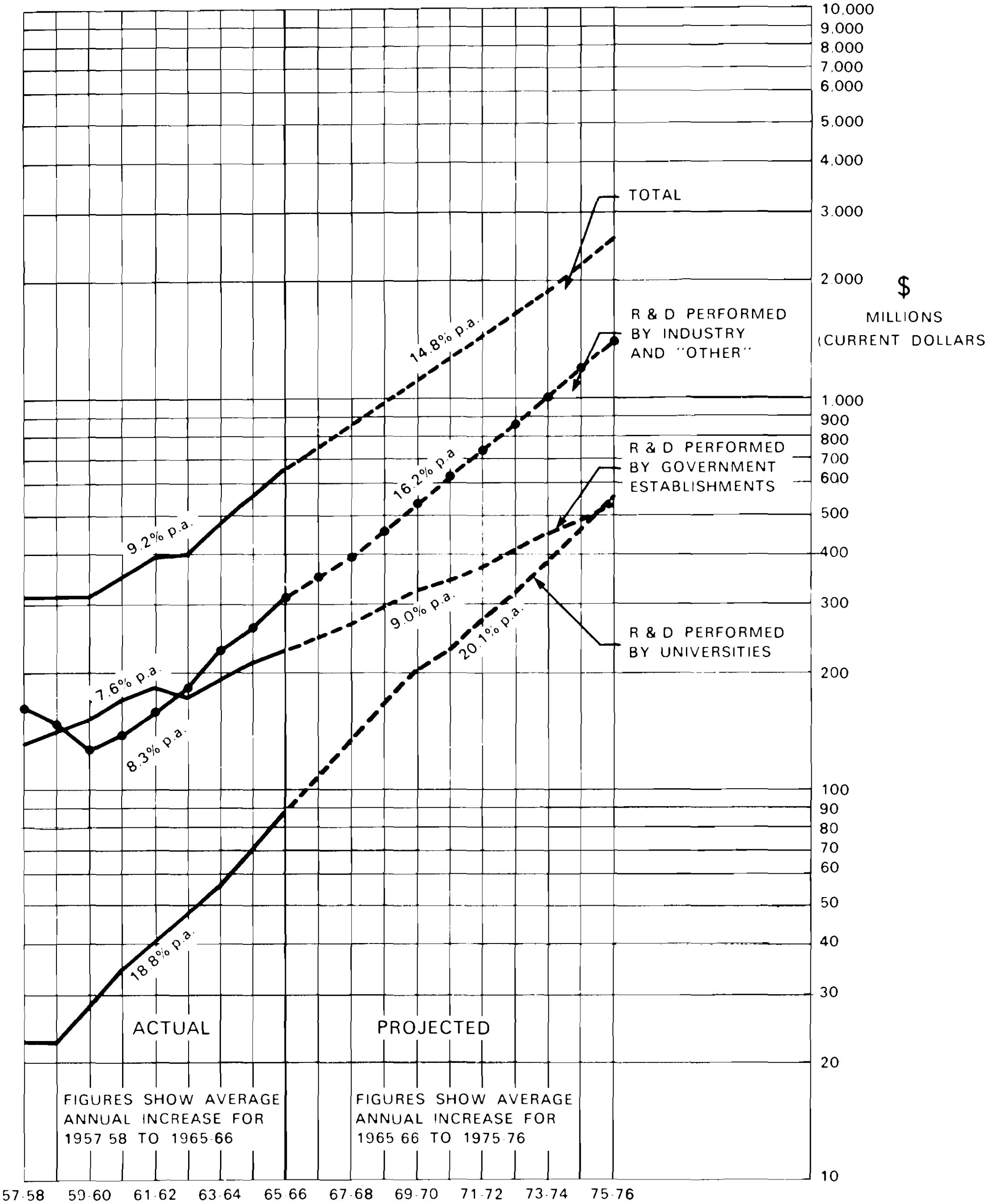
More than 97 per cent of the world's production of scientific and technical information is generated outside Canada. The remaining few per cent are the fruit of Canada's own R & D effort. However, to support this relatively small but highly diversified R & D work, and to avoid surprises by unrecognized foreign developments, it is necessary that the relevant parts of the world's information production be made available in Canada. This puts a heavy stress on the relatively small R & D community to deal with a large quantity of diverse information; in other words, it influences the percentage of funds that must be allocated to information services relative to the total R & D funds. Though little can be said quantitatively on the desirable relationship between the allocations on R & D work itself and on information search, it is clear that the percentage should be substantially higher in Canada than, for example, in the United States where the R & D effort leads to a higher portion of the world's STI production. For the U.S. Government, the reported information budget is around 4 per cent of the total R & D budget. In comparing such a figure with any corresponding Canadian figure, much more should be known about the breakdown of costs and the amount of unreported costs affecting an estimate of the actual STI expenditures in the two countries. For comparison purposes, Figures 5 and 6 show the present and projected total R & D expenditures by source of funds and by location of performance. An example of industrial spendings for information services by companies performing R & D relative to R & D expenditures in Figure 2, Section IV.2, shows that the average is about 2 per cent. These spendings appear to be considerably below the desirable level.

Figure 5.—Total R and D Expenditures in Canada (Proposed New Programs Included) by Source



Source: Science Secretariat Special Study No. 4

Figure 6.—Total R and D Expenditures in Canada (Proposed New Programs Included) by Performance



Source: Science Secretariat Special Study No. 4

Another point to be considered is that the allocations to STI handling should not necessarily be proportional to the R & D costs. If for some reason the R & D funds are curtailed, it can be argued that the spendings on information acquisition should be sharply increased as a substitute for the country's own R & D results. Instead of producing its own information by R & D a country may live, for a limited time, on other countries' R & D results as they are published in the world literature.

However, without any indigenous R & D efforts the exploitation of published results alone is not enough to sustain a satisfactory level of growth. Any task-oriented compilation of known facts and techniques requires either a concerted effort (including R & D) to bring them together or the take-over from someone else of all the co-ordinated know-how that is needed in a particular operation. The latter, however, is usually not available in the form of a published document but only in the form of technology transfer under licensing agreements which require much higher payments. In the extreme, with no spending on R & D, all technology would have to be bought at a high price instead of being produced. (This is discussed further in Section VI. 4.) It is apparent that there must be a careful balance between the allocation of resources to R & D, STI handling, and imported technology. Clearly, a national policy on STI must be carefully tuned to the prevailing policies on R & D, which in turn must be related to the balance in technology trade.

VI.2 Geographical Distribution of User Needs

Canada is a large country with a low overall population density concentrated in a few regional areas. Historically, this has led to information activities (libraries, etc.) aiming at self-sufficiency with a high degree of duplication in resources, institutions, and operations. With the growing world production of printed information, a doubling of publications within 10 to 15 years requiring bigger and bigger library buildings, miles of new bookshelves, etc., the decentralized approach is no longer economically justifiable. Though user needs will continue to dictate some degree of decentralized operations, the modern computer and communication technologies allow the formation of regional and nation-wide networks where the individual centre acts in a communications switching function in addition to the traditional but limited and well-defined storage and distribution function.

Since nation-wide networks can reach across institutional borders, it follows that governments as well as universities, industrial centres, research institutions, etc. will all be affected. The formulation and execution of a national policy are clearly required.

One element of that policy must express the principle of allocative neutrality, which means that the institution and the place where a user locates his activity should not decisively depend on the availability of information. Within reasonable limits, at any location and at any institution he should (taking into account certain time lags and costs) have access to information as readily as someone located near a centre of information. This principle expresses the fact that access to information is a service function which, by its very nature, is not basically determined by geographical location or institutional affiliation. It must, therefore, be subordinated to those economic factors that have priority in deciding where a particular operation may best be located in the country. As an example, Ottawa is often referred to as a favourable location for certain activities because of the proximity to national research and library facilities. This may be true in today's situation but should not be a factor overriding other considerations that may be more basically important to the national economy.

VI.3 Implications of Rapid Growth of Labour Force

As shown in the Fourth Annual Review of the Economic Council of Canada, Canada's labour force will, as the result of the high birthrate of the 1940s and early 1950s, be growing for some time at a rate very much faster than that of any other modern industrial country. Over the 15-year period 1965-80, Canada's labour force will increase by 50 per cent, a rate of expansion 60 per cent greater than that of the United States and many times larger than that of the Western European communities. As a consequence, the Canadian economy has to grow more rapidly than that of most other countries if we are to avoid serious unemployment. J. J. Deutsch, in a recent speech on "The Future of Canada's Technical Manpower"[8] emphasized that:

> "... an adequate rate of economic growth is not likely to be achieved unless the Canadian economy manages to take the fullest advantage of the fastest growing industries. These are the science-based and technically sophisticated industries and services."

As a consequence, the demand for technical and professional manpower in an ever-widening range of occupations will be accelerating. Simultaneously with these conditions in Canada, and as a result of modern technology in communications and transportation, world trade has been expanding much more rapidly than world production. Therefore, Canada's need for rapid economic growth is coupled with a need to improve the competitive and trading abilities of Canadian industry. Together, these two impelling needs require a restructuring of industry with a call for much new investment and skilled manpower for new design, development, and management.

One obvious conclusion drawn from the foregoing analysis is that one would be remiss in not relating the stated objectives of Canadian industrial development to the priority that must be given to the highest possible degree of utilization of the world's resources in scientific and technical information. If Canada is to meet the stated objectives, one must avoid waste of manpower and funds by unnecessary duplication of work, by failure to keep track of other countries' achievements, or by spending efforts uselessly without reference to the success or failure of others. It must be a stated national objective that the world's knowledge is available to Canadian users in a form that ensures the highest degree of efficiency and effectiveness in adapting it to new industrial products and services in Canada.

VI.4 STI versus Bought Technology

The argument of the preceding section can be continued by stressing a point that has already been mentioned, namely, the economic effort of the transfer of technological know-how under licence agreements, patent contracts, arrangements between companies or company divisions. With increasing specialization of secondary industries, it appears that the trade in technology transfer in the form of products, processes, or prototypes is of great benefit to the originators as well as to the recipients. This is because an advantage of one country in a certain field of specialization can benefit another country, which is then not forced to develop the same technology under less favourable conditions. The acquisition of technological know-how *per se* can certainly be ranked with those factors that stimulate economic growth, as exemplified by the Japanese postwar development. However, simultaneously with the acquisition of know-how in some fields there should be a capacity for the production of know-how in others so that a too heavy dependence by one country on another can be avoided. It was mentioned in Section IV.2 that there has been, and probably still is, a substantial imbalance in Canada between outgoing payments and receipts of licence fees. Such an imbalance in technology trade may be interpreted as an indication that Canada's productivity is not yet self-supporting, that the need for the import of new technology to sustain the level of productivity is higher than the ability to create new technology. In this connection, it is also interesting to note that the number of Canadian licence agreements with Japanese firms dropped from 2.4 per cent of the Japanese total during the 1949-59 period to 1.1 per cent during 1960-64, whereas the corresponding figures for German agreements with Japan rose from 7.9 per cent to 13 per cent. These figures were reported by OECD[9] with the following comments:

> "If, therefore, one assumes that Japan has been a 'good and successful' purchaser of foreign technology, data on the country of origin of technology imports by Japan will be a good indication of member countries' performance in originating innovations."

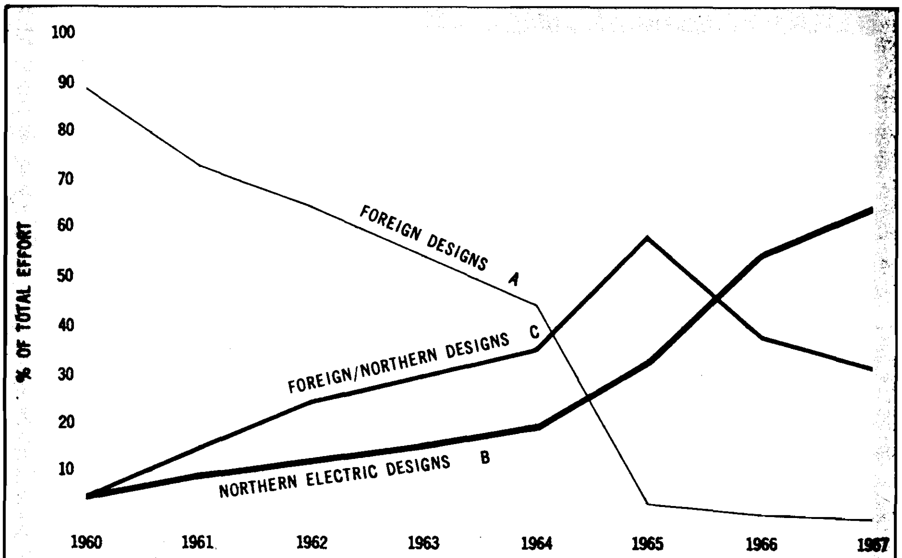
This argument also indicates that Canada's share in the creative production of new technology is lagging.

It is evident that one important way of improving the effectiveness of R & D work is to arrange for the best possible exploitation of existing sources of scientific and technical information. Particularly in countries with a rapidly developing secondary industry, it is apparent that collecting and processing of world-wide STI and its dissemination to organizations and individuals are considered of high priority in national policies. Japan, besides spending large sums for imported technology, has an advanced information centre (JICST) established in 1957, with an annual budget of $2.6 million in 1966. Germany pays similar attention to information handling–a factor which certainly contributes to her high performance in technology export. (One German company, Siemens, reports that its earnings from selling patent rights exceed payments for obtaining patent rights by 4 to 1.) If any conclusion can be drawn from this, it certainly indicates that improved Canadian scientific and technical information transfer is highly desirable as a counterforce against too great a dependence on the straight acceptance of foreign technology.

The aim should, therefore, be to stimulate the process of building up Canadian competence through the process of development from known facts to new concepts, and by avoidance of repeating what other people already have done. This point gains considerable weight in the light of the immediate needs of Canada's economy, as described in the previous section. Professor Deutsch also mentions this point in the following words:

> "In a vast and empty land we have borrowed technology, know-how, skills and capital from others and have applied these to rich material resources to build a new modern country. It has been successful and much has been accomplished, but the time has come for a greater contribution from ourselves."

That such a transition from foreign technology to Canadian design is indeed possible, and can be stimulated deliberately by improved access to world-wide sources of scientific and technical information, is clearly demonstrated in a recently published case history. The example is taken from an account of the Research and Development Laboratories of Northern Electric Company Limited, as published in *Telesis,* November 1967.



ANALYSIS OF EFFORT DISTRIBUTION BY DESIGN SOURCE AT THE MONTREAL REGIONAL LABORATORIES.

The graph shows the decline of imported product development during the period 1960-67 and its rapid replacement by the company's own designs. The following is quoted from the same source:

> "During the past 10 years, Northern Electric has passed through a period of transition from a large purchaser of foreign technology to our current position where most of the design information for new products is originated within the company. The reference to design information originating within the company is not to be construed to mean that the technology has necessarily originated within the company as well. Any laboratory, large or small, can only generate a very small percentage of new technology. The scientific staff in all laboratories have access through literature and personal contact to

> the technology in most arts shortly after they are conceived. The success of any industrial laboratory, therefore, depends upon the capability of the staff to use the technology and its successful application to the development of new or improved products."

The R & D laboratories of the company spend about $250 000 annually on internal library and information services and operate their own computer-aided information retrieval centres. The growth rate of the document collection is stated to be 20 per cent per annum. When asked in a survey to rank in order of importance the channels through which present information needs are met, the company gave first priority in a list of 12 ranks to commercial publications in the form of scientific and technical journals and serials, and second priority to publications from unaffiliated sources outside Canada.

Clearly, what benefits one of Canada's largest R & D organizations would equally benefit a multitude of smaller organizations which, for economic reasons, are not in a position to operate their own computerized retrieval centres but would be willing to pay for services if they were available on a reasonable basis to improve their capability for new design.

VI.5 STI Needs of Higher Education

Another consequence of the above-described abnormal growth of Canada's labour force during the next decade is the predicted rapid increase in university enrolment which, in turn, will increase the demand for teaching staffs. As shown in Figure 4 in Section IV.4, projections from 1967 to the year 1975 show a doubling of both undergraduate and graduate enrolment in science and engineering, a 50 per cent increase in undergraduate teaching staff (taking into account a marked increase in the use of audio-visual aids), and an increase of over 150 per cent in graduate teachers. The resulting strain on the availability of sources for scientific and technical information is obvious. And it is also obvious that there would be a colossal waste if the demand on information continued to be filled by a completely decentralized increase of all local information facilities and by the independent establishment of a multitude of service centres in which many functions would be unnecessarily duplicated. In fact, the formation of interuniversity library networks on a regional basis is under way, but much more is needed in co-ordination and collaboration on a nation-wide basis, and the inclusion in networks of government and industrial centres of information services.

Coupled with the rising number of students there is, of course, the rising number of emerging scientists and engineers in Canada who constitute the main segment of the user population for scientific and technical information. Table 1 shows the presently anticipated growth in the number of scientists and engineers, broken down into place of employment. The totals are estimated on the basis of manpower statistics, increasing at a rate corresponding to that of university graduation shown in Figure 4, and the breakdown follows percentage figures based on five-year averages as reported by OECD.

The numbers shown in Table 1 indicate a doubling of the number of scientists and engineers within the next eight years—a rate that will exert strong pressures on the expansion of information services. If left uncontrolled in an unco-ordinated, decentralized environment, undue cost escalation is inevitable—as demonstrated by the projections of future university library costs published in the Downs report which indicate considerably more than twice today's spendings by 1975.

Table 1.– Estimated Numbers of Scientists and Engineers in Canada

Employer	1967-68	1975
Industry - 70%	84 000	168 000
Government - 22%	26 400	52 800
Universities - 8%	9 600	19 200
Total - 100%	120 000	240 000

Source: Professional Manpower Reports 12, 13, 14, extrapolated to 1967, OECD Reviews of National Policies for Education, Canada, 1966. Growth rate 1967 to 1975 from Figure 4.

If the needs of the growing user population at university level, and arising out of it at all levels of scientific and technical activity, are to be met, immediate and strong efforts in consolidation and co-ordination of all information services are a national necessity.

VI.6 Labour's Changing Pattern

Finally, we refer to the general shift of the labour processes in all modern industrialized countries from physical work to the manipulation of controls of machines and automatic functions. Human strength is vastly inferior to modern power sources, and also human capabilities in perception and processing of routine data are vastly surpassed by modern electronic machinery. As a result, more and more of the functions previously performed by humans are transferred to machines, and the human element is used in those areas where machines fail, namely, functions involving judgment, risk, intuition, creative thinking, adaptation to change, and all other things that are not "programmable". This leads to an enormous task of re-education of those who are forced to adapt themselves to the new environment, of those who are expected to teach the new methods, and those who are in the business of producing new machines and methods for their programming. All this amounts to the need for mass use of scientific and technical information to an extent unthinkable a few years ago. There are estimates[10] that at the present time over 90 per cent of the GNP-producing labour is of the type that can, in principle, be performed by electronically controlled machines. The trend toward using such machines cannot be stopped without jeopardizing the economic future of a country. The only practical answer is acceptance of the inevitable need for adaptation; and one of the fundamental methods of doing this is to provide the right form of training and education in order to apply specific knowledge. The easier it is to gain access to an information system, the less demanding are the requirements for the stores of knowledge at the user level. What previously required a universal genius in memory and skill can soon be surpassed by anybody who knows the rules for asking those questions that lead to the desired answer, provided that the question concerns a problem that had been dealt with before anywhere in the world.

The foregoing argument may sound like science fiction, but a glance at the pace of technical advancement during the last few years suffices to illuminate the danger that lies in the neglect of adopting the sole prescription for survival and growth: the spreading of knowledge.

Section VII

DEVELOPMENT OF A NATIONAL STRATEGY FOR STI TRANSFER

VII.1 Objectives

It is the main theme of our studies that a strong national policy on scientific and technical information is of paramount importance in Canada's national strategy for stimulating economic growth. The need established, one can formulate a number of objectives that lead to a number of possible approaches, depending on certain matters of basic policy such as degree of centralization, extent of government involvement, and priorities. The objectives may best be stated by defining those STI functions which the national complex is expected to perform:

(1) Response to user enquiries from industry, government, research and educational institutions, and the public at large, at many different levels, from a scientist's computer-oriented search activities to a farmer's information supply through field service representatives.

(2) Provision of access to international sources irrespective of origin, language, or format.

(3) Ensuring that service is available regardless of the institutional sector and, taking into account certain time lags and costs, the location at which the user is working.

(4) Ensuring that the results of Canadian publicly supported R & D are effectively disseminated nationally and internationally.

(5) Ensuring that the information entering the national complex has, to the greatest possible extent, undergone professional scrutiny to avoid flooding with worthless material.

(6) Encouragement of continuing research and development in the field of information retrieval and man-machine interaction.

(7) Provision of services at costs which are established on the basis of overall productive efficiency, i.e. such that the costs to society are minimized.

(8) Ensuring that the operation of the total complex or its subsystems does not result in the exploitation of either the producers of primary and secondary information or the users of this information, i.e. preventing the formation of monopolies (exclusive control of one type of service) or monopsonies (services for the exclusive benefit of one user).

(9) Ensuring that within the national complex there is no discrimination against the peculiarities of a particular type of service arising out of institutional or disciplinary requirements, as determined by user needs.

Objectives of the kinds listed above can also be considered as criteria for the evaluation of alternative ways of implementing the national information network.

Once accepted as guidelines, they should be used as a set of ground rules against which organizational, functional, and administrative details can be tested and validated.

VII.2 National Focus for STI

Canada's present scientific and technical information complex is characterized by a great variety of different institutional influences. Funding and operation are usually controlled by the interests of the group or organization to which a particular information service belongs. It is only in rare cases that the economics of the information service itself, rather than the policies of the parent organization, determine the *modus operandi.* A library, or other information-retrieval service, may be federal, provincial, municipal, or private; it may be mission-oriented or discipline-oriented, serve industrial or educational purposes; it may form an inseparable part of the operation to which it belongs, or it may be responsible to a number of different bodies or agencies which are not necessarily under the same jurisdiction. Similarly, information production in Canada–be it in the field of primary information as a result of R & D work or of secondary information (indexing, abstracting, reviewing, analyzing)–may be part of activities in government, industry, trade associations, professional institutes, educational and research establishments, profit-oriented or publicly supported, subject to a variety of different jurisdictional and fiscal practices.

If under these circumstances a consolidation on a national scale is desired, based on some broad objectives such as those shown in the preceding section, it is of prime importance that a functioning focus for scientific and technical information systems be established. This focus in a political, administrative, and economic sense must take into account the independent jurisdictional and institutional framework of the national information complex. It must bring together the interests of all different sectors concerned and it must, through a number of techniques, develop a consistent information policy. Financial incentives and service advantages must be recognized as motivating forces for sustained network consciousness–purely idealistic reasoning has proved to be insufficient in the light of the participants' natural tendency towards institutional autonomy (see subgroup report on Libraries). In terms of analogy, the focus might be considered to play the role of a central bank which in various ways, not the least by persuasion, develops a consistent monetary policy required by society. Before discussing further aspects of the formation of such a focus, we will describe some of the considerations of highest priority.

VII.3 Social Optimization of Operations

The traditional library is manually operated and employs techniques that have changed little during the last century. It selects and purchases the materials it requires, catalogues them according to an indexing system, stores, and then moves them to users by means of loans, gifts, sales, or the provision of study areas. Each step in the process costs a certain sum of money, for salaries, rent, supplies, and so on, and there is an obvious trade-off between speed and sophistication of service on the one hand and cost on the other. It costs more to buy a greater range of acquisitions than a small one and to provide a 24-hour answering service for requests than a four-week one.

Trying to calculate the most efficient way to run his scientific information system, the independent operator of a traditional, commercially oriented system would invest new capital until he reached the point where additional investment to gain higher levels of output produced only equal increments in income. If operating on a fixed budget, he could try to establish the best compromise between the various factors with the aim of giving the best possible service at the lowest possible total cost.

This process of optimization by continuous application of cost effectiveness analysis is quite practical in a small, autonomous operation, even taking into account rapid technological changes of the available information retrieval methods. But it has the disadvantage that certain services, which are more expensive to provide than others, are bound to suffer; and some may be completely unobtainable because of their economic disadvantage. Retrospective search, for example, is always more costly to provide than current information, so that strictly profit-oriented or a minimum-cost-oriented operation will tend to concentrate on those services for which it is cheaper to attain higher levels of sophistication and volume than on others. This, however, may not be to the benefit of the user. His costs are not put into the analysis and, as a result, the user has either to turn to other more costly methods, in time or money, or to forego the possibility of being served, both to the detriment of society. It thereby turns out that the social costs of the service are high despite carefully controlled internal economics of the system.

There is a well-established answer to this problem: pooling of service, network operation, and co-ordination. It is then possible to make available to the user services which are beyond the individual resources of any one of the participants. There is no reason why cost-effectiveness analysis could not be extended to network operation and eventually to a whole national complex. However, this is true only in the broadest meaning of the term cost-effectiveness, the main difficulty being that institutional differences preclude the application of a common yardstick for measuring effectiveness. Institutional prerogatives and peculiarities may dictate individual operations which are best suited to a particular user group without being ideally adapted to the national operation. In that case, again, "social optimization" requires that the best compromise be found between maintaining all benefits internal to the individual user groups while at the same time achieving maximum external benefits accruing from the group's participation in the network.

This leads to the conclusion that a satisfactory functioning of the whole complex is possible only if the participants are held responsible for the most efficient and effective way of running their operation, subject to certain agreed-upon ground rules of economic analysis. The allocation of resources may then be set up in such a way that they are part of the capital and operating costs of the organization benefited. In this way, evaluation and judgment of the effectiveness of any subsystem are under constant review, and the initiative, drive, and creativity of persons involved are less hindered by remote bureaucratic direction.

In such an environment, oriented towards social optimization, it is also possible to arrive at guidelines on questions such as the position Canada should take towards the burgeoning commercial information services offered by U.S. companies. These independent scientific and technical information systems are able to operate at a profit (in certain specific types of services) mainly because of the large market existing in U.S. industry and government. On the basis of commercial competition, Canadian information business enterprises would have the greatest difficulty to exist, let alone get started. The alternatives are then either to utilize U.S. service, thereby exploiting the advantages of U.S. conditions but exposing ourselves to the remote possibility of being cut off, or to pay a substantially higher price for obtaining the information by other means. The second alternative amounts to some kind of subsidization. This should be considered only if it were impossible to compensate the unilateral flow from the United States to Canada by the development of some specialized Canadian information services for which Canada is in a position of relative advantage and for which there is a U.S. market. The danger of arbitrary decisions that might interrupt the flow is then decreased. Again, "social optimization" would favour the bilateral exchange because Canada would benefit by both the lower U.S. prices and the development of business in which a special Canadian advantage exists.

VII.4 Federal Government Involvement

The processes of production and dissemination of scientific and technical information reach across political and institutional borders and affect the well-being of the nation as a whole. Therefore, there is a definite role for Federal Government involvement. The extent might, at first glance, be open to a wide variety of possibilities, ranging from a purely advisory co-ordinating function to the monolithic structure of a completely centralized information centre. However since, on one hand, the Federal Government through its departments and agencies is already the principal information operator in the country and since, on the other hand, institutional prerogatives and responsibilities clearly require decentralized operations throughout the country, the variety of practical roles for the Federal Government is considerably narrowed. Obviously, its main central function is that of providing the basis on which a national policy toward a co-ordinated approach can be established. In implementing the policy, it will then be necessary to:

(1) Bring the existing services together in a more co-ordinated fashion;
(2) Supplement them in areas where national need exceeds the scope of existing establishments;
(3) Represent Canada internationally;
(4) Provide a financial basis for research, education, and training in the information field.

All this will have to be done by an evolutionary process of transition from the present situation into a future overall network.

In assessing the Federal Government's present involvement one can distinguish two main areas:

(1) Operation of information services by Federal Government departments and agencies;
(2) Provision of financial support to the operation or development of information services by other agencies at provincial, municipal, and private levels.

Decisions on whether, in a particular field, the Government should be involved at all, or which of the two above-mentioned approaches is preferable, are presently based on historic development, political pressure, and government policies as reflected in statutory departmental responsibilities. The main areas are briefly outlined below.

VII.4.1 Fields Subject to Extensive Government Regulation

Some areas of scientific enquiry or economic activity are heavily regulated by the Government. There are no private alternatives to the Defence Research Board in the defence sciences, nor the RCMP in scientific work related to crime. The Food and Drug Directorate of the Department of National Health and Welfare is inevitably involved in information work on account of laws regulating production and sale of food and drugs, while the Dominion Bureau of Statistics is the agency to uphold the provisions of the Statistics Act. Many other agencies in the Government are affected by similar regulations.

VII.4.2 Fields Subject to Imports from Foreign Government Sources

The bulk of the scientific information used in Canada is derived from foreign sources, often from foreign government sources. Many of these foreign governments insist on the transfer of information on an intergovernmental basis and, consequently, look to the Canadian Government to maintain some suitable agency to receive their output. The National Aeronautics and Space Administration in Washington, for example, prefers to deal with the National Science Library in Ottawa, while the U.S. Department of Defense sends its classified materials only to the Defence Research Board in Canada.

VII.4.3 Import of Non-governmental Information

Commercial publishers abroad are another main source of technical information for Canada. The Canadian publishing industry maintains extensive marketing facilities to handle the importation and sale of foreign technical literature. In many cases these firms are branches of foreign publishers. Only a limited number of Canadian publishers carry out sizeable operations in the field of technical information, and the reduction in the number of domestic firms has been quite marked in recent years. Although not a direct responsibility of government, more encouragement should be given to, if possible, the stimulation of the publication of STI literature in Canada.

VII.4.4 Fields Likely to Exceed the Scope of Private Information Agencies

Because of political pressure, or a sense of social responsibility toward particular segments of the national population, the Federal Government may guarantee the provision of scientific and technical information to specific sectors of the economy and the public and will, therefore, have to carry out the actual dissemination effort as long as these sectors are unprofitable ones for information operators, or if the economics of the situation were to put a private operator into an uncontrolled monopoly situation. Examples are the preparation and dissemination of topographical maps by the Department of Energy, Mines and Resources; or the publications of the Departments of Fisheries, Agriculture, Forestry and Rural Development, and perhaps the Department of National Health and Welfare. Also in this category are the National Science Library and the Technical Information Service which perform functions not available from other agencies.

VII.4.5 Fields in which Financial Support Is Extended to Other Agencies

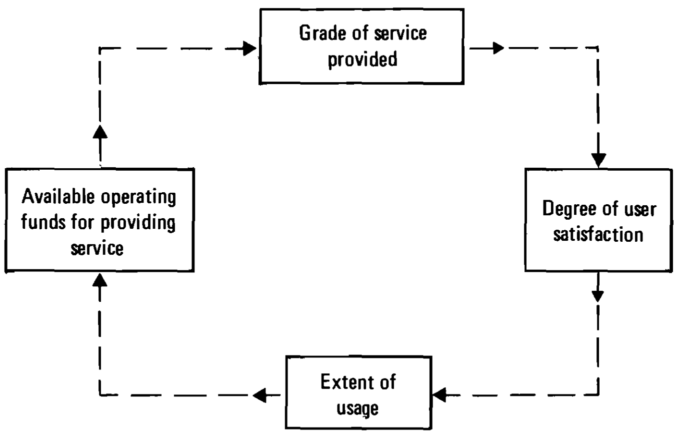
In fields subject to provincial or municipal jurisdictions, such as education, and in fields of general R & D work, whether in the public or private sector, government involvement is expressed mainly by financial subsidization, grants, or tax incentives to the benefit of STI activities. Such financial support of specific projects or activities provides a powerful instrument for influencing the direction in which the country's STI services are moving. The details of the financial conditions can often be used to ensure satisfactory results. For example, in the United Kingdom, government help is extended only during the development phase of a new STI service, whereas the subsequent operation is expected to be self-supporting. This is likely to have a salutory effect on the thoroughness of the development work with regard to practical, economic, user-oriented design. Where further government support cannot be expected, the operation would collapse if not suitably adapted to user needs.

In the light of the extent of involvement of the Federal Government, it is clear that its influence on the country's STI operations is extremely strong. Particularly, the development of commercial information services (emerging in growing numbers in the United States but still conspicuously lacking in Canada) will be decisively affected by the extent to which STI functions are pre-empted by the Government. It appears to be a point of high priority that the Government's role in the STI field be clearly defined, and that areas be outlined in which private enterprise is given room to expand. The main criterion for such division of responsibilities is social optimization as described in Section VII.3, and the main forum for its discussion is the organization of a national focus as mentioned in Section VII.2. An example of the beneficial effects of a co-ordinated effort in the information field involving government, private industry, and the public is found in the Province of Alberta. The Provincial Oil and Gas Conservation Board enforces the collection and distribution of data on oil and gas wells in the province, in conjunction with the Dominion Bureau of Statistics, to promote economic development. It thereby provides a basis for the operation of the Petrodata System, of Lowe Engineering Incorporated, Calgary, which has been able to draw on provincial and federal facilities to devlop a profitable information service on well data.

VII.5 Cost Recovery

Information services are part of activities in R & D, management, and education, and are traditionally administered internally in the organization which pursues the particular activity. Funding is therefore subject to the organization's policies, and often not identified as a separate entity. The availability of outside information services, provided through either government or commercial agencies, and the internal pressure of increased user demands for more comprehensive coverage and quicker and better response, are changing this picture. Information service is increasingly recognized as something to which a price is attached, a commodity for which price and value are related, and something that is worth considering in the evaluation of alternatives in the performance of an operation.

As soon as a price that the user has to pay is attached to information—a price that serves to offset, at least in part, the cost of the service—there is a feedback mechanism:



This feedback leads automatically to improvement, temporary stability, or economic failure of the particular system. "Free" services can never achieve such self-regulating characteristics; in a free-service environment the extent of usage is not a measure of true user satisfaction, and the agency financing the service operates in a vacuum. Furthermore, "free" services provided out of public funds have a detrimental effect on the development of commercially oriented services which may be much better adapted to user needs but cannot find sufficient initial support. Society, therefore, suffers rather than benefits from the existence of "free" service, especially in the field of scientific and technical information in which the link between information and economic productivity is more direct than in the other fields of arts, humanities, and entertainment.

It has been stressed in most of the submissions received by the Study Group that users individually and corporately, in business and industry, recognize the value of information if provided in the right form at the right time, and are prepared to pay for it.

It can therefore be stated as an objective of high importance that information services wherever they are provided—in government, industry, and universities—be operated on a businesslike basis by relating costs to revenues, regardless of whether the revenues are obtained through institutional funding or individual user charges, or both. As a first step in this direction it will be necessary to develop agreed-upon procedures for establishing costs, and methods of evaluating alternative solutions on the basis of cost-effectiveness analysis. The next step is to arrive at certain guidelines for the mechanisms of cost recovery for the various subfunctions of the service. It was pointed out in Section V that the input costs of an information system can be treated almost independently of the output costs. As a refinement of this thought, one might consider the network costs as another identifiable entity, thus arriving at three cost components:

(1) Input of information in the form of documents, abstracts, references, including the functions of translating, indexing, and abstracting;
(2) Network costs of distributing input and output between national, regional, and local distribution centres;
(3) Output of information to the user in the form of referrals, documents, analyses, and data.

That part of the input costs that arises before the centre becomes operational must be considered as part of the initial investment. Subsequent input costs, network costs, and output costs are current or operating expenses. This leads to possible schemes of cost assignments such as the following:

(1) The Canadian Government might take financial responsibility for the initial setting up of information centres, including the initial input of information, by funding of collections, centralized computer storage of indexes and abstracts from domestic and foreign sources.
(2) Federal, provincial, commercial, and professional agencies might carry the costs of network distribution and the establishment of "switching" centres as dictated by local, regional, and national interests.
(3) The output might be charged to the user, whether individual, corporate, or institutional, by relating the price as directly as possible to the type and volume of wanted information plus a cost element reflecting the average costs of all current input operations. Certain high-cost special services may have to remain subsidized pending the introduction of new methods which may lower the price to acceptable levels.

Such a division of cost assignments is mentioned here as an example only. The problem is one that can be treated only by the co-ordinated effort of all principal network participants, and by stating an overriding requirement for social optimization.

In the discussion of the evolution of a Canadian nation-wide information utility, which may eventually transcend STI and cover the whole gamut of social, economic, cultural, and technical information, it is interesting to refer to the evolution of the North American telephone system. In densely populated urban areas, large-scale, well-organized telephone systems developed early with a high degree of centralization. In thinly populated areas, however, and in isolated pockets of population, a multitude of "independent" telephone operators emerged (there are still well over one thousand of them in Canada) who operate under provincial franchises and are guided financially and technically by regulations administered by provincial service commissions and similar authorities. Without doubt this highly diverse complex of multitudes of small units, operating independently but united under some regulations that ensure interoperability, was instrumental in the formation of the advanced networks of the United States and Canada. The argument that the "independents" are gradually disappearing by absorption in the large private and provincial operating entities does not invalidate their historical role—without them there would not have been enough capital available to the large organizations to cover remote areas, or the urban areas would have had to subsidize operations in the outlying districts.

A decentralized but well co-ordinated information distributing complex based on a system of "franchised" operating units, supplied from the network and subject to guidelines in grade of service and cost recovery, is a concept which, at least initially, adapts itself better to user needs than does a rigidly controlled centralized system.

VII.6 Organization of Focus

OECD in its General Report on Scientific and Technical Information Systems and Policies (Document CMS (68)18) recommends:

> "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."

This is the concept which, for the co-ordination of the national sector, was postulated in Section VII.2. Recommendations for detailed structure and function of the focus are contained in other reports of the Study Group. From the point of view of the economics of information systems, it is important to note that the council or agency which constitutes the focus must:

(1) Have the fiscal situation of the national complex under constant review;
(2) Develop guidelines for cost-effectiveness analysis of participating services;
(3) Work out policy recommendations in those areas that deserve government intervention or financial support;
(4) Clarify the relative roles of publicly and privately financed sectors of the complex;

(5) Define areas for government-sponsored studies and R & D work in technology and problems of usage.

The organization of the focus will require a secretariat that will be capable of providing services and administering grants, contracts, and other instruments.

The detailed investigations that are necessary to provide answers to the questions arising from the agency's work, and the development of the methodology to ensure continuing review, can be done on a contract basis, either by specialists delegated from the outside to the agency or by outside organizations. In these studies the early introduction of computer processing of the large amount of data is desirable in order to be able to simulate the network problems of the complex and to establish preferred distribution patterns.

Further, the council or agency which constitutes the focus must, directly or through a connected government agency, represent Canada internationally in the general co-ordination and standardization work of OECD and other international bodies. Part of this activity would have to aim at compatibility of Canada's national information network with those of other countries to ensure that the most efficient use is made of world-wide sources and services in the STI field.

Section VIII

FUTURE LEVEL OF SPENDING ON A NATIONAL SCALE

VIII.1 Libraries, Information Centres, and Users

The present level of spendings in various typical user communities has been described in Section IV as a rough measure for the value attached to STI. It was shown that users in the scientific and technical community spend a substantial portion of their time on search for information. Expressed in salary costs, exclusive of overhead, this reaches up to $2 000 and more per user per year, depending on the degree of professional training. It was further shown that the library services provided to graduate level scientific and technical users in industry and universities, again excluding overhead costs, amount to $300 to $700 per user per year. At the lower levels of training, the large number of undergraduate students accounts for some $85 per student per year for library services, and it may be assumed that a similar figure applies to the large numbers of non-graduate technical workers in industry and trade.

Before extending these figures into the future, it is worth looking at some further published data that appear to set lower and upper limits for presently encountered service costs.

(*a*) The National Science Library of the National Research Council had in 1966-67 a budget of $1.4 million to serve an NRC user population of some 1 500 plus a nation-wide user clientele. Enquiries and loans are stated to be divided roughly half and half between internal and external services. Therefore, applying one half of the total costs to the NRC user population, we arrive at some $400 to $500 per user per year, similar to the expenditures of research-oriented industries quoted above.

(*b*) Project MAC[11] at the Massachusetts Institute of Technology (MIT) is expected by 1975 to involve costs of $1 000 per scientist per year: 15 000 scientists will then be able to "converse" freely via remote terminals with the store of information which by that time will contain 50 per cent of the world's new STI output, the balance being accessible through computer-directed reference to other associated libraries. At $1 000 per user per year it seems possible, in an environment such as MIT, to provide conditions where practically all user demands can be filled instantaneously at the push of a button.

(*c*) The budget for the Halifax Area Regional Information Centre which is planned to serve all principal scientific and technical establishments in that area calls for $750 per user per year, based on an arbitrarily fixed percentage of the research budgets of all participants (see Libraries Subgroup report).

(*d*) Commercially available current awareness services, selected on the basis of individual user subject profiles, cost some $100 to $150 per user per year for typical profiles. Over and above that the user has, of course, other service requirements such as retrospective search and browsing which he cannot satisfy by a commercial subscription.

Summarizing these observations, it can be said that at present the costs of library and information services provided to users across the country average between \$85 and \$700 per user per year, depending on the type of user community, and neglecting capital building and institutional overhead costs. At an average of \$500, the 120 000 scientists and engineers in Canada (Table 1, Section VI.5) would account for a total of about \$60 million annually. In addition, the 100 000 science and engineering students (Figure 4) would account for some \$15 million annually. To this must be added the costs of library services provided to the large number of persons in all technical, health and welfare, and teaching professions, whose number throughout Canada is certainly over half a million. At present most of these last groups have only limited access to information sources but their demands are bound to increase substantially in the coming years. A total of \$100 to \$150 million a year for library and information services to the present scientific and technical user community appears to be a conservative estimate. In addition, as shown in Section IV.2.1, much larger amounts, in the order of several hundred million dollars a year, are spent in the generation and distribution of trade information which plays an increasingly significant role in the transfer of scientific and technical information. Projecting these figures into the future, various factors must be taken into account.

The capital and overhead requirements for the extension of present facilities to larger numbers of users and larger quantities of information will grow at an accelerated rate and, being specifically related to information transfer, will be added to the costs of service. The more decentralized the overall complex, the more duplication will be necessary to establish the multitude of unconnected, self-contained centres, and the higher will be the total costs. A large part of these costs would have to be funded by the Government which, directly or indirectly, is financing most activities in the STI field. This trend of cost escalation by duplication and decentralized operation can be stopped only by a concerted effort toward co-ordination and network operation in which each dollar expended benefits not only the particular activity to which it is assigned but also the whole community of users having access to the network.

Most submissions received by the Study Group emphasized that the present systems of STI transfer are unsatisfactory and that a much higher level of coverage, accompanied by ease and speed of access, must be achieved to be able to cope with future demands. If these demands remain unsatisfied the consequences would definitely be detrimental to the national economy, as shown by the various considerations presented in Section VI.

Improved coverage and speed of access require the utilization of modern retrieval techniques and nation-wide network co-ordination. As shown in connection with the industrial statistics of Figure 1, it appears that such techniques, where applied to a large number of users, do not necessarily require expenditures which, on a per user basis, exceed those of less sophisticated services. It may therefore be assumed that the costs per user will not be substantially affected by the introduction of service improvements provided the costs are spread over a very large number of users, and that any cost increases would easily be absorbed by the users who are prepared to spend more when they find that the services are good.

The most important factor affecting future STI expenditures is the growth and spread of the user communities. The increase in the number of professionals in Canada appears to occur at a rate of about 8½ per cent annually (i.e. doubling between now and 1975), as shown in Table 1 and Figure 4. This, coupled with the high initial costs of service improvements, would then account for an initial increase in expenditures similar to the projected growth rate of R & D expenditures (15 per cent) shown in Figures 5 and 6.

However, in addition to the growing number of professionals in the fields of science, technology, health and welfare, and teaching, there is a rapidly growing number of technicians, skilled craftsmen, and others who will need and demand access to the sources of professional knowledge so as to be able to adapt their skills to the rapid changes in technology. This will add hundreds of thousands of persons to the communities of users of scientific and technical information. An indication of this trend may be found in the fact that already about 20 per cent of all enquiries received at public libraries in large urban areas are for technical information.

All these factors together indicate that the total user community for STI services in Canada will reach and exceed the one million mark in the near future. Further, we have shown that if cost allocations are made on a per user basis as an essential support of the user's work, a small percentage of the user's salary can be sufficient to lead to a radical change of the whole information environment. Under these conditions, the seemingly high overall expenditures, distributed over a large number of users, result in a high total beneficial value at a relatively low cost per user. Approaches of this kind have proved their value in many large-scale operations. They provide economic justification for all schemes that involve seemingly high costs with benefits to many people.

A recently reported UNESCO scheme in the field of primary education in developing countries may serve as an example. According to D. Najman (Chief of Primary Education, UNESCO[12] many African countries suffer from an extremely high percentage (up to 90 per cent) of insufficiently trained teachers using outmoded textbooks from colonial times. This leads to a high dropout rate (65 per cent) and a high repeat rate of students (50 per cent per school year) during the six-year primary cycle. The result is that, in spite of vigorous attempts to improve education and in spite of increasing expenditures at individual schools, the percentage of illiteracy is actually rising. To combat this trend, it is planned (UNESCO pilot project at the Ivory Coast) to introduce closed-circuit TV access into all schools, centralized teacher training, and radically modernized curriculum development. In spite of the undoubtedly high costs of such a plan, it is expected that by drastic reduction of dropout and repeat rates the actual cost per student for a completed six-year education will be lower than today's.

Similarly, it appears in our case that today's STI system, in spite of steadily increasing costs, is also increasingly incapable of coping with the situation. If, however, already available new technology is introduced, together with appropriate organizational measures based on co-ordination, it appears that user satisfaction can be obtained at costs which, on a per user basis, are easily justifiable. As access to scientific and technical information is closely related to the user's time and ability to solve his problems, the expenditures necessary to improve this access represent no more than many other expenditures that are taken for granted to support the user's work. Once STI is recognized as an essential sector of resource allocations, the costs on a per capita basis would appear to be one of the least expensive investments toward economic growth.

VIII.2 Computer and Network Operation

To determine the economic justification of a national system of computer-based information centres and interconnecting networks, the order of magnitude of their costs can be established by using the estimates presented in Section V. It is considered advisable to base the estimates on existing arts or those that will be available within the next two or three years. Computers would be used at first primarily for the storage of surrogates, as it is unlikely that the use of large-capacity computers capable of storing full text for even a moderately sized library will be economically viable for a number of years, to say nothing of the high costs for transmitting full text electronically. In addition, the present types of commercially available communication circuits and tariffs should be considered for interlibrary networks, as it will probably be some time before video and wideband communications will become economically practical on a switched basis. In these circumstances, computer and intercommunication networks would serve to augment and broaden the services of existing libraries and information centres.

On this basis a computer centre may be associated with an existing complex of local or regional libraries serving educational institutions, industry, and governments at the federal, provincial, and municipal level. In the evolution of a Canadian national network 6 centres might be established in the first 5 years and a total of 20 in the first 10 years. All these centres would have to be interconnected by communication links consisting of teletype, data, facsimile, and voice transmission facilities.

As shown in Section V, the costs of such computer centres on a recurring basis (including equipment rental, personnel, updating of input, operating, and overhead, but excluding programming and initial data input) amount to around \$2.5 million per centre per year. To this must be added nonrecurring programming and data input costs of initially \$2 million per centre, later somewhat less to account for use of common programming and increased experience.

The network transmission costs depend on the systems layout and the degree of interlinking of the computer operations. The EDUNET plan referred to in Section V.2 gives a good example. If limited to a number of groups of telephone channels, usually in multiples of 12 channels per group, the costs of a coast-to-coast network, including branch lines and terminal connections, averaged over a number of centres, are in the order of some $100 000 to $200 000 per year per centre. This would allow facsimile and data transmission at fairly high transmission rates. If video transmission were added, the costs would increase substantially.

Based on these cost elements, and assuming a gradual growth of the 20-centre network, the average annual expenditures over the next 10 years may be estimated as follows:

Average Annual Costs

(Rounded off in millions of dollars at present level of personnel and equipment costs and dollar value)

	6 centres years 1 to 5	Addition of 14 centres years 6 to 10	Total of 20 centres after year 10
Recurring cost of centres ($2.5 million per centre)	8	33	50
Recurring cost of network transmission ($150 000 per centre)	1	2	3
Nonrecurring cost of centres ($2 million for first 6 centres) (1.6 million for next 14 centres)	3	5	–
Total average cost per annum	12	40	53

These costs would be offset at an increasing rate by revenues from user charges which should eventually lead to self-support of the main network functions. As mentioned before, some special services may have to remain subsidized pending the introduction of more economical techniques.

If the system is laid out and interrelated with existing library and information centres in such a way that it benefits the whole scientific and technical user community, including the users of trade and construction information, the cost per user would obviously be quite low. The system would substantially improve the utility of present library and information services at costs which would amount to the addition of a fraction of the costs of services presently extended to the higher levels of scientific and technical workers (shown above to be between $300 and $700 per user per year excluding overheads). Compared to the expenditures incurred by the user's time spent on search for information (up to $2 000 as shown in Section IV.1), the added costs are negligible. This substantiates the argument that the unavoidable increased spendings can be kept under better control and can be utilized much more effectively in a network evolution than in an unco-ordinated, uncontrolled growth process.

Section IX

SYNOPSIS

The following paragraphs summarize those points that throughout the report are discussed as the most important economic factors for consideration in the development of a national policy on scientific and technical information. The selection is aimed at highlighting the report's main arguments.

STI serves individual users: out of the store of significant world-wide information the individual user must be able to select that which is of greatest relevance to him in the particular phase of his work. Therefore, the economics of STI transfer must be established on the basis of the number and type of individual users in the various user communities, and the different types and qualities of information service required.

In each user community the present cost of STI service per user is a fairly consistent figure which, after appropriate increase to account for increased service requirements, represents a basis for budgeting and funding.

The actual present costs of information services to individual users, even in research-oriented user communities (around $500 per annum for library services) do not exceed a small percentage of the user's salary and are considerably below the level of other costs which are taken for granted as overhead expenses supporting the user's position. Considering the vital role of STI, even a substantially increased percentage can easily be justified. Information services must be recognized and allocated as a specific cost item in the funding of user's work.

The increasing volume of information and the increasing number of users at institutionally and geographically separate locations lead, under the present conditions of unco-ordinated operations, to cost escalation without service improvement to the user. This pattern can be changed only by co-ordination of services into a network where the funds allocated to one member benefit the users of the whole network. Only then can the economics of scale and of computer technology be utilized to the advantage of the individual user at the least cost to society.

The assessment of costs of STI services in practically all types of organization is made difficult and often impossible because of the lack of recognition of the STI function as a separate accounting entity. To gain better cost control it is necessary that:

(1) Statistical methods for the collection of data on manpower, capital and operational costs of STI activities be clearly defined and applied to all new programs;
(2) Accounting procedures be set up to separate STI expenditures and revenues from other accounts in all new programs;

(3) International (OECD) procedures be followed in statistical methods for determining STI costs and expenditures on a national scale in order to compare conditions in Canada with those in other countries and facilitate international co-operation.

Rationalization of STI services on a national scale requires the establishment of a national focus for STI systems. This focus must, in a political, administrative, and economic sense, take into account the independent jurisdictional and institutional characteristics of the components of the national information complex, and act as a point of contact for international activities.

As a guideline for decisions on alternative ways of meeting the needs of various user communities in the evolution of a national network, certain ground rules or objectives must be established. Such objectives may take the form of those listed in this report. Abbreviated from Section VII.1, they are:

(1) Response to user enquiries at many different levels of sophistication;
(2) Provision of access to international sources;
(3) Availability of service at reasonable cost regardless of institutional and geographical location;
(4) Effective dissemination of publicly supported R & D results;
(5) Elimination of worthless material before entry into national complex;
(6) Encouragement of R & D in the information field;
(7) Provision of services and degree of self-support determined by overall productive efficiency;
(8) Prevention of monopolies and monopsonies in information transfer;
(9) Prevention of discrimination against particular institutional or disciplinary requirements.

The effective evolution of an information system needs the development of feedback mechanisms in which user satisfaction, extent of usage, and grade of service are kept in balance. One factor providing such feedback reaction is the charging of fees for services rendered, and basing the grade of service at least partly on the revenues from fees, regardless of whether the revenues are obtained through institutional funding or individual user charges, or both. Eventually this should lead to self-support of the services.

The formation of a Canadian industry for the commercial distribution of STI will depend heavily on the part that Federal and Provincial Governments play in this field (for example, policies for provision of "free" services). Clear demarcation lines are required so that private enterprise can be encouraged to enter the information field in specific areas.

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Appendices

Appendix A

QUESTIONNAIRE
STUDY OF SCIENTIFIC AND TECHNICAL INFORMATION IN CANADA

You can help materially—at this vital stage in the study for improving Canada's technical information services—if you will indicate below:

1. How much of your time each year (roughly speaking) is spent in procuring needed scientific and/or technical information from in-company *and* other sources.

   Obviously this cannot be answered precisely, but please read the suggestions on the back of this page, then make a broad estimate:

   .... Less than 5%
   .... 5% to 10%
   .... 10% to 15%
   .... 15% to 20%
   .... 20% to 25%
   ....Over 25%

2. Your field is: ..... Education ...... Industry ...... Government.

3. Your involvement in your field is mainly as an:.......... Administrator ..... Engineer .... Scientist ...... Technician ..... Teacher .... Other.

4. Your principal function is in: ...... R & D ...... Design .... Production .... Marketing....... Teaching .... Service and Maintenance ....Planning, Programming, Directing.

5. Income bracket: ....Less than $10 000 a year
   .... $10 000 to $15 000
   .... $15 000 to $20 000
   .... $20 000 to $25 000
   .... Over $25 000

Please return this sheet to your local representative. *No signature is required.*

SUGGESTIONS

As an aid in arriving at the percentage asked for, it is suggested that you consider the following, then jot down a figure for each.

	%
a) Time spent in searching for published information in libraries or elsewhere	....
b) Communications relating to all such	....
c) Scanning technical magazines and journals	....
d) Holding conferences with vendors and suppliers or their field men	....
e) Consulting technical experts or researchers	....
f) Attending meetings and conventions	....
g) Attending lectures or instruction classes	....
h) Patent searches	....
i) Other	....
Total:	

Appendix B

ANALYSIS OF 1 564 REPLIES TO QUESTIONNAIRE SHOWN IN APPENDIX A

(a) Percentage of replies in order of institutional sector:
30 per cent - Education
45 per cent - Industry
25 per cent - Government

(b) Percentage of replies in order of type of work:
56.0 per cent - Research and development
21.5 per cent - Teaching
22.5 per cent - Design, production, programming, planning

(c) Median salary in the $10 000 to $15 000 bracket

(d) Percentage of time spent each year in procuring STI from in-house and other sources:
9.4 per cent of all replies reported less than 5 per cent
24.2 per cent of all replies reported 5 to 10 per cent
21.0 per cent of all replies reported 10 to 15 per cent
16.8 per cent of all replies reported 15 to 20 per cent
12.3 per cent of all replies reported 20 to 25 per cent
15.9 per cent of all replies reported over 25 per cent
Median around 15 per cent.

(e) Percentage of time each year spent in procuring STI in order of sources (total replies: 995):

(a) Time spent in searching for published information in libraries or elsewhere	5.2 per cent
(b) Communications relating to all such	1.3 per cent
(c) Scanning technical magazines and journals	4.6 per cent
(d) Holding conferences with vendors and suppliers or their field men	1.2 per cent
(e) Consulting technical experts or researchers	2.4 per cent
(f) Attending meetings and conventions	2.3 per cent
(g) Attending lectures or instruction classes	1.4 per cent
(h) Patent searches	1.5 per cent
(i) Other	.7 per cent

(f) Average costs per user per year (salary only) associated with time spent in procuring information in order of occupation:

Administrators	$2 106
Engineers	$1 792
Scientists	$2 114
Technicians	$772
Teachers	$1 912
Consultants and others	$1 774

(g) Average costs per user per year (salary only) associated with time spent in procuring information, in order of institutional sector:

Education	$1 913
Industry	$1 717
Government	$2 073

Average: $1 879

SPECIAL STUDY
No. 8

Scientific and Technical Information in Canada Part II Chapter 7 Economics