Dissemination of Scientific and Technological Information in Canada*

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A highly science- and technology-based industry with strong academic and governmental backing, chemistry and chemical engineering are dependent on information retrieval services. These are principally centered in the National Science Library of the National Research Council of Canada. The National Science Library operates CAN/SDI, a national current awareness service employing 11 data bases and serving over 3000 end-users of which 39% belong to chemical disciplines. The newly established Information Exchange Centre keeps on file all federally funded university-based research projects. The Technical Information Service of NRC provides management- and production-related information of a consultative nature. These and several other I/R activities in Ottawa and elsewhere are components of a nation-wide network which is developing, according to government directives, into a coherent Canadian Scientific and Technological Information Dissemination System.

When accepting, with very great pleasure, the invitation to discuss the developing scientific and technological information network of Canada, I felt the embarassment of a chessplayer who is asked to describe a game he will play. To push this analogy a little further, the designer of a national information system is always playing the black chessmen; he is not starting the game but responds to the opening move with a strategy, with a plan to win. Chess games and information services are developed in the intricate interaction of people, in the sensitive link of human partnership. Before each move, we have to learn a little more about the partners, the generator and user of scientific and technical knowledge. In short, we believe that building a national system for a very large, compartmentalized, and stratified clientele must be gradual and also a continuously evaluating and self-correcting process.

The Canadian environment for such a developing scientific and technological information (STI) system has its own unique characteristics. The second largest country on earth with less than 1% of the world's population, we sometimes refer to Canada as a big country and sometimes we call her a small country; strangely enough, both statements are true. Small concentrations of user communities are separated by vast distances. Not too long ago it was still true that science and technology belonged exclusively to the 4000-mile-long southern belt bordering the United States; this simplistic view, however, has been gradually losing ground. Science and technology is spreading north, to the subarctic oil fields, to pipeline builders on permafrost, to city-planners in polar regions, to geologists exploring mineral resources, and to designers and constructors of power plants in the wilderness of yesterday.

But the long common border with the United States and the convenience of importing knowledge from a scientifically and industrially most productive and friendly country, has created a rather passive "consumer attitude" in Canada. Why duplicate what is easily available from south of the border? Why spend effort and money for information that is available for money alone or often even free of charge? These questions, which in the past so frequently have silenced Canadian initiatives, are perhaps not quite relevant any more.

First, information became a costly commodity which is expensive to produce, sort, store, and retail to the individual customer. Big science has invented its own information industry which today offers some seventy-five commercially available bibliographic data bases on the international market for reprocessing and disseminating their information content. From the modest over-the-counter shopper, Canada became a wholesale buyer of information, acquiring data bases, scientific and technological literature to back up its own information retrieval services. What has developed in the last 5 to 6 years is one of the finest secondary information industries in the world.

Second, the dissemination of scientific and technological information is now a widely debated issue in Canada, in fact a prime component of a developing national science policy. Our organization of STI, our resources, services, and information dissemination policies were extensively reviewed by OECD,[1] an international organization, and by two study-groups of the Science Council of Canada.[2,3] The resulting reports point to the necessity of creating a coherent nationwide network of services for all levels of the scientific and technological communities. In keeping with the recommendations of "Science Council Report No. 6," the federal government has assigned the responsibility for developing a national scientific and technical information system to the National Research Council of Canada.

Besides the geographical characteristics, our consumer attitudes and our concern with national science policy, I would like to add a final line to the sketchy contours of the Canadian environment. This refers to a very special structural difficulty which perhaps can be summed up with a few borrowed words from Alfred Tennyson's Ulysses: " ... manners, climates, councils, governments ... but honour'd them all."[4] The Canadian Constitution, the British North America Act of 1867, has delegated all responsibilities for education to the provincial govern-

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ments. Consequently, universities function under the jurisdiction of the 10 provinces, and this also applies to their affiliated research institutes. The provinces have their own research councils and various legislative bodies which to some extent are all involved in the handling and dissemination of scientific and technical information. In developing a national system, we have to respect all the cultural, social, and professional manners, consider the varieties in scientific climates, and do honor to councils with various jurisdictions and to the authorities of the federal and 10 provincial governments.

STI AND THE NATIONAL SCIENCE LIBRARY

It we magnify this bird's-eye view of the Canadian situation, two important national organizations become visible in the center. One is the National Library which, empowered by the National Library Act of 1969, controls and coordinates a very broad spectrum of activities in Canadian librarianship. Its role includes the guidance of harmonious development of bibliographic resources, the standardization of library procedures, the maintenance of the National Union Catalogue, and the coverage of the literature in the social sciences and humanities. The other central organization, which I would like to introduce a little more extensively, is the National Science Library (NSL), a division of the National Research Council of Canada. There exists a very close association, in fact a symbiotic relationship, between these two national libraries which are both located in Ottawa.

NSL represents a great deal more than what its name, in the traditional connotation of the word "library," implies. Partly it is indeed the largest scientific collection in the country for the natural sciences, medicine, and technology, functioning as a back-stop resource, a libraries' library, and providing also direct services to individual users. Last year. 166,000 loan and photocopy requests were handled, which gives an average of 672 for each working day; 26,000 reference inquiries were received during the same year.[5] What makes NSL the natural focal point of a scientific and technological information network for the whole country lies beyond its identity as a large conventional library: it is NSL's organizational ability to provide several types of accessory, supporting, and coordinating services on a national scale.

Let me interject here this presentation with a brief remark. Intentionally, I have not even mentioned so far chemistry and chemical information, because our activities and plans related to this field can only be viewed against the total background—i.e., within our over-all efforts to create a national system for scientific and technological information. Consequently, the library as well as the accessory and supporting systems of NSL serve chemistry as directly as all the other disciplines in the natural sciences and engineering.

For example, the "Union List of Scientific Serials in Canadian Libraries"[6] is a computer-based locating tool giving information on the holdings of 225 science and engineering libraries. The Translations Centre provides English or French versions of foreign scientific papers and maintains the Canadian branch of the International Translations Index with some 250,000 entries. These and other services are of course of great benefit for chemists and chemical engineers, as well as for other disciplinary communities.

The latest addition to the roster of services offered by the National Science Library is the so-called "Information Exchange Centre," a facility for the storage and retrieval of information on on-going university-based research projects funded by the federal government. With the cooperation of 21 granting bodies, a data-base was created on "who is doing what, where, and how supported." This nation-wide inventory assists researchers and research program managers in avoiding duplication of efforts and also in locating expert advice in all the sciences. In addition, the service provides fiscal and various statistical data for science policy planning purposes.

In outlining NSL's resources and the components of the Canadian scientific and technical information system, I would like to emphasize the special importance of the Canadian Selective Dissemination of Information Service, in short CAN/SDI.[7-10] This is a fully operational and continuously developing personalized current awareness system which as of now searches over 1100 user profiles against eleven data bases and serves approximately 3000 end-users across the broadest spectrum of Canadian science and technology. Its success is due mainly to a unique preprocessing method by which various data bases are converted into a common matrix: a Library of Congress MARC-like format. Thus, the user can access any of the source tapes with one single search formulation, which enables him to switch without difficulty from one tape to another and to tap the information content of several tapes without major changes in the composition of search terms or in the search logic.

After three years of experimentation and testing, Jack E. Brown, the National Science Librarian, offered CAN/SDI as a national service in April 1969. The number of data bases grew from the single *Chemical Titles* of the Chemical Abstracts Service to 11 with the addition of (2) the source and citation tape of the Institute for Scientific Information in Philadelphia; (3) *Chemical Abstracts Condensates;* (4) INSPEC from the Institute of Electrical Engineers in London, England; (5) MEDLARS from the National Library of Medicine in Bethesda, and its on-line version, MEDLINE; (6) *Biological Abstracts Previews* from BIOSIS in Philadelphia; (7) the Pollution Information Project tape of NSL; (8) MARC II from the Library of Congress; (9) Geological Reference File (GEO-REF) from the American Geological Institute in Washington; (10) *Computerized Engineering Index* (COMPENDEX) from New York, and (11) *Government Reports Announcements* from the National Technical Information Service (NTIS), Springfield, Va.

On the list there is one tape service, Pollution Information Project, whose name might not sound familiar. This has been jointly developed by NSL's Tape Services Branch, the Associate Committee on Scientific Criteria for Environmental Quality and the Division of Biology, both of the National Research Council of Canada. The file, which now contains over 57,000 citations of pollution-relevant documents, has been built up by computer-search of the *Chemical Abstract Condensates,* ISI, *Biological Abstract Previews,* and the *Health Effects of Environmental Pollutants* (HEEP) tape of BIOSIS from September 1968 to date. The Pollution Information Project operates in an interactive online mode with video terminals.

The potentials of the National Science Library do not all originate from its own strength. Being situated within the National Research Council, NSL is able to utilize the expertise of scientists who are always available for consultation and advice. It is located under the same roof with the Technical Information Service of NRC, which serves the Canadian industry directly and through its field offices. NSL is in liaison with governmental information sources in Ottawa, with universities and several centers of excellence across the country. As its head, the National Science Librarian has put it, "NSL is not a library in the

conventional sense of the word, but rather an information transferral agency. Its resources and services are developed in close cooperation with all major libraries and information centres in Canada and designed to supplement and complement local information services."[11]

FOUNDATIONS OF A DECENTRALIZED SYSTEM

To use again the analogy of chess, it appears that we are already in mid-game when the pieces had been moved into advanced positions, and the lines of attack are visible. There is a rough-edged and somewhat loosely structured system already working in Canada with several of the components tested and functioning. This stage has been reached partly by the voluntary cooperation of libraries and partly by the conscious planning of services to satisfy manifested needs. A few examples can demonstrate that NSL has played a significant role in both categories.

It can be estimated that in the scientific and technical fields, the National Science Library handles about one-third of all inter-library serial loan tranactions in Canada. It is the only source for several thousand rarely used and requested serials, reports, conference proceedings, and other items. NSL has built up the widest international exchange program for scientific and technical literature in Canada with 600 organizations participating in more than 50 countries.

A small unit of NSL, the Health Sciences Resource Centre[12] is engaged in coordinating the serial acquisition work of the 16 medical schools and is now conducting a survey of audio-visual materials in the health sciences. The Centre held a workshop recently for mid-career medical librarians from various universities, updating them with new methodologies in information handling, services, and administration.

The Tape Services Branch has trained some 300 search editors for the CAN/SDI project. These people are spread all over the country in universities, industrial plants, research centers, and governmental organizations to look after their own clientele by formulating and updating their search profiles and monitoring the feedback from their users. Just recently, the contractual agreement between the National Library of Medicine in Bethesda, Md., and NSL has been extended to cover besides MEDLARS services the new interactive MEDLINE system. Under the administrative supervision of NSL, Canadian information centers can set up their own MEDLINE terminals tied to the nodes of the nation-wide Timeshare network in the U.S. Besides the already functioning system for pollution information, which I mentioned earlier, and the presently offered MEDLINE, the design of an online query system for Engineering Index (COMPENDEX) has just been completed.

These examples, and many others which could be easily added to the list, show a significant common feature: they all promote the networking of services. By coordination, service support, and geographical branching, NSL aids the creation of a more coherent national system and, at the same time, is strengthening the switching mechanisms in the interfaces between the central node in Ottawa and remote user groups. Networking is an ongoing effort with the objective to help us create a decentralized, perhaps regionalized, information dissemination structure in the future. The model of such a system is still in the blueprint stage but some cooperative patterns of decentralization—mainly those related to CAN/SDI—have already been put to use.

I realize, and not without uneasiness, that my account on Canadian developments is somewhat reductive and one-sided. I call perhaps too much attention to the activities of the National Science Library which, while being the focal point of the over-all system, is only one of the component parts.

For explanation, I would like to refer back to the introduction of this paper which described the Canadian situation as being unique in its structural character. Of course, we have a good number of excellent libraries and information centers in Canada, but none of them is as close to the formative forces of development as the National Science Library. NSL is not only the delegated and recognized national center for scientific and technical information but also the organization that can be shaped by the federal government without jurisdictional difficulties and authoritative restrictions for this national task. Consequently, the formation of the national system, if not in its totality but in its principles and directions, can be seen best by looking at NSL.

In fact, the National Science Library is not developing the national system; it is only an instrument to this end. The mandate was given to NSL's parent organization, the National Research Council of Canada which, according to governmental directives, has appointed a policy-making Advisory Board for Scientific and Technological Information (ABSTI) consisting of 20 prominent representatives of generators, processors, and users of information. The directive of the federal government to NRC includes the instruction that the system should be developed under the general direction of the National Librarian. This is to ensure that the common policies and standards will be equally observed in both spheres of the total national information system—in the humanities and social sciences as well as in the natural sciences and technology.

STI AND CHEMISTRY

How are all these developments affecting chemistry and chemical engineering in Canada? The question is to some extent rhetorical since a few direct implications are obvious.

The population of Canadian chemists and chemical engineers can be estimated as being roughly 12,000. Some 600 new graduates (1970/71) join the profession annually with degrees ranging from bachelors with honors to Ph.D's. If we look closely at this growth rate, we find that during the sixties the number of chemistry masters increased by a factor of 2.35 and Ph.Ds by 4.45; both are lower than the national growth factors of all the other categories of graduates over the ten-year period.[13] Emigration to other countries, mainly the effect of the "brain drain" to the United States, has shown lately a significant decrease. In 1971, 114 chemists emigrated to the U.S., a decrease of 25% from 1970.[14] Thus, the population figures are creeping slowly upwards, increasing gradually the number of potential users of chemical information.

It is customary to divide professional groups by affiliation and employment into three main sectors: industry, educational institutions, and government. Although we have not done any reliable study to explore the demand and supply ratios in information for these three sectors, we assume that chemists and chemical engineers in academic and governmental environments are sufficiently catered with information. These are the areas where in-house services, with strong ties to NSL and other information sources, are well developed and where individuals potentially belong to "invisible colleges" utilizing informal

channels to exchange knowledge and to achieve information transfer on a personal basis. Chemists and chemical engineers in industry are perhaps in a less advantageous situation.

The vertical distribution by affiliation and employment can be further refined, horizontally, by fields of activity: research and development (R & D), management, production, technical sales back-up, etc. Important information sources in the production and sales areas are provided by the Chemicals Branch, Department of Industry, Trade and Commerce, the publisher of Canadian Chemical Register,[15] Chemical Import Trends,[16] and Canadian Chemicals for Export.[17] To serve the fields of management, development and production, the Technical Information Service (TIS) of the National Research Council maintains a nationwide organization with 11 field offices. Besides regularly provided on-site advice by field officers, the engineering staff of TIS in Ottawa responded in 1971 to about a thousand chemical enquiries of a consultative nature. Regarding information supporting R & D, NSL is probably the prime source through its CAN/SDI service for current and its Reference and Research Department for in-depth information. Incidentally, the head of this department is a chemist with considerable laboratory experience.

How large is the R & D community in chemistry and chemical engineering? According to the President of the Chemical Institute of Canada, "29% of all graduates in chemistry and 12.5% of all branches of engineering are associated with R & D. Business enterprises have the highest percentage of researchers, 41% of the chemists and chemical engineers, followed by educational institutions with 38% and government laboratories with 20%."[18]

The National Science Library can offer to this sizeable group a combination of information services. Let us first look at CAN/SDI which as of now has 1116 subscriptions for its 11 data bases. A survey conducted in 1970[19] showed that each subscription serves an average of 2.8 individuals. This means that the information retrieved by a search profile is shared with a number of other professionals, coworkers, members of the team. It also happens quite frequently that the retrieved citations are converted into a retrospective file that is open for search to many people.[20]

CAN/SDI has 439 subscriptions for the data bases supplied by the American Chemical Society: the two types of *Chemical Abstract Condensates* and *Chemical Titles*. The 439 multiplied by 2.8 gives 1229 individuals. Of course, this figure is only one of the indicators of usage; nevertheless, it shows that 39%, or roughly one in three, users of CAN/SDI is receiving chemical information. Most, if not all, of these users are associated with R & D in chemistry and chemical engineering.

Concerning other than CAN/SDI services, the close association of NSL with scientists in the National Research Council is of great importance. Requests for information and problems delegated to information specialists in the National Science Library are very often answered or solved by direct consultation with in-house experts, many of them leading authorities in their specialties.

The chemical industry, which produces 6% of the total manufacturing output of Canada and employs some 80,000 people in 1200 plants, is responsible for about 15% of all the industrial research and development undertaken in the country.[21] Being a highly science- and technology-based industry with strong academic an governmental backing, chemistry and chemical engineering are strongly dependent on intormation retrieval services. Within the developing scientific and technological information system, the National Science Library has assumed a large share of the responsibility for creating an information-rich environment for Canadian chemists and chemical engineers.

LITERATURE CITED

(1) Organization for Economic Cooperation and Development, "Review of Science Policy in Canada," Paris, OECD, 1969.

(2) Science Council of Canada, "Scientific and Technical Information in Canada," Special Study No. 8, Ottawa, Queen's Printer, 1969.

(3) Science Council of Canada, "A Policy for Scientific and Technical Information Dissemination," Report No. 6, Ottawa, Queen's Printer, 1969.

(4) Tennyson, Alfred, "Ulysses," 1.6.

(5) National Science Library of Canada, "Annual Report 1970/71," Ottawa, National Research Council of Canada, 1971.

(6) National Science Library, "Union List of Scientific Serials in Canadian Libraries," 4th ed., Ottawa, NSL, 1971.

(7) Brown, J. E., "The CAN/SDI Project: the SDI Program of Canada's National Science Library," *Special Libraries* **60**, 501-9 (1969).

(8) Brown, J. E., "The CAN/SDI Project: Training of Users," Papers presented at FID (International Congress of Documentation), September 21-24, Buenos Aires.

(9) Mauerhoff, G. R., "NSL Profiling and Search Editing," *Proc. Ann. Meet. Western Canada Chap. ASIS* **2**, 32-53 (1970).

(10) Gaffney, I., CAN/SDI: Experiences with Multiple-source Computer-based Current Awareness Services of the National Science Library," 71st Annual Meeting of the Medical Library Association, June 11-15, 1972, San Diego (in press).

(11) Brown, J. E., "The Canadian National Scientific and Technical Information (STI) System: a Progress Report," 1972, Miles Conrad Memorial Lecture, Philadelphia, National Federation of Science Abstracting and Indexing Services, 1972.

(12) Ember, G., "The Health Sciences Resource Centre: a New Information Service of the National Science Library of Canada," *Proc. 3rd Intern. Congr. Med. Librarianship*, May 5-9, 1969, Amsterdam, Excerpta Medica, 1970, pp. 383-9.

(13) "University Enrollment," *Chemistry in Canada* **24**, 7 (Feb. 1972).

(14) "The Brain Drain," *Chemistry in Canada* **24**, 8 (Apr. 1972).

(15) Department of Industry, Trade and Commerce, Chemicals Branch, "Canadian Chemical Register," Ottawa, Queen's Printer, 1971.

(16) Department of Industry, Trade and Commerce, Chemicals Branch, "Chemical Import Trends," 1965-1966-1967, Ottawa, Queen's Printer, 1970.

(17) Department of industry, Trade and Commerce, "A Directory of Canadian Chemicals Available for Export and the Manufacturing Companies," Ottawa, Queen's Printer, 1970.

(18) Streight, H. R. L., "The Climate for Research in the Seventies," *Chemistry in Canada* **24**, 13-16 (May 1972).

(19) Wolters, P., and Brown, J. E., "CAN/SDI System: User Reaction to a Computerized Information Retrieval System for Canadian Scientists and Technologists," *Can. Lib. J.* **28**, 20-3 (1971).

(20) Cedergen, R. J., "Computer Aided Bibliographics for Personal or Group Use," *J. Chem. Doc.* **11**, 224-6 (1971).

(21) Mackenzie, D. L., "Canada's Chemical Industry," Speech to the Banff School of Advanced Management, November 19, 1971, Ottawa, The Canadian Chemical Producers' Association, 1971.