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**PROBLEMS AND CHALLENGES IN THE HISTORY OF CANADIAN SCIENCE AND
TECHNOLOGY REVISITED: THE MAKING OF A BIBLIOGRAPHY**

R. Alan Richardson¹ and Bertrum H. MacDonald²

The publication of *Science and Technology in Canadian History: A Bibliography of Primary Sources to 1914*, is the culmination of several years' work and the efforts of many people.³ In this essay we offer a few comments on the background which led to the project, explain the actual structure of the Bibliography, mention a few difficulties with compilation, discuss potential uses and conclude with an evaluation of its possible place in the larger context of Canadian studies.

BACKGROUND

The history of science and the history of technology are very recent additions to the Canadian intellectual scene. Yet, remarkable progress has been made during even the past ten or so years, mainly as the result of the combined efforts of a diverse but dedicated group of people: archivists, curators, engineers, historians, librarians, museologists, scientists and others. The healthy state of the Canadian Science and Technology Historical Association (CSTHA) and its journal, *Scientia Canadensis*, indicate the continued support for historical studies and projects concerned with the effects of science and technology in our national and cultural history.⁴

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³ R. Alan Richardson and Bertrum H. MacDonald, *Science and Technology in Canadian History. A Bibliography of Primary Sources to 1914* (Thornhill, Ontario: HSTC Publications, 1987).

⁴ Canadian Science and Technology Historical Association/Association pour l'Histoire de la science et de la technologie au Canada (CSTHA/AHSTC), and the Association's journal, *Scientia Canadensis*, (previously known as *HSTC Bulletin*) which has been published since 1976.

need for Canadian research tools, especially detailed bibliography.⁵ He reviewed the efforts then being made to introduce undergraduate instruction in Canadian science and technology in at least two universities. There was, Richardson observed, inadequate knowledge of science, medicine and technology in the four broad cultural-historical periods of our past, which he identified as: (1) aboriginal; (2) French regime; (3) English regime; and (4) Post-World-War I/autonomous multicultural society. The fascinating question of the influence of the culture of one period on another, as well as the recognition of continuities and discontinuities between periods had received little study. Understanding of the impact of science and technology, in Richardson's opinion, lagged far behind the more traditional approaches of military, political and economic history. The little existing secondary literature ranged from excellent to awful, with enormous gaps existing in all areas. Much of the good literature was of a biographical nature measuring the achievements of an outstanding individual in terms of international status or recognition. Little was being said about the cultural and social effects of science and technology in our own society. The history of science, medicine and technology in Canada was simply not recognized as a serious branch of scholarship twenty years ago. All this has now changed for the better in a remarkably short period of time and involving few but very committed individuals.

It was with a view to making some positive and lasting contribution to the encouragement of Canadian studies that Richardson (later joined by MacDonald⁶) decided to produce a detailed bibliography designed specifically for use by historians and a wide range of interested individuals. Fortunately, excellent resources, human and technical, existed at the University of Western Ontario to bring this plan to fruition. A first-class research group, centred on the School of Library and Information Science, with the co-operation of the Faculty

5 R. Alan Richardson, 'The History of Medicine and Science in Canada: Problems and Challenges,' paper read at the annual meeting, History of Science Society, San Francisco, 1973. The history of medicine in Canada are now available: Charles G. Roland and Paul Potter, *An Annotated Bibliography of Canadian Medical Periodicals. 1826-1975* (Toronto, 1979) and the Hannah-supported work by Charles G. Roland, *Secondary Sources in the History of Canadian Medicine: A Bibliography* (Waterloo, Ont., 1984).

6 See Bertrum H. MacDonald, 'Science in Canada to the Twentieth Century: A Bibliography,' paper read to the Canadian Society for History and Philosophy of Science, Fredericton, New Brunswick, May 1977, and Bertrum H. MacDonald and R. Alan Richardson, 'Science and Technology in Canadian History: A Report on the Construction of a Retrospective Bibliography,' paper read to the Association for the Bibliography of History, San Francisco, December 1983.

of Medicine, was eventually called into being to produce the needed research tool.

The Symons Report of 1975 did much to encourage the elaboration of a broad range of Canadian studies.⁷ The present Bibliography was a child of the wave of interest in things Canadian during the seventies and a response to real need in terms of undergraduate teaching. What started literally as a shoe-box collection of 5 x 7 cards sprouted into a computer-based pilot study⁸ and blossomed into a full-blown vigorous research project involving thirty full- and part-time assistants over a period of three years. The research was very generously supported by the Social Sciences and Humanities Research Council of Canada.⁹

CONSTRUCTION OF THE BIBLIOGRAPHY

We begin our discussion of the construction of the Bibliography by describing the structure of the final product simply because that structure, to a large extent, dictated how the data was collected, recorded and manipulated to produce the end product. Keeping in mind that very few people have, from the beginning, a precisely clear vision of a final product that is three years in the making, what we describe below reflects not only design features that were established at the beginning of the project but also revisions in the design that were made as experience with the data was gained. If it is a truism among bibliographers that one's ideas about the design of a particular bibliography are not totally finalized until the bibliography is nearing completion, then this Bibliography is characteristic of that pattern. A number of features of the final product were very clear from the beginning, however. We knew, for example, that both an author catalogue and a subject catalogue would be produced and that a number of indexes were possibilities. We will describe each briefly.

More than 10,000 individual authors -- including corporate and pseudonymous authors -- wrote the publications represented in the author catalogue. This catalogue contains entries for only those works with known authors; some 24,000 out of 58,109 total entries were published anonymously. Each entry in this catalogue is a complete bibliographic record and all the records are sorted alphabetically by author. Multiple works by a single author are sorted chronologically by date of publication and if an author produced more than one work in

7 T.H.B. Symons, *To Know Ourselves. The Report on the Commission on Canadian Studies* (Ottawa, 1975), 2 vols.

8 Bertrum H. MacDonald and R. Alan Richardson, *Preliminary Bibliographical Inventory of Sources in the History of Science, Technology, and Medicine in Canada to the Twentieth Century* (London, 1981).

9 Funding was made available under the Canadian Studies Research Tools -- Strategic Grants programme.

a single year, the bibliographic entries are sorted alphabetically by title.

The author catalogue contains 34,760 entries but not all of these are unique since a work with multiple authors is duplicated in the catalogue as many times as there are authors for that work. Each author's name appears in an authorized form, usually surname, followed by given names and then by a qualifier such as birth and death dates; the extensive work required to build the name authority file is described elsewhere.¹⁰ In addition to the bibliographic records, the author catalogue contains more than 650 'see' references which direct a user from a variant author name to the authorized name under which all that author's works are listed.

From the beginning of the project, it was decided that subject access was a necessary priority since access by author or title alone would not be sufficient. That decision, however, led to considerable difficulty in determining which subject classification should be employed. Ultimately, a subject classification, designed specifically for this Bibliography, was created and has been described in more detail elsewhere.¹¹ Approximately 175 subject categories were used to classify the bibliographic entries and these represent the wide range of scientific and technological topics encountered in the literature.

The subject catalogue contains complete bibliographic records for all entries in the Bibliography. These records are sorted into three main sections: a) scientific topics; b) technological topics; and c) topics that overlap the previous two sections such as education, societies and museums. The bibliographic entries in each main section are arranged chronologically under major subject categories and their subdivisions and multiple works dealing with a single category published in the same year are sorted alphabetically by author or by title for anonymous works. The subject catalogue contains 86,771 records but, as with the author catalogue, not all of these are unique since a publication dealing with multiple subjects was classified according to each subject category (maximum six) and, therefore, appears in the catalogue as many times as there are subject categories assigned to it.

The third main catalogue in the Bibliography is the title catalogue which contains all 58,109 bibliographic records arranged alphabetically by the first fifty characters of the title starting with the first key

10 Clara M. Chu, Judith Green, Bertrum H. MacDonald and R. Alan Richardson, 'The Case of Tweedle-Die and Tweedle-Dum: Authority Control in a Retrospective Database,' paper read to the Canadian Association for Information Science, London, May 1987.

11 Bertrum H. MacDonald and R. Alan Richardson, 'The Development of a Subject Classification Scheme for the Bibliography of Canadian Science and Technology to 1914,' *Papers of the Bibliographical Society of Canada* 24 (1985), 103.

word. Records with titles having the same first fifty characters are sorted chronologically by date of publication. Since the title catalogue was used to generate indexes, each record in this catalogue was assigned a unique record number which is used to link an index entry to the full bibliographic entry in the title catalogue.

Two indexes to the bibliographic records in the title catalogue were generated. A KWOC (Keyword-Out-of-Context) index and an index to the monograph titles in the *Bibliography*. The KWOC index provides the most detailed means of access to records in the *Bibliography* because it is created from the words of each title, except for insignificant words which are excluded. The keywords are sorted alphabetically and when there is more than one title per keyword the titles are sorted chronologically by date of publication. The monograph title index provides access to the monographs in the *Bibliography* -- 5,690 entries out of 58,109 -- and is an alphabetical listing of the titles based on the first significant word of the title.

COMPILATION OF THE DATA FOR THE BIBLIOGRAPHY

One of the important features of this *Bibliography* is that a record was created for only works that were seen and scanned by the editors or research assistants. This meant, of course, that visits to libraries were required. Holdings in libraries and a few archives all across Canada and at the British Library were examined. Invariably, staff members at each of these institutions were very helpful in arranging access to collections and alerting staff of the *Bibliography* to possible works to examine.

The *Bibliography* contains records for only published primary works consisting of either periodical or monographic literature. By far, most (approximately 90%) of the entries in the *Bibliography* arise from periodical literature. More than 200 early Canadian and foreign periodicals were systematically searched for relevant information. The decision to search these particular periodicals was based on work completed for a pilot project and a search of the *Union List of Scientific Serials in Canadian Libraries* published by the Canada Institute for Scientific and Technical Information (CISTI).¹²

Entries for monographs are based on the examination of holdings at a number of libraries, notably the Eric Dennis Collection of Acadia University, the Lande Collection of McGill University, the Canadiana Collection of Queen's University, the Canadiana Collection of the Thomas Fisher Rare Book Library and collections of the British Library. One of the most useful collections of pre-1900 monographs is the microfiche collection of the Canadian Institute for Historical

¹² Canada Institute for Scientific and Technical Information, *Union List of Scientific Serials in Canadian Libraries* (Ottawa, 1979) and subsequent editions.

Microreproductions (CIHM)¹³ which has been purchased by a number of Canadian and foreign libraries. The CIHM collection was systematically searched for relevant entries for the *Bibliography*; approximately 30,000 of the estimated 60,000 titles in the CIHM collection were available at the time of the search. In the search for periodical and monograph literature suitable for listing in the *Bibliography* a number of definitions were applied as follows:

i) Only primary literature was included. By way of explanation, all secondary works, namely biographies and historical assessments of scientific disciplines or industrial firms were excluded.

ii) Only works published prior to 1914 were included. While publication dates extend back into the sixteenth century, most of the works listed in the *Bibliography* were published post-1850.

iii) Works could be published in any language. By far, most of the works were published in English and these were followed in number by those in French and then other European languages.

iv) A broad definition of Canadian was employed. By this we mean that a work was included in the *Bibliography* if it was written by a Canadian and published inside or outside Canada or if it was written by a non-Canadian and published inside or outside Canada provided that the work deals in some substantial way with Canada. This definition mirrors that adopted by the National Library of Canada for *Canadiana 1867-1900 Monographs* (*Canadiana Retro*)¹⁴ and the Canadian Institute for Historical Microreproductions.

DIFFICULTIES IN COMPILATION OF THE BIBLIOGRAPHY

Leaving aside the difficulties of creating a bibliography with almost 60,000 entries, there were a number of other problems worthy of note here. Because approximately 90% of the entries in the *Bibliography* came from periodical literature, locating copies of the periodicals was a matter that required ongoing attention throughout the data collection period of the project. The CISTI *Union List of Scientific Serials* was very helpful for locating copies of periodicals, but it is not complete and, as may be expected in a union list, some of the information which it contains is no longer valid. For example, some Canadian libraries had 'deacquired' periodicals that were listed in the *Union List*. Very few Canadian libraries contain complete runs of early Canadian periodicals and this meant travelling to different locations to obtain access to all the issues of a periodical that needed to be examined. Some Canadian periodicals could not be located in any Canadian

¹³ Canadian Institute for Historical Microreproductions, *Canada, the Printed Record* (Ottawa, 1981) and subsequent editions.

¹⁴ National Library of Canada, *Canadiana 1867-1900 Monographs* (Ottawa, 1980).

libraries. A further concern is the sometimes very fragile condition of some of the issues of periodicals that were examined. In this regard we are pleased that the Canadian Institute for Historical Microreproductions is currently developing a proposal to prepare microfiche copies of pre-1900 Canadian periodicals much like their project with pre-1900 monographs.

Associated with the difficulty of locating copies of some early Canadian periodicals was the limited or in some cases non-existent bibliographic information about some of the periodicals, such as the number and details of title variations that occurred. Because of this lack of needed information, it was necessary to build detailed records of the periodicals that were searched. This information has been published with the *Bibliography* as the 'List of Serials Searched.'

The major problem in obtaining the monographic information for the *Bibliography* was the difficulty in determining what titles had been published. This is an ongoing problem for bibliographers of Canadiana. There is no published union list of monographs, so that even if a title were identified, it then became a problem of locating a copy from which to obtain the bibliographic information. Some libraries have prepared finding aids which list their holdings of Canadiana monographs in chronological order by date of publication, and some libraries permitted our editors or research assistants to go directly to the stacks of special collections and remove everything from the shelves in an effort to locate 'unknown' publications. No doubt, our efforts in collecting bibliographic information for monographs was not as successful as that for periodical information and this is reflected in the smaller number of entries for monographs in the *Bibliography* (less than 10%). A future edition of the *Bibliography* will need to pursue this aspect more vigorously.

POTENTIAL USES OF THE BIBLIOGRAPHY

If we return to the problems and challenges posed earlier in this paper, are there any that *Science and Technology in Canadian History: A Bibliography of Primary Sources to 1914* will aid in reaching a resolution? At least in partial answer to this question, we see the *Bibliography* facilitating the following types of studies:

1) Chronological Studies:

Richardson suggested that there was inadequate knowledge of science, technology and medicine in what he termed as four broad cultural-historical periods of Canadian history. By its very nature, the *Bibliography* cannot be of any assistance with the fourth of Richardson's periods, i.e. post-World War I/Autonomous Multicultural Society. The *Bibliography* does not deal with that period. But for the other three periods, the *Bibliography* is admirably structured to respond to questions dealing with chronological developments. In the Author Catalogue, the entries are arranged chronologically by date of

publication under each author. Entries in the Title Catalogue are arranged primarily alphabetically by title and secondarily by date of publication. Similarly, in the Subject Catalogue, the entries are arranged chronologically by date of publication under each subject category. The KWOC Index to the Title Catalogue provides a chronological arrangement by date of publication of titles under each key word. Studies tracing the development of scientific disciplines or technological advancements over time and/or the interface between the periods Richardson identified, can be undertaken with this Bibliography as a major resource.

2) Thematic Studies:

Thematic studies can be readily supported by this Bibliography. Both the Subject Catalogue and the KWOC Index to the Title Catalogue provide access to the wide range of scientific and technical subjects that concerned Canadians prior to the First World War. Thematic studies might focus on the published literature of a particular subject, or a study of which subjects were most prominent might be undertaken. For example, the establishment of the Geological Survey of Canada 1842 and its continued operation up to the present day has ensured that many geological publications are listed in the Bibliography. The related subject of Mining also contains a large number of publications. But other topics were also important in the period before 1914: agriculture, botany and transportation to name a few.

3) Studies of Particular Authors:

With more than 10,000 authors represented in the Bibliography, studies of particular authors could occupy researchers for many years. Extensive research was conducted to verify the accuracy of author names¹⁵ and in many cases some biographical information is provided. Many authors published few works but there are others who were much more prolific. Studies of authors could range from an examination of the work of a particular author to a comparison of several authors. Biographical studies should be aided by this Bibliography. Some authors were more prominent than others; for a great many there are no published biographies. The Bibliography does not purport to provide a complete listing of publications for each author. Other researchers may wish to extend the work of this Bibliography by preparing more complete bibliographies of individual authors.

4) Studies of the Types of Literature and Outlets for Publication:

The Bibliography provides a rich source of information amenable for use by sociologists, historians of publishing and bibliometricians, all of

¹⁵ See the paper cited in note number 10 above.

whom may be interested in studies of the means of dissemination of scientific and technical information, especially in nineteenth century Canada. The Bibliography can reveal the outlets for publication, i.e. the publishers of both monographic and periodical literature. As noted earlier, periodical literature forms the largest segment of the Bibliography, showing that a study of this type of literature is necessary in order to understand developments in science and technology in the early decades of this country.

Using the Bibliography to assist in all of the above types of studies, complemented with easier availability of the literature -- currently monographic literature only -- provided by work of the Canadian Institute for Historical Microreproductions¹⁶ should lead to further enlightenment about science and technology in Canadian history and a resolution of some of the problems outlined by Richardson in the early 1970s.

CONCLUDING REMARKS

As the study of the history of science and technology in Canada is a dynamic and exciting enterprise, new 'problems and challenges' have, of course, emerged. Much of permanent value, however, has been accomplished. We have already commented above on the formation of the CSTHA and its journal. The fifth biennial meeting of the Association scheduled for autumn 1987 is a benchmark in the development of Canadian studies. As a stimulus for future research, an enormous amount of hitherto unorganized and difficult-to-locate materials on science, and especially technology, are now made conveniently available to interested scholars. We feel these accomplishments are all large steps in the right direction.

In addition, and no less significant, is the marked increase in the participation of general historians to the field as well as the increase in the number of publications on issues in Canadian scientific and technological history. A start has been made in the area of graduate studies. The bibliographical project itself has served as an important training experience for several students. Another source of satisfaction for those in the field has been the development of extremely cordial relationships with our French-speaking colleagues who have made, and continue to make, outstanding contributions to the writing of our national scientific and technological history.

¹⁶ The Canadian Institute for Historical Microreproductions estimates that about 60,000 titles will be available in microfiche format when the project on monographs is completed.