Scientia Canadensis
Canadian Journal of the History of Science, Technology and Medicine
Revue canadienne d'histoire des sciences, des techniques et de la médecine

The National Research Council of Canada: Its Historiography, its Chronology, its Bibliography

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Volume 15, numéro 2 (41), 1991

Building Canadian Science: The Role of the National Research Council

URI : https://id.erudit.org/iderudit/800335ar
DOI : https://doi.org/10.7202/800335ar

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Éditeur(s)

CSTHA/AHSTC

ISSN

0829-2507 (imprimé)
1918-7750 (numérique)

Découvrir la revue

Citer cet article

Phillipson, D. J. (1991). The National Research Council of Canada: Its Historiography, its Chronology, its Bibliography. *Scientia Canadensis*, *15*(2), 177–193. https://doi.org/10.7202/800335ar

Résumé de l'article

Cet essai porte sur la place occupée par le CNR dans l'histoire des sciences au Canada, telle que reflétée par l'historiographie, et dans les débats sur la politique scientifique canadienne. Il est suivi d'une chronologie des principaux événements qui traitent de son histoire.

THE NATIONAL RESEARCH COUNCIL OF CANADA: ITS HISTORIOGRAPHY, ITS CHRONOLOGY, ITS BIBLIOGRAPHY

Donald J.C. Phillipson[1]

Abstract

The history of the NRC is approached from two perspectives: first, in terms of the historiographical ideas presented in the literature, and second, in terms of its place within the science policy debates. There follow a select chronology and bibliography of the NRC.

Résumé

Cet essai porte sur la place occupée par le CNR dans l'histoire des sciences au Canada, telle que refletée par l'historiographie, et dans les débats sur la politique scientifique canadienne. Il est suivi d'une chronologie des principaux événements qui traitent de son histoire.

At not many conferences do the papers presented form by themselves a complete and proportionate portrait of their subject. That of the Canadian Science and Technology Historical Association in 1991 on the 75th anniversary of the National Research Council of Canada was no different. This essay is written both in order to summarize the published historiography of the NRC and to sketch such a portrait for readers who may not be familiar with its literature.

There now are some two dozen books about the National Research Council in whole or in part, and twice as many articles, by a variety of hands from doctoral candidates to mature scholars and from hired propagandists to personal memoirists. It covers the range from narrative to critical history, shading into polemic.

The literature of the NRC is unusual in one respect: the influence on historians of a single document written by non-historians, the *Lamontagne Report*, discussed below. Because of either its literary qualities, its adoption by government staff or the absence of any alternative, its hundred-page historical summary has

1 4050 Hall's Road, Carlsbad Springs, Ontario K0A 1K0.

had more influence than any other work on historians writing since 1970 about the NRC.

Narrative History of the National Research Council

The history of the NRC is divisible into convenient periods.

1. From its foundation (1916) up to the NRC Act of 1924. The period may be called a quest for internal leadership and a social niche, as the new organization defined its role in the national and government communities.

2. The growth period, 1924 to 1945, of the Tory and McNaughton presidencies, including the Depression, 1929-39, when the NRC Laboratories were manned, and the Second World War, when they grew to their present order of magnitude.

3. Postwar development, between the NRC Acts of 1964 and 1966: the so-called 'Golden Age' of the Mackenzie and Steacie presidencies.

4. The last 25 years.

The first three periods, up to the 1960s, are now basically if not exhaustively documented. The NRC was formed during the First World War as a general-purpose national scientific agency, like Britain's Department of Scientific and Industrial Research and the Commonwealth Scientific and Industrial Research Organization of Australia. Like them, it had a unique prehistory. The Royal Society of Canada, the Canadian Institute of Toronto and the Montreal business community had earlier agitated for the development of national science.[2] The Canadian government convened an Honorary Advisory Council on Scientific and Industrial Research in 1916 in answer to these lobbies, modelled on the Imperial Trust for Scientific and Industrial Research formed in Britain in 1915.

The early history of the NRC (as it came to be called) is documented in *The Inner Ring* (1966) by Mel Thistle, a staff member for thirty years. This work is not a formal history but a selection of primary documents with a connecting narrative. The book is indispensable to the history of Canadian science and the selection generally excellent: Thistle identified in the records of 1916-35 many primary topics, such as the NRC's relation with government departments and ministers, of recurring importance.

2 Philip C. Enros, 'The "Bureau of Scientific and Industrial Research" of the Royal Canadian Institute 1914-1918,' **HSTC Bulletin** 23 (1983).

The *Inner Ring* remains an essential source, however narrowly based on NRC records and staff lore. Its flaws are those of 'insider writing' and by themselves demonstrate the ideology or loyalty of the NRC staff which was for decades one of its practical instruments. Its historiographic defects were largely repaired in Wilfrid Eggleston's *National Research in Canada* (1978), a narrative history of the NRC's first fifty years. A newspaperman with a lifelong interest in the NRC, Eggleston's research methods sent him to *Hansard* and other sources Thistle omitted, so that his account of the NRC Bill of 1921, the first disaster in NRC history, shows where Thistle's is anachronistic and unreliable.

As Thistle noticed, one reason for Tory's success in persuading the government to approve the establishment of the NRC Laboratories was the creation of the Ontario Research Foundation, and Ottawa's unwillingness to do less than Queen's Park.[3] Tory's larger ambitions towards national science were frustrated by continuing bad relations with the technical civil service and by the Depression. Only months before the NRC's 'palace of science' was opened in 1932, the government abolished all vacant posts throughout the public service, before the NRC Laboratories were half manned.

A.G.L. McNaughton made enlarging the NRC staff a condition of his accepting the presidency in 1935.[4] A totally different personality, McNaughton developed successful political relations with the technical civil service, while maintaining harmoniously the extramural university scholarships and grants created by his predecessors.[5] He took the NRC into the international realm at the Commonwealth Scientific Conference of 1936[6] and in 1938 introduced the NRC into the domain of medical research, just in time to develop aviation medicine and other such specialities in wartime.

By 1939 the NRC Laboratories had 300 staff (75 research professionals) in four laboratory divisions. Histories of the divisions of Biology, Physics and Mechanical Engineering[7] provide abundant detail about their foundation and the person-

3 Peter Oliver, 'Government, Industry and Science in Ontario' in **Public and Private Persons** (Toronto, 1975).

4 John Swettenham, **McNaughton: Vol. 1 1887-1939** (Toronto, 1968).

5 Yves Gingras, **Physics and the Rise of Scientific Research in Canada** (Montreal and Kingston, 1991).

6 D.J.C. Phillipson, **International Scientific Liaison and the NRCC, 1916-1974** (Ottawa, 1985).

7 N.T. Gridgeman, **Biological Sciences at the NRCC: the Early Years to 1952** (Waterloo, 1979); W.E. Knowles Middleton, **Mechanical Engineering at the NRCC, 1929-1951** (Waterloo, 1984) and **Physics at the NRCC, 1929-1952** (Waterloo, 1979).

alities and projects of the time. The history of the Chemistry division, half the Laboratories staff, was never completed as planned.

By the outbreak of the Second World War the NRC was poised to mobilize national science for war research, as had not been possible in 1914-18. C.J. Mackenzie became Acting President, chief science adviser to the three armed services and the link with American and British research: the NRC was in Canada the counterpart of the OSRD or the Ministry of Supply. The NRC Laboratories staff grew to nearly 3,000 after the creation of a large radar branch and the administrative absorption of the Anglo-French atomic project. The early war period is documented in Thistle.[8] After the war, the NRC commissioned a general account of those of its activities that could then be made public [9]

Later specialized works deal with wartime foods research,[10] war gases,[11] radar,[12] experimental aircraft [13] and the Churchill/Mountbatten scheme for an iceberg aircraft carrier.[14] The atomic project functioned as a division of the NRC from 1944 onwards, was 'Canadianized' in 1946, and became a separate Crown corporation, Atomic Energy of Canada Ltd, in 1952; its official historian is Robert Bothwell[15] and there are books by LeBourdais,[16] Eggleston [17] and others. Periodical literature varies from Laurence to Fawcett. [18]

8 Mel W. Thistle,(ed.), **The Mackenzie-McNaughton Wartime Letters** (Toronto, 1975). Mackenzie's periodical reports to McNaughton.

9 Wilfrid Eggleston, **Scientists at War** (Toronto, 1950).

10 F.T. Rosser and M.W. Thistle, **War Stories from Biology** (Ottawa,1955).

11 John Bryden, **Deadly Allies: Canada's Secret War 1937-1947** (Toronto, 1989).

12 W.K. Knowles Middleton, **Radar Development in Canada: the Radio Branch of the NRCC** (Waterloo, 1981) and David Zimmerman, **The Great Naval Battle of Ottawa** (Toronto, 1989), 'Organization of Science for War... Canadian Radar Development, 1939-45,' **Scientia Canadensis** 31 (1986) and 'Radar and Research Enterprises Limited,' **Ontario History** 80:2 (1988).

13 Rex King and Harald Penrose, 'The Ptailless Ones: G.T.R. Hill's series of Pterodactyl...,' **Aeroplane Monthly** (July, 1973).

14 Susan Langley, 'Project Habbakuk: World War II Prototype Vessel,' **Scientia Canadensis** 31 (1986).

15 Robert Bothwell, **Nucleus: the History of Atomic Energy of Canada Ltd** (Toronto, 1988).

16 D.M. LeBourdais, **Canada and the Atomic Revolution** (Toronto, 1959).

17 Wilfrid Eggleston, **Canada's Nuclear Story** (Toronto, 1965).

18 G.C. Laurence, 'Canada's Participation in Atomic Energy Development,' **Bulletin of the Atomic Scientists** (Nov. 1947); Ruth Fawcett, 'Early... Nuclear Power Reactors of Wilfred Ben-

Victory brought the NRC a new and freer charter. The Cabinet revived in 1944 for postwar planning the Privy Council Committee on Scientific and Industrial Research (the first statutory Cabinet committee in Canadian history, dating from the NRC Act of 1917) and invited the NRC to absorb the whole of government research. No doubt to the politicians' surprise Mackenzie declined, and instead recommended (jointly with Charles Camsell, deputy minister of Mines) substantial growth in government science after the war, but on a specialized, departmental and polycentric basis. Under this rubric the Defence Research Board was created in 1947,[19] the atomic project independently constituted in 1952, and the Medical Research Council in 1960 from the postwar NRC Division of Medical Research. Not least, the NRC was authorized to maintain the staff and budget ($6 million) to which it had grown in wartime. It then constituted 40 per cent of government science, a proportion which declined to 12 per cent by 1961, as the other organizations grew.

Under an amended Act of 1946, the NRC was authorized to build pilot-scale industrial plants and to form a subsidiary, Canadian Patents and Developments Ltd, for the commercial development of Crown-owned patents. The NRC Laboratories were reorganized, pure research divisions created for physics and chemistry and dozens of NRC post-doctoral fellowships created to keep the Laboratories in touch with the latest developments in academic science.[20] Independent or non-industrial research was authorized elsewhere in the NRC Laboratories for selected individuals and teams, of which radio astronomy was the most notable.[21]

The years from 1945 to the 1960s are now remembered as the 'golden age' of the NRC. For the first time the organization had both a general plan for national development and the resources to carry it out, including political backing and the enthusiastic co-operation of university scientists as well as an adequate independent budget. The general plan was based on the conventional wisdom of the day. There were three sectors of the national community, academe, government and industry, three types of scientific and engineering knowledge, pure, applied and

nett Lewis,' **Scientia Canadensis** 31 (1986), 132-8.

19 D.J. Goodspeed, **DRB: a History of the Defence Research Board of Canada** (Ottawa, 1958).

20 A.W.T. Tickner, 'Postdoctoral Fellowships in the National Research Laboratory,' **Canadian Chemical News** (October, 1985), 17-19. See Tickner's article in this collection.

21 A.E. Covington, 'Beginnings of Solar Astronomy in Canada,' in W.T.Sullivan III (ed.) **The Early Years of Radio Astronomy** (Cambridge, 1984), R.A. Jarrell, **The Cold Light of Dawn** (Toronto, 1988) and Gayle Young, **The Sackbut Blues: Hugh Le Caine, Pioneer** (Ottawa, 1989). See also Covington's article in this collection.

commercial or product-oriented, and a natural affinity between the two sets. The university was the foundation, as the proper repository of fundamental knowledge and the sole source of supply of trained researchers. Industrial research was a matter for business, since no one else could understand markets so well as people who lived in them. There was, however, a role for government science, in bridging any gaps, i.e. providing those services and performing that research which was truly in the public rather than the private interest, and not provided by the university or industrial sectors.[22]

The logically first priority in 1946, just as in 1919, was to train more researchers because the Canadian supply did not yet meet Canadian needs. The NRC took up this second rather than first, since universities were in the postwar years underfunded and crowded with returning veterans. University expansion began only in the late 1950s, after the federal government began making capitation grants (proposed by the Massey Report, 1951). The number of NRC scholarships grew from 141 in 1946 to 423 in 1961, worth $1.2 million.[23] From about 1950 the Defence Research Board began making extramural grants and scholarships on the NRC model, followed by the AECL and other Crown agencies. The NRC grants system was extended to buy capital equipment, funds were redirected from NRC-controlled Associate Committees to disciplinary grants committees. The shock of Sputnik provoked the government to increase NRC funding for universities and induced engineering schools to accept it on the same basis as the natural sciences. By 1968 NRC grants approached $30 million a year and Canada was for the first time producing as many new PhDs in science and engineering as there were jobs for them.

Within government, the success of the NRC's trial of pure research enclaves in industrially-oriented public laboratories led to its emulation by the departments of Mines and Agriculture in 1959. The NRC created new divisions for building research, radio and electrical engineering, chemical engineering, aeronautics and local industrial support in the Prairies and the Atlantic regions.[24] Its role as co-ordinator of governmental science, a challenge to departmental tradition in Tory's day, was strengthened by Presidents Mackenzie (1944-52) and Steacie (1952-62.) They succeeded where Tory failed, in making the NRC the spokesman for science in government as *primus inter pares* rather than a threatening empire.

22 C.J. Mackenzie, 'Industrial Research in Postwar Canada,' **Engineering Journal** (March, 1944), 136-149.

23 W.P. Thompson, **Graduate Education in the Sciences in Canadian Universities** (Toronto, 1963).

24 Wilfrid Eggleston, **National Research in Canada: the NRC 1916-1966** (Toronto, 1978.

The administrative vehicle for government-wide co-ordination was a new body, the Advisory Panel on Scientific Policy, on which the statutory powers of the Privy Council Committee were devolved in 1949. NRC presidents chaired the Advisory Panel ex officio; the members were the research chiefs of all Crown agencies significantly active in science, such as the Chairman of the DRB and the deputy minister of Health.

No history of the Advisory Panel has yet been written. This is regrettable because brief references to it in the Glassco Report on Government Organization (1963) are defective in important respects. An example is the NRC's Industrial Research Assistance Programme, the basic precedent in Canada for making public grants to private industry. This may be thought of as either the culmination of the NRC's postwar industrial programme, or an act of desperation because every other incentive had been tried, without success, or a revolution in political ideology since 1946, when such grants to private industry were unthinkable. [25]IRAP was the main business of the Advisory Panel and of its NRC staff in 1961, and kept secret until approved by the Cabinet and announced the following year.

The core of the Glassco Report had then been written and two fundamental conclusions reached. The policy machinery had broken down since the Privy Council Committee ceased to meet in 1949; and the NRC had 'turned aside from its original duty of advising on broad national policy' and concentrated its attention on its own laboratories and university science. The Glassco field staff were unaware of the transfer of the Committee's powers to the Advisory Panel, which they did not investigate: and so did not discover the existence of IRAP until it was announced. Before publication their text was revised to add a reference to IRAP, the opinion of an industrialist that it would do no good. The Glassco Report never mentioned IRAP by name and, having prepared recommendations for co-ordination of national science policy by a Cabinet minister with an independent advisory council, did not temper its conclusions about what had actually happened in the past decade.

The new government of 1963, elected on a reform ticket, received the Glassco Report with considerable enthusiasm, and many of its recommendations were implemented in the next decade. Revisions to the NRC Act in 1966 terminated its responsibility to advise the Cabinet, which it had exercised one way and another since 1917, and the Council was in that respect superseded by the Science Secretariat formed in the Privy Council Office in 1964. The Science Secretariat became the Ministry of State for Science and Technology (MoSST) in 1971; this

25 D.J.C. Phillipson, 'The Steacie Myth and the Institutions of Industrial Research,' HSTC Bulletin 25 (1983), 117-34.

policy ministry was absorbed into the department of Industry, Science and Technology in 1990.

The Glassco Report became important as a historical source for two dissimilar reasons. The minor reason was its publication of the first technically acceptable statistics on R and D, covering 1951-61. These began thirty years of increasingly reliable work on science by Statistics Canada. Secondly, the Glassco Report's hundred-page description of governmental science was taken as a reliable summary of its true character by the authors of the OECD report on Canadian science policy (1969), the Special Committee on Science Policy of the Senate, which published the *Lamontagne Report* in four volumes 1970-74 and other authors in the new discipline of science policy.

These two inquiries could and did refer to publications unavailable to the Glassco Commission, particularly those of Thistle, Babbitt,[26] Eggleston and Brown.[27] The Lamontagne Committee's reliance on the Glassco Report and other secondary sources was demonstrated by instructions to witnesses to deal only with events since 1963.

Subtitled 'A Critical Review: Past and Present,' the first volume of the *Lamontagne Report* (1970) included a historical narrative of more than 100 pages. Its conclusions were that the NRC had a science policy before 1939 which (for no fault of its own) it was unable to implement; in 1945-63 (citing Glassco) the public duties, especially to industry, and policy mechanisms in the NRC Act were both ignored; and the NRC was principally responsible for the unsatisfactory state of Canadian science in 1970. These conclusions led to a passionate and bitter debate that lasted several years. Like the *Lamontagne Report* itself this debate mixed past history and future policy alternatives, and the merits of either are beyond the scope of a historiographic essay.

Science Policy and the NRC Today

Independently of their specific criticisms of individuals and institutions in Canadian history, the Glassco and Lamontagne Reports were only one aspect of a general cultural change in the 1960s, which may be characterized as a worldwide professionalization or disciplinarization of functions carried out in earlier

26 J.D. Babbitt, **Science in Canada: Selections from the Speeches of E.W.R. Steacie** (Toronto,1965).

27 J.J. Brown, **Ideas in Exile** (Toronto, 1967

generations by precedent (tradition), personal leadership (innovation), consensus and common sense (shared social values, sometimes unwritten). The simplest visible sign of the new era was its attitude to paper. The old system did not require that information be written down or values exhaustively explicit, in order to reach firm decisions. In other words, the opinion of the top man (minister, NRC president, research director, deputy minister, etc.) was usually accepted as effective decision-making. The Glassco Report condemned this tradition in several spheres besides science (e.g. foreign affairs and broadcasting). The new approach for which it was the spearhead claimed to make the process objective by removing the harmful effects of personality and prejudice. Specifically, it required or preferred information on paper, and at times seemed to exclude *a priori* personal experience, 'informed opinion' or any form of non-disciplinarized claims to knowledge.

Post-Glassco reforms of the federal system of government introduced over the next fifteen years several formal techniques of modern management. For applied economics, to a considerable extent the parent discipline, an Economic Council was founded that sought to model the whole Canadian economy in mathematical terms, as well as provide non-partisan expert advice to politicians and citizens. For science, a new international discipline of Science Policy emerged, that promised both to optimize and de-politicize the national planning and maintenance of science. Now generally considered to have disappointed many of their early aims, each was part of an irresistible *Zeitgeist*.[28]

Perhaps prompted by Centennial celebrations, Canadian history was stimulated at the same time. There was an enormous increase in the 1970s in the production of history, in both French and English. For the first time, complete histories appeared of such institutions as the Geological Survey, the Surveys and Mapping Branch, the Fisheries Research Board and so forth. The NRC began in 1975 a historical program of its own, creating an archives office and producing Eggleston (1978) and the Gridgeman, Middleton and Phillipson titles mentioned above. Post-graduate institutes for the study of science were founded at the universities of Toronto and Montreal, and the Canadian Science and Technology Historical Association came into existence in 1978.[29]

The relevance of pure science was the focus of debate about the *Lamontagne Report*. The social sciences suggested that, in any long-lived institution, there was a

28 Richard French, **How Ottawa Decides: Planning and Industrial Policy-Making 1968-1980** (Toronto, 1980).

29 R.A. Jarrell and N.R. Ball, **Science, Technology and Canadian History** (Waterloo, 1980).

natural 'goal displacement' from the duty of social usefulness towards 'fundamentalization' or concentration on pure research.[30] Doern represented the younger, academic, critical school, and Hayes defended the traditions and innovations of the previous generation as both honest and successful.[31]

Oral debate was polarized between Sen Maurice Lamontagne, arguing that the NRC had displaced its goal towards pure science, which was generally wrong, and Gerhard Herzberg, the NRC's only Nobelist, citing Canada's now mature scientific reputation as proof that the NRC's goal of pure science was generally right. When pressed, both protagonists agreed that the records of the NRC Laboratories showed it had never spent more than 20 per cent of its manpower and money on pure science, as Steacie had told a parliamentary committee in 1960. But arguments about pure science and 'relevance' dominated science policy after Lamontagne.[32] The best publications on the topic are The Science Council's Report No. 18 (1972) and Background Study No. 21 (1971). Their ideas were however too subtle to be taken up by the Canadian political clientele, a contingency for which the discipline of Science Policy had made no provision.

For public institutions, current science policy governed renewed interest in the 1970s in the history of science. As their dates of publication suggest, three quarters of the items cited here appeared in the last twenty years. Further items of NRC interest included memoirs and biographies,[33] anniversary publications[34] and institutional histories.[35]

30 G. Bruce Doern, 'The NRC: the Causes of Goal Displacement,' **Canadian Public Administration** 13:2 (1970); Yakov Rabkin, 'Transnational Variables in Science Policies: Canadian and Soviet Experiences,' **Canadian Public Administration** 24:1 (1981).

31 G. Bruce Doern, **Science and Politics in Canada** (Montreal and Kingston, 1972) and F. Ronald Hayes, **The Chaining of Prometheus: Evolution of a Power Structure for Canadian Science** (Toronto, 1973).

32 D.J.C. Phillipson, 'Medical Research Policy for Canada,' **Journal of the Canadian Medical Association** 110 (1973), 1388 and 111 (1973), 58.

33 W. H. Cook, **My Fifty Years with NRC, 1924-1974** (Ottawa, 1977), J.H. Parkin, **Aeronautical Research in Canada 1917-1957: Memoirs** (Ottawa, 1983), 2 volumes, and E. Christine King, E.W.R. Steacie and Science in Canada (Toronto, 1989).

34 N. T. Gridgeman, 'A Semicentennial: the NRCC Research Journals 1929-1979,' **Canadian Journal of Physics** (1979).

35 R.H. Haskins, **A Brief History of the NRCC Prairie Regional Laboratory** (Saskatoon, 1984) and **NRCC Division of Building Research, The First 25 Years, 1947 to 1972** (Ottawa, 1973.

Historians have however written almost nothing about changes at the NRC since 1970, or elsewhere in government science such as the absorption into a department of the previously independent Defence Research Board.[36] This lends special poignance to the official status of the *Lamontagne Report*, still used in 1992 by government officials as the essential source on the NRC and the general historical background on Canadian science.

In no other sphere of public policy (e.g. medical, defence, economic) is a twenty-year-old document considered current, let alone essential. The discipline of science policy has shifted its ground in twenty years, from the wing of applied economics (suggesting precise calculation to approach an agreed goal) to that of political science (implying negotiation between people and interests with opposing goals). The process is documented in the work of Bruce Doern, prominent since his 1972 *Science and Politics in Canada* which enthusiastically applied to Canada the new theories of disciplinarized science policy. An exemplar was the Science Council's Report #4 (1968), predicated on a clear division of responsibility between politicians, whose proper sphere was the promulgation of social and economic goals, and science policy technicians, who could calculate the optimal means to fulfil those goals.

Empirical evidence accumulated in the next decade shows that these theories did not work in the Canadian context, contrary to expectations.[37] Another ten years later he concluded that the administrative union of science policy, trade policy and industrial policy was unlikely to succeed in integrating them logically or politically.[38]

Since 1966 the NRC has changed in fundamental respects. It is no longer the largest or the highest-reputed scientific organization in the country. The largest is Bell-Northern Research Ltd and, while the NRC's citation impact factor is high, many universities now have larger and more specialized research teams. NRC's financial responsibility for university science, i.e. the infrastructure of national science, ended in 1978. Its governing Council has changed from the élite of university science to a representative sample of industrial research chiefs, inevi-

36 The case of the Fisheries Research Board is treated in Frances Anderson, 'Policy Determination of Government Scientific Organizations: A Case Study of the Fisheries Research Board, 1963 to 1973,' (Unpublished PhD dissertation, Université de Montréal, 1988).

37 G. Bruce Doern, **Government Intervention in the Nuclear Industry** (Montreal, 1980) and **The Peripheral Nature of Scientific and Technological Controversy in Federal Policy Formation** - Science Council Background Study 46 (Ottawa, 1981).

38 G. Bruce Doern, 'The Department of Industry, Science and Technology: Is there Industrial Policy after Free Trade?' in K. Graham, ed., **How Ottawa Spends, 1990-91** (Ottawa, 1990).

tably lacking the prior personal acquaintance and common experiences that provided the basis of policy consensus when the whole scientific community was much smaller.

The real dispute about public science and the role of the NRC was less about the 'relevance' and economic and social utility than about criteria by which that utility was to be assessed. Different criteria have been used in four distinct periods of Canadian history.

Economic and social utility were specified in the NRC Act of 1917, as in most statutes providing for government-funded activities, and proclaimed in bronze at the front door of the NRC's Sussex Drive headquarters:

> This building was constructed for the purposes of fostering the scientific development of Canadian industry for Canadian needs and for the extension and expansion of Canadian trade at home and abroad.

In the period up to the Second World War, this utility was assessed by personal consensus between spokesmen for public science, the chief executives of the NRC and other agencies, and their political masters. There were no strict rules of evidence. Both parties could make their own demands, typically politicians requiring that science conform to the Canadian tradition of regional balance and scientists seeking professional autonomy in such matters as research publications. They were arbitrated by personal discussion. The ultimate sanction, dismissal or resignation on a point of principle, was never reached in the history of the NRC's relations with its politicians.

A notable NRC contribution to science policy in the postwar era, attributed principally to E.W.R. Steacie, was an enlargement of the definition of appropriate public science beyond applied or industrial research.[39] Its objective was the health of the scientific institution, on a national or smaller basis. In order to remain healthy (intellectually productive), the NRC Laboratories, a government foundation with industrial responsibilities, needed the psychological and intellectual stimulation best provided by a changing population of young temporary researchers (post-doctoral fellows), working alongside the tenured and aging NRC staff.[40] The norms by which Steacie justified this innovation were the familiar and accepted ones; personal reputation and do-it-yourself history, such as the truth that many of the material innovations of the Second World War, such as

39 C.J. Mackenzie, **op. cit.** (1944).

40 E. Christine King, **E.W.R. Steacie and Science in Canada** (Toronto, 1989).

radar, penicillin and the atomic bomb, came out of universities rather than government laboratories.

The beneficiaries of Steacie's pure research theory were the NRC staff of these divisions and the floating population of PDFs. Both were envied, the NRC staff by colleagues in other divisions and the PDFs at the universities or industries they later joined, where two whole years of full-time research was then simply impossible. The world-wide fame of the Steacie system, and clarity with which its results documented themselves (in research publications, which NRC work on standards, assignments for government departments and industrial contracts rarely produced) meant that it featured prominently in NRC pride and propaganda. Statistics of research staff and spending suggest that one of Steacie's secondary goals, of the NRC modelling the lifelong research career, which Canadian universities and industries would be tempted to emulate, was totally successful. It was ironic that this success would later provide a convenient stick for the NRC's back, when the visible achievements of 15 per cent of the NRC were construed to suggest the whole of the NRC was a 'republic of science,' where private interests were pursued at public expense, disdainful of the industrial work for which Parliament appropriated the money.

When Science Policy claimed the status of a specialized discipline, it offered new and different criteria for decisions. Its ultimate promise was to replace personal impressions about scientific matters with a truly scientific calculus, usually conceived as a giant input-output matrix which could reliably forecast the consequences of alternative choices. This promised to relieve politicians of the burden of acting beyond their sphere of personal experience, and to relieve scientists of the need to lobby uncomprehending politicians to get the money the national interest genuinely required. The prospect of a comprehensive decision-making calculus extended far beyond laboratory research to all spheres of government. Many influential bureaucrats genuinely believed in the 1970s that new techniques would allow them to compare the net benefit to Canadians of $1 million added to one 'envelope,' e.g. pharmaceutical grants or public health education, or taken away from another, e.g. hospital funding or medical research. Enthusiasts of 'systems management' tended to suggest merely proving the advantages of something new would actually cause people to implement it. As early as 1973 the Chairman of the Science Council warned that it was no good the government's promulgating an excellent policy without incentives for humans to carry it out.[41]

41 Roger Gaudry, 'Annual Report of the Chairman,' in Science Council of Canada, **Annual Report 1972-73** (Ottawa, 1973.

For reasons beyond the scope of this essay, the new methods of science policy and public administration did not satisfy either politicians or scientists to the degree their designers had confidently expected. Science policy today appears to have entered a fourth phase, different from both social practice 1917-64 and structural theory 1964-80. Its character is imprecise, except that in hard economic times government science has been 'repoliticized' more than was thought likely twenty years ago.

This is not an isolated phenomenon or all bad. The present government has paid more attention than any of its predecessors to the role of provincial governments in science policy, which is constitutional common sense.[42] But other decisions and emphases have alienated both members of the scientific community and science policy professionals (a remnant, because most of the policy staff of the 1970s have moved into other types of work). Well-documented warnings of the deterioration of the national infrastructure of science have been generally ignored by political authority. In 1992 the government abolished both the Economic Council and the Science Council, hitherto the official sources of non-partisan expert advice.

The competence and quality of scientific advice to government was the reason Canada adopted the new discipline of science policy after the Glassco Report. Hitherto an NRC responsibility, as Clause 5 of the 1917 Act was interpreted, it became a function of deputy ministers of MoSST. When that ministry was absorbed the post of Chief Science Adviser was written into the organic Act of the department of Industry, Science and Technology (1990) – and left vacant. The government had formed in 1986 a new National Advisory Board on Science and Technology, chaired by the prime minister (with terms of reference almost identical with those of the NRC in 1916). This body was reorganized in 1991 when it met once.

Internally, the NRC has been totally reorganized by President Pierre Perron since 1990. The number of vice-presidents (seven or eight under his predecessor) were reduced to three in a new management system. NRC laboratory Divisions were reorganized as Institutes; the post of Divisional Director, an NRC innovation in 1928, was replaced by a Director-General, the same nomenclature as in government departments. When Dr Perron first took office he turned for long-term policy ideas not to the Council, under the NRC's tradition, but to the Science Council, which held a special two-day conference for the purpose.

42 Paul Dufour and Yves Gingras, 'Development of Canadian Science and Technology Policy,' **Science and Public Policy** 15 (Feb. 1988), 13-18.

These changes together tell historians there has been a transformation of institutional memory, but that memory is still acknowledged as a prerequisite of effective policy.[43] In Canada up to the 1960s, the personal experience of NRC presidents and Council members, university deans, deputy ministers and so on, appeared to be an effective and legitimate basis of institutional memory. As the Glassco Report agreed, many aspects of Canadian science thrived vigorously in the 1950s. But the reformers also pointed out the traditional system did not support the mechanisms of guaranteed efficiency and impartiality promised by new management techniques, and political authority found this convincing.

An independent force for change was the sheer growth of the body of scientific knowledge and the numbers of the Canadian research community. Personal knowledge might be adequate for managing and enlarging a fraternity of a few hundreds in 1945, but could not be expected to cope with a Canadian research community of 18,000 in 1975 or at least 50,000 in 1991. As scholars from Max Weber to Derek Price had observed, the *Gemeinschaft* was bound to evolve into a *Gesellschaft* and to change its social relations.

The institutional memory formerly pooled from the minds of a few score individuals is now represented by more than a metre of Science Council reports and studies 1966-90 and the increasingly refined publications of Statistics Canada's science and technology section (some recently discontinued for economy). Immeasurably more, and more concrete, information now exists than was available to the science policy structures of twenty years ago: but those mechanisms have been largely dismantled.

The parent stock of so many Canadian institutions, from the Canadian Standards Association to today's university grants councils, the NRC has declined relatively as its scions grew to maturity. When it was free to act independently, the NRC made no attempt to preserve the monopolies of power that characterized it in the 1940s. By a deliberate act of policy, it sought to plant out science broadly throughout Canada, beyond its own institutional borders.

Choosing itself not to grow, the NRC could not have hoped to maintain its power, because the intellectual and industrial systems of the world have grown at least tenfold since 1945. 'Monopoly' is no exaggeration to describe the NRC at that date. In some fields of industrial technology, such as electronics, acoustics, the chemistry of explosives and foods, the NRC staff of 1945 knew more than any industrial team in Canada. In certain academic disciplines, from biometrics and nuclear physics, the NRC enjoyed a similar monopoly of up-to-date knowledge;

43 G. Bruce Doern, **Government Intervention in the Nuclear Industry** (Montreal, 1980).

in all disciplines, what Council members and NRC staff did not carry in their heads could be easily obtained through their web of personal contacts with all Canadian and many foreign scholars.

Between 1960 and 1980 this ceased. The Canadian centre of intellectual gravity in industrial technology is now in industry, and of academic science in the universities – precisely what the NRC had set out to create. Science within government had achieved similar maturity and ceased to depend on the NRC's resources. Government departments require expertise on aviation safety, radioactivity in the atmosphere, the effectiveness of tax incentives for corporate research and a thousand other technical topics. Thirty years ago the NRC was the only Canadian source of this expertise: today all departments have appropriately specialized scientists and engineers of their own. This too indicates successful completion of the NRC's 1945 policy of polycentric growth.

The body of scientific knowledge has so changed that it is no longer possible for twenty Council members or a few hundred researchers to command it to the degree the NRC could claim in the 1940s. Not least, the membership of the Council stands in a different relation to its client community. Canadian industry, than formerly when its members represented academic science. Because membership was an honour, the NRC in earlier years could draw on the whole Canadian university community for Council members. Council membership is not similarly considered an honour among Canadian industrialists, and some corporations simply will not allow their research directors to sit on such bodies as the Council of the NRC. However broadly the Council of 1992 represents Canadian industry, it does not provide the NRC with the intellectual resources it used to derive from a university-based Council.

Even the environment of bureaucratic power has changed fundamentally in Ottawa since the Glassco Report. The most obvious case is the source of senior managers, deputy ministers and likely future deputy-ministers. For scientific departments such as Mines and Health, these were selected in the bad old days exclusively from men of individual departmental or professional reputation, aged fifty or more, with experience in administration and a demonstrated natural gift for it.[44] The adoption throughout government of new management techniques, administered by the Treasury Board, effectively created a new ruling class, of

44 The privileged autonomy of managerial scientists with professional qualifications was demonstrated by their names: Dominion Archivist, Dominion Astronomer, Dominion Cerealist, Dominion Chemist, Dominion Geologist, Dominion Hydrographer, Dominion Limnologist, Dominion Statistician, and so on. All these titles have now been abolished: less because the word 'dominion' is out of fashion, it appears, than because the supervision of scientists and professionals no longer requires scientific or professional standing, as for the previous century.

trained men and women, whose expertise is in those techniques. A crucial difference is that the ambitious individual has to join this career stream before the age of forty. Few scientists of ability are willing to give up research so early. The present system may make it practically impossible for the best government scientists to end their careers in senior management positions.

A political foundation, the NRC has not in recent years been of much interest to politicians. This was not always so. Discussion in the House of Commons of the NRC Act of 1946 was passionate and wide-ranging. Continuing lively interest was manifest in Commons Committee investigations in 1950, 1956 and 1960, and reached its climax in the Lamontagne Senate Committee hearings of 1967-70. In the last 22 years, however, neither chamber of Parliament has investigated any aspect of the NRC except jobs abolished in economy drives.

Politicians' indifference to the NRC reflects the logic of amendments to the NRC's mandated sphere of work. Since 1945 the NRC has 'lost' responsibility for military research, nuclear energy, medical research, advice to the Cabinet, university support and most recently space research (1989). On the other hand, Parliament has never managed to say specifically what it wishes the NRC to do. Older scientists often interpret the devolution of specific NRC functions as punishment for the indictment brought by the Glassco and Lamontagne Reports; most younger men and women are apathetic about bureaucratic arrangements that do not affect them personally or professionally.

This leaves open the questions of what the NRC is expected to do in 1993, now just one institution among many, and how to maintain in hard times the intellectual youth and vigour it so valued a generation ago. The determining environment of both is the character of 'Ottawa,' and the rules of being a government institution. Fortunately none of these is a question the historian is obliged to answer.