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

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Volume 15, Number 1 (40), Spring–Summer 1991

URI: https://id.erudit.org/iderudit/800318ar
DOI: https://doi.org/10.7202/800318ar

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Publisher(s)

CSTHA/AHSTC

ISSN

0829-2507 (print)
1918-7750 (digital)

Explore this journal

Cite this article

Hull, J. P. (1991). Networks of Knowledge: Two Canadian Scientists and their Transborder Contacts. *Scientia Canadensis*, *15*(1), 50–57. https://doi.org/10.7202/800318ar

Article abstract

Recently published letters of Dr Karl A. Clark, who worked from 1920 to 1949 on the hot water separation process for extracting petroleum from the Athabasca oil sands, and records of Dr Clara W. Fritz, who, in the 1930s, examined the problem of pulp mill slime which weakened and discoloured paper products offer insights into how Canadian scientists worked in an international network of scientists. What were the roles played by these scientists in managing the international flow of scientific knowledge? How did they work? Who were their contacts? What were the institutional foci of their work? In answering these questions, we will come to a better understanding of the Canadian scientific infrastructure during this crucial period.

NETWORKS OF KNOWLEDGE: TWO CANADIAN SCIENTISTS AND THEIR TRANSBORDER CONTACTS

James P. Hull[1]

ABSTRACT

Recently published letters of Dr Karl A. Clark, who worked from 1920 to 1949 on the hot water separation process for extracting petroleum from the Athabasca oil sands, and records of Dr Clara W. Fritz, who, in the 1930s, examined the problem of pulp mill slime which weakened and discoloured paper products offer insights into how Canadian scientists worked in an international network of scientists. What were the roles played by these scientists in managing the international flow of scientific knowledge? How did they work? Who were their contacts? What were the institutional foci of their work? In answering these questions, we will come to a better understanding of the Canadian scientific infrastructure during this crucial period.

RESUME

La publication de lettres du Dr. Karl A. Clark, qui travailla de 1920 à 1949 à la mise au point du procédé de séparation à l'eau chaude utilisé pour l'extraction du pétrole de sables bitumineux de l'Athabasca, de même que les archives du Dr. Clara W. Fritz qui, dans les années 1930 étudia le problème des boues des moulins à papier qui affaiblissaient et décoloraient les papiers, permettent de jeter un regard neuf sur la manière dont les scientifiques canadiens s'inséraient dans un réseau scientifique international. Quels furent les rôles joués par ces scientifiques dans la circulation de l'information? Comment travaillaient-ils? Quels étaient leurs contacts à l'étranger? Dans quel cadre institutionnel oeuvraient-ils? La réponse à ces questions permettra de mieux comprendre le potentiel et les limites de l'infrastructure canadienne au cours de l'entre-deux-guerres.

INTRODUCTION

Canada can easily be viewed as a nation of the periphery, or, in Innis's terminology, the margin.[2] At best a 'middle power of the first rank,' Canada has had continually to define its place in the world in terms of greater powers, more advanced societies and larger economies. In particular, Canada spent much of its earlier history attempting to gain greater recognition and freedom of action

1 Department of History, Okanagan College, Kelowna, BC, V1Y 4X8

2 See H.A. Innis, **The Fur Trade in Canada**, revised edition (Toronto, 1956), 386-92.

within the British Empire, only to emerge as a junior economic partner, to state it generously, within the United States' sphere of influence. This so-called 'colony to nation to colony' interpretation is of more than academic interest with the apparent solidifying of an American-led and dominated North American free grade area and its concomitant reinforcement of the integration of the US and Canadian economies.

One aspect of these circumstances which has attracted the attention of Canadian historians of science and technology as well as policy makers and polemicists is the influence of continental economic integration on Canadian industrial technology. US domination of secondary manufacturing has been seen as retarding, if not precluding, the emergence of any genuinely autonomous Canadian industrial technology within a capitalist political economy. Branch plant firms are 'truncated' versions of their US parents, lacking their own industrial R&D facilities and producing only for Canadian markets with licensed US technology. An extensive body of literature ranging from public documents such as the Gray Report through academic studies such as those of Naylor, Williams and others to J.J. Brown's lament for a nation's technology chronicle and explicate this story.[3] Apart from A.E. Safarian's cogent counter-analysis[4], the only replies had come from those wishing to cite Canadian 'firsts' which is perhaps the least helpful form of history of science or technology. Recently, however, a body of literature has emerged to raise a host of questions about the received view of Canadian science, technology and industry. The new literature suggests that efforts to link science and industry in late nineteenth and early twentieth century Canada were more successful and less derivative than has been portrayed.[5]

This paper presents two case studies of two Canadian scientists, each working at the centre of a network of interested investigators on a significant industrial project. These networks extended across international boundaries and operated in the context of growing US capital investment in Canadian resource industries and continued growth in the role of the Canadian state in facilitating the exploitation of those resources by means of the promotion of scientific industrial research. These studies suggest that a simple centre-periphery model may be

3 'A Citizen's Guide to the Herb Gray Report,' **The Canadian Forum** (December 1971); R.T. Naylor, **The History of Canadian Business 1867-1914** (Toronto, 1975); Glen Williams, **Not For Export** (Toronto, 1983); and J.J. Brown, **Ideas in Exile** (Toronto, 1967).

4 A.E. Safarian, **Foreign Ownership of Canadian Business** (Toronto, 1973).

5 See James P. Hull and Philip C. Enros, 'Demythologizing Canadian Science and Technology: The History of Industrial R&D' in Peter Karl Kresl, ed., **Topics on Canadian Business** (Montreal and Ottawa, 1988), 1-22.

inadequate to an understanding of Canadian industrial science in the first half of the twentieth century.

CLARA WINIFRED FRITZ

Pulp and paper was one of many industries transformed by the second industrial revolution. The traditional handicraft paper making enterprise which had been mechanized in the first industrial revolution was 'scienticized' with the development of chemical pulping techniques and automatic machinery. Driving the process of technical change were changes in demand for paper products. The volume of demand for such products was increasing at an enormous rate under the influence of growing literacy rates, mass distribution systems based on printed advertising and new packaging techniques. As well, the market demanded a wider range, higher quality and more uniform quality of paper and other outputs. Meeting that demand involved increasing the rate of throughput in pulp and paper mills and much more closely monitoring and controlling the subprocesses of production. Empirical methods of process control gave way to more scientific approaches as materials flowed through grinders, digesters, beaters and Fourdrinier machines at ever faster rates. Interruptions in the overall flow of production became increasingly both costly and intolerable to mill managers and engineers.[6] Clara Winifred Fritz was perhaps the world's outstanding authority on the serious, albeit unglamorous, problem of pulp mill slime. Certainly she played the central role in a network of researchers and production engineers concerned with this problem. Educated at McGill and the University of Toronto (like her better known sister, invertebrate paleontologist Madeline Alberta Fritz), upon graduation she joined the Canadian Forest Products Laboratories as Timber Pathologist. The FPL had been established in 1913 by the Forestry Branch of the Dominion Department of the Interior. Fritz became the only FPL researcher outside of the Pulp and Paper Division to make significant contributions to that industry.

Losses due to the discoloration of paper and weak spots resulting from accumulated slime in pulp mill equipment made this a widely recognized but seemingly intractable problem in the industry. FPL superintendent D. Roy Cameron assigned the problem to microbiologist Fritz, whom he had identified quickly as an especially promising investigator.[7] The story of her efforts over a decade shows

6 James P. Hull, 'Science and the Canadian Pulp and Paper Industry, 1903-1933,' (Unpublished PhD dissertation, York University, 1986).

the role she played not just as a researcher in her own right but as a manager for the flow of technical information about this problem.[8]

Fritz's initial assault on the slime problem took place over a twelve month period from February 1926 to January 1927. During that time, she conducted on-site examinations at four mills in New Brunswick, Ontario and Quebec. In addition, Fritz drew upon the results of a number of independent investigations. These included work by the Riordon Pulp and Paper Co (Hawkesbury, Ontario), Prof Whipple of Harvard using alum and chlorine, S.C. Brayton at Consolidated Water Power and Paper Company of Wisconsin Rapids using liquid chlorine and copper sulphate, and H.N. Lee of Hammermill Paper Company of Erie, PA, a former FPL staff member. The Hammermill researches seemed to show the effectiveness of caustic soda and were tested for the FPL by a Canadian cooperant firm. Fritz also conducted her own laboratory experiments back at the FPL. She identified the fungi responsible and later summarized her results and suggested the use of chlorine.

In 1930 the FPL sent a circular letter to Canadian mills asking about slime prevalence and methods of control used. At the suggestion of George E. Shipman, chemical engineer with Donnacona Paper Company, the FPL communicated with N.C. Cooper, chemist with Roessler and Haschlacher Company, a Niagara Falls, NY, chemical company, regarding the use of chlorine in slime control. Cooper sent two papers of his and mentioned the results of a discussion of the issue sponsored by the Technical Association of the Pulp and Paper Industry, a US technical body. Later in 1931, Fritz sent a copy of her reports on slime control to Dr J.R. Sanborn, bacteriologist with International Paper Company of New York, at his request. Fritz's FPL colleague, J.H. Ross, in February 1932 suggested a study of the effect of temperature on slime growth, as mill men were more willing to use heat than chemicals. Fritz replied that probably at temperatures over 100oF slime mold fungi growth was inhibited. In 1934 Fritz assisted three more eastern Canadian mills with their slime problems.

Perhaps the best illustration of Fritz's reputation, however, comes from another source entirely. A Spanish consulting engineer wrote to Fritz in 1935 to ask her advice on slime control in certain pulp mill configurations. She replied with data of her own and suggested contacting J.R. Sanborn who was then with Arthur D. Little. Also in that year Fritz disabused one FPL correspondent of the notion

7 D. Roy Cameron to W.W. Cory, 4 December 1925, National Archives of Canada, RG 39 vol. 252, file 33904-2.

8 The records of Fritz's investigations are in NAC RG 39 vol. 421 Project 0-54 and RG 39 vol. 253 files 33904-3 and -4.

that using creosoted timbers in pulp and paper mills was likely to do much to control slime. In 1936 she furnished information to Monsanto Chemicals of St. Louis regarding slime molds and their prevention. When Charles Sankey, research engineer at Ontario Paper, wrote to her for information on slime prevention that same year, Fritz pointed him to the work of International Paper. In 1938 Fritz handled an inquiry from the Works Manager of the Minas Basin (Nova Scotia) Pulp and Paper Company, wondering why his mill and not another had experienced slime problems. Fritz offered advice and also mentioned a publication of the US Forest Products Laboratory and two chemical suppliers, one US and one the Canadian subsidiary of Monsanto.

Here, then, is the picture of a Canadian-trained researcher in a government laboratory responding to the specific problems of production engineers in Canadian pulp and paper mills. She conducted her own research, sponsored the pooling of information among firms and drew upon results from Canadian and US firms, chemical suppliers and research bodies. In so doing, she brought individuals in different settings and countries into contact with one another, thus benefitting from and contributing to an international flow of technical knowledge which she was uniquely qualified to manage.

KARL ADOLPH CLARK

The Athabasca River Bituminous Sands region lies northeast of Edmonton, roughly centring on Ft McMurray. The resource itself is a tar-like substance, a mixture of hydrocarbons, sand and other minerals covered by an overburden. Though not recoverable by conventional means, its potential has been investigated for more than a century. One line of experimentation centred on its possible use as a road surfacing material, but the most important investigations have aimed at developing an economic means of separating bitumen from the sands and its subsequent refining into petroleum products.

One of the outstanding features of the research assault on the oil sands reaching back into the nineteenth century has been its cooperative nature. At various times agencies of the Federal and Alberta governments, private oil firms in Canada and the United States, users of oil products, university scientists, oil equipment manufacturers and engineering consulting firms have been involved. The man who was principally responsible for the development of the hot water separation process for extracting useable petroleum products was Dr Karl A. Clark. Unfortunately, his work culminated in 1949 just as the Leduc and Redwater fields of conventional crude were coming on stream, thus reducing the urgency to undertake costly and uncertain exploitation of the sands.[9]

Clark did not simply develop a piece of technology. From his institutional base first with the Mines Branch of the Federal government and then with the University of Alberta and the Research Council of Alberta he managed a flow of scientific and technical information regarding the oil sands. This involved a multitude of functions.[10] At the most general level it meant that Clark held a sort of watching brief with respect to the sands. He made himself and was regarded as the best informed person on the problem of the sands. From time to time he would brief other interested parties on the general progress of oil sands development. This also enabled him to act as a sort of informal employment bureau, advising on prospects of employment in the industry or giving references for scientists and engineers seeking employment with firms interested in or involved with the sands. It was also Clark who kept the US technical and trade publications up to date with oil sands investigations and potential. In the summer of 1930, for instance, an article on the sands was solicited from Clark by the editor of the New York journal *World Petroleum*. In October of 1947 while pleading that he was not yet ready to write a technical article for his journal, Clark provided the editor of Tulsa-based *World Oil* with an update on the most recent developments in Alberta petroleum.

Clark had extensive contact throughout his investigations with numerous government agencies in the United States. In a 1926 report to University of Alberta President H.M. Tory, Clark mentioned correspondence with the Highway Research Board of the US National Research Council plus the US Bureau of Mines. As well, he informed Tory of his plans to make an extensive trip through the United States to meet with both private oil interests and the State Highway Departments of Illinois, Indiana, North Carolina, Kentucky and California regarding road surfacing material. His contacts with the California Highway Commission were particularly fruitful, as that state also possessed difficult to work deposits of bitmunious sands and difficult heavy oil wells. The US Bureau of Mines was also consulted by Clark regarding US petroleum engineering firms which might design oil sands operations physical plants.

More important, however, were Clark's many and varied contacts with private parties, principally firms wishing to be involved with or kept informed of oil sands developments. This included some of the major players in the game. He helped to establish links between Universal Oil Products, a US firm interested in oil sands operations and Consolidated Mining and Smelting, the most promising

9 Barry Glen Ferguson, **Athabasca Oil Sands** (Regina, 1985).

10 The relevant correspondence has been published in Mary Clark Sheppard (ed), **Oil Sands Scientist** (Edmonton, 1989).

market for petroleum products refined in northern Alberta. On Abasand Oils' initiative, Clark met with the Canadian Manager of General Engineering in December of 1943. Under the aegis of the wartime Oil Controller, General Engineering was to redesign the Abasand plant, drawing upon the work of Clark at the Research Council of Alberta. Three officials of the Pennsylvania based Sun Oil Company met with Clark in July of 1944 to discuss the sands. As Suncor, that firm would later bring on stream an oil sands megaproject. Clark also provided information to Dr Sidney Born of Born Engineering which would later build the Bitumount plant for the Alberta government based on Clark's hot water separation method. Clark also reported on the activities of private firms to his superiors in government and the university. Similarly, he provided information of US firms to Canadian enterprises, such as his advice to Consolidated Mining and Smelting regarding US petroleum engineering firms which might design or construct oil and refinery equipment. Clark also corresponded with Dow Corning Products of Toronto, the Canadian subsidiary of a US firm, regarding the use of one of Dow Corning's products in tar sands processing.

Not all these contacts were institutional in nature. An active scientist, Clark kept in touch with other specialists in world geochemistry. He also kept up a lively and productive correspondence with key figures such as Sidney Blair and Max Ball through the three men's successive public and private institutional affiliations. Such easy movements among industry, various levels of government, the academic world and across borders have been an important part of the flow of technical information and have thus contributed to a greater degree of openness in attitude towards technical knowledge in North American industry.[11]

CONCLUSIONS

In studying the flow of technical information across national boundaries we cannot restrict ourselves to the counting of patents and licences. We cannot look only at patterns of corporate ownership and control. Even in the twentieth century much of the flow of technical knowledge has been at the personal level, though within specific institutional frameworks.

While this technical knowledge has been extremely valuable and the value has accrued to specific corporate interests (and, by a variety of mechanisms, to the

11 James P. Hull, '"A Common Effort to Determine the Facts": The Sharing of Technical Knowledge in Canadian Industry, 1900-1939,' **Journal of Canadian Studies** 25:4 (Winter 1990-91), 50-63.

state), proprietary control of technical knowledge has been only one part and not the most important part of the management of knowledge. Indeed knowledge has flowed with remarkable freedom among corporations, sectors and nations. In the two cases studied in this paper political jurisdictions have had remarkably little effect on scientific and technical outcomes.

In this process, Canada has not just been a receiver of technical knowledge. Canadians have contributed to the general pool of knowledge accessed by parties in various countries and in some cases coordinated the flow of knowledge. In these cases discussed above, the technical problems involved in one instance an industry where Canada was a world leader economically and in the other where it pertained to a Canadian resource with largely site specific problems. These cases do not overthrow the image of Canada as a nation of the periphery, nor are they meant to. But they do suggest that a more careful approach is needed in the analysis of questions of centre and margin in the history of science and technology.[12]

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12 These issues are discussed at greater length in James P. Hull, 'Technology and Continental Economic Integration: The Canadian Pulp and Paper Industry 1913-1939,' paper presented at the 1991 Biennial Meeting of the Canadian Science and Technology Historical Association.