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The Second Industrial Revolution and the Staples Frontier in Canada: Rethinking Knowledge And History

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See table of contents

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Article abstract

In the late nineteenth century and the early twentieth century the exploitation of Canada's softwood forests was transformed by the new technologies of the second Industrial Revolution. This can be understood in terms of Innis's staple thesis as the exploitation of natural resources on a margin for and using the technology of a more advanced Euro-American centre. The sociology of knowledge also provides a framework for analysis as old and new bodies of technical knowledge were possessed by and altered the relationships among different social groups. Changes were experienced both in the woods (pulpwood logging) and in the mills (pulp and paper making) in ways which were broadly similar but different in timing and other significant respects.

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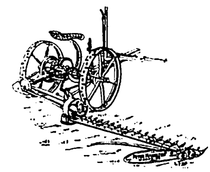

JAMES P. HULL

RÉSUMÉ
À la fin du 19e et au début du 20e siècle, l'exploitation des forêts canadiennes conifères a été transformée par les nouvelles technologies de la Seconde révolution industrielle. Dans les termes de la théorie du produit générateur de Innis, cette transformation peut être vue comme le résultat de l'exploitation de ressources naturelles frontalières utilisant la technologie d'un centre Euro-Américain plus avancé. Le sociologie de la connaissance offre également un cadre d'analyse en ce que les connaissances techniques anciennes et nouvelles des différents groupes sociaux ont également modifié les relations unissant les groupes entre eux. La chronologie et les caractéristiques des modifications des technologies de traitement du bois sont comparables bien qu'assez différentes de celles qui ont affecté les technologies des moulins à papier.

ABSTRACT
In the late nineteenth century and the early twentieth century the exploitation of Canada's softwood forests was transformed by the new technologies of the second Industrial Revolution. This can be understood in terms of Innis's staple thesis as the exploitation of natural resources on a margin for and using the technology of a more advanced Euro-American centre. The sociology of knowledge also provides a framework for analysis as old and new bodies of technical knowledge were possessed by and altered the relationships among different social groups. Changes were experienced both in the woods (pulpwood logging) and in the mills (pulp and paper making) in ways which were broadly similar but different in timing and other significant respects.

INTRODUCTION

The Second Industrial Revolution is conventionally defined to include new chemical processes, electrification and the internal combustion engine. These technological, but science-based, innovations transformed production during the late 19th century and early 20th century, first in Germany and the United States, but spreading quickly elsewhere. As the factory system was the organizational form which embraced the new technologies of the First Industrial Revolution, the modern multi-unit corporation played that role with respect to the Second. Both industrial revolutions had profound social consequences as well, those of the Second Industrial Revolution linked both to the rise of monopoly capitalism and to the rise of the middle class.

The Second Industrial Revolution came to a Canada still feeling the effects of the First. It came not just to the urban industrial southern Canadian borderlands, but as well to the Shield, the cordillera and even the sub-arctic in the form of the new staples of hydroelectricity, pulp and paper and non-ferrous metal mines. This can be understood in Innisian terms as the exploitation of natural resources on a margin for and using the technology of a more advanced EuroAmerican centre. Such a view nicely unites several strands of Canadian historiography including the staples thesis itself, metropolitanism, "colony to colony" nationalism and Brownian views of technological failure.

But is such a view either fair, complete or accurate? I would argue not and that the shortcomings arise from a considerable degree of terminological fuzziness relating both to technology itself and the concepts of frontier, hinterland, margin and so forth. The latter will be further discussed in the conclusion, but it is important first to remember that technology is not hardware, it is knowledge. Yes that technology may be embodied in devices or processes and some few of those may be patented. We must, however, come out of the patent office, and instead consider the whole structure of technical knowledge relating to production. This paper looks at the transformation of the structure of technical knowledge in one sector, forest products, a classic Canadian staple the economic importance of which hardly needs stressing. The Second Industrial Revolution in Canada saw not just a new body of knowledge applied to the economic exploitation of the Canadian forests as this country became the world's dominant newsprint producer. As well the infrastructure of knowledge — institutions and procedures for creating, disseminating, storing and bringing to the point of production useful knowledge — its intellectual categories and the social groups possessing and exploiting that knowledge all were transformed as well.[1]

KNOWLEDGE AND PRODUCTION

The transformation of technical knowledge brought some startling co-existence of forms to the forest products industry. Shortly after World War One the Canadian and United States pulp and paper industries' technical associations produced a series of textbooks on pulp and paper manufacture. On one page a method of using laboratory-derived sets of curves, displayed on a chart mounted up for the benefit of a machine tender, is described as the modern means of controlling a process. On another page the technique of puting a plank down atop a large pressure vessel and sitting on it to feel, through the seat of an experienced workman's pants, the state of the process so as to judge its completeness, is the state of the art. One issue of an industry technical journal in the 1930s had consecutive advertisements for GMC trucks and for horses, accompanied by technical articles on the use of each in hauling timber.[2]

Both the mill and the forest operations not only created new bodies of technical knowledge to apply to production, they also, separately and together, created new institutions and procedures for managing that knowledge. In 1903 the Biggar Press founded the *Pulp and Paper Magazine of Canada (PPMC)* which remains, with a slightly modified title, the industry's most important technical journal. The federal government's Forestry Branch created the Forest Products Laboratories of Canada (FPL) in Montreal in 1913. A week before TAPPI, its U.S. counterpart, the Technical Section of the Canadian Pulp and Paper Association (CPPA) came into existence as an association of mill technical personnel. Two years later, the Woodlands Section joined it. In the 1920s, the Pulp and Paper Division of the FPL joined with the CPPA's own cooperative research efforts and the McGill University Chair of Cellulose and Industrial Chemistry in a single institution, the Pulp and Paper Research Institute of Canada (PAPRICAN). A sure indication of the maturity of the knowledge structure is its codification in textbooks, manuals, and the like. As mentioned above, this was done for mill operations in the early 1920s, while not until twenty years later did the CPPA produce a handbook for woodlands operations. Indeed it also took somewhat longer to coordinate the technical work at the woodlands end of operations,which was not represented in PAPRICAN. Only in 1936 did the National Research Council of Canada (NRC) appoint an Associate Committee on Forestry. That committee had on it representatives of the NRC itself, the FPL, Dominion and Provincial forestry services, the Department of

Agriculture, universities, trade associations as well as lumber, wood preserving and pulp and paper firms.[3]

Why did these changes occur? The reasons are varied, with room for interpretation and differences of emphasis regarding the relative importance of different factors. As with many other industries, the sheer volume of demand and the need for higher rates of throughput outstripped the existing knowledge structure, as contemporary observers were well aware. As mills became more continuous process operations, the need for a reliable, year-round flow of raw materials became more acute. This was a special problem for the pulp and paper industry, which faced costs of deterioration of pulpwood stocked for months in mill woodyards, as well as inventory costs or possible downtime. Gaining greater control of production costs was another obvious motivation and cost accounting too became more sophisticated. The lash of competition from more technologically advanced areas prompted what might be termed defensive innovation. Certainly the need not just to reduce labour costs but address very serious labour shortages and the problems of a sometimes recalcitrant labour force prompted careful attention to more capital intensive technologies. But as well, certain new technical problems were simply beyond the abilities of traditionally-trained personnel. These included the cruising of vast and remote tracts, watershed management and the production of very high grade dissolving pulp to provide the cellulose needed in rayon manufacture.[4]

The need for uniformity in production provided one of the most critical motivations for change. This in particular meant the need to produce specific and specifiable outputs, consistently, from exceedingly heterogenous inputs. The outputs included not just grades of newsprint, but fine and specialty paper products, lignin plastics, alpha cellulose and new types of boards (paper, card, particle and chip). While spruce remained the pulp tree par excellence, the exploitation of other species represented a crucial issue. Balsam, for instance, could be used in the same process with spruce, with which it may be harvested. However the two trees do not have the same characteristics and are prone to different diseases and infestations. Producers could gain significant cost advantages from using at least a good percentage of balsam with spruce in a given pulping process, and over time the percentage did rise. Hardwoods as well could be exploited for certain types of output in certain pulping processes. Even when dealing with a single species the matter of uniformity loomed large. Mills desired wood with uniform characteristics of moisture content, density etc. delivered to their gates. In turn, woodlands operators needed to recognize and judge exactly, or measure, such characteristics either for culling or segregating loads. Indeed the variability of volume of output in hand cutting itself represented a problem which mechanization attempted to address.[5]

Whatever the mixture of motivations, which historians of labour, business and technology may debate, the technological changes aimed at closer control of the processes of production. This was as true in the mill as in the forest. Rule-of-thumb methods gave way first in the mill to greater control over the conditions of production at each step. Such control rested on experimental investigation both in the mill and extramurally and also on the routinizing of scientific testing procedures by the laboratory. By the 1920s mill technical personnel could talk of "scientific control". The result could be quantified as faster throughput, reduction of consumption of raw materials per unit of output and a more specifiable output.[6] Control over production in the forest embraced a series of woodlands operations. Mining of the forest at least began to give way to sustained yield silviculture. Certainly that was the ideal and no-one spoke any longer in terms of unlimited resources. The graduates of university forestry schools, aided by aircraft and instrumentation, replaced experienced woodsmen as timber cruisers as timber limits became larger and more remote. The transportation of logs by land and by water came not just to be performed by motorized vehicles but planned by civil engineers and its problems studied in the laboratory. A new professional, the logging engineer, emerged, either as a woodlands supervisor or an independent consultant.[7]

By "closer" control of production we mean in part a shift from the qualitative to the quantitative. Raw materials, intermediate products and final quality control came to be judged by instruments not by sensory perception and recorded automatically not by hand. Experimentation and systematic data gathering replaced experience and craft mysteries. The "practical man" gave way to the university graduate. Metering and instrumentation allowed pulp and paper mills to generate more production related data, implement better testing protocols and move towards automatic control of processes. Timber cruising came to rely on aerial photographs and specialized devices to interpret them. Holding booms for logs had their strains measured by gauges and calculated by formulae. Dynamometers measured the pulling capacity of logging sleighs. Freeness, a measure of how quickly water drains away from pulp stock as it forms up into paper, could be tested and thus controlled quantitatively by carefully calibrated and standardized testing apparatus. Engineers subjected both pulp and paper to a growing array of tests. Such tests became more uniform and standardized both for optimization within the mill and to facilitate the exchange of information or its reporting in technical journals.[8]

These tests originated in the research laboratory then moved quickly into the mill. Researchers at the FPL in the 1930s noted that pulp companies already performed extensive tests of the density of woods used because of its relationship to final yield. In the January 1940 number of *PPMC* a McGill researcher described, for the benefit of users of wood, a variety of physical, chemical and electrical methods of determining the percentage of water in wood. In making decisions regarding the purchase of new equipment or the introduction of new technology, precise, quantitative testing yielded the sort of data which firms came to require. Thus for example the Logging Chain Committee of the Canadian Engineering Standards Association made use of the FPL to design testing equipment for use in writing specifications for such chains. The efficiency of different types of chain saws was quantified. Study of the energy consumption levels of bucksaws of various designs under various conditions led to the writing of specifications for their optimal use and maintenance.[9]

To implement this type of control and this methodology, forest products firms required a new, university–trained personnel and other educational reforms. Pulp and paper schools in such important regions as the Niagara Peninsula, La Mauricie, northern New Brunswick and the Ottawa Valley offered a vocational level of education. While a general training in industrial or applied chemistry or chemical engineering could be obtained at a number of universities, graduate level training in cellulose chemistry became available by the mid-1920s at McGill under the direction of Harold Hibbert. Forestry education in both Ontario and Quebec began early in the 20th century, bringing the best European and United States ideas to this country. In common with early agricultural schools, however, the graduates tended to enter government forestry services, rather than private industry. Calls were heard early on, first in British Columbia, then in eastern Canada, for the inclusion of more industry-oriented and engineering courses in the curricula of forestry schools. This did not always sit well with more traditional educators but did reflect the realities of the woodlands operations.[10]

This points to another problem. It is all very well to be generating new information and creating new personnel; implementation is still a difficult task, particularly in the forest. Lumbering operations had to be convinced that forestry graduates should be placed in responsible charge of operations, in preference to practical men. Or, conversely, the necessity had to be seen of training foremen in new ways with new knowledge. Workers too needed new training. This included classroom, night school education for mill hands along with correspondence courses, one being based on the above–mentioned textbook series. Manuals and handbooks on woodlot operations were prepared, in part using NRC funding. On site training helped to get the information generated by careful programmes of investigation into workers' hands. Equipment suppliers cooperated with forest products firms to train workers in new machinery.[11]

Clearly, this transformation in technological knowledge had a tremendous impact on the nature of work in both the mill and the forest. In analysing this social change it is important to remember that while labour market issues figured prominently among the motivations for change, so to did very real technical problems and the very real limitations of traditionally trained personnel. Digester loads could be improperly cooked or pulp improperly bleached resulting in material losses and interruptions of production. Raw materials wastage could result from improper booming, wasteful cutting practices or prolonged storage. Equipment and materials could be poorly chosen. These and other issues saw the replacement, gradually, of old time empiricism with measurement and analysis; equally it saw the gradual replacement of practically trained craft workers and woodsmen with chemists, engineers and forestry graduates. This occurred, at different times and rates in different places, for every step of production from timber cruising to paper making. By the early 1930s very few mills lacked a technical department and some had substantial staffs. Obviously, this change did not occur without resistance. Some of that resistance came from management, especially non–technically–trained management which had to be shown and reminded of what university graduates could do. Even more important was the relationship between the new university–trained personnel and the older practically trained. Not unreasonably, the latter resisted their own marginalization, sometimes with limited cooperation, foot–dragging or even disruption. But the story is ambiguous. The paper makers' union favoured the expansion of technical education. Loggers on piece work welcomed chain saws. River driving had been shockingly hazardous. If the most skilled jobs disappeared so did the least skilled materials handling ones. The result in the mill was a more uniform, semi-skilled work force of machine tenders. In the bush, as will be discussed below, the result was not so much deskilling as a changed type of skill mixture.[12]

KNOWLEDGE AND INDUSTRY

The Second Industrial Revolution and its new structure of knowledge gave firms in an industry good reasons to behave as a unit on technical matters, not as a group of competitive firms. This related to technical knowledge in a number of ways. Firms saw their real competition as being in other countries. Europe had more advanced forestry and processing techniques. The southern United States, by the 1930s, was poised to repeat the Canadian experience of basing tremendous expansion on command of raw materials, thanks to new techniques for pulping southern pine species. As well, forest products could substitute for, or be substituted by, glass, plastics, metals and other fibrous materials in a range of applications. Scientific control and the ability to tailor outputs for specific user needs kept that range widening, as did the pool of common industrial processing techniques.[13]

This is only one explanation for the remarkable degree of openness which characterized the approach to technical knowledge. If mystery and secrecy characterized workers' knowledge, the Second Industrial Revolution saw a higher degree of willingness to share knowledge, including placing that knowledge into the public domain. Why would firms behave in this fashion? In fact they had several motivations in addition to competitive pressures from other industries and areas. Optimization through the search for best practice became a common method of technical advance. Everyone will do what each producer does best. The overhead costs of developing new technology or choosing among alternatives could be shared by pooling knowledge. If everyone accesses essentially the same pool of knowledge, this offers a measure of stability to the industry; mature technical systems do not in any event seek revolutionary breakthrough inventions. Information about a firm's product could have a real advertising value as well as a less tangible prestige value and educate actual or potential users. Finally, university trained personnel exerted their own pressures to be allowed to publish and present papers at conferences of their peers. If firms hoped to attract and retain good scientists and engineers such pressures could not be ignored.[14]

What were the specifics behind these general considerations? A joint committee of the CPPA's Technical and Woodlands sections observed that companies actively exchanged information on new mechanical equipment for use in logging operations. A. Koroleff, long-time guiding figure in the Woodlands Section, discussed the losses incurred in the industry from improper booming of logs. While individual ad hoc improvements had been made, he noted the need for systematic data gathering, testing, theoretical and experimental work, including laboratory as well as field work. Price Brothers, for example, published the results of investigations on a new saw and the floatability of birch and booming. That firm and Canada Paper cooperated on trials of a new saw, and then released the results. In an article on light alloys, a McGill scientist remarked on the flow of knowledge between sales engineers of metal producers and pulp and lumber engineers regarding applications. Equipment manufacturers, or at least some of them, realized the need for up- and down-stream flows of technical information between themselves and their customers. This involved learning by selling, benefitting from users' learning by doing and the training of users. Some capital goods firms were happy to act as technical service bureaus for their customers while others grumbled that their customers were forever trying to get free engineering services.[15]

The ready exchange of technical information could facilitate vital commercial intercourse and lower transaction costs. As early as 1908 Judson De Cew, a pioneer Canadian trained pulp and paper chemist, called for impartial pulp testing services to eliminate disputes between buyers and sellers. One critical problem, prior to the integration of pulp making and paper making, was the determination of the moisture in pulp delivered to the paper mill door, as price depended on this. Agreeing upon a sampling and testing procedure involved reconceptualizing a commercial dispute as a common technical problem. Similarly, mills had a variety of standards which they applied in accepting a percentage of rot in trees. Still, in spite of these advantages, firms needed constant reminding to allow their technical personnel to attend meetings, give papers and otherwise freely exchange information.[16]

In a 1950 address to Canada's foresters, Lincoln L. Thiesmeyer, the Director of PAPRICAN, discussed not just the importance of an open flow of knowledge but also the importance of its co-ordination and management. In fact, PAPRICAN and the FPL played exactly such roles. Moreover, they had crucial functions as technically expert but commercially neutral bodies. Interested parties referred disputed technical questions to them for suitable resolution. As government bodies, they insisted always that the results of investigations be open to all parties and on the whole preferred to work with trade associations more than individual firms. Two FPL researchers undertook the testing of various designs of buck saws. FPL Timber Pathologist Clara Fritz coordinated a cooperative study of the deterioration of stored pulpwood; the study included experimental work under her supervision. Another investigation of pulpwood density by the FPL drew upon data gathered from CPPA member companies on a questionnaire sent out by a Joint Committee of the Woodlands and Technical Sections. The FPL, forest products firms and equipment manufacturers all cooperated with the CPPA Woodlands Section in the process of mechanization of forest operations, from chain saws to mechanical harvesters. Other government agencies involved in research work included the NRC, the Dominion Forest Service's Division of Forest Research and, in the Department of Agriculture, the Division of Botany, the Tree Planting Section and the Entomological Branch. Finally, the Canadian Engineering Standards Association provided a neutral forum to settle contentious standards issues.[17]

From these details, one very broad change in the overall structure of knowledge may be discerned. During the Second Industrial Revolution, much technical knowledge relating to production became recategorized. Knowledge specific to one industry and resting on traditional craft knowledge (how to make paper, how to brew ale, how to blow glass), became less important relative to information common to many industries and resting on university-learnt applied science (the behaviour of pressure vessels, the phase rule, the use of pyrometers). We may characterize this as the shift from a vertical, industry-specific, to a horizontal, cross-industry, structure of knowledge. Such important developments as the rise of unit operations in chemical engineering and the shift in importance from product to process innovations are part and parcel of this restructuring.[18]

For the forest products industry this phenomenon manifested itself in two ways, both related to a moving away from knowledge of the forest, of trees and even of wood. It also happened, in eastern Canada, in two different periods, for the mills climaxing after World War One and for woodlands after World War Two. In pulp and paper making the change is signalled by the institutional evolution of the Forest Products Laboratories. Initially conceived as a technical service bureau and research laboratory for all industries using Canadian woods, it had origins closely linked to Progressive era conservationist ideas of efficient resource utilization. A decade of operations however made it clear that the knowledge needs of pulp and paper manufacturers had become quite distinct from other users of wood. Why? Because the industry was not a forest, not even a wood using industry. It was a cellulose processing industry with a knowledge base in chemistry and chemical engineering and much in common with other continuous flow chemical process industries. To a certain extent that had been noticed from the start. The FPL had little to do with research on standing timber, which was the province of other agencies or bodies. The FPL's Pulp and Paper Division had its own industry Advisory Committee in addition to the FPL's general advisory committee. But with the creation of PAPRICAN in the mid-1920s institutional relations clarified themselves. No wood-using firm outside the pulp and paper industry evinced interest in keeping the FPL together at McGill. Instead, all other Divisions moved to Ottawa as the Pulp and Paper Division became part of the new PAPRICAN.[19]

The evolution of woodlands operations followed a distinct path. But here too the body of knowledge used in production became not just more science based but the skills used also more mechanical than forest oriented. Lumbering had traditionally relied on the skills of men knowledgable about the forest, about felling and hauling trees. These would have been widely distributed in eastern Canada amongst settlers experienced in clearing off their own lands and who would have combined farming with lumbering. Professional lumbermen with specialized skills and deep knowledge of the woods formed the productive core. By the mid-twentieth century much of this had changed. Loggers were called a type of mechanic. The skills they required were skills to wield and maintain a power saw or drive and maintain a tractor. Logging had become as much a transport industry as a forest industry with attention to vehicle fleets, and roadbuilding, not just judging how a tree will fall. Timber cruising had become an exercise in aerial photography and photo interpretation, not eyeing the lay of the land and sizing up trees. Logging, in short, became a branch of engineering with investigations conducted in engineering laboratories. Workers shared skills with other operators of machinery, drivers of heavy equipment and mechanics, not with trappers and pioneer bush farmers. Forestry school training offered more engineering of a sort familiar to other engineers – civil, mechanical and chemical – and less exclusively forest subjects.[20]

CONCLUSION

Both mill and woodlands operations saw their restructurings of technical knowledge relating to production. This involved new skills, new personnel, changing relations among social groups, new institutional arrangements and new demands on the State. Though unique in its details, this story is no more than a case study of the Second Industrial Revolution. If it has interesting aspects it is in the compressed time scale, the unevenness of developments and the coexistence of forms. Ultimately, however, the point is that the study of the Canadian forest products sector is a good example of the Second Industrial Revolution. What happened there happened in its broadest outlines in many other industrial sectors in many other nations.

That fact, however, leads us into consideration of the historiographic questions which began this paper. It is easy and tempting to equate such relationships as centre-margin, centre-periphery, heartland-hinterland, core-fringe, settled-frontier. Each case carries at least connotations of dependency, rawness, incompleteness and derivativeness, the second of each pair on the first. But in fact the terms and the relationships are not equivalent. And within each different aspects of a relationship may coexist. Perhaps the least problematic is the term frontier, for it allows for notions of creativity in solutions to unique problems of a given environment. The Canadian staples frontier was in fact a site of great technical creativeness, not a passive receiver of externally derived technology. That creativity involved, yes, the implementation of external technology and its adaptation, but also new solutions to technical problems, some of which diffused elsewhere, and the sharing in broader, international technological developments.[21]

NOTES

1 Alfred D. Chandler, *The Visible Hand,* (New York: Knopf, 1977). E.J. Hobsbaum, *Industry and Empire,* (London: Weidenfeld and Nicolson, 1968). Ian Drummond, "Ontario's Industrial Revolution 1867-1941," *Can. Hist. Rev.* 69, 3 (1988), 283-314. Craig Heron, "The Second Industrial Revolution in Canada, 1890-1930," in Deian R. Hopkin and Gregory S. Kealey, *Class, Community and the Labour Movement,* (Wales: Llafur/CCLH, 1989), 48-66. James P. Hull "Science and the Canadian Pulp and Paper Industry, 1903-1933," PhD Diss, York, 1985. Ian Radforth, *Bushworkers and Bosses* (Toronto: University of Toronto Press, 1987). Edwin T. Layton, "Technology As Knowledge," *Technology and Culture* 15 (1974), 31-41.

2. Various authors *The Manufacture of Pulp and Paper* (New York: McGraw-Hill, 1921). L.R. Scheult, "Log Hauling With Trucks in Winter," *PPMC* (July 1934), 418 et seq. J.W. Sutherland, "Horses in Woods Work," *PPMC* (July 1934), 422-28. A forty year review of technical developments in the pulp and paper industry may be found in a series of articles in the July 1942 number of *PPMC.*

3 J.N. Stephenson, "A Magazine Was Born to Grow With an Infant Industry," *PPMC* (1953), 135-45. R.H. Campbell, "Canada's New Forest Products Laboratories," *PPMC* 15 June 1913, 417-8. James P. Hull, "Early Membership of the Technical Section, Canadian Pulp and Paper Association," *Scientia Canadensis* 26 (1984), 68-72. Fred Stevens, "The Section's First Sixty Years," Pulp and Paper Canada 78 (Nov. 1977), 17-45. Charles A. Sankey, *Paprican: The First Fifty Years* (Montreal: PAPRICAN, 1976). C.D. Howe, "The Need of Basic Research for the Solution of Our Forest Problems," *The Forestry Chronicle* 10 (1934), 144-50. "Associate Committee on Forestry Appointed by National Research Council," *PPMC* (March 1936), 211-12. A. Koroleff, *Woodcutter's Handbook,* (Montreal: CPPA, 1942).

4 C.D. Howe, "Rewards for Trained Foresters in Canada," *Illustrated Canadian Forestry Magazine* 16 (Nov. 1920), 526-8. T.L. Crossley, "Before We Became Technical," *PPMC* (May 1953), 163-66. F.A. Harrison, quoted in *Canadian Pulp and Paper Industry* 16 (May 1963), 49-50. A.W. Bentley et al. *Organization and Administration of Woods Operations,* (Montreal: Woodlands Section, 1938). A. Koroleff, "Mechanization of Our Logging Operations," *CPPA-WS Papers* (Jan. 1939). "Pulp and Paper Association on Woodlands," *PPMC* 29 November 1917, 1105-09. A. Koroleff, "Economic Possibilities of Mechanized Logging," *PPMC* (Feb. 1938), 221 et. seq. J.A. Henderson, "Construction of Timber Dams," *CPPA-WS Papers* (1931). S. Wang, *History of the Sulphite Process in Canada,* (Hawkesbury: CIP, 1948).

5 R.W. Wellwood, "Pulp Quality and the Forester," *PPMC* (Feb. 1957), 89-91. "Paperboard and Cardboard with Reference to Canada's Resources," *PPMC* 26 (14 June 1928), 815-18. G.A. Mulloy, "The Balsam Fir," *PPMC* Convention Issue (1937), 210 et seq. *Papers. Canadian Section Society of Chemical Industry* 5 (1912), 15. W.R. Brown, "Hardood

Pulpwood," *PPMC* (May 1938), 412-4. *Report of the Superintendent, Forest Products Laboratories of Canada*, Aug. 1915, Dec. 1917. Douglas Jones, "Our Future Wood Requirement," *PPMC* Convention Issue (1944), 213-9. A. Koroleff, "Pulpwood Cutting," *PPMC* (May 1940), 406 et seq.

6 L.H. Shipman, "Connecting Research and Manufacturing in a Paper Mill," *PPMC* 10 Jan. 1918, 25-26. Letter, Kynock to Campbell, 29 May 1922, NAC RG 39 file 33904. G.H. Gemmell, "Scientific Control in the Paper Mill," *World's Paper Trade Review*. 103 (1925), 1692-4. News item in *PPMC* Convention Issue 34 (1933) 71-77.

7 Radorth op. cit. 56. L.A. Nix, "Will Technical Control in Logging Open the Door to Better Silvicultural Management?" *The Forestry Chronicle* 9 #2 (1933), 17-23. Howe, "Rewards" loc. cit. C.R. Towsend, "New Developments and Trends in Logging Technique," *PPMC* (Oct. 1940), 736 et seq. K.G. Fenson, "The Effects of Seasoning on the Floatability of Logs," *CPPA-WS Papers* (1930). Richard Rajala, "Managerial Crisis: The Emergence and Role of the West Coast Logging Engineer, 1900-1930," in Peter Baskerville (ed) *Canadian Papers in Business History* (Victoria: The Public History Group, 1989), 101-28. J.D. Gilmour, "Logging Roads," *PPMC* (Feb 1937), 259 et seq.

8 R.V. Knapp, "Application of Meters and Instruments in Pulp and Paper Mills," *The Paper Industry* 10 (1928), 1190-4. George R. Sonley, "The Monoscope," *The Forestry Chronicle* 21 (1945), 43-45. G.E. LaMothe, "Dynamometer Tests on Truck-Sleigh Hauls," *CPPA-WS Papers* (1940). W.E. Wakefield, "The Efficiency of Logging Sleighs for Pulpwood Operations in Different Types of Terrain," FPL Report Project 107 April 1938. G.E. LaMothe "A Method of Determining Strains and Safe Loads on Holding Booms," *CPPA-WS Papers* (1939). E.P. Cameron, "Freeness as a Control Test for Groundwood Production," FPL Report March 1922.

9 Project 16-L-4 Abitibi-Price Archives. J.D. Hale and J.B. Prince, "A Study of Variation in Density of Pulpwood," *PPMC* (July 1936), 458-9. G.H. Gemmell, "Wood-Pulp Testing Methods," *World's Paper Trade Review* 96 (1931), 1217 et seq. H.R. Soderston, "Information on Chains," *PPMC* (July 1938), 512-6. *Report of the Superintendent, Forest Products Laboratories of Canada*, June 1925. R. Darnley Gibbs, "The Determination of Water in Wood," *PPMC*. (Jan. 1940), 31-34. "Logging Machinery Demonstration," *PPMC* 6 Aug. 1931, 907-8.

10 James P. Hull, "New Knowledge - New Workers," *Pharos* 1 (1991), Melville L. Wolfram, *Harold Hibbert 1877-1945*, (New York: NAS, 1958). J.W.B. Sisam, *Forestry Education at Toronto*, (Toronto: University of Toronto Press, 1961). Avila Bedard, "History of the Quebec Forestry School," *The Forestry Chronicle* 4 (1928), 3-6. A. Koroleff, "Co-operation of Industry and Forest Schools Would Aid Their Service," *CPPA-WS Papers* (June 1932). G.M. Cornwall, "Logging as an Engineering Science," *Report of the 14th Convention of the Canadian Forestry Association* (1912).

11 J.D. Gilmour, "Employment of Forestry Graduates in Logging," *CPPA-WS Papers* (25 Jan. 1933). D. Dyer, "Foreman Training," *CPPA-WS Papers* (March 1949). A.M. Stewart et al. "Training of Woods Supervisory

Personnel," *CPPA-WS Papers* (1951). Howard Kennedy, "The Farm Woodlot," *PPMC* (June 1937), 506-07. E.R. Goulet, "Practical Applications of Woodlands Section's Studies," *CPPA-WS Papers* (Dec. 1941). Gordon Godwin, "Increasing Worker Efficiency," *CPPA-WS Papers* (Jan. 1942).

12 Elwood Wilson, "Forestry Progress Based on Facts," *PPMC* 17 Oct. 1918, 927-30. Thomas Southworth, "Do We Need a Forestry College in Ontario," *Canada Lumberman* 27 (Aug. 1907) 19. A. Koroleff, "Booms," *PPMC* 7 Jan. 1932, 1 et seq. Radforth, op. cit. 56. J.A. Doyle, "Logging Waste in Eastern Canada," Forest Products Laboratories Bulletin #115 (Ottawa, 1954). editorial *PPMC* 1 Jan. 1913, 6-7. Elwood Wilson, n/t *PPMC* 9 Dec. 1920, 1249-51. J.O. Wilson, "Driving Small Streams," *CPPA-WS Papers* (Jan. 1934). R. Bell-Irving, reported in *PPMC* 21 Nov. 1931, 1243. F.L. Moore, "Contributions of the Chemist to the Pulp and Paper Industry," *The Journal of Industrial and Engineering Chemistry* 7 (April, 1915), 292-3. W.B. Campbell, letter to the editor, *PPMC* 1 April 1920, 343-4. John S. Bates, "Reminiscences of Technical Section Early Days," *PPMC* 75 (Jan. 1974), 20-25. F.F. Dority, "Forty Years of Progress in Materials Handling," *PPMC* 43 (1942), 616-7. Charles S. Robb, "From Cutter Boy to Machine Tender," *PPMC* 30 (1930) 443 et seq.

13 A. Korleff, "Is Canada Penny Wise and Pound Foolish in Regard to its Forest Research?" *PPMC* 40 (Nov. 1939) 694 et seq. James P. Hull, "The Canadianization of Technical Knowledge: The Case of the Pulp and Paper Industry, 1913-1939," *International Journal of Canadian Studies* 5 (Spring 1992), 69-87. A.H. DeWolf to A.E. Wicks 17 Feb. 1940, A.E. Wicks Co. Ltd records, Archives of Ontario MU4 144. Horace Freeman, "Southern Pine Newsprint vs, Canadian Newsprint," *The Forestry Chronicle* 14 (1938), 88-93. W. Kynoch, "The Technical Man and the Wood Industries," *The Forestry Chronicle* 16 (1940), 227-32.

14 J.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.

15 Progress Report of the Joint Committee, *PPMC* Convention Issue (1940). A. Koroleff, "Booms" loc. cit. LaMothe "Method" loc. cit. Woods Department, Price Bros. "Investigation of Floatability of White Birch," *CPPA-WS Papers* (1930). Price Bros. & Co. and Canada Paper Co. "Trials of the Dolmar Saw in Cutting Pulpwood," *PPMC* (March 1939), 316-21. Gordon Sproule, "Light Alloys," *CPPA-WS Papers* (1941). W.J. Carson, "New Uses For Tractors on Logging Operations," *PPMC* (Sept. 1937). Godwin, "Increasing" loc. cit. Bob Griffin, "The Development of Whole Log Hydraulic Barking in British Columbia," unpublished paper, Victoria, Sept. 1987.

16 Judson De Cew, *PPMC* 6 (May 1908), 121-22. report in *PPMC* Convention Issue (1939) editorial *PPMC* 13 1 Dec. 1915, 595. remarks of C.H.L. Jones quoted in *Canadian Pulp and Paper Technical Section Proceedings* (1936).

17 Lincoln L. Thiesmeyer, "Teamwork in Research," *The Forestry Chronicle* 26 (1930), 279-86. G.H. Rochester and William E. Wakefield, "An Inves-

tigation into the Various Factors Governing the Efficiency of Buck Saws," Interim Report #2, 23 July 1931 Forest Products Laboratories. Clara W. Fritz, "Rate of Deterioration of Pulpwood in Storage," *PPMC* (March 1936), 217-8. Hale & Prince, "Study," loc. cit. Radforth, op. cit. 86-87, 183 ff. "Conference on Forestry Research," *PPMC* 36 (Dec. 1935) 657-9, see also Dean Howe's Correspondence, Forestry Papers, Box 2 File 76 University of Toronto Archives. Soderston,"Information," loc. cit.

18 Martha Moore Trescott, *The Rise of the American Electrochemical Industry, 1880-1910,* (Westport: Greenwood, 1981). Alexandra Oleson and John Voss (eds), *The Organization of Knowledge in Modern America 1860-1920,* (Baltimore: Johns Hopkins University Press, 1979). Mark William Wilde, "Industrialization of Food Processing in the United States, 1860-1960," PhD Diss, Delaware, 1988. William Anderson Liddell, "The Development of Science in the American Glass Industry 1880-1940," PhD Diss, Yale 1953. John A. Heitmann, *The Modernization of the Louisiana Sugar Industry 1830-1910,* (Baton Rouge: LSU Press, 1987). Paul Bryan Israel, "From the Machine Shop to the Industrial Laboratory," PhD Diss, Rutgers, 1989.

19 James P. Hull, "From the FPL to PAPRICAN," *HSTC Bulletin,* (Jan. 1983) See also *Report of the Superintendent, Forest Products Laboratories* February 1915.

20 Radforth op. cit. 25, 201-19. Cornwall, "Logging" loc. cit. Korleff, "Booms," loc. cit. Godwin, "Increasing" loc. cit. Clifford R. Kopas, "Logging Without Axes," *PPMC* (Dec. 1946), 106-8. D.M. Matthews, "Election of Equipment, Road Standards, and Road Spacing," *CPPA-WS Papers* (Aug. 1939).

21 Dianne Newell, *Technology on the Frontier* (Vancouver: UBC Press, 1986). James Otto Petersen, "The Origins of Canadian Gold Mining," PhD Diss, Toronto, 1977. Barry Glen Fergusson, *Athabasca Oil Sands* (Regina: CPRC, 1985).

ABBREVIATIONS:

PPMC *Pulp and Paper Magazine of Canada*

CPPA-WS *Canadian Pulp and Paper Association, Woodlands Section*

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