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

# Technology and The North American Forest

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Volume 16, Number 2 (43), 1992

URI: https://id.erudit.org/iderudit/800354ar
DOI: https://doi.org/10.7202/800354ar

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Publisher(s)

CSTHA/AHSTC

ISSN

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

Explore this journal

Cite this article

Brown, M. K. (1992). Technology and The North American Forest. *Scientia Canadensis*, *16*(2), 193–212. https://doi.org/10.7202/800354ar

Article abstract

This paper is a critical review of recent historical literature relating to nineteenth and twentieth-century European-based technology in the North American forest. My discussion is limited to the industrial technologies of logging, sawmilling, pulp and paper milling, and forestry. These technologies will be discussed with reference to three issues in the history of technology: first, the nature of technological change; second, the environmental and social impacts of technology; and finally, the role of social values in determining choices of technology. Throughout, there will be an attempt to compare Canadian and American perspectives, when these diverge.

# Technology and The North American Forest*

MARIAN K. BROWN**

RÉSUMÉ

Cet propose une revue de la littérature concernant l'adoption en Amérique du nord, au cours des 19e et 20e siècle, de technologies forestières européennes. On discutera surtout du traitement des billes de bois, des technologies touchant les moulin à scie et les pâtes et papier, et ce en relation avec trois thèmes importants en histoire des technologies: 1) la nature des changements techniques, 2) l'environnement et les impacts sociaux des technologies et 3) le rôle des valeurs sociales dans le choix des technologies. Adoptant une perspective comparative, on signalera également les différences entre le cas américain et le cas canadien.

ABSTRACT

This paper is a critical review of recent historical literature relating to nineteenth and twentieth-century European-based technology in the North American forest. My discussion is limited to the industrial technologies of logging, sawmilling, pulp and paper milling, and forestry. These technologies will be discussed with reference to three issues in the history of technology: first, the nature of technological change; second, the environmental and social impacts of technology; and finally, the role of social values in determining choices of technology. Throughout, there will be an attempt to compare Canadian and American perspectives, when these diverge.

THIS PAPER is a critical review of historical literature relating to European-based technology in the North American forest, with a focus on the increasingly mechanized technology of the nineteenth and twentieth centuries. The forest has long been interpreted as a resource essential to the transplantation of European civilization to this continent. We have valued the forest as the habitat of commercially-exploited animals; as the regulator of water supplies; and above all, as a source of wood products relied upon in everyday life.[1] Our culture's relationship with the forest has been expressed dramatically in technology, defined by Lynn White as "Systematic modification of the physical environment for human ends."[2] We have effected such modification both by the use of tools

and machines, and by rationalist ideas of resource exploitation and management; for technology is both "a way of doing things and a way of thinking about things."[3]

My discussion is limited to the industrial technologies of logging, sawmilling, and pulp and paper milling, and to forestry, a "way of thinking" that in North America has been allied with the commercial exploitation of the forest. As these technologies have long been integrated with one another, both economically and in the historical literature, they will not be separated in this paper. Instead, they will be discussed with reference to three issues in the history of technology: first, the nature of technological change; second, the environmental and social impacts of technology; and finally, the role of social values in determining choices of technology. Throughout, there will be an attempt to compare Canadian and American perspectives, when these diverge. Publications in the realm of so-called "forest history" have proliferated since World War II; most of the works considered date from that period.

## TECHNOLOGICAL CHANGE IN FOREST INDUSTRIES

Some historians have interpreted the whole of North American technological development in terms of the environmental determinism of the forest: blessed with an abundance of wood, North Americans were drawn into technological and economic substitution of wood for other inputs, to an extent long impossible in deforested Europe.[4] This extravagant use of wood of course stimulated commercial logging and wood processing, and mechanical innovations to increase the output of these industries. Nathan Rosenberg argued that simple abundance of wood propelled the United States to world leadership in the design and production of woodworking machinery.[5] On the other hand, mechanical inventions such as the flooring machine (tongue and groove cutter) have influenced the exploitation of particular forests.[6] Thus technological change both has been determined by the nature of the forest, and has determined changes in the nature of the forest.

Few historians, however, have interpreted the development of forest methods and machinery in terms of any articulated theory of technological change. There is no published historical synthesis on forest-related technology in Canada or the United States, although specific technologies have received some attention, and regional studies have established partial chronologies of invention, diffusion, and innovation. An outstanding study of a specific technology is

Stephen J. Pyne's article "Fire Policy and Fire Research in the U.S. Forest Service," which examines how the use of fire has been influenced by factors such as scientific management and military interests. More representative is Barbara R. Robertson's *Sawpower: Making Lumber in the Sawmills of Nova Scotia*, a painstaking narrative of technological change in provincial mills, which deliberately eschews any attempt at theorization.[7]

In the forest history literature, as in North American history in general, technological change is rarely the central focus of study, but "commonly operates as either one of several elements in a composite thesis or as a nearly unconscious presupposition influencing the author's general approach."[8] Indeed, technological change has never really been an organizing principle in Canadian forest history; instead, our historiography is dominated by Harold Innis's staples theory of economic development, with its overwhelming concern for the influence of external markets and external capital on Canadian industry.[9] Nor does American forest history provide strong models of technological change. An early exception is Evelyn Dinsdale's 1965 article "Spatial Patterns of Technological Change," which applies Lewis Mumford's definition of technological phases to the lumber industry of northern New York. The following summary of this article serves to outline the broad historical pattern of forest technology in North America.

Dinsdale identifies spatial patterns of forest exploitation which are characteristic of Mumford's eotechnic, paleotechnic, and neotechnic ages of technology. The eotechnic complex of animal or water power, simple engines, and wood construction was manifested in small-scale logging and sawmills supplying non-competitive local markets. The development of the log drive, inspired by the abundance of streams in northern New York and similar regions, was the key eotechnic innovation: it increased markets, allowed commercial milling, and engendered competition within the region.

Beginning in the mid-nineteenth century, steam power dictated the new spatial patterns of the paleotechnic age. The high capital requirements of steam milling resulted in fewer, larger mills; the steam-driven circular saw, and later the band saw, replaced the water-powered up-and-down saws of the eotechnic era. Such innovations served the goals of increased output and lower per-unit costs.[10] As the capacity of mills increased, the railroad was adapted to logging in order to ensure a steady flow of logs from increasingly remote stands. In turn, the capital costs of railroads demanded

maximum payloads, and favoured clearcutting of the forest.[11] Dinsdale identifies the paleotechic as the era of resource mining and the quantification of nature in terms of money value.

Electricity, the internal combustion engine, and new engineering materials heralded the neotechnic age, furthering the pursuit of efficiency in the use of sawlogs and milling waste. The early years of this phase coincided with the twentieth-century shift to pulp production in regions where sawmilling had already consumed prime timber. Yet Dinsdale attributes to this age "the transformation from reckless *paleotechnic* destruction and waste to *neotechnic* ideas of conservation and controlled exploitation which ensured adequate supplies of raw material for the future."[12]

Lest this appear a too-tidy progression of forest technology, Dinsdale admits that technological change did not benefit regions that had already experienced the height of resource mining. Regional forest industries have tended to maintain the technological system that was in place during their period of peak production, because after that time any potential increase in profits was not sufficient to stimulate technological change.[13] Thus, in northern New York, the new, conservationist version of efficiency never arrived to encourage reforestation of "mined-out" stands. It was only in the last-exploited forests of America, those of the Pacific Northwest, that maximum production coincided with the conservation potential of neotechnic technology.[14]

In light of more recent critical assessments of conservation forestry (see below), Dinsdale's interpretation now seems complacent in its satisfaction with the progress of forest technology. However, her article points to a consensus regarding conservatism in the technology of logging and milling that has little to do with principles of conservation. The most noted technological changes in nineteenth-century forest exploitation were in the area of transportation, which tended to set regional patterns of industry. River booms and railroads enabled industry to take advantage of the increasing urban demand for lumber and fuel—and to fulfil the existing capabilities of steam milling.[15] But logging equipment and techniques changed only slowly, and even in profitable times, sawmilling was not noted for innovativeness. Even the prosperous Weyerhaeuser mills adopted electricity and gas engines only after these were considered proven in other industries and other mills: Frederick E. Weyerhaueser commented that "I would like to let the other fellow do the experimenting."[16]

Many authors view technological conservatism, especially in logging, as an appropriate adaptation to local terrain, climate, and trees. The long-established "high-lead" system of West Coast logging, for example, suits the size and weight of the trees and the difficulties of the terrain.[17] Similarly, environmental factors such as soft ground and variable stand density have accounted for long delays in the implementation of mechanical harvesting in the Canadian Shield.[18] Historians also cite abundant labour as a prime factor in delayed mechanization in central Canada.[19]

While recognizing environmental limitations, some Canadian technologists have also bemoaned our forest industry's preference for proven equipment, its reluctance to innovate, and its "lack of commitment" to technological change[20]. In contrast, American historians such as Thomas Cox have simply pointed to the decentralized capital structure of the logging and sawmilling sectors, which prevented financial commitments to research and development.[21] Nineteenth-century milling in particular faced low economies of scale, as each saw demanded human attention; and transportation costs prevented individual mills from dominating large areas of production.[22] In such circumstances, company engineers had difficulty imposing the concept of efficiency upon "financially strapped operators and 'rule of thumb' managers."[23]

Apparently sluggish technological change in logging and sawmilling has probably served to limit specific studies on this topic. More detailed work is needed to illuminate periods of accelerated change, for example the Depression-era concentration and mechanization of milling, and the recent period of mechanized logging and computerized milling. In the absence of analytical studies in this area, there is a continuing strain of "internalist" literature establishing the genealogy of particular innovations such as the circular saw, the band saw, the steam mill, the logging railroad, and so on.[24] In general, such studies bow to the guiding value of technology itself, the pursuit of efficiency, with little reference to contextual factors beyond environmental determinism.

In contrast to logging and sawmilling, the pulp and paper industry is distinguished by a strong historical pattern of mechanization and automation that began with the development of the Fourdrinier paper machine in the early nineteenth century. Yet once this "most wonderful machine" was adopted, only slow incremental change occurred, due to the "momentum" or "inertia" of massive capital investment. As Avi J. Cohen pointed out, modifications to the Fourdrinier were limited not only by desire to recoup its

enormous initial cost, but by the fact that innovation demanded non-productive experimental use of the same costly equipment.[25] These circumstances favoured industry cooperation with government pulp-and-paper research laboratories, both in Canada and in the United States. James P. Hull has taken an admiring view of these efforts to inject science, in this case chemistry, into industrial development: he concludes that as a consequence of research cooperation, the "knowledge structure" of pulp and paper grew faster than that of other forest industries. [26]

The clearest historical debate over the nature of change in forest technology has concerned the "knowledge structure" of American forestry as a profession. Forestry's long-hallowed role as apostle of the "gospel of efficiency" has been challenged by criticism of its inertia in the face of changing social values. In the conventional view, as presented by Clepper, Cox, and others, the United States Forest Service succeeded in diffusing methods of efficient resource use.[27] This favourable interpretation is assailed by David Clary in his book *Timber and the Forest Service*, which views the federal foresters as technocrats defending a rigid and increasingly anachronistic system of knowledge. "The Service held firm in its resolve to provide more wood for the nation, despite the nation's declining per capita need for wood;" and revenue generation dominated Forest Service policy to the extent that the government fell behind private industry in conservation practices. Samuel Hayes argues that the foresters' resistance "was symbolic and ideological, emphasizing form more than substance, a threat to their values more than to the amount of wood production."[28]

Only amidst the preservationist uproar of the 1970's did the Forest Service come to consider change in its "way of doing things and way of thinking about things," in order to accommodate "changes in the national culture ... nonmaterial interests in such things as wilderness, scenery, and nongame wildlife."[29] A crucial force for change was the diffusion of forestry knowledge into the environmental movement; the Forest Service could no longer claim a monopoly of resource management expertise. The shift in public values, and the diffusion of forestry knowledge, have both had considerable influence on historical literature concerning the impacts of forest technology.

## IMPACTS OF CHANGING TECHNOLOGY: OF TREES AND MEN[30]

Staudenmaier commented in 1985 that in the history of North American technology, "It is much less common to discuss the impact of a new technology on its ambience than the other way around."[31] This pattern is reversed in recent forest history; there has been much concern with the impact of forest technology on its environmental and social contexts. Two issues have claimed prominence: the environmental impact of forestry practice and, more specifically, the influence of the sustained-yield concept; and the social impact of technological change on workers in logging and pulp and paper milling. A third issue, the impact of forest industries on entire communities, deserves more attention. Debate over these issues reflects increasing concern with the non-economic value of forests, decreasing faith in the forest technocracy, and the introduction of class analysis into the forest history literature.

The visibility of logging "cut-overs" in successive regions of North America has long aroused concern with forest depletion, yet there have been few specific historical studies of deforestation and regrowth, of the kind that might help evaluate the environmental impact of changing forest technologies. This is due in part to a lack of consistent forestry data: Donald MacKay pointed out that in Canada, there were no consistent or regular forest surveys until after World War II, and since then there has been only haphazard documentation of deforestation and regrowth.[32] Any national assessment would doubtlessly be difficult, but perhaps more effort could be made towards case studies of particular management units or jurisdictions.

Recent American literature has featured optimistic assessments of forest regeneration, particularly in the South. Michael Williams, in his 1989 synthesis *Americans and Their Forests*, concluded that the forest first encountered by American colonists is today diminished by half, but that it has been recovering from a low point before World War II. Logging of mature timber has resulted in thicker new growth; the increasing concentration and efficiency of agriculture has allowed the reversion of marginal farms to bush; and the technologies of fire suppression, pesticides, and tree-planting have increased the survival rate of new growth. Perhaps most importantly, total American consumption of wood was one-sixth less in 1980 than in 1900. Williams concludes that:

since the Second World War some semblance of order and stability has prevailed where none did before ... the conclusion is inescapable that the forest is entering into an era of increased application of scientific knowledge and careful management of the trees, all undreamed of in the 'cut out and get out' days of previous decades and centuries.[33]

Yet most of the recovery which Williams describes does not seem to have resulted from conscious choice of forest technology; in fact, some technologies of reforestation – fire suppression and pesticides –are now criticized for undesirable impacts.

Despite the need for more evidence on actual rates of deforestation and regeneration, American historians have freely debated whether or not the concept of sustained yield has had an impact on industrial forestry. On the optimistic side, Thomas Cox's *This Well-Wooded Land* exudes confidence in the power of "scientific forestry" to prevent depletion. According to Cox, by the 1920's the United States Forest Service was inducing timbermen to accept the idea of sustained-yield forestry as "good business" and as a guarantee of the future profitability of the forests.[34] It should be noted that historians of the Weyerhaeuser empire took a considerably more cautious view of sustained-yield practices, commenting in 1963 that "In truth, tree farming is still experimental in many respects.... Only time will tell if tree farms are economically practicable for private enterprise in the long run."[35]

William Robbins argues that in the American Northwest, private enterprise in fact valued sustained yield only as a means of controlling production and restricting competition to large companies which were able to carry nonproductive stands.[36] David Clary makes a more moderate critique of the failure of sustained yield policy, interpreting the 1944 Sustained Yield Act as an ill-conceived initiative which foundered on opposition from small operators, unions, and others who opposed government concessions to large firms.[37]

Other American historians have argued that forest depletion was forestalled, not by attempts at sustained yield, but by the declining market for wood. In this view, economic determinism, not conservation technology, preserved remanents of the North American forests. Sherry Olson's 1971 history of timber use by American railroads argues that reforestation was essentially uneconomical, because "there were no real shortcuts to producing timber." Instead, railways avoided depletion of their wood supply firstly by logging a wide range of accessible locations; and secondly, by

developing alternative construction materials as well as wood preservatives for existing structures. Consumer-driven research and development, not technological change in forestry or forest industries, effected the adjustment.[38] Thus America's forests escaped eradication thanks to the "invisible hand" of market forces.

In contrast to the optimism of some American forest historians, Canadian forest history betrays a strong concern with forest depletion in this country. Gillis and Roach's *Lost Initiatives* (1986) is, as its title suggests, a despondent litany of forest policy failure which contrasts sharply with laudatory chronicles of the U.S. Forest Service. Donald MacKay's less scholarly *Heritage Lost* (1985) despairs that in Canada, "Neither good intentions nor legislation has shown up in the woods where it was needed.... "[39] Despite Crown control of forest lands, Canadian government forestry seems to have been crippled by industrial influence, by east-west and federal-provincial bickering, and by bureaucratic division of responsibilities –difficulties shared by American forestry.[40] Gillis and Roach particularly blame provincial control of public lands for fracturing the forestry effort.[41] The Canadian forest industry, for its part, has blamed the failure of reforestation upon taxes and tenures that discourage long-term management – complaints also voiced by its American counterparts.[42]

Perhaps more distinctive of Canada was the failure of 'scientific forestry' to find the powerful political sponsorship which it enjoyed in the United States. Here, government attempts to emulate American forestry, and industry gestures towards cooperation, constituted so much "conservationist window-dressing" which dissipated with successive economic recessions and competitive crises in the industry.[43] Hodgins, Benidickson and Gillis characterize early Canadian foresters as "practical men" who "did not fully comprehend ... either the scientific principles underlying forest engineering or the tremendous political commitment required...."[44] Governments did not compensate for the shortcomings of the profession, failing to "commit the financial resources or muster the political will to bring about an effective forestry system."[45] Gillis and Roach similarly blame not rapacious corporations and co-opted foresters, but rather government failure to transcend the exploitative ethic, and public failure to demand better government. The impact of technology is here clearly linked to collective social choice.

This concern with collective politics also distinguishes Canadian literature on our second issue of technological impact, the effects

of mechanization on forest industry workers. American histories of forest labour have been little concerned with technological change, concentrating instead on struggles for unionization, "bread-and-butter" issues, and internal union politics.[46] In contrast, recent Canadian studies of forest industry labour have entered the debate over the effects of technological change on the labour process. Differences between the forest workplace of the logger and the increasingly automated man-made environment of the paper-maker are highlighted in contrasting interpretations of mechanization. We are reminded of the technological disparity between the two industries by Ian Radforth's comment that:

> These new science-based corporations of the pulp and paper industry poured enormous amounts of capital into scientific research and sophisticated technology for their mills, and yet in their woods operations they relied on the labour-intensive and remarkably static technological complex developed much earlier by the family firms of the province's lumber industry.[47]

Radforth's study of twentieth-century woodsworkers in Northern Ontario focusses on the effects of post-World War II mechanization. Mechanized harvesting equipment, including chainsaws, power skidders, and mechanical harvesters, effected "a modest erosion of the bushworkers' autonomy;" but workers supported technological change because it was accompanied by increased piece-work earnings, reduced physical effort, and the opportunity to acquire mechanical skills. An effective union reaped the benefits of technological change (for example, by maintaining the same piecework rates for fallers even after chainsaws increased their productivity), while limiting undesired effects (for example, by maintaining employment through retraining programs and a shorter work week.) Workers retained considerable bargaining power because their propensity to quit threatened the productivity of costly equipment.[48] Consequently,

> What happened in the Ontario logging industry was not so much a straightforward trend towards deskilling, but a complex process of job redesign that involved trade-offs in terms of autonomy, technical skill, status, and a considerable amount of reskilling.[49]

Radforth refuses to view technology as deterministic and dehumanizing; and he dismisses the proposition of a capitalist program

of reducing worker control, although some "unintentional" reduction of control accompanied mechanization.[50] He attributes the persistence of worker autonomy in part to the forest itself: "Woods managers could never easily control scattered work groups in an ever-changing forest environment." In fact, Radforth extends this "environmental determinism of the labour process" to natural resource industries in general:

> Factors related to the natural environment and to the characteristics of the staple itself have resulted in late mechanization, continuing limitations on management's control over workers, and a tendancy to opt for incentives such as piece rates or some form of 'dependent commodity production,' along the lines of owner-operating. Thus Canada, a country heavily dependent on resource expoitation, has experienced work-related transformations in ways that differ from countries where the manufacturing sector dominates.[51]

Richard Rajala takes an opposite position on the impact of overhead harvesting systems and "scientific management" on West Coast logging: " ... by 1930 the interlocking processes of technological and managerial change had imposed a factory-like production regime in the coastal woods."[52] From Rajala's Marxist perspective, the university-educated logging engineer or forester was an instrument of increasingly centralized control over the work process. By the use of topographical maps, engineers and managers were able to make operational decisions with less participation by the loggers on site, thus separating the conception of work from its execution and depriving workers of control. In this view, capitalists dominate social choice of technology, determining its impacts.

Jean-Pierre Charland, in *Les Pates et Papiers au Quebec 1880-1980*, even more strongly characterizes technology as the instrument of a capitalism which is little concerned with environmental or social impacts. Mechanized paper-making required enormous investment; the result was a highly concentrated industry that sought to reduce labour costs, which were rising faster than productivity. Charland's study traces the impact of particular mechanical and electronic innovations, considering both positive effects (such as accident reduction), and the elimination and simplification of jobs.[53] He is also concerned with the ascendance of chemists and engineers over "practical men" during the 1920's and 1930's, thus providing a plant-floor context for Hull's account of the growth of

scientific knowledge in the industry. Here the impact of automation was glaring, as tests of control instruments against worker judgment graphically "disqualified" experienced paper-workers.[54]

Yet Quebec paperworkers offered little more resistance to technological change than did Radforth's Ontario loggers. In Quebec, large-scale papermaking arrived in the form of mechanized newsprint plants that never required a skilled local workforce. In the face of rural underemployment and company preference for imported technicians, workers took what they could get. The reality of overcapacity and competition within the industry maintained a threat of layoffs. To these restraining factors Charland adds the conservative influence of the Catholic Church; the consolation of higher wages consequent to mechanization; and the invidious effects of scientific management and paternalism.[55]

Of particular interest is Charland's examination of worker involvement in technical education and in the implementation of innovations that eventually displaced labour. In 1927 the International Brotherhood of Papermakers supported technical education, faced with the fear that "the paper maker may lose his self-confidence and a sense of inferiority takes its place.... "[56] Charland perceives here the co-option of workers into new standards of efficiency: "La gestion économe du travail en vient à se confondre dans l'esprit des travailleurs, avec les exigences d'une technologie assimilée au progrès."[57]

Charland's disappointed Marxism contrasts sharply with Judith McGaw's liberal interpretation of the initial mechanization of American paper-making in the mid-nineteenth century. But contextual differences forbid facile comparison between these two accounts of response to technological change. McGaw's Massachusetts papermakers were a community of skilled labourers and local capitalists who together adopted, and adapted to, the Fourdrinier.[58] In contrast, a cultural gulf separated Quebec workers from "foreign" capitalists and technicians, and paper-making came to Quebec at a later and more highly mechanized stage of its development.[59]

McGaw's study is all too rare in its consideration of the impact of industry on an entire community, as well as upon those directly employed. While North American forest history contains frequent disconsolate references to abandoned towns in the "cut-overs," there has been little historical attention to the community repercussions of forest exploitation.[60] Graeme Wynn's *Timber Colony* is a model of this approach, establishing links between forest

depletion, capital concentration, and social polarization in nineteenth-century New Brunswick.[61] On the other side of the continent, William Robbins' *Hard Times in Paradise* illuminates the debilitating effects of capital mobility, automation, and environmental destruction on the stability and social health of Coos Bay, Oregon.[62]

## SOCIETY, TECHNOLOGY, AND ENVIRONMENT

Recent work on the negative impacts of forest industries has obviously raised the issue of social control of technology, and the possibility of alternative technological choices. Until the last decade, few forest historians had stepped outside North American forestry's internal frame of reference: control over nature in the service of capitalism. Forester-historians such as Clepper affirmed the technocratic commitment, reminding us that professional forestry is dedicated to "the scientific management of goods and services." From this perspective, wildlife, too, is viewed as a "crop," in which view logging may constitute "wildlife habitat improvement."[63] Even authors who are most critical of forest exploitation are trapped in the hope of a "technological fix:" MacKay, for example, would like to believe that more foresters, more tree-planting, and more research will put us at peace with the forest.[64] Others have placed their faith in the autonomous operation of capitalism's "invisible hand," which has loosened its death-grip on natural resources as they have become scarce and costly.

Yet the idea that forest recovery can only follow the nadir of forest destruction has been challenged by a shift in values among a sector of the North American public that includes many academics concerned with the forest. The materialistic, utilitarian view of nature is of course now strongly criticized by those whose incomes are not directly dependent upon resource exploitation, and who have the leisure to find aesthetic and spiritual values in wilderness. Technology has furthered popular appreciation of forests by allowing more and more North Americans to visit the woods in comfort and convenience. Samuel Hayes has gone so far as to proclaim a "dramatic reversal in values" associated with the North American forest, and its transmutation from "the commodity to [the] amenity role" in our lives.[65] The determinant power of social values is evident to Hayes in new forestry practices:

The environmental view gives rise to different systems of measurement and classification of the wildlands resource, to different concepts as to what the flow regulated by management should be, to different management skills and different management plans.[66]

The shift in values is reflected in recent work that attempts an ecological integration of forest biology with the history of human encroachments. This "ecosystem approach" is exemplified by Susan Flader's multidisciplinary compilation on the Great Lakes forest, wherein essays in biological science and human history appear side by side (although there is little apparent integration of disciplinary perspectives.) Here we encounter both environmental determinism in the idea that the forest has a "destiny of its own,"[67] and technological determinism in the reflection that:

technological man, as a result of more than a century of impacts on the forest environment of the Great Lakes region, is now irrevocably locked into technological manipulation of the system for the continued well-being of humankind, if not for that of the forest.[68]

A special concern of the historian of technology is the question of who, and what values, are controlling these manipulations. Recent works in forest history have only begun to address this concern. The Marxism of Rajala and Charland, Clary's critique of technocratic values, and Gillis and Roach's denunciation of public and government irresponsibility, all signify a new concern with control of forest technology. Much of the Canadian pessimism on forest management can be attributed to the sense, most strongly expressed by Lower, that forest exploitation is beyond the control of regions courting export markets and outside investors:

... huge distances and the government gap prevent mobilization of effective metropolitan sentiment in favour of measures of control. If these are to be taken, they must be taken by the people on the spot – and the people on the spot invariably prefer to sell off ... the capital with which nature has presented them.... The only dependable defence against the ravages of a great staple trade is the growth of a community in the hinterland being depleted.[69]

American historians have made similar criticisms of forest industries in the South and Northwest, resource-dependent regions which have most recently suffered the economic and social insta-

bility characteristic of North American forest exploitation.[70] Such interpretations challenge Cox's satisfaction with American forestry's "quest ... to devise more open, democratic, and effective means of meeting the many demands of a modern, heterogenous society."[71]

There remains much opportunity to explore the changing relationship of technology and the North American forest. Historians and geographers have made strides towards placing forest technology in the contexts of regional society and culture, as well as recognizing its role in national and international political and economic relationships. The history of technology points to the need for critical assessment of social forces governing technological choice in the past and present. The emerging ecological perspective demands that we study humans and their technology within the ecosystem of the forest. Forest technology must now be interpreted in the double context of forest and society, of man and nature. This new direction suggests the possibility of a fuller forest history, one that goes beyond the fortunes of industry and government.

## NOTES

* This paper was originally submitted in partial fulfilment of requirements for a doctorate field in the History of Technology at the University of Ottawa, 1991. The author has attempted only limited updating of the paper, and takes responsibility for all omissions. Special thanks to Professor Donald Davis of the University of Ottawa.

** Marian Brown was formerly a curator with the Canadian Museum of Civilization, and is now a PhD candidate in History at the University of Ottawa, and a third-year law student at the University of Victoria.

1 See, for example:
Thomas Cox, *et al, This Well-Wooded Land: Americans and Their Forests From Colonial Times to the Present* (Lincoln: University of Nebraska Press, 1985), 62; A.R.M. Lower, *The North American Assault on the Canadian Forest: A History of the Lumber Trade Between Canada and the United States* (Toronto: Ryerson, 1938), xx; Brooke Hindle, ed., *America's Wooden Age: Aspects of Its Early Technology* (Tarrytown, New York: 1975), *passim.*

2 Quoted in John M. Staudenmaier, *Technology's Storytellers Reweaving the Human Fabric* (Cambridge, Mass.: Society for the History of Technology and MIT Press, 1985), 35.

3 Quoted in William Kuhns, *The Post-Industrial Prophets Interpretations of Technology* (New York: Weybright, 1971), 6.

4 Brooke Hindle, *Emulation and Invention* (New York: W.W. Norton, 1981), 8-10.

5 Nathan Rosenberg, "America's Rise to Woodworking Leadership," in Hindle, *America's Wooden Age*, 41.

6 Use of the flooring machine increased the demand for hardwood from the American South. Cox, *This Well-Wooded Land*, 164-165. Change in the technology of "non-forest" sectors has also had profound impacts. For example, the increased productivity of agriculture reduced farm acreage, resulting in substantial reversion to forest. Technological changes in home heating, iron manufacturing, and engine fuelling reduced the demand for fuel wood, which had exceeded the demand for sawn timber until the late nineteenth century. Michael Williams, *Americans and Their Forests: A Historical Geography* (Cambridge: Cambridge University Press, 1989), Chapters 10 and 11.

7 Stephen J. Pyne, "Fire Policy and Fire Research in the U.S. Forest Service," *Journal of Forest History* April 1981, 64-77; Barbara R. Robertson, *Sawpower: Making Lumber in the Sawmills of Nova Scotia* (Halifax: Nimbus Press and the Nova Scotia Museum, 1986.)

8 Staudenmaier, *Technology's Storytellers Reweaving the Human Fabric*, 38.

9 Arthur Lower's work in the 1930's entrenched the staples thesis in Canadian forest history. Lower's books *Settlement and the Forest Frontier*, *The North American Assault on the Canadian Forest*, and *Great Britain's Woodyard*, remain the foundation of Canadian forest history, and their very titles reflect a basis of concern with metropolitan dominance of Canadian resource industries.

10 Evelyn M. Dinsdale, "Spatial Patterns of Technological Change: The Lumber Industry of Northern New York," *Economic Geography* 41 (1965), 264.

11 Ibid., 264.

12 Ibid., 270.

13 Ibid., 272. Quebec's Chief Forester in 1925 defended such technological conservatism on the grounds that "market conditions, especially the invasion of eastern North America by western woods of all dimensions, placed the pine industry in a precarious position; any interference by way of adding costs – forcing it to live up to approved silvicultural techniques, for example – would only hasten its demise." Bruce W. Hodgins, Jamie Benidickson, and Peter Gillis, "The Ontario and Quebec Experiments in Forest Reserves, 1883-1930," *Journal of Forest History* 26 (January 1982), 32.

14 John C. Bliss's recent article "Evidence of Ethnicity: Management Styles of Forest Owners in Wisconsin," *Forest and Conservation History* 36 (April 1992), 63-72, suggests that cultural values rather than technological progress determine whether or not forest owners employ conservationist techniques. This is a welcome direction, but unfortunately the value of Bliss's research is limited by its tiny sample of subjects, its leading interview questions, and its failure to assess adequately the impact of other variables such as landscape.

15 Thomas Cox examined the transition from river rafting to booms in Pennsylvania, while Robert Kuhn McGregor illustrated how railroad construction increased local sawmill output: "With the railroad, the upper limit of the industry was set by the technology of production rather than by the technology of distribution." Thomas Cox, "Transi-

tion in the Woods: Log Drivers, Raftsmen, and the Emergence of Modern Lumbering in Pennsylvania," *Pennsylvania Magazine of History and Biography* 104 (1980), 345-364; Robert Kuhn McGregor, "Changing Technologies and Forest Consumption in the Upper Delaware Valley, 1790-1880," *Journal of Forest History* April 1988, 80-81.

16 Ralph W. Hidy, Frank Ernest Hill, and Allan Nevins, *Timber and Men: The Weyerhaeuser Story* (New York: 1963), 362. See also Thomas R. Cox, *Mills and Markets: A History of the Pacific Coast Lumber Industry to 1900* (Seattle: University of Washington Press, 1974), 130.

17 Vernon H. Jensen, *Lumber and Labour* (New York: Farrar and Rinehart, 1945), 102.

18 C.R. Silversides, "Mechanized Forestry World War II to the Present," *Forestry Chronicle* August 1984, 233; Ian Radforth, "In the Bush: The Changing World of Work in Ontario's Pulpwood Logging Industry During the Twentieth Century," *Material History Bulletin* 19 (Spring 1984), 17.

19 Louise Proulx, *Les Chantiers Forestiers de la Rimouski (1930-1940) Techniques Traditionelles et Culture Materielle* (Rimouski, P.Q.: Universite de Quebec a Rimouski, 1985), v. Radforth, "In the Bush," 18.

20 Silversides, "Mechanized Forestry," 233-4. See also R. Hayter, *Technology and the Canadian Forest Products Industry: A Policy Perspective* (Ottawa: Science Council of Canada, 1988), *passim.* Ian Radforth, in contrast, reports that "scholars looking more closely at specific industries have begun to find considerable evidence of creativity, particularly in the adaptation of technologies to Canadian needs – this kind of transfer of technique is itself a creative process –" Ian W. Radforth, *Bushworkers and Bosses: Logging in Northern Ontario, 1900-1980* (Toronto: University of Toronto Press, 1987), 200.

21 Cox, *This Well-Wooded Land,* 175; Hidy *et al, Timber and Men,* 168. James P. Hull notes that the contrasting oligopolistic structure of the U.S. pulp and paper industry enabled it to lobby more effectively for federal research aid than could the logging or sawmilling industries: James P. Hull, "The Programme of the Pulp and Paper Division, Forest Products Laboratories of Canada, 1913-1933," *Scientia Canadensis* X/2 (Autumn/Winter 1986), 110.

22 Williams, *Americans and Their Forests,* 217.

23 Richard Rajala, "Managerial Crisis: The Emergence and Role of the West Coast Logging Engineer, 1900-1930," *Canadian Papers in Business History,* ed. Peter J. Baskerville (Victoria: University of Victoria, 1989), 119.

24 See, for example, Norman Ball, "Circular Saws and the History of Technology," *Association of Preservation Technology Bulletin* 7/3 (1975), 79-89; John O. Curtis, "The Introduction of the Circular Saw in the Early Nineteenth Century," *APT Bulletin* 5/2 (1973), 162-89; Rodney C. Loehr, "Saving the Kerf: The Introduction of the Band Saw Mill," *Agricultural History* 23 (1949), 168-72; Reynold M. Wik, "Benjamin Holt and the Invention of the Track-Type Tractor," *Technology and Culture* 20/1 (January 1979), 91-103.

25 Avi J. Cohen, "Technological Change as Historical Process: The Case of the U.S. Pulp and Paper Industry, 1915-1940," *Journal of Economic History* 44 (1984), 791-792.
26 Hull, "Programme of the Pulp and Paper Division," 117.
27 Henry E. Clepper, *Professional Forestry in the United States* (Baltimore: Johns Hopkins University Press, 1971); Cox, *This Well-Wooded Land.*
28 David A. Clary, *Timber and the Forest Service* (Lawrence, Kansas: University Press of Kansas, 1986), 66, 152. Samuel P. Hayes, "Human Choice in the Great Lakes Wildlands," in Susan L. Flader, ed., *The Great Lakes Forest An Environmental and Social History* (Minneapolis: University of Minnesota Press, 1983), 306.
29 Ibid., 196.
30 For an initial exploration of women's role in forestry, see Lee F. Pendergrass, "Dispelling Myths: Women's Contributions to the Forest Service in California," *Forest and Conservation History* January 1990, 17-25, and other articles in the same issue.
31 Staudenmaier, *Technology's Storytellers*, 39.
32 Donald Mackay, *Heritage Lost: The Crisis in Canada's Forests* (Toronto: Macmillan, 1985), 65, 124.
33 Williams, *Americans and Their Forests,* 467-468.
34 Cox, *This Well-Wooded Land,* 238.
35 Hidy *et al, Timber and Men,* 582.
36 William G. Robbins, "Lumber Production and Community Stability: A View From the Pacific Northwest," *Journal of Forest History* October 1987, 190.
37 David A. Clary, "What Price Sustained Yield? The Forest Service, Community Stability, and Timber Monopoly Under the 1944 Sustained-Yield Act," *Journal of Forest History* January 1987, 18.
38 Sherry Olson, *The Depletion Myth: A History of Railroad Use of Timber* (Cambridge: Harvard University Press, 1971), 181-183. Olson suggests that the "depletion myth" promulgated by the U.S. Forest Service was one reason for the lack of innovation among lumber manufacturers, who were doubtful of future wood supplies and therefore reluctant to invest in new equipment.
39 MacKay, *Heritage Lost,* x.
40 R. Peter Gillis and Thomas R. Roach, *Lost Initiatives: Canada's Forest Industries, Forest Policy and Forest Conservation* (Westport, Connecticut: Greenwood Press, 1986), 68, 77.
41 Ibid., 197, 222.
42 MacKay, *Heritage Lost,* 125.
43 Ibid., 172, 213.
44 Hodgins, Benidickson, and Gillis, "The Ontario and Quebec Experiments in Forest Reserves," 21.
45 Ibid., 33.
46 Harry Edward Graham, *The Paper Rebellion: Development and Upheaval in Pulp and Paper Unionism* (Iowa City: University of Iowa Press, 1970); Harold M. Hyman, *Soldiers and Spruce: Origins of the Loyal Legion of Loggers and Lumbermen* (Los Angeles: Institute of Industrial Relations,

UCLA, 1963); Jensen, *Lumber and Labour;* Robert L. Tyler, *Rebels in the Woods: The I.W.W. in the Pacific Northwest* (Eugene: University of Oregon Books, 1967); Zieger, Robert H., "Oldtimers and Newcomers: Change and Continuity in the Pulp, Sulphite Union in the 1930's," *Journal of Forest History* October 1977, 188-201. An interesting exception is Thomas Cox's article on conflict between farmer-raftsmen and employee log drivers over the introduction of boom technology on the Susquehanna River (Cox, "Transition in the Woods.")

47 Ian Radforth, "In the Bush," 14.

48 Radforth, *Bushworkers and Bosses*, 221-230.

49 Ibid., 219.

50 Ibid., 242-243.

51 Ibid., 207, 244. Forest engineer C.R. Silversides, one of Radforth's informants, responded to the slow and costly implementation of mechanized logging by commenting that Canadian forestry might be better served by "a 'softer' technology ... one which brings the three elements of man, machine, and forest into balance." Silversides, "Mechanized Forestry," 235.

52 Rajala, "Managerial Crisis," 122.

53 *Jean-Pierre Charland, Les Pates et Papiers au Quebec 1880-1980 Technologies, Travail et Travailleurs* (Quebec, P.Q.: Institute Quebecois de Recherche sur la Culture, 1990), chapter 5.

54 Ibid., 240.

55 Ibid., 357.

56 Quoted in Ibid., 249.

57 Ibid., 237.

58 Judith A. McGaw, *Most Wonderful Machine Mechanization and Social Change in Berkshire Paper Making 1801-1885* (Princeton: Princeton University Press, 1987), *passim.*

59 Hodgins, Benidickson, and Gillis recognize the importance of cultural factors, specifically the nationalistic goals of the Roman Catholic colonization movement and of L'Action Francaise, in the formation of Quebec forest policy: Hodgins, Benidickson, and Gillis, "The Ontario and Quebec Experiments in Forest Reserves," 32.

60 Robert G. Lee attributes the historical success of sustained-yield forestry in Europe to political concern with community stability and social order. Lee suggests that North Amercian governments and industry similarly have favoured sustained yield at times of war, depression, and rapid social change: Robert G. Lee, "Sustained Yield and Social Order," in Harold K. Steen, *History of Sustained-Yield Forestry: A Symposium* (Santa Cruz: Forest History Society, 1984), 90-100.

61 Graeme Wynn, *Timber Colony: A Historical Geography of Early Nineteenth Century New Brunswick* (Toronto: University of Toronto Press, 1981), *passim.*

62 William G. Robbins, *Hard Times in Paradise: Coos Bay, Oregon, 1850-1986* (Seattle: University of Washington Press, 1989.) Not available for review at the time of writing was Barbara Amy Breitmayer Vatter's *A*

*Forest History of Douglas County, Oregon, to 1900: A Microcosmic Study of Imperialism* (New York: Garland Publishing, 1989.)

63 Clepper, *Professional Forestry*, 2, 116.

64 MacKay, *Heritage Lost*, 8, 236. For an international perspective on the economic and social possibilities of sustained yield forestry, as well as varying definitions of the term, see Marion Clawson and Roger Sedjo, "History of Sustained Yield Concept and Its Application to Developing Countries," in Harold K. Steen, *History of Sustained-Yield Forestry: A Symposium* (Santa Cruz: Forest History Society, 1984), 3-15.

65 Samuel P. Hayes, "Human Choice in the Great Lakes Wildlands," in Flader, *The Great Lakes Forest*, 296, 300.

66 Hayes, "Human Choice," 309.

67 Orie L. Loucks, "New Light on the Changing Forest," in ibid., 31.

68 Flader, *The Great Lakes Forest*, xxvi.

69 A.R.M. Lower, *Great Britain's Woodyard: British America and the Timber Trade, 1763-1867* (Montreal and London, McGill-Queen's University Press, 1973), 246, 248.

70 Williams, *Americans and Their Forests*, 286. Robbins, "Lumber Production and Community Stability," 196.

71 Cox, *This Well-Wooded Land*, 192.