Labour/Le Travailleur

The Industrialization of Tree Harvesting Systems in the Eastern Canadian Forest, 1955-1995

Peter MacDonald et Michael Clow

Volume 58, automne 2006

URI : https://id.erudit.org/iderudit/llt58rn01

Aller au sommaire du numéro

Éditeur(s)

Canadian Committee on Labour History

ISSN

0700-3862 (imprimé)
1911-4842 (numérique)

Découvrir la revue

Citer cet article

MacDonald, P. & Clow, M. (2006). The Industrialization of Tree Harvesting Systems in the Eastern Canadian Forest, 1955-1995. *Labour/Le Travailleur*, *58*, 145–168.

RESEARCH NOTES / NOTES DE RECHERCHE

The Industrialization of Tree Harvesting Systems in the Eastern Canadian Forest, 1955-1995

Peter MacDonald and Michael Clow

USING AS HIS CENTRAL METAPHOR the "forest as factory," Richard Rajala has, in two important studies,[1] expanded historical knowledge of what he himself characterizes as a seriously understudied sphere of Canadian experience.[2] Furthermore, using Braverman as a point of departure,[3] he has analysed the alteration between

[1]Richard A. Rajala, "The Forest as Factory: Technological Change and Worker Control in the West Coast Logging Industry, 1880-1930," *Labour/Le Travail*, 32 (Fall 1993), 73-104, and Richard A. Rajala, *Clearcutting the Pacific Rain Forest: Production, Science, and Regulation* (Vancouver 1998).

[2]To the sources he cites in *Clearcutting*, xx, we would add the following which deal specifically with the history of mechanization: C.R. Silversides (accompanying essay by Richard A. Rajala), *Broadaxe to Flying Shear: The Mechanization of Forest Harvesting East of the Rockies* (Ottawa 1997); C.R. Silversides, "Logging Mechanization in Eastern Canada," unpublished and undated manuscript, Forest Engineering Research Institute of Canada [FERIC] Library, L/C SD 388 S561; and Ken Drushka and Hannu Konttinen, *Tracks in the Forest: The Evolution of Logging Machinery* (Helsinki 1997).

[3]Harry Braverman, *Labour and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York 1974).

Peter MacDonald and Michael Clow, "The Industrialization of Tree Harvesting Systems in the Eastern Canadian Forest, 1955-1995," *Labour/Le Travail*, 58 (Fall 2006), 145-167.

1880 and 1970 of the logging labour process in the Pacific rain forest brought about by the introduction of new technology.

Examining a production process characterized by the felling and bucking of trees into logs which then were relocated to a central point for transport to the mill, Rajala concentrates on the relocation or yarding process which was at once the source of the largest problems and the process yielding the greatest potential gains in productivity. From a logging system in the 1880s characterized by horses and oxen dragging logs over skid roads comprised of logs, steam-powered donkeys using the ground-lead logging system replaced teamsters by the turn of the century. Even larger steam engines enabled the advent of sophisticated overhead cable logging systems, thereby eliminating many of the difficulties associated with skidding.[4] Finally, overhead cable yarding evolved to the stage of the portable steel spar, which greatly facilitated its relocation from harvesting site to harvesting site. The final stage — the addition of the automatic grapple — eliminated the chokers previously required to attach cables to the log being yarded.[5] Not without reason, then, does Rajala characterize this change as the "technological revolution" in West Coast logging.[6]

Concluding that "[m]echanization and related changes in the division of labour reduced timber capital's dependance upon the physical and conceptual skills of loggers,"[7] Rajala conceives of the technology "embedded in logging machinery and systems"[8] as the primary determinant of how the labour process was altered by this industrial revolution in the woods. Because these technological innovations manifested themselves in the labour process as the "progressive narrowing of the task range and discretionary content of occupations, and the outright elimination of so many others,"[9] Rajala concludes that his analysis "confirms the essential thrust of Braverman's degradation of work thesis."[10]

We envision this Research Note contributing to the issues raised by Rajala's analysis in two important ways. Fundamentally, we wish to parallel Rajala's study by examining the industrialization of tree harvesting systems in a very different part of the country, the forests of Eastern Canada.[11] Secondly, we wish to make a modest contribution concerning the conceptualization of the labour process characterizing tree harvesting systems.

[4]Skidding denotes dragging logs over the ground, a problematic exercise because of friction, obstructions, etc. Overhead cable yarding systems, which transferred logs in the air, eliminated these difficulties.
[5]Rajala, "The Forest as Factory," and Rajala, *Clearcutting*, 1.
[6]His characterization can be found in "The Forest as Factory," 73; his summary is on 77.
[7]Rajala, "The Forest as Factory," 104.
[8]Rajala, "The Forest as Factory," 75.
[9]Rajala, *Clearcutting*, 49.
[10]Rajala, *Clearcutting*, 49.
[11]Forest engineers consider Eastern Canada to be that area to the east of the Rocky Mountains. This classification is founded on the size of trees.

A word on what we will not attempt to do. We have chosen not to intervene into the "Braverman debate." Though far too complex for discussion in a Research Note, we do feel that those interested in the difficult questions of skill, deskilling, and the acquisition of new skills in industrial development would find the transformation of woods work fertile ground for their investigations. Moreover, for two reasons, we do not address the importance of worker response regarding the deployment of harvesting systems in the woods. First, we have written elsewhere on the many local and contingent factors — including worker response — which appeared from our research to have influenced the specific mix of harvesting systems adopted for use in particular locations.[12] Secondly, our principal sources of information regarding local conditions — forest engineers, mill woodlands managers, and contractors — are not optimal to understanding the active role of workers. They comprehend labour largely in terms of problems — labour supply, costs, skills, supervision, commitment, and discipline — and tend to downplay any active role workers may have had in the shaping of system design or choice.

Given that industrialization is the progressive development through a series of different production systems, each with its particular organization of the labour process, conceptualizing the labour process of tree harvesting in terms of a common set of relevant variables is absolutely crucial.

Conceptualizing Tree Harvesting Production Systems

Because the question of development lies at the heart of industrialization and its concomitant alterations in the labour process, tree harvesting systems must be conceptualized such that each stage can be identified and arranged according to the time line of their historical appearance. Thus we commence with the identification of the production activities common to all tree harvesting systems which will enable us to centre on the configuration of these activities into a specific division of labour. Secondly, as industrialization is the history of successive forms of mechanization, we must deal with the changing nature of the technology used in the performance of these activities. Finally, in light of a feature peculiar to the nature of tree harvesting, our conceptual system must provide for the geographical or topographical location of the constituent activities.[13]

[12]Our specific research has been in the Miramichi region of Northern New Brunswick where we interviewed approximately 50 individuals. The complicated questions concerning the effect of regional and local factors (including worker response) on industrial development we are able to address only at this local level, whereas this Research Note is concerned with Eastern Canada as a whole. For our attempt to deal with these factors, see Michael Clow and Peter MacDonald, "If You Go Down to the Woods Today ...: Accounting for the Survival and Eclipse of Tree Harvesting Production Systems on the Miramichi River in New Brunswick, Canada," *Technology in Society*, 23 (2001), 29-57.

[13]We have developed the conceptual scheme to be presented over a period of time, the first version of which appeared in Peter MacDonald and Michael Clow, "Just One Damn Ma-

Tree harvesting is a production process whereby a tree standing in the forest is converted into a manufactured product (saw logs and/or pulpwood) located at the side of the logging road awaiting shipment to the mill. Harvesting systems may be deconstructed into their constituent production elements or "building blocks." Because these are generic to all tree harvesting systems, we designate them as the elemental activities: they are felling, delimbing, slashing, and off-road transfer. Felling is that productive activity which transforms a standing, vertical tree into one that is horizontal. Delimbing refers to the removal of both the tree's limbs and top. Slashing is the process whereby a tree trunk is "bucked" or cut into appropriate lengths. Off-road transfer[14] is the transportation of the material produced at the "stump" (where the tree was standing) to "roadside" (the logging road from which it will be transported to the mill). Together, these elemental activities produce the manufactured or finished product ready for transport from roadside to the saw or pulp mill.

These activities are configured into a labour process socially organized in terms of the three properties of topography, division of labour, and technology identified above. Beginning with topography or the geographical location of the elemental activities, by their intrinsic nature there are three possible locations: at the stump where the tree to be harvested is standing, at roadside (the landing area next to the logging road), and the area in between over which the material produced at the stump must be moved in order to relocate it at roadside. Two of these elemental activities are fixed: felling can only occur at the stump, and off-road transfer can only occur over the area between the stump and roadside. The remaining two are moveable: delimbing and slashing can occur either at the stump or at roadside. Where these are located has much to do with the type of harvesting system.

That the elemental activities can be articulated in different ways — in different combinations in different sequences[15] — gives rise to the second property, the division of labour. Characterizing the division of labour are two conceptually critical properties: the assignment of elemental activities to discrete, separate positions, and the articulation or connection of these positions with reference to one another. Therefore, not only may some number of activities be allocated (combined into or separated from) to a particular position in the division of labour,[16] there is also the

chine after Another? Technological Innovation and the Industrialization of Tree Harvesting Systems," *Technology in Society*, 21 (1999), 323-344.

[14]This is the technical term employed by forest engineers.

[15]To provide one example, tree length harvesters combined felling with delimbing. While most felled before delimbing, the Beloit Harvester delimbed the standing tree prior to felling it.

[16]Given that there are four elemental activities, the maximum number of positions constituting the division of labour of a tree harvesting system would be four.

central question regarding the interrelations or connections between each of those positions.[17]

The final social organizational property is technology, deriving its importance from the fact that mechanization is the root of industrialization. Here we wish to rely on Marx where he makes the distinction between tools and machines.[18] Marx conceives of tools as an extension of the worker, thereby sustaining the unity of the mental with the manual. Machines, on the other hand, subject the worker to the performance of a predetermined set of activities at a predetermined pace where the control of work activity is embodied in its technology. Accordingly, conception is bifurcated from execution.

The Industrialization of Tree Harvesting Systems in Eastern Canada[19]

The observer of the 1950s pulpwood forests of Eastern Canada would, apart from the intrusive noise of the chainsaw, encounter a relatively agrarian scene constituted by large numbers of men working with a motorized hand tool — the chainsaw — and horses. By the early 1970s, this same observer in these same forests would encounter far fewer men operating massive self-propelled machines which dominated the forests. And by the 1980s, our observer would discover much the same scene, though the machines themselves would be very different. In less than 30 years, the harvesting of small tree forests for pulp and lumber experienced an industrial revolution, the drama of which was marked both by its rapid tempo and by its thoroughgoing mechanization. But this industrial development assumed two very different trajectories, each reflecting the manual harvesting system from which it emerged.

Historically two types of manual harvesting systems were utilized in the small tree forests of Eastern Canada.[20] Differentiated by the length of wood, the shortwood system was used for the production of pulpwood;[21] here length — typi-

[17]This is true only of those tree harvesting systems which have a minimum of two positions in their division of labour.

[18]Karl Marx, *Capital*, Vol. I, 364-365.

[19]Most of the documents on which this section is based can be found in the FERIC Library.

[20]Though this is generally true, there were some exceptions to the purely manual. Small steam engines on wheels or caterpillar tracks were sometimes used. Later, crawler tractors were utilized. Though this may not count as genuine mechanization, wheeled arches drawn by teams of horses that lifted one end of the load being skidded from the ground (thus easing the skidding task) were sometimes utilized. See Drushka and Konttinen, *Tracks in the Forest*, ch. 2 and ch. 3.

[21]Pulpwood is the raw material from which pulp (for paper) is manufactured. The harvesting problem here is the most desirable form for the delivery of this raw material to the pulp mill. At the time, the answer was four-foot lengths of wood. Bruce McColl, in his later work, came to the position that the most efficient harvesting system was one where full trees were converted to wood chips at roadside, prior to delivery to the mill. See B.J. McColl, "An Appreci-

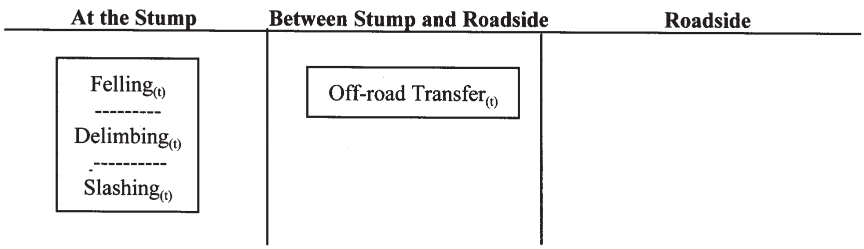
cally four feet — was determined by what a worker could reasonably pile and load. The long-wood system was used for the production of saw logs;[22] here length was determined by the desired end use of the product — typically the longer the better — though limited by what a team of horses could drag.[23]

In the motor-manual shortwood system (so named because of the chainsaw), workers felled trees and processed them (removed their limbs and cut the result into four-foot lengths) at the stump. Because carrying[24] was more efficient than dragging, these piles of short, thin logs (pulpwood) were loaded onto jumpsleds and pulled to roadside over snow-laden ground by horses.

In the long-wood system, workers with chainsaws felled trees and processed them (removed their limbs and cut the result into desired lengths) at the stump. The length was determined both by the trunk diameter of the felled tree and by the length a horse could drag. The single or small bunches of long, thick logs (saw logs) were dragged[25] to roadside over snow-laden ground by horses.

Because these two manual harvesting systems served as the foundation from which their respective paths of development emerged, the depiction of their social

Figure 1. Social Organization of Manual Harvesting Systems



ation of Problems of Full Tree Logging," *Report to the Pulp and Paper Research Institute of Canada* (July 1958).

[22]Saw logs are the raw material from which various forms of lumber are manufactured. The harvesting problem here is to provide the longest saw logs practical to the saw mill, for it was most efficient to produce lumber from long saw logs.

[23]Though the two manual harvesting systems were historically grounded on the different products each produced, the introduction of skidders and forwarders (to be discussed below) gave rise to harvesting systems which quickly became capable of producing both shortwood (pulpwood) and long wood (saw logs); mechanization rendered their names anachronistic. As either system could be used to produce both pulpwood and saw logs, the two harvesting systems became direct competitors. As both could produce either product, the significant developmental question came to be where should this processing occur — at the stump or at roadside? This is the reason for the importance of the topic of topography.

[24]This is technically known as "forwarding."

[25]This is technically known as "skidding." Given the technology of the time, they could not be carried. In any event, it was more efficient to skid than to forward saw logs.

organization is crucial to comprehending subsequent development. In Figure 1, we simultaneously portray the three properties of their social organization in a single diagram. The first property, topography, is presented on the horizontal dimension at the top of the schematic, with each of the elemental activities located underneath in the appropriate column. For the second, a single box represents one position in the division of labour, containing the number of elemental activities constituting that position. Finally, technology is depicted by the subscript $_{(t)}$ or $_{(m)}$, located next to the elemental activity in question with the former symbolizing tool, the latter machine.

Commencing with topography, the maximum number of elemental activities in both systems is located at the stump. For the second property, the division of labour, the three elemental activities of felling, delimbing, and slashing are combined into a single position, whereas the activity of off-road transfer is separated into its own. And for mechanization, as foreshadowed by their respective names, both of these harvesting systems depended on the manual labour of horses and workers, aided by a powered tool rather than a machine — the chainsaw. Finally, given that both harvesting systems are represented in the same diagram, both are obviously identical in their overall social organization.

This symmetry in social organization, while it provided an identical baseline from which development was to emerge, also afforded two divergent paths of development. Both of these paths were initiated at the same historical moment by the introduction of the first authentic harvesting machines in the early 1960s. In both manual systems, these machines replaced the horse — with the forwarder carrying pulpwood in the shortwood system, and the skidder dragging saw logs for the long-wood system.[26]

Initiating the shortwood developmental path, the introduction of the forwarder gave rise to the trailcutter harvesting system.[27] Because each individual trailcutter continued to fell, delimb, and slash at the stump, the forwarder altered neither the topography nor the division of labour characterizing the prior shortwood manual system. With the single exception of the mechanization of off-road transfer, the social organization of the trailcutter system remained identical to that of the manual shortwood system depicted in Figure 1.

[26]Forwarders are large, wheeled logging tractors equipped with a loading boom for loading and unloading pulpwood, and a bay at the rear where pulpwood is carried. Skidders are also logging tractors, but in place of a loading boom and bay there is an A-frame and winch used for the dragging of saw logs.

[27]For an analysis of the evolution and decline of this harvesting system in Northern New Brunswick, see Michael Clow and Peter MacDonald, "The Rise and Decline of Trailcutting on the Miramichi, 1960-1990: A Perspective Based on Oral history," *Acadiensis*, 26 (Autumn 1996), 76-91.

A contemporary forwarder. Photo by permission of T.C. Bjerkelund.

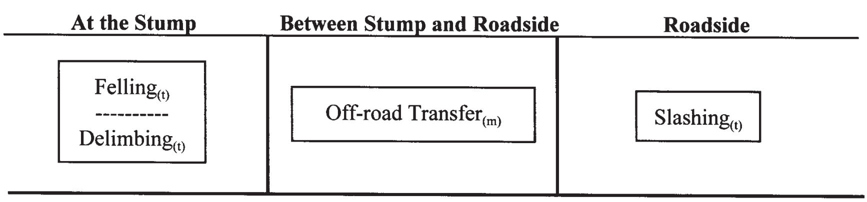
A grapple skidder. Photo by permission of the Forest Engineering Institute of Canada.

Initiating the long-wood developmental path, the introduction of the skidder to the long-wood manual system gave rise to the skid-and-slash harvesting system.[28] The outstanding feature of the skidder was that, given its power advantage over the horse, complete tree lengths (i.e., felled and delimbed trees) instead of saw logs could now be transferred to roadside. Thus, for the first time in the history of tree harvesting, slashing could now be performed at roadside instead of at the stump.

Production units in the early iterations of skid-and-slash systems were constituted by a work team of three. Two were cutters, felling and delimbing at the stump. The third was the skidder operator who, alternating between the cutters, yarded the tree lengths to roadside. Depending on the operation, the tree lengths were slashed by the skidder operator (sometimes with the assistance of the cutters) or, in larger operations, by a fourth worker.

Unlike the case of the forwarder, the introduction of the skidder did alter the social organization of the long-wood manual system. This new form of social organization, depicted in Figure 2, is marked by the relocation of slashing from the stump to roadside. As for the division of labour, we now have the combination and allocation of two of the elemental activities into a single position together with the separation of the other two elemental activities into two distinct positions. Finally, off-road transfer has been mechanized by the introduction of the skidder. For the

Figure 2. Social Organization of the Skid-and-Slash Harvesting System



first time in the history of the development of tree systems, the unity of the three elemental stump activities has been decomposed.

While the introduction of machines to the shortwood manual system had no effect on the two remaining social organizational properties, mechanization did affect these remaining properties for the long-wood manual system. This early difference established diverging contours of development, differences which multiplied as development proceeded. In other words, the industrialization of tree harvesting systems conformed to two disparate paths of development, an argument which can

[28]For an analysis of the origins and developmental significance of the skidder and the "skid and slash" harvesting system, see Peter MacDonald and Michael Clow, "What a Difference a Skidder Makes: The Role of Technology in the Origins of the Industrialization of Tree Harvesting Systems," *History and Technology*, 19,2 (2003), 127-149.

be documented by examining the changes in the social organization of each of the subsequent developmental stages constituting the two paths.

To provide a ready point of reference, the stages — together with their respective social organizational properties — of the shortwood developmental path are depicted in Figure 3.[29]

Figure 3. Stages of the Shortwood Path of Development

Developmental Stages	Topography	Division of Labour	Mechanization
Manual	Stump	2	0
Trailcutter	Stump	2	1
Shortwood Harvester	Stump	1	4
Double-grip Harvester	Stump	3	3-4
Single-grip Harvester	Stump	2	4

Koehring Shortwood Harvester. Photo by permission of the Forest Engineering Institute of Canada.

[29]In the endeavour to convey complex information with both clarity and brevity, as well as to facilitate its tabular presentation, topography is represented by stump (with both processing activities located at the stump), by intermediate (with one located at the stump, one at roadside), and by roadside (with both located at roadside); the division of labour by the number of separate or distinct positions (ranging from 1 to 4); and mechanization by the number of elemental activities mechanized (again from 1 to 4).

Having dealt with the manual and trailcutter stages, we now turn to the Koehring Shortwood Harvester, appearing in early 1970s, which finally perfected the earlier and various attempts to mechanize at-the-stump processing.[30] This awesome machine itself mechanized all of the elemental activities, automatically delimbing and slashing each of the trees that it felled, loading the resultant product into a bay at the rear of the machine for forwarding to roadside when full. The outstanding feature of the social organization of this harvesting system was its consummate mechanization, even extending to partial automation, signifying as it did a "developmental leap" in comparison with its partially mechanized precursor. The fact that there was little alteration in the remaining properties of social organization serves to emphasize the developmental continuity of this mechanization property.

The next developmental stage in the shortwood system was marked, for the first time, by the appearance of Scandinavian technology. The arrival of the dou-

A Single-grip Harvester. Photo by authors.

[30]A number of prototypes were developed, some of which appeared to adhere to "the build it and see if it works" philosophy. See Drushka and Konttinen, *Tracks in the Forest*, and Silversides, *Broadaxe to Flying Shear.* A notable exception was the Busch Combine, developed and used in the southeastern United States in the 1960s. Though tested in Canada, it was found to be unsuitable due to, among other factors, more demanding terrain conditions; see Silversides, *Broadaxe to Flying Shear*, 62.

ble-grip harvester[31] in the late 1970s provided a machine which delimbed and slashed previously felled trees at the stump for later relocation by the forwarder. Often, this harvesting system was completely mechanized with the maximum number of elemental activities performed at the stump. The distinguishing feature of this developmental stage was its division of labour, with two elemental activities combined (delimbing and slashing) and two separated (felling and off-road transfer).

The final stage of development was represented by another Scandinavian machine, the single-grip harvester.[32] This computerized machine, arriving in the mid-1980s, felled, delimbed, and slashed individual trees at the stump with a forwarder relocating the product to roadside. Its social organization was identical to the trailcutter harvesting system in terms of topography and division of labour, the only difference being the total mechanization of all elemental activities. Otherwise, this final developmental stage has returned to its authentic roots; indeed, forest engineers often refer to the single-grip harvester as the mechanical trailcutter.

We now turn to the contrasting long-wood path of development. Again, to provide a ready point of reference, the stages — together with their social organizational properties — of this developmental path are depicted (adhering to the same conventions utilized in Figure 3) in Figure 4. Having already discussed the organizational characteristics of the manual long-wood and skid-and-slash stages, we can now examine the subsequent stages of development.

Figure 4. Stages of the Long-Wood Path of Development

Developmental Stages	Topography	Division of Labour	Mechanization
Manual	Stump	2	0
Skid & Slash	Intermediate	3	1
Tree Length Harvesters	Intermediate	3	4
Feller-forwarder	Roadside	3	4
Feller-buncher	Roadside	4	4

[31]These machines were equipped with booms which picked up felled trees (either manually or by machine, which is the reason for the mechanization entry in Figure 3) and placed them in a processor mounted on the rear. Trees were fed through the processor, being delimbed, then slashed, with the process repeated until the entire tree was processed. Examples include machines manufactured by Volvo and Rottne.

[32]These machines were equipped with a felling/processing head located at the end of a boom. They felled the tree, rotated it to a vertical position where it was delimbed, then slashed, with the process repeated until the entire tree was processed. Examples include machines manufactured by FMG/Timberjack and Rottne.

Superceding the skid-and-slash stage was the tree length type of harvesting system, incorporating mechanized felling and delimbing. Appearing in the mid-1970s, these machines[33] — designed to produce tree lengths for the new grapple skidder[34] — felled and delimbed trees at the stump, bunching them into piles to facilitate efficient skidding. Completing this system was the advent of mechanical roadside slashers which slashed the tree lengths into both pulpwood and saw logs.[35] The basic change, warranting its own developmental stage given that neither location nor division of labour was altered, was the mechanization of all harvesting activities.

Though the final two stages were approximately conterminous, the feller-buncher stage possesses a much greater developmental significance than that of the

A Feller-forwarder. Photo by authors.

[33]Various iterations of tree length harvesters appeared, including the Beloit Harvester, the Timberjack RW 30, and the CAT 950. As each felled and delimbed differently, it is impossible to provide a generic description. The important point is that these machines produced bunched tree lengths.

[34]Unlike the cable skidders described above, grapple skidders reversed to the bunched wood, lowered its rear-mounted grapple to the pile, grasped it with the two arms of the grapple, and skidded to roadside. This was much quicker than using cables and winches, but it did presuppose bunched felled trees.

[35]These were self-propelled machines equipped with a loading boom to pick up tree lengths, placing them on a platform with a large circular saw located at one end. A number of trees would be slashed simultaneously, with the boom unloading the result either onto the ground or onto waiting trailers.

Early feller-buncher. Photo by permission of the Forest Engineering Institute of Canada.

feller-forwarder. Not only was it more numerous, it has persisted to the present while feller-forwarders have disappeared.[36]

The feller-forwarder felled and forwarded full trees in ten-cord bundles to roadside where they were subsequently delimbed with a stroke delimber and slashed. With reference to social organization, this was a roadside system characterized by a three-position division of labour (felling and forwarding included in a single position) with all activities mechanized.

The final developmental stage in the long-wood path was the feller-buncher harvesting system. This machine specialized in felling, bunching these felled full trees (trees with limbs still attached) into piles for transfer to roadside by ever more powerful grapple skidders. Accompanying their introduction, thus making the full tree type of harvesting system possible, was the appearance of the stroke delimber[37] in the late 1970s, a roadside machine specializing in delimbing.

The feller-buncher harvesting system represented the final iteration in the social organization of the long-wood path. For the first time in the history of harvesting system development, all moveable elemental activities are located at roadside,

[36]Because these machines were so large, they required a particular set of conditions — large clearcuts on relatively gentle terrain — to be efficient.

[37]These machines possessed a sliding head on a long rail boom. Holding the butt end of the tree with a clamp, the moveable head slides on the boom removing limbs with its knives.

as portrayed in Figure 5. Moreover, the division of labour has all the elemental activities fragmented, with each in its own separate position. Finally, all elemental activities are mechanized.

Figure 5. Social Organization of the Feller-Buncher Harvesting System

At the Stump	Between Stump and Roadside	At Roadside
Felling(m)	Off-road Transfer(m)	Delimbing(m) Slashing(m)

Thus, two quite different paths of development, apparent precisely because we conceptualized tree harvesting systems in terms of the properties of their social organization, characterized the industrialization of tree harvesting systems in the forests of Eastern Canada. The social organization of the shortwood path of development was marked through all of its developmental stages by the relative constancy in two of the three properties. There was no alteration in topography. Though there were minor modifications in the division of labour in the two interim developmental stages, the final stage reverted to its origins. Accordingly, one may conclude that the key feature impelling this developmental path was the achievements of mechanization, commencing so strikingly with the Koehring Shortwood Harvester.

For the long-wood path of development, not only were all three properties of their social organization fundamentally transformed, these alterations adhered to a specific developmental pattern. Each of the developmental stages progressively relocated the moveable elemental activities to roadside; each progressively detailed the division of labour such that all elemental activities became separated into their own positions; and finally, each activity became mechanized. All three properties of social organization, therefore, were responsible for shaping development.

It is worthwhile noting that a common error when analysing development is confounding the invention of new machines and harvesting systems with the actual dissemination and utilization of these systems. Simply because new machines and new systems are devised is not to say they will acquire widespread adoption. The latter is dependent on a variety of factors ranging from the capital investment required, the productivity of a given system, the reliability of the technology, the requirements levied on producers by the state to most efficiently utilize the resource, and the like.[38] A rigorous analysis of development and its stages, then, must investigate not only the devising but also the diffusion of systems.

[38]Indeed, these latter factors are capable of shaping the developmental process itself wherein local conditions can, at times, produce a deviation from the standard developmental process. See Clow and MacDonald, "If You Go Down to the Woods Today."

Thanks to the work of the Forest Engineering Research Institute of Canada [FERIC], a relatively complete set of historical figures on the dissemination of the various types of harvesting systems in Eastern Canada exists. A note on terminology is necessary in order to render that employed by forest engineers commensurate with ours. They classify harvesting systems in terms of the product transferred to roadside: shortwood systems transfer pulpwood; tree-length systems transfer tree lengths; and full-tree systems transfer full trees. Their shortwood systems correspond with our shortwood developmental path, though we will need to break this down (by types of stump machines utilized) later in this section in order to speak to the specific developmental stages. Their tree-length and full-tree classes of systems correspond with our long-wood developmental path. Again, because their tree-length category contains our skid-and-slash and our tree-length harvester developmental stages, we will need to deconstruct the broad taxonomic categories later in this section in order to address these intermediate stages of development.

Development of the different categories of harvesting systems, measured by the shifting proportion of the total volume of the harvested wood contributed by each class of system, is presented in Table 1.[39] Over the half-century covered in this table, marked developmental trends are revealed. The period between 1960 and 1965 is particularly striking; coincidentally, it is the era in which both forwarders and skidders were introduced. Here the progressive decline in the dominance of shortwood types of systems commenced.[40] As well as documenting the relative success of the long-wood path of development, an additional factor responsible for the enduring decline of the shortwood path was the retirement of the Koehrings in the late 1970s. However, due to the introduction of the single-grip harvester, the shortwood path experienced something of a resurgence in the 1990s.[41]

[39]Particularly in the early years, these figures are less than complete. They were gathered by LOG (Logging Operations Group) survey-type questionnaires, sent to all the woodlands managers of the FERIC member pulp-and-paper companies, asking about harvesting practices and machinery used. In some cases the questionnaires were not returned. If one were interested only in smaller regions of Eastern Canada, the figures would be suspect. However, we are interested in the broad trends for all of Eastern Canada. Moreover, the patterns are so marked that incomplete information is unlikely to alter the master trends.

[40]This decline is somewhat overstated. Because pulpwood was historically the dominant product of harvesting systems in Eastern Canada, it is not surprising that shortwood systems producing pulpwood dominated. Only with the advent of harvesting systems capable of producing both pulpwood and saw logs can the systems be seen as commensurate. This became technically possible in the mid-to-late 1960s; it became legally required with the advent of best-end use regulations imposed on harvesting companies by the state. In other words, the beginning point of the shortwood system is artificially inflated, thereby rendering the decline of shortwood systems greater than reality.

[41]See J.-F. Gingras and M. Ryans, "Future Woodlands Equipment Needs in Eastern Canada: 1992-2001," Technical Note TN-193, December 1992, FERIC Library, 3, where they predict shortwood systems to constitute 15 per cent of the total in 1991 and 31 per cent in 2001,

Table 1. Percentage of Total Volume of Wood Harvested by Type of Tree Harvesting Systems in Eastern Canada

Year	Shortwood	Tree Length	Full Tree
1950[a]	95	5	0
1955[b]	90	10	0
1960[b]	80	20	0
1965[a]	45	50	5
1970[a]	30	65	5
1975[a]	20	70	10
1977[c]	14	68	18
1986[c]	12	35	53
1989[d]	6	15	79
1991	15	13	72
1997	25[e]	15[e]	60

[a]J.A. McNally, "Mechanization in the Woods: From the 1930s to the 1970s," paper presented at the 59th Annual Meeting of the Woodlands Section, Canadian Pulp and Paper Association, Montreal, 1978, 5.
[b]J.R. Erickson, "Mechanization in the Timber-Producing Industry," *Forest Products Journal*, 18,7 (1968), 21.
[c]J.-F. Gingras, "Forest Mechanization Trends in Eastern Canada," paper presented at the 11th Annual Council of Forest Engineering Meeting, Quebec City, September 1988, 9.
[d]J.-F. Gingras, "Harvesting Small Trees — the Eastern Canadian Story," in Bruce J. Stokes, ed., *Harvesting Small Trees and Forest Residues*, USDA Forest Services, Auburn, AL, 1989, 121. Unlike the other figures in this table, these are an aggregate of some of the harvesting systems within each category.
[e]Note that this figure includes only single-grip harvesters; therefore, it understates the total percentage of wood harvested by shortwood systems. Equally, the figure for tree-length harvesting systems is overstated.

based totally on the increasing popularity of the single-grip harvester. Also see J. Favreau, E. Swift, and J.-F. Gingras, "Comparison of Roadside and In-Stand Stroke Delimbing: A Case Study of Two Harvesting Systems," SR-76, March 1991, FERIC Library, 1, where they found single-grip harvesters accounting for 25 per cent of the total harvest. This certainly accords with what is currently happening in New Brunswick. FERIC recognized their increasing significance in the late 1980s when they produced for their member companies both an introductory description and later an evaluation of this genre of machines. See Robin Richardson, "An Introduction to Off-Road Processors and Harvesters," Technical Note TN-126, December 1988, and Robin Richardson, "Evaluation of Five Processors and Harvesters," Technical Report TR-94, November 1989.

For the long-wood development path, the original popularity of the skidder was responsible not only for its appearance but also for the alteration in social organization responsible for its rapid growth, with dominance secured by the arrival in the early 1970s by the tree-length harvester. The subsequent shift to the dominance of full-tree systems in the decade of the 1980s resulted from the introduction of the feller-forwarder and the feller-buncher and, crucially, the appearance of the stroke delimber in the late 1970s.[42] As noted above, this ascendancy was called into some doubt by the reinvigoration of shortwood path in the 1990s.

By using the benchmark of the actual adoption of harvesting systems, we can plausibly conclude that the industrial development of tree harvesting systems in Eastern Canada adhered to the two paths of development suggested by the analysis above. This documentation of developmental paths fails, however, to directly address the specific stages of development within each. But by examining the utilization of various types of forest machines over time, we can approximate the specific stages of development because each stage uses machines peculiar to it. We will examine those machines operating at the stump for they, more so than the other types of machines, define their type of harvesting system because they produce the type of product to be relocated and thus the specific developmental stage. To relate this to the trends revealed in Table 1, we will also indicate the developmental path to which each machine belongs: SW for the shortwood developmental path; and TL for tree-length and FT for full-tree, both of which belong to the long-wood developmental path.

In the relatively brief period between 1977 and 1987, development in the long-wood path saw the displacement of tree-length systems by full-tree systems. This is also the period which saw the nadir of the shortwood path of development, but also points to the seeds of its eventual resurgence, defined by the emergence of the Scandinavian harvester systems. Because this ten-year period seems a significant developmental moment, it makes sense to concentrate on this time frame.

The type and number of stump types of machines is recorded in Table 2 below.[43] Clearly the decline in significance of the shortwood path of development during this period is conterminous with precipitous decline in its intermediate shortwood harvester stage, revealed by the fate of its most important machine — the Koehring Shortwood Harvester. As it represented the first successful attempt to fully mechanize this type of harvesting system, the effects of its increasing disuse could not but be otherwise. However, foreshadowing the reassertion of this devel-

[42] Between 1977 and 1987, their numbers increased from 35 to 215, an increase of 514 per cent. See J.-F. Gingras, "Forest Mechanization Trends in Eastern Canada," paper presented at the 11th Annual Council of Forest Engineering Meeting, Quebec City, September 1988. This number is an extrapolation given that the original uses bar graphs.

[43] All of the figures to follow are taken from Gingras, "Forest Mechanization Trends," 9-10. As they are presented as bar graphs, the numbers are our extrapolations.

opmental path as revealed in Table 1 is the first appearance of the Scandinavian harvesters, providing for the final two stages of the shortwood path of development.

This era also saw the substantial transition in the latter two developmental stages of the long-wood developmental path. The tree-length harvester stage which itself had supplanted the skid-and-slash stage for practical purposes disappeared, marked by the rapid and dramatic decline of tree-length harvesters. Accompanying this was the rapid increase in this short period of feller-forwarders and feller-bunchers, with the latter becoming the most common stump machine in the forests. Not only did this define the transition to the feller-buncher stage of development, it also reinforced the dominance of full-tree systems documented in Table 1.[44]

Table 2. Types and Numbers of Stump Harvesting Machines

Machine	Path	1977	1987	% Change
Koehring Shortwood Harvester	SW	175	45	-74
Single- and Double-grip Harvester	SW	0	10	–
Tree Length Harvester	TL	40	7	-83
Feller-forwarder	FT	10	40	400
Feller-buncher	FT	78	190	144

In conclusion, this rather lengthy analysis of the industrial development of tree harvesting systems has documented two fundamental, underlying paths of development. Defining the ebb and flow of the shortwood path was the transition from the shortwood harvester stage of development to the double-grip and especially the single-grip harvesters stages. The overall prominence of the long-wood path was originally procured by the tree-length harvester stage, itself emerging from the skid-and-slash stage. Finally, the triumph of full-tree types of systems was secured by the popularity of the feller-buncher stage of development.

Conclusion

Emerging from the above analysis are two profound features differentiating the industrialization of the Pacific Coast forestry from that of Eastern Canada. One is the far more extensive mechanization characterizing Eastern Canadian development. The other is that Eastern Canada experienced two quite different and diverging patterns of development.

[44]Gingras also provides figures for processing and off-road transfer machines. With the latter, especially, the increasing incidence of ever more powerful grapple skidders testifies to the dominance of the feller-buncher system. See Gingras, "Forest Mechanization Trends." For reasons of length, the figures have been omitted.

Rajala, in his analysis of West Coast logging, divided the tree harvesting process into the three separate segments of felling the trees and bucking them into logs, relocating the logs so produced from the stump to the landing at roadside, and their transport to the mill.[45] Though he discusses the replacement of hand saws by the chainsaw for the first, and the evolution from steam drives to railways and finally trucks for the third, he spends much of his analysis on the second segment — yarding the logs to roadside.[46] This is hardly a surprise, for this is where much of the West Coast mechanization occurred.

Using this same classification of harvesting activities, the case for the more extensive mechanization in Eastern Canada becomes evident in that much of the most sophisticated technology was developed for the felling, delimbing, and bucking of trees — certainly an order of magnitude removed from the chainsaw which, for Eastern Canada, served as the point of departure for industrialization rather than the culmination of development. At least in part this divergence is due to two salient and differentiating properties: small tree size[47] and terrain.

Tree size is vital in that it plays an enormous role in the determination of the productivity of harvesting systems.[48] Because the harvesting of small trees intrinsically hampers productivity, the motivation to mechanize in order to enhance efficiency is intensified. Abetting this objective, the natural fact of tree size rendered technological development feasible given that it is more practical to devise machines to handle small trees. Finally, the far less demanding nature of the eastern terrain again made it much simpler to develop self-propelled machines.

Thorough and ongoing mechanization also eased problems which arose from the nature of the pre-mechanization workforce. All observers argue that the 1950s workforce in the small tree forests of North America were surplus seasonal agricultural labourers employing their hand tools (and then chainsaws) and draft animals.[49] In Canada, the terrain difficulties meant that yarding was possible with

[45]Rajala, *Clearcutting*, 7.

[46]Rajala, *Clearcutting*, ch. 1.

[47]Recall that the very definition of Eastern Canada is founded on the presence of small tree forests.

[48]Tree size and productivity are intimately related. The additional quantity of labour time required, for instance, to remove the limbs from a large tree as compared with a small one is not at all commensurate with the quantity of the resulting product. The large tree will contain much more raw material. Based on the harvesting operations for which he was responsible, Jarck found that the cost to produce a cord of pulpwood by the same type of harvesting system decreased by 37.4 per cent when the diameter of the butt head of the tree increased from 6" to 8". See Walter Jarck, "The Case for Short Wood," *Pulpwood Production and Saw Mill Logging*, 15 (July 1967), 12-18.

[49]These circumstances led most in the industry to project future labour shortages, especially in light of the post-war "long boom" of capitalist development. For North America, see Drushka and Konttinen, *Tracks in the Forest*, 69. For Canada, see Silversides, "Logging Mechanization." For New Brunswick, see J.D. Duffie, "Woods Labour Policy with Particu-

horses only on frozen, snow-covered ground. Mills wished to free themselves from both the seasonality of production, and the part-time availability and problematic commitment of workers. In short, they wanted a smaller, all-season workforce committed to woods work.

Skidders and forwarders made all-season woods work possible. Mechanizing the felling and processing of wood enabled mills to reduce the large number of "sometime" workers upon whom they relied, lighten the "bullwork" of the jobs, and sustain rising wages from a more productive workforce for whom work became a full-time, year-round occupation. This had the additional and not inconsiderable benefit of reducing the need to carry large inventories of wood in the mill yard to counter seasonal production. The conjunction of these factors facilitated a far greater degree and depth of mechanization of tree harvesting in Eastern Canada.

Perhaps serving as a testimonial to the utility of our conceptual scheme for the analysis of tree harvesting systems is its revelation of two very different developmental paths. The long-wood path appears to adhere to the classic pattern of industrialization, more closely resembling the development found by Rajala. With the progressive detailing of the division of labour, together with the corresponding mechanization of these single, fragmented activities, we appear to have a close resemblance to the model identified by Marx, with development originating from the craft-like manual long-wood system. Indeed, the feller-buncher harvesting system, with its fully detailed division of labour and its processing activities located at roadside,[50] truly epitomizes the "factory in the woods."

The shortwood path, in contrast, owes its developmental impetus entirely to the devising of a sophisticated technology capable of mechanizing a number of the elemental activities simultaneously, while leaving the division of labour and location relatively constant. Indeed, the partially automated Koehring Shortwood Harvester and the computer-assisted single-grip harvester stand as eloquent testimony. Conspicuously absent from this developmental path is the detailing of the division of labour which holds a privileged position in Marx's analysis of 19th-century industrialization.

The question of course is why two paths? One part of the answer is that development emerged from two existing manual systems, with one producing pulpwood, the other saw logs; one carrying fully processed wood to roadside, the other dragging semi-processed wood. These existing systems served to provide both the

---

lar Regard to Conditions in New Brunswick," MSc thesis, University of New Brunswick, 1952, 12 and 17-18, and Howard J. Irving, "Labour-Management Relations in the Logging Industry with Particular Reference to Conditions in Eastern Canada," MSc thesis, University of New Brunswick, 1953, 22. Finally, for an account of an actual wood shortage attributed to a shortage of reliable workers, see Clow and MacDonald, "The Rise and Decline of Trailcutting," 81-82.

[50]The fact that the all-important processing activities were topographically concentrated at roadside rendered them much more amenable to close supervision.

orientation — the paradigm or problematique — and the practical problems within which innovators worked. It was the mills which propelled mechanization;[51] those associated with the pulp-and-paper industry were concerned with improving pulpwood (i.e., shortwood) production systems; those associated with saw mills concerned themselves with existing saw log (i.e., long-wood) production systems. Early in the development process mechanization made it possible for both types of systems — at-the-stump and long-wood to roadside — to produce the full range of lengths of wood required for the production of both kinds of products. But once begun, both paths "worked," and no one knew in advance what the "best" starting point was.

The notion that both shortwood and long-wood paths "worked" needs closer examination. Worked to do what? All those we have interviewed argue that what was required of industrialization was to produce more wood, at lower cost, and with fewer and fewer workers — in short, to increase the rate of exploitation of the workforce. As it turned out, there was more than one way to achieve this objective by altering some combination of the division of labour, the location of the processing activities, and the means with which workers laboured. Both mechanized at-the-stump and long-wood systems did that; both by the end of their developmental processes (to date) have resulted in highly productive, low cost-per-cord systems. While it appears that the feller-buncher system is slightly more productive and lower cost than the single-grip harvester,[52] the latter leaves a much smaller ecological footprint, thereby facilitating and easing regeneration efforts. Moreover, it is more effective at maximizing the value of harvested trees by producing — because of computerized measurement — more saw logs from a given situation. The relative strengths and weaknesses of each have permitted both to exist, if not on equal terms.

Is it possible to resolve this apparent contradiction in the analysis of these two divergent paths? As Rajala himself has pointed out, "[e]xploitation, not control, is the 'central dynamic' of capitalist production. The exertion of control by capital is thus one technique ... to intensify the rate at which workers are exploited."[53] If the exertion of control (by deskilling) is but one means to the larger goal of exploita-

[51]Michael Clow and Peter MacDonald, "A Tale of Two Forwarders: Why Did Canada Do More of the 'Heavy Lifting' in the Industrialization of Tree Harvesting after World War II?," a paper presented at the joint conference of the British Association for Canadian Studies and New Zealand Studies Association, University of Kent, Canterbury, 11-14 April 2005; and Michael Clow and Peter MacDonald, "The Agriculture-Forestry Nexus and the Industrial Revolution in the Woods," a paper presented at the European Society for Rural Sociology Conference, The Institute of Technology in Sligo, Eire, August 2003.
[52]Michael Clow and Peter MacDonald, "Public Policy and the Success and Failure of New Technology: The Case of Tree Harvesting Systems on the Miramichi in New Brunswick, Canada," *British Journal of Canadian Studies*, 17,1 (2004), 61-80.
[53]Rajala, *Clearcutting*, 4.

tion, other means (and thus, alternative paths of industrial development) to this larger end are potentially possible. In short, exploitation is the more fundamental developmental principle which subsumes the specific properties of the two paths of development.