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Résumé de l'article

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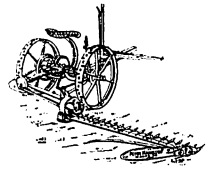


GORDON M. WINDER

RÉSUMÉ
Cette étude examine, dans un contexte continental, l'innovation ontarienne en moissonneuses. On maintient que les licences reçues par les sociétés ontariennnes des propriétaires américains, loin d'enfoncer les fabricants ontariens dans la dépendance technologique, ont transféré la technologie aux sociétés canadiennes. Entre 1830 et 1900 les fabricants ontariens ont profité des licences américaines pour acquérir les dessins des produits; dès 1890 ils avaient maîtrisé la possession des dessins et avaient construit la capacité technique de produire leurs propres dessins brevetés.

ABSTRACT
Ontario innovation in harvesting machinery is reviewed in continental context. It is argued that rather than embedding Ontario manufacturers in technological dependence, license agreements taken out by Ontario firms with U.S. licensors transferred technology to Canadian companies. In the period 1830 to 1900 Ontario manufacturers took advantage of U.S. licenses to acquire product designs and by 1880 had mastered ownership of the designs and built the technical ability to produce their own patented designs.

1. INTRODUCTION

Our agricultural machinery is made after Ohio and Illinois patterns, with perhaps a few Canadian improvements.
Canadian Manufacturer, 6 January, 1882, p. 2.

Canadian manufacturers demonstrated little concern for the disadvantages of technological dependence through licensing agreements. [They lost] ... the capacity to manipulate technology through the creation of ... [their] own marketable innovations.
G.Williams, 1983, *Not For Export*, Toronto, McClelland and Stewart, pp. 24-25.

Canada's technological dependence was both deep-rooted and consciously cultivated. Technology, like capital and labour, was something to be allocated from a more developed area, and Canadian government policy

from an early period assiduously solicited an influx of American techniques.
R.T.Naylor, 1975, *History of Canadian Business*, Toronto, James Lorimer, II, p. 63.

Canadian industry and the agricultural implements industry in particular have a very bad press when it comes to product innovation. The industry has been accused of long-standing technological dependence, which in turn is used as an explanation of the domination of Canadian industry in the twentieth century by American direct investment. It is argued here that the nineteenth century Canadian harvester industry cannot be characterized by the terminology of technological dependence invoked to describe twentieth century experience. Rather, two alternative conclusions are proposed and defended:

1. Until the last decade of the nineteenth century there was an open market in harvester technology which operated throughout the United States and Ontario without favour.
2. Within this market Ontario harvester companies operated as both innovators and adopters and mastered the development of harvesting machines as well as the ownership of patent rights.

While there was an imbalance in the flow of licences between Canada and the U.S.A. in favour of a south to north direction, and while Canadian firms built largely American machines, these are insufficient grounds for declaring there to be technological dependence. Although Williams and Naylor claim that the patent data support the conclusion of dependence their case is flawed because they ignore several aspects of the nature of the nineteenth century market for product innovations and the ways in which transactions in this market can be measured.

Flows of technology cannot be measured through American patent registrations in Canada. As Rosenberg has pointed out, patents are a poor guide to innovation and comparisons between the patent records of different industries are best viewed

as explaining the allocation of inventive effort, since the set of patented inventions bears a tenuous relation, as Schmookler recognized, to the much smaller set of commercially successful innovations. Not only do most patents never reach the stage of commercial exploitation, but many commercially successful inventions are unpatented.[1]

Within this industry the patent record in Canada is best discussed as a record of competing claims for property rights in the context of significant changes in product type and institutional changes in technology transfer. To regard patents as referring to particular inventions is ludicrous in this industry, as will become apparent. Patent registrations far exceed innovations and licences.[2] The number of patents indicates a market for innovations rather than the drowning of Canadian inventiveness under a deluge of Yankee patents. At best patents have an ambiguous character as both a sign of an invention and as a property right and any discussion of them is necessarily complicated by the gradual shift from farmers to mechanics as the important innovators. Nevertheless, by analyzing both company technology histories and the relative proportions of Canadian patents, American patents, American patents registered in Canada and American assignments of patent rights to Canadians, a great deal can be revealed about the patterns of technology transfer in this industry, that is about ownership of technology.

Further, the technology market in this industry was not simply a Canadian one. Many American companies participated in the same way as Canadian firms in a North American, indeed an international, technology market. Even the largest American harvester companies took out licences from other companies. Furthermore Canadians registered patents in the United States, won medals at international exhibitions and, in one case, may even have licensed a leading American company. There was no peculiarly Canadian policy of soliciting American technique.

Consequently it is insufficient to measure the one-way flow of American patents using Canadian patent data. Ontario harvester companies were linked into a common North American pool of technology. The most important form of access to this technology was through licenses, but there were other ways. Technical advice was obtained from experts and workers who had served apprenticeships or worked in other plants. Attendance at agricultural trials and fairs where ideas were exchanged was common practice. There was also domestic product innovation, including adaptation of American designs to local conditions and the transfer of Canadian improvements to American firms. Domestic industrial and technical capability was established through technology transfer to locally owned companies through licences. In the mid–1870s domestic firms began to patent their own product developments though there were few major Canadian inventions because of the late start

of the Canadian industry. Ontario firms followed American harvester development faithfully, because of the similarities of the farm systems and the early start of the U.S. producers, but, most of all, because of the openness of the international technology market in their product.

A licence to manufacture represents a short term rental of technology with the possibility of technology transfer, including ownership, to the domestic firm. As long as a rental market for harvester technology under licences persisted the proper questions for us to ask concerning "dependence" are: did Canadian firms learn to develop or adapt the technology, come to own it, and establish their own means for producing it? In the nineteenth century licensing was the standard way of obtaining an economic return from product technology in distant regional markets and was thus directly related to the iron, steam and wood technology of the small-scale, craft industry of the era. It is anachronistic to apply the term "technological dependence" to this period since the term is properly associated with "truncation" and the branch plant economy which are twentieth century phenomena. In the long term technological dependence did not rise out of licensing but out of the emergence of corporations with their own engineering departments producing designs related to the new technology of steel, gasoline engines and chemicals which could not be mastered by mechanics or farmers, and with an internal market for technology which they then transferred through branch plants and international sales organizations. Corporations arose in this industry partly because of the interminable problems involved in trying to secure control of innovation through market power, but also because of changes in production.

Given the nature of the nineteenth century market for harvesting machinery technology Ontario firms had the opportunity in the period from 1850 to 1890 to move into harvester manufacture on the basis of American product systems. The key questions are: how did the Ontario harvester industry fit into the international pattern of product transfer? what were the effects on its long term competitiveness of its early reliance on American product systems? did the industry develop its own inventive capability?

In answering these questions the paper is organized in four sections. The first briefly summarizes the development of reapers, mowers and harvesters and the origins and nature of innovation. The paper then turns to a description of the implications of changing industrial organization for technology transfer in the industry.

The remaining sections describe innovation in the Ontario industry. The Patent Act of 1872 is used as a break point and the discussion of post–1872 harvester innovation describes one company's product and patent history in detail, before placing this case in context.

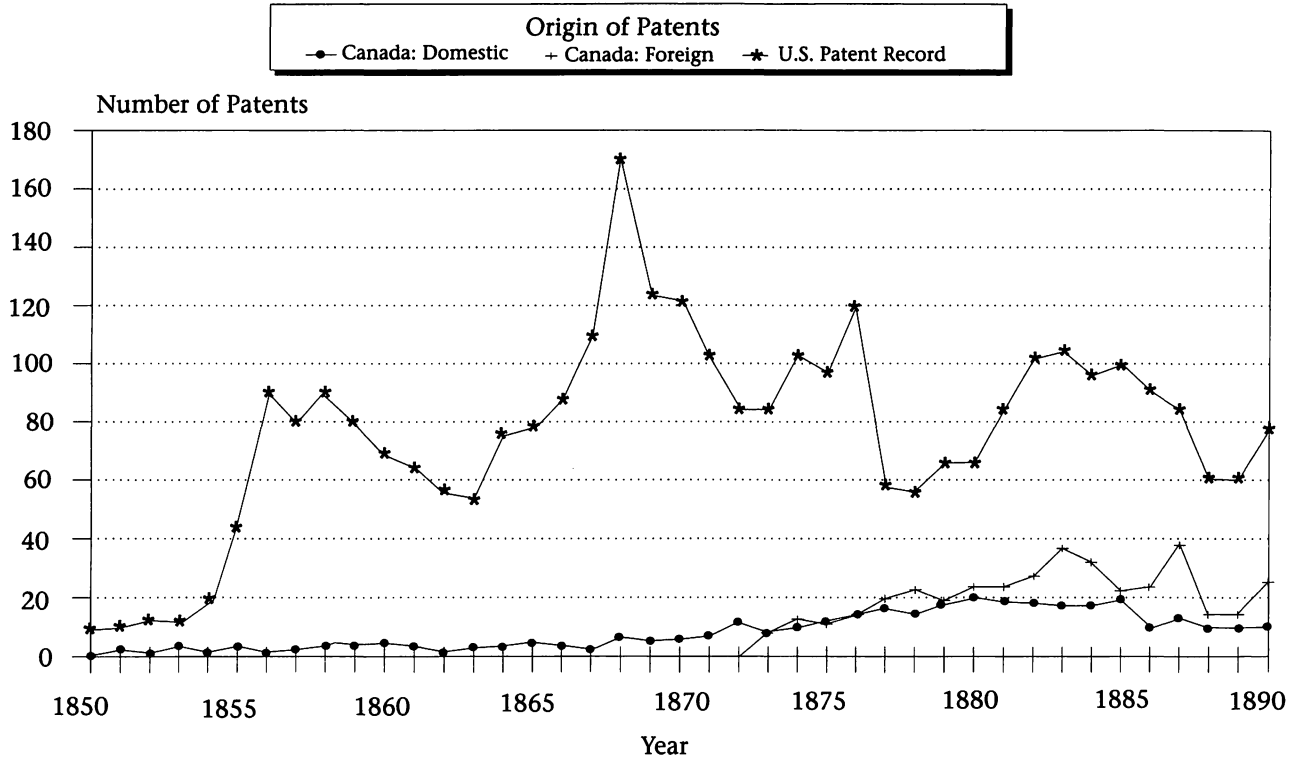
2. DEVELOPMENT OF HARVESTING MACHINERY

American innovation in harvesting machinery has been discussed in some detail by L.Rogin and R.L.Ardrey within the context of the machinery's labour displacing capability.[3] Patenting occurred in three quite distinct waves (Figure 1) which appear to be distinct product cycles for self-raking reapers, hinged bar mowers and combined reaper-mowers in the 1850s, for harvesters in the 1870s and for binders in the 1880s. But so far there has been no analysis of the patents on this basis, and we must rely on the summaries of product development given by Ardrey and Rogin.

The basic development in this industry was the reaper. The two important early American designs were those of Hussey and McCormick. Both machines were relatively simple, consisting of many wooden parts and a metal cutting apparatus, the knives of which were driven by the main drive wheel. Initially, attention was paid to the arrangement of sickles and knives in the cutter bar and here Hussey secured important patents which were licensed to virtually every North American reaper and mower manufacturer. Apart from refinements to the working parts, additions were made to these reapers in the next two decades first manually and then automatically to rake the grain into piles. The new reapers were respectively known as hand-rake reapers and side-rake or dropper reapers.

Mowers of hay were developed later than reapers. Reapers and mowers perform similar functions, follow similar design principles and the patents relating to them are interrelated and overlapping. While companies tended to make both reapers and mowers, the designs seldom had parts which were interchangeable between machines. Combined reapers and mowers did not appear until the late 1850s. By 1853, one wheel, rigid bar mowers were being made, but mower development did not reach its peak until the two wheel hinged bar mowers appeared in the late 1850s.[4] Combined reaper-mowers were either mowers which had attachments (self rakes, table and reel) for reaping, or were reapers with the rakes, table and reel detachable.

Figure 1
Canadian and U.S. Patents for Harvesting Machinery 1850-1890.



The harvester was in principle a reaper with an elevating device – an endless canvas apron driven by chains and rollers – which raised the cut grain from the reaper table. Initially the grain was then bound by men standing on the harvester. Later it was done by mechanical binding devices. Wire binders were introduced in 1877-78, but were quickly replaced by twine binders from 1880 on. The twine binder and harvester combination, sometimes referred to as a harvester-binder or simply as a harvester, represents the culmination of reaper development and after 1880 only minor changes were made to the function of machines. Innovation continued, however, in the construction of machines with the introduction of steel fabrication (1882-87) and roller bearings in the late 1880s.

The header represents a different principle. It was pushed into the grain and the cutting apparatus took the head off the grain rather than cutting the stalk with the head. This reduced the amount of straw that had to be threshed. However the header could only be used when the grain was very dry and therefore tended to be used only in California, Australia and Argentina. It was also found in some western American states where the labour efficiency of the machine offset the loss in grain occasioned by the need to delay the start of harvest until the grain was sufficiently dry. The header and combine are related and constitute a separate line of development. The combine consisted of the combination of a header and a threshing machine with a self feeder, elevator and spreader which was initially driven alongside but in the 1920s incorporated into one machine. The combination was effected in California in the 1880s but was not practised elsewhere. In the late 1920s the integration of threshing and harvesting was accomplished by the introduction of steel, self-propelled combines which were developed in Canada, Australia and the United States. But these did not become important until the early 1940s and until then threshing machinery and harvesting machinery were separate lines of product development.

In product cycle terms reapers and mowers had already reached product standardization by 1870 and harvesters and binders by 1885. In its early stages, each basic machine was the subject of constant innovation of an incremental kind. Each year a slightly different model would be produced.[5] By the 1880s style changes and annual changes had become minor and the important developments, also of an evolutionary character, were in harvesters and binders. Product development was incremental in character

because all of the harvest functions were gradually combined in harvesting machines: reaping, raking, binding, threshing. Although self-rake reapers replaced earlier reapers and binders replaced self-rake machines, the successive product developments were each based on previous machines. There was a great deal of continuity in harvester design despite constant experimentation, annual modifications and styling changes. It is impossible to identify a single inventor for virtually any product modification or even early developments. Instead, we must look to a long process of innovation, involving prior inventions and alternative designs.[6] Innovation was an "evolutionary process" of "innumerable small improvements and modifications", which merely rearranged or recombined existing components or introduced new materials.[7] An individual product became functionally more complex over time, but even at the beginning of the industry there was no one inventor, only complex pedigrees, systems of related patents giving control over a marketable product, and general, industry-wide product developments. These characteristics of product development had important implications for both the pattern of technology transfer, which became characterized by copying, licensing and collective invention, and for industrial organization, which was dominated by skilled workers and foundry operations because innovation tended to become centred in the factory rather than on the farm.

3. INNOVATION AND CHANGING INDUSTRIAL ORGANIZATION: THE WINDOW OF OPPORTUNITY

Any discussion of technology transfer in this industry is complicated by the fact that harvester manufacture grew out of farming and foundry operations. Reapers and mowers were transferred to foundries and it was the skilled workmen and, in a few cases, the inventor-manufacturers in these establishments, sometimes aided by independent farmer inventors, who were responsible for subsequent product development. In agricultural implements as a whole inventions tended to be made by farmers,[8] but not so in reapers and mowers. Inventions, including the ideas behind both the wire and twine binding mechanisms, were made by small manufacturers, farmers and other people not engaged in manufacture but increasingly reaper and mower patents were registered in the names of factory personnel.

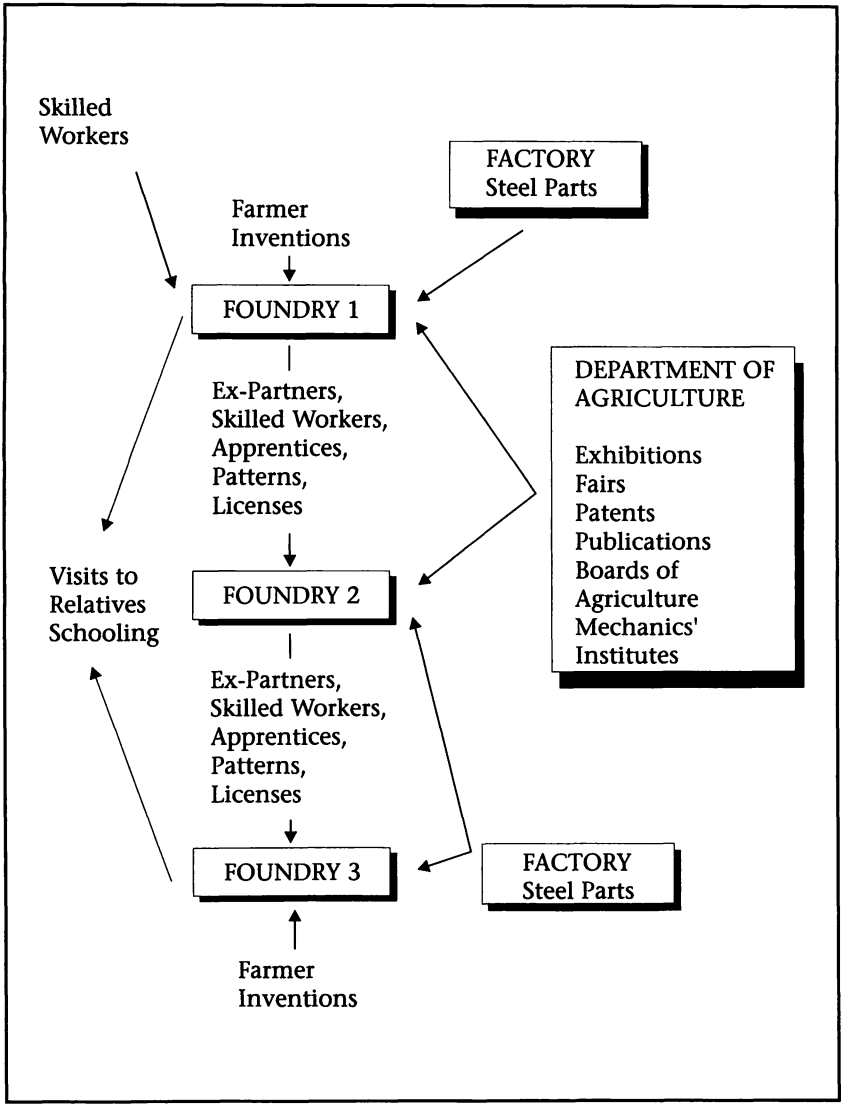
The refinement of an invention was the area in which the industry's skilled mechanics dominated. Initially it was the task of

the foundry owner to develop or acquire the product. Later factory superintendents in association with key skilled workers were responsible for innovation. Until around 1890 product development was achieved by a complex interaction between skilled mechanics, owners (controlling patents), and "inventors" brought into the plant, supplemented by the purchase of patent rights and patterns from other inventors and manufacturers. There were no engineers with university engineering degrees in the industry until about 1890. Scientific testing procedures were rare but separate "engineering departments" were established in the large works in the 1880s. These consisted of groups of skilled mechanics. Well before this time the foundry had become the centre of innovation in the harvester industry.

Foundries faced two fundamental logistical problems. They were unable to specialize and attain scale economies of production because founding followed batch production and proved difficult to mechanize. A second problem related to the "friction of distance": a large organization of salesmen or the services of a wholesale merchant were required if sales were to be more than local transactions. One way founders dealt with these problems was by turning to an extended product range using the same general-purpose capital equipment. This allowed them to make the most of local demand while capitalizing on the versatility of their foundry. Expansion of production to new areas was then achieved by establishing new local foundries.[9] Under this strategy there was local innovation on the basis of many fairly similar machines throughout the industry, little direct competition, and transfer of personnel and ideas rather than products between regions. Alternatively, the foundry could specialize in harvesting machinery, expand production even although few economies of scale or specialization would accrue, and develop an extensive network of set-up men, salesmen, repair men and merchant houses to sell machines over a wide territory. The potential for growth using this strategy was limited by the capacity of the plant, and the extent of competition. Foundries following this strategy sought to overcome the "friction of distance" but were unable to escape constraints on production efficiency. They also remained enmeshed in the existing system of foundry-to-foundry transactions in ideas, patterns, product designs and workers.

It was through the movement of skilled labour, private capital and patterns to daughter foundries that technology was transferred to new regions. The resulting movement of artisans across the

Figure 2
Technology Transfer on the Industrial Frontier 1830-1860.



Note: This pattern of technology transfer occurred throughout the North American industry regardless of the border between Canada and the United States. New foundries were established on an industrial frontier by the migration patterns of skilled worker and founders.

North American continent as part of the moving frontier of settlement constituted an industrial frontier (Figure 2).[10] Southern Ontario was part of the North American foundry frontier from 1830 through to the mid 1850s.[11] Like regions south of the border, Ontario developed a pool of skilled workers, capital equipment, and long lasting network linkages with American suppliers of apprentices, materials, products and techniques. Port towns became centres for the resettlement of founders through southern Ontario.[12] As a result Ontario foundries were replete with U.S. connections, and these connections were important in the informal transfer of products and techniques. In both the U.S. and Canada the manufacture of reapers and mowers was diffused to foundry operations through these connections between foundries in the 1850s.[13] These relations were codified in licensing agreements.

To begin with McCormick and Hussey dominated diffusion of the product technology since they controlled the key patents, and pioneered manufacture of reapers.[14] After their patents expired in 1847, the number of patents taken out on reapers and mowers increased rapidly and new sources of product development emerged from their licensed manufacturers. At least thirteen distinct reaper, mower and harvester product systems, established before the American Civil War, have been identified by Ardrey and Rogin.[15] These product systems consisted of products, each associated with a brand name, which took a particular form or design, and were systematically related to a set of patents and license agreements. Collections of related patents protected a product as a system of interrelated parts, which could be licensed to other manufacturers. A licence or shop right usually entailed the transfer of patterns and occasionally machinery to allow production of the patented forms and arrangements. Each system was related to a geography of regional producers with assigned shop rights and sales territories. Each product system served as the basis for ongoing improvements and modifications, and there was considerable leeway available to the licensed manufacturer to alter the machine and its parts. In this way the transfer of complex machines between foundries was made possible under formal license agreements.

Several of the new manufacturers in the 1850s began by building under licence, and all of them allocated licences to other manufacturers. As the number of competing patent systems increased in the 1850s and 1860s so did the number of reaper and mower manufacturers. Licenses were granted to Canadian, British and European

manufacturers. The size of territorial assignments increased. The product systems were refined in the 1860s so that by 1870 "the foundation features of reapers had all been invented and substantially perfected."[16] In the 1870s new manufacturers were licensed and few if any new systems were developed. One or two new entrants grew very quickly to become large producers but the prospects for creating new product systems were severely limited.[17] Late starters did contribute innovations, but the main developments in the 1870s and 1880s were in binding apparatus and here the trend was for industry-wide adoption of a basic design with minor modifications by company.[18] Despite the rather successful attempts by the industry majors to buy binder rights and control other manufacturers through infringement suits, binder designs were widely diffused across the industry. Licences remained a common feature of the industry well into the 1880s, and every manufacturer particpated in the licensing market, usually as a licensee.

Transfer by licence really amounted to a formalization of existing transfers between foundries to cope with property rights and more complex products, only now the product system was moved instead of skilled workers and patterns. A royalty payment was expected by the owners of the product system. There was little risk involved for the licensor. His firm was unlikely to be able to supply the market on its own, and would have found it expensive and time-consuming to develop its own sales organization.[19] He would enjoy a low-risk return on his existing investment. The licensee obtained a working machine and a chance to learn the new product. He had to accept a restriction on his sales area, but this would only last the life of the patent. The large companies participated fully in the "patent wars" taking out and giving licences, hunting down alternative patent rights, launching infringement suits and bargaining with other majors over product rights. Small manufacturers were in a less secure position:

> The "little man" ... was ... obliged to pay royalty to his big competitor and enter the selling field under a severe handicap. Because types of implements were changing so rapidly, he was periodically faced with the alternative of making expensive alterations in factory machinery or going out of business. Unless he were exceptionally fortunate, his future and his present were one – to earn a modest living by supplying the locality in the immediate neighborhood of his plant.[20]

At least, this was increasingly the situation facing small plants in the 1880s as their window of opportunity for independent product development, or escape from licences began to close in the late 1870s, but it was not the case in the United States before 1875, and in Canada, as we shall see, national patent laws delayed attempts at monopoly by the leading American firms.

Until the window closed, a complex pattern of technology transfer existed in this industry. In addition to the interfirm licensing agreements, manufacturers obtained inventions and innovations from local farmers, from skilled workers in their own factories and from consulting or joint ventures with other companies. Process innovations tended to be transferred from capital equipment suppliers. Parts, especially steel components (cutter bars, reaper knives, and sickles) were purchased from specialist parts suppliers. Here Whitman and Barnes Manufacturing Company of Akron, Ohio obtained a near monopoly in the 1870s. It was also possible to make patterns from a finished machine and then manufacture the machine in a foundry, but there were few cases of illegal copying.[21] Manufacturers were seldom so blatant as to copy an entire machine but most companies sent representatives to observe competitor's machines at field trials, fairs and expositions. The latest innovations would be noted and alternative means found to achieve the same result. This meant that the product systems could be transferred between foundries in a variety of ways.

Beyond this interfirm interchange the state encouraged innovation through departments of agriculture. These departments sponsored the fairs and exhibitions at which bonuses and prizes were awarded to implement manufacturers. In both the U.S. and Canada boards of agriculture and the arts, mechanics' institutes, and engineering schools were funded by the department. These institutions supplied technical education to skilled workers, and disseminated information and intelligence garnered by the department on products, patents and technical matters. The ministers of agriculture were also responsible for the patent office and the census. This infrastructure was designed to facilitate domestic innovation by training local skilled workers and to assist the informal transfer of products and techniques between firms.

Transfers by license and the informal foundry to foundry transfers were part of the general expansion programmes of American manufacturers. They licensed other American manufacturers as well as British and Canadian firms. By 1860 all the leading American companies had licensees in Britain and, except for Mc-

Cormick, in Canada.[22] Within the United States the patent laws required registration of licences, transfers and assignments of patent rights, and these rights were fought over in and out of the patent courts. The U.S. patent law had the effect of encouraging licences, since a licence could be used in court to ensure ownership of the invention. Outside the United States, American manufacturers were confronted with various legal regimes regarding licences and patent registrations. Until 1872, Canada did not require registration of licensing agreements and forbade registration of foreign patents. Changes to the Canadian patent law in 1872 recognized U.S. patent rights and licences. Consequently, the early licensing agreements between U.S. and Canadian manufacturers took place without regard to the international border, tariffs, or Canadian patent law. To all intents and purposes Canada was part of the U.S. market in reaper and mower patent rights.

The overall effect was to ensure a common market in new innovations. The industry was characterized by "learning by doing" and "collective invention". The American reaper and mower patents quickly became a tangled mess of overlapping claims in which no company could monopolize the store of patent rights. Innovations were diffused across the United States and internationally by a combination of licensing, patent purchasing and copying. It was almost impossible to prevent the diffusion of new innovations to competitors. It was only possible to make them pay a royalty and court costs. Patent protection was very difficult to establish because of the multiplicity of ways to do the same thing and the increasing number of overlapping and unrelated patents.

This did not prevent leading manufacturers from trying to establish patent monopolies by waging a ceaseless campaign to purchase patent rights and form patent pools with other manufacturers and patent holders.[23] By the 1870s it was standard practice for companies to purchase licenses from other manufacturers, and to recruit personnel from other shops. It was not until the development of binders that these practices were able to be used to make the industry accept one product design controlled by one ring. Even although the ring obtained control after the binder had been diffused to a number of firms, this made the transition to binder manufacture particularly difficult for small manufacturers, since there was no longer a series of competing product systems from which to buy.

Attempts at patent control shifted the locus of patent activity away from the inventor to the owner of many patents, so that the

American patent system, "rather than promoting invention through protection of the inventor, ... had come to protect and reward the monopolizer of inventions."[24] But until the rise of the science-based corporation, monopoly had to be achieved through lawsuits and patent purchasing, not the ownership of laboratories. The overall effect of the patent litigation was to maintain the predominant positions of the early entrants to the industry:

> The ten or a dozen producers who controlled the rather small annual supply of reapers and mowers in 1860, were equally masters of an output ten times as large twenty-five years later.[25]

But in this industry no one firm was able to create a patent monopoly.[26] Patent claims became so complicated and interconnected that it was often deemed easier to share the rights than seek a monopoly.[27] For a long time, a common market of competing product systems characterized intellectual property rights and small manufacturers were able to enter the industry at only a slight disadvantage.

Attempts at patent control and ownership within the technology market required firms specializing in harvesters to develop engineering departments. Some firms accomplished this by merging separate organizations.[28] In the 1880s Deering, McCormick, W.A.Wood and Plano became single company corporations based on single plants producing fifty to one hundred thousand machines each. Product innovation became centred in engineering departments although these were staffed by skilled mechanics and not engineers. Their chief function was to convert industry-wide inventions into innovations controlled within the company's product system. As production techniques became more scientific and as the products were standardized using increasing numbers of steel parts, university-trained engineers were brought into these departments which became the centres of invention as well as innovation. This shift to corporate organization during the 1890s changed the basis of technology transfer and competition in the industry. Interfirm technology transfers were phased out as the corporations began to develop their own product innovations and to produce and sell them for the entire North American market within their own organization. Nevertheless, there were several competing corporations and therefore licensing continued until around 1890. The open market for harvesting machinery technology was effectively closed with the I.H.C. merger of 1902 following

the financial failure of many of the larger American harvester companies. Corporate control closed the market in licences by the twentieth century.

In the United States then, there was an intial period from 1830 to 1847 when two companies virtually controlled reaper patent rights in a very small market. By the 1850s U.S. patent law had converted reaper and mower innovations into commodities with an extensive market. New product systems in reapers, mowers, combined machines and harvesters were developed and licensed to many firms. By the 1880s firms were beginning to control the still growing market for innovations through more effective patent pools associated with the new binder designs. For about 30 years it was possible to enter the reaper and mower business on the basis of a licence and develop a firm with competitive product design. Companies which entered the industry in this fashion were placed at a disadvantage in the market but could also gain from technology transfer and rapid expansion. This constituted a window of opportunity for late starters.

The slow growth of the Canadian market meant that Canadian companies operated within this common market in product systems on the same terms as the late starter U.S. companies. Their position inside the market was protected by the Canadian patent law of 1872, which made it impossible for the major American companies to protect their patent rights in Canada without licensing a domestic manufacturer. Canadian companies were therefore partly protected from American competition in their market. Their position in the product market therefore became substantially better than that of small American companies because they were immune from the law suits of the patent pools.

Product innovation and diffusion was therefore intimately bound up with the nature of innovation, the pattern of industrial organization, the channels for technology transfer and the rules governing intellectual property rights. In this industry innovation was evolutionary and collective, and industrial organization was for a long time restricted to at best regional production units. Technology was diffused as part of an industrial frontier, by licenses and copying. Consequently from 1850 to 1890, Ontario was a beneficiary and contributor like other producing regions.

4. ONTARIO HARVESTER DEVELOPMENT TO 1872

The Ontario industry followed harvester development in the United States, developing some ten years later than the American market. This late start was not a serious disadvantage because Ontario companies had access to the North American product innovations. By adopting American product developments through licences and copying they could quickly master reaper and mower technology, and they could then develop their own product systems, keep up with every development through judicious licensing agreements, or emulate many of their American counterparts by stopping product development when they failed to obtain a necessary licence. At least two firms, Massey and Harris, late starters by American standards, became international competitors in all harvesting machinery lines by the 1880s, through exploiting the American market in product innovations. Ontario manufacturers did very well out of the licensing game, better than most American late starters. This would suggest that rather than creating technological dependence, licensing promoted technology transfer.

Ontario generated only a small market for harvesters until the 1870s. Until then Ontario reaper makers were founders producing for local markets within the province, not manufacturers producing for the regional Ontario market. The small size of Ontario foundries (only one firm had more than 150 workers in 1871 and most employed under 30) posed a problem because complex products like reapers and mowers could not be constructed in blacksmith shops.[29] Indeed few of the leading manufacturers in the U.S. manufactured all the parts of their reapers themselves.[30] Fully equipped foundry, carpentry and machine shops were required, and a large inventory of patterns. There were only two ways to transfer this technology. One was a comprehensive technical agreement between an established manufacturer and another foundry using licences to continue the old transfer system under a proper legal agreement. They covered the provision of patterns for moulds, some machinery and technical assistance. The second method was for an established shop to copy someone else's machine. This presumed a previous transfer of process techniques to the firm of the copier and a long period of experimentation. It also prevented future linkages with the firm whose machines were copied.

Company catalogues confirm that generally Ontario improvements, whether patented or not, were made on American designs.

Table 1
Ontario Manufacturers Known to Have Built
American Reapers and Mowers Before 1872.

Manufacturer	Product System	Year
1. J. Bingham	Buckeye mower, Dodge rake	1871
2. Brown & Patterson, Whitby	Cayuga Chief mower	1871
3. L. Cossitt	Buckeye reaper	1863
4. Eastwood & Co., Ingersoll	Buckeye reaper	1871
5. J. Forsyth, Dundas	Ohio combined, Johnston's self rake, Buckeye mower	1871
6. Frost & Wood, Smith's Falls	Wood mower	1861
7. J. Grout	Buckeye reaper, Dodge rake	1871
8. J. Haggert, St. Mary's	Ohio combined, Johnston's self rake	1868
9. J. Hall, Oshawa	Ohio combined, Cayuga Chief mower, Hubbard reaper, Brinkerhoff reaper	1864
10. Harris & Son, Beamsville	Kirby mower, Dodge rake	1871
11. Massey, Newcastle	Ketchum mower, Burrell reaper	1851
	Manny reaper	1855
	Wood mower and self rake	1862
	Hubbard reaper	1871
12. Maxwell & Whitelaw, Paris	Sprague mower	1871
13. Noxon, Ingersoll	Ohio combined	1864
	Johnston self rake	1871
14. Oswald & Patterson	Buckeye mower, Dodge rake	1871
15. Patterson & Bro, Richmond Hill	Seymour & Morgan, Cayuga Chief mower	1868
16. Paxton, Tate & Co., Port Perry	Marsh harvester	1868
17. L.D. Sawyer, Hamilton	Ohio combined	1861
	Wood mower	1869
	Dodge rake	1871
18. J. Scott, Dundas	Wood mower and reaper	n.d.
19. Stratford Agricultural Works	Ohio combined	n.d.
20. J. Watson, Ayr	Wood mower	1863
	Johnson self rake	1871

Note: The year given indicates either when machines were first produced or the date of reference.

Source: *Canadian Farmer's Manual of Agriculture*, 1876, 490-492; L.D. Sawyer & Co., *Illustrated Catalogue*, 1869; R.T. Naylor, *History of Canadian Business 1867-1914*, II 41-42; W.G. Phillips, *The Agricultural Implements Industry in Canada*, 39.

The first known case of a licence granted for harvesting machinery was Massey's licence for the Ketchum mower and Burrell reaper obtained on a trip through New York state in 1851.[31] Other companies followed, although it was not until the 1860s that widespread production of American designs occurred (Table 1). Each American product system was made by several Ontario manufacturers, but in the 1860s every Canadian manufacturer built American machines.

Until 1870 Ontario manufacturers produced a remarkably small range of American designs: mowers and combined machines, a few reapers, all from New York state and Ohio. Some Canadian manufacturers imported parts and fitted them to local iron and wood components while others used American patterns and moulded their own parts.[32] Perhaps some companies "pirated" American designs by making patterns from American machines, but the only evidence of this is the case of Frost and Wood.[33]

Only 68 patents were registered for harvesters in Ontario before 1872, a much lower figure than for the United States (Figure 1). The patent holders were overwhelmingly Ontarians; only two patents were registered from Quebec. Ontario patent law did not permit Americans to take out patents. The 68 patents were held by 58 patent holders, with a maximum of four taken out by J.Lawrence of Palermo. Most of the important Ontario reaper and mower companies of the 1870s are represented in the patent list: Haggert, Watson, Sawyer, Noxon, Hall, Forsyth, Cossitt, Abell, and the various manufacturers at London; but well known makers like Massey and Harris are missing.

Generally the patents as described in the patent records were "improvements" to reapers and mowers, some being designed to meet local conditions, like Griffith's 1851 patent for a clover seed gatherer. Most of the improvements were changes to the cutter bar, changes in the gearing and construction of the knives, the reel and the rake, much like American developments. Three Ontario brand names are mentioned in the patents but it is doubtful whether any of these constituted domestic product systems since they were probably based on American designs and parts.[34]

There are three important questions in this process: how did the Ontario manufacturers get hold of American designs? why did Ontario manufacturers seek out American products? and why did American companies transfer products and techniques to Canada, without patent protection? These questions are difficult to answer from the official records. American companies were not granted

patent rights in Canada until 1872 and the U.S. Patent Office did not record license agreements with foreign companies so there is no official record of the transfer of technology. The number, content, and conditions of the transfer agreements were never made public.

The reasons why Ontario manufacturers sought American licenses to make harvesting machinery are spelled out clearly in the advice to farmers offered by L.D.Sawyer and Company in 1869:

> Avoid all newly invented or newly introduced machines. Why, Because you want a *perfect* machine, and do *not* want to test, perfect and introduce it at your own expense. ... An invention is not always an *improvement*. All the primary features of all Harvesters are old, and the new inventions are upon some minor parts of the machine, and a majority of them are worthless. All successful machines are the combinations of the inventions of many men. The valuable and important patents on Harvesters are owned by men who have been some years in the business, and no machine can be made to work successfully without using parts that infringe many of these patents. ... It requires several years of experiment, observation and use, the study, experience and invention of many men, and the expenditure of many thousands of dollars, to detect all the faults of the best machine and apply the safe and proper remedies.[35]

This catalogue entry was designed to sell the then somewhat outdated Ohio machine to farmers in the face of new competition, but buying an established product system was sounder than trying to develop a new design.

Licensing was common practice within the American harvester industry. In addition American companies sought out licensees overseas in the 1850s and 1860s, particularly in Britain and Canada.[36] A few American manufacturers, Manny and Wright, and Seymour and Morgan, supplied the British market from home, and those with licensees also sold finished machines through the local firms, but by 1860 all the leading American companies had licensees in Britain. Beginning in 1856 machines were introduced to Europe. In Canada the pattern was the same. Out of the informal transfer of founders, patterns and capital on the North American industrial frontier grew a formal transfer of product systems under licences. This was a logical response to logistical problems in foundry production, the complexity of the new harvester products and the widespread demand for the goods.

The Canadian governments were gradually forced to acknowledge and regulate this state of affairs. The Ontario government had begun to promote a domestic manufacturing system modeled on American and British practice through the establishment of societies to promote agriculture and the useful arts, mechanics' institutes and incentives to inventors. Experts were sent to investigate foreign industrial practices and to report on how Canada could obtain similar results.[37] These official trips must be seen within the broader context of the Canadian attempt to replicate the American apparatus of invention. In 1857 Boards of Arts and Manufactures were established in both Canadas. The activities of these boards were overseen by the Department of Agriculture and Arts which had been set up in the 1850s and modeled after its U.S. predecessor. It began to establish "technical schools of arts" to teach mining, civil engineering, architecture, chemistry, designing, modelling, mechanical drawing and their applications to manufactures and arts. A campaign of bonuses to establish mechanics' institutes doubled the number of institutes in Ontario from 13 to 26 from 1868 to 1869.[38] By 1872 there were 42 institutes. Through the institute libraries the department distributed copies of the *Canadian Patent Recorder*, and other departmental publications advertising the latest inventions and techniques. At the provincial fairs prizes were awarded for implements and other products. In Toronto 200 pupils attended evening classes organized by the Mechanics' Institute in 1865-66, increasing to 265 in 1868-69.[39] The Toronto courses later served as the basis for the School of Practical Science established in 1878.[40]

In this fashion Ontario developed an explicit industrial policy based on the Department of Agriculture, the Patent Office, Mechanics' Institutes, and protective tariffs in the 1850s. The policy was modeled upon American institutions and at Confederation was extended from a provincial to a national policy. Jarrell has shown that Ontario's science policy was competitive with Michigan's in the nineteenth century and largely comprised expenditures related to agriculture.[41] The Ontario and Canadian governments copied the American government's entire system of regulating and encouraging invention except that they followed European practice by refusing to allow an absolute right of property to an inventor or patent rights to foreigners.

The Canadian government's refusal to allow American inventors patent rights in Canada was gradually eroded. Domestic manufacturers and farmers wanted American products and the way to get

them was through licences. In the 1850s and 1860s Canadians made private and official excursions to the U.S. to obtain product rights, and attended U.S. shows and field trials. Increasingly, spin-off/mother-daughter plant relationships, family connections, exchange of personnel and copying gave way to licences. Department of Agriculture publications, the mechanics' institutes, fairs and exhibitions, the Patent Office and Department of Agriculture museum came to reflect the pattern of transfer. In 1872 the Patent Act was brought into line with reality by the Canadian government. This way technology transfer in agricultural implements could be regulated and the demands of the growing number of domestic and foreign implement manufacturers for greater legal protection as licensees and licensors could be met.

In the period to 1872 Ontario reaper and mower manufacturers did not differ organizationally and technologically from most American producers. There was little domestic innovation and virtually all of it was based on American machines, but this is not distinctive. Coming late to the harvester industry, Ontario manufacturers followed American developments as they built up their own experience in the products. Licensing, because of the small scale of factories, the regional character of distribution and the nature of licensing, resulted in an open market in technology characterized by technology transfer. Indeed the change in the patent law in 1872 was specifically designed to regulate this transfer in such a way as to promote domestic technical capability.

5. THE PATENT ACT OF 1872

In 1872 the Canadian patent law was revised to allow foreigners to hold patents in Canada, although the rights granted were extensively qualified. No patent was to be issued if it compromised existing Canadian producers. The foreigner had to take out a patent within 12 months of application in his home country. Any Canadian manufacturer manufacturing the product within the 12 month period had the right to continue. The most onerous restriction required the product to be manufactured in Canada within two years, with no imports allowed after 12 months. Some extensions were later permitted by the Commissioner of Patents, especially on large equipment with limited or custom markets.[42]

While the effect of the new law may have been to encourage the transfer of technology to Canada, the Canadian government was

aware of this problem. It wished to avoid the patent monopolies characteristic of the U.S. technology market and to preserve a large number of Canadian manufacturers. The changes were only a modification of the basic Canadian position: invention should be given protection and monopoly rights only when it resulted in the manufacture of useful products in Canada for Canadians. In 1872 it was officially acknowledged that licences could fulfil this objective.

That fundamental differences remained between the American and Canadian patent laws became evident as the precise nature of patent claims for precedence on complex reapers and mowers was finally confronted. Naylor has claimed that there were no patent law cases over infringement of patent rights on harvesters until 1885.[43] In fact, there were infringement cases before 1885 but generally they were suits between patentee and licensee, not between two licensees or between two Canadian patent holders. This stands in marked contrast to the situation in the U.S. where the McCormick case of 1847 was only the most celebrated of a long litany of suits between patent holders. The Canadian Parliament refused to make a patent into an absolute property in all its consequences. This effectively avoided the U.S. patent wars.

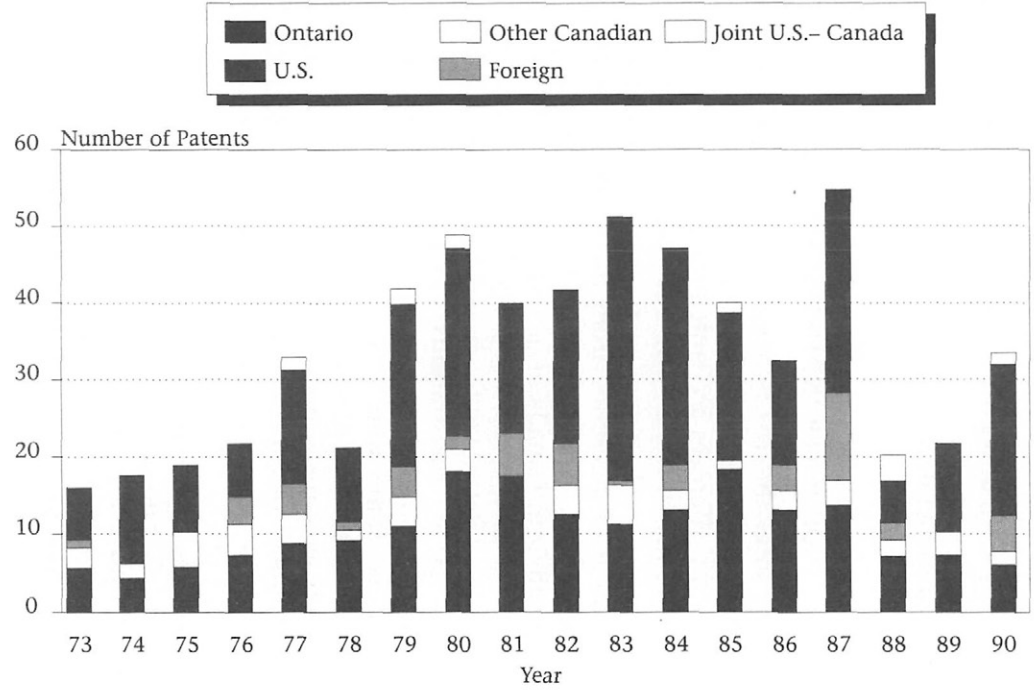
This interpretation is not the same as Naylor's.[44] Naylor viewed the 1872 Patent Act as an attempt to encourage transfer of American techniques to Canada. To my mind this was only an incidental result of the change in the law, which was primarily designed to promote Canadian invention and maintain a relatively free market in inventions *within* Canada. American licences had been offered to Canadian manufacturers since the late 1850s despite a lack of patent protection, and the 1872 law sought to regulate this situation while imposing onerous conditions (by American standards) on the American patent holders. These conditions were directly in line with European practice. European nations, intent upon fostering domestic innovations, applied restrictions to foreign patent holders similar to those scheduled in the Canadian law of 1872. At international patent law conferences American interests lobbied for a freer, standardized international market for innovations.[45] Like many European patent laws, the new Canadian law was designed to control and regulate foreign techniques and property rights, rather than to encourage and solicit them. After 1872 the Department of Agriculture sent no more agents to the U.S.A. and Britain to obtain machines, models and licences.

But regardless of this interpretation, the question is whether Naylor's conclusion is accurate: did the policy result in "the submergence of Canadian innovative capacity under a flood of American-imported techniques."?[46] Did the extension of conditional patent rights to Americans in 1872 change the nature of the cross border technology transfer? Did it compromise Canadian innovative capacity, or was the basic pattern of technology transfer characteristic of early licensing perpetuated within the framework of harvester product development?

6. INNOVATION IN THE ONTARIO HARVESTER INDUSTRY AFTER 1872

Immediately after the 1872 change to the patent law American inventions began to enter the patent lists (Figure 3). Through to 1890 American patentees accounted for about half of the patents on harvesting machinery in any one year. The actual number of assignments to Canadian manufacturers was much smaller. In fact it is impossible to determine from the Canadian patent records how many licenses were granted.[47] It became common practice to take out a patent in Canada in order to advertise the invention to prospective Canadian manufacturers. American farmers, for example, registered patents in the hope of attracting Canadian investors. Most U.S. registrations were made by American manufacturers. Some of them were direct assignments to local manufacturers, some were joint registrations with Canadians, others protected early joint ventures and the one branch plant, but many patents were never manufactured in Canada. Consequently the large number of American patent registrations identified by Naylor leaves the true status of Canadian innovation unknown and overstates the place of American product technology in Canada.[48] Naylor takes the increasing number of American patents as a sign of growing technological dependence: the submergence of Canadian innovation under a deluge of American technique. Whatever the merits of Naylor's case for a variety of industries in the twentieth century, in the mid to late nineteenth century we must be very careful how we interpret the rising number of American patent holders in the Canadian lists in this industry. Until the twentieth century there were only three branch plants – two short-lived harvester plants and a parts manufacturer – in Ontario and local manufacturers performed the full range of manufacturing functions, including construction of capital equipment. Truncation, which

Figure 3
Origin of Harvester Patents Registered in Canada 1983-1890.



Source: Canadian Patent Office Recorder

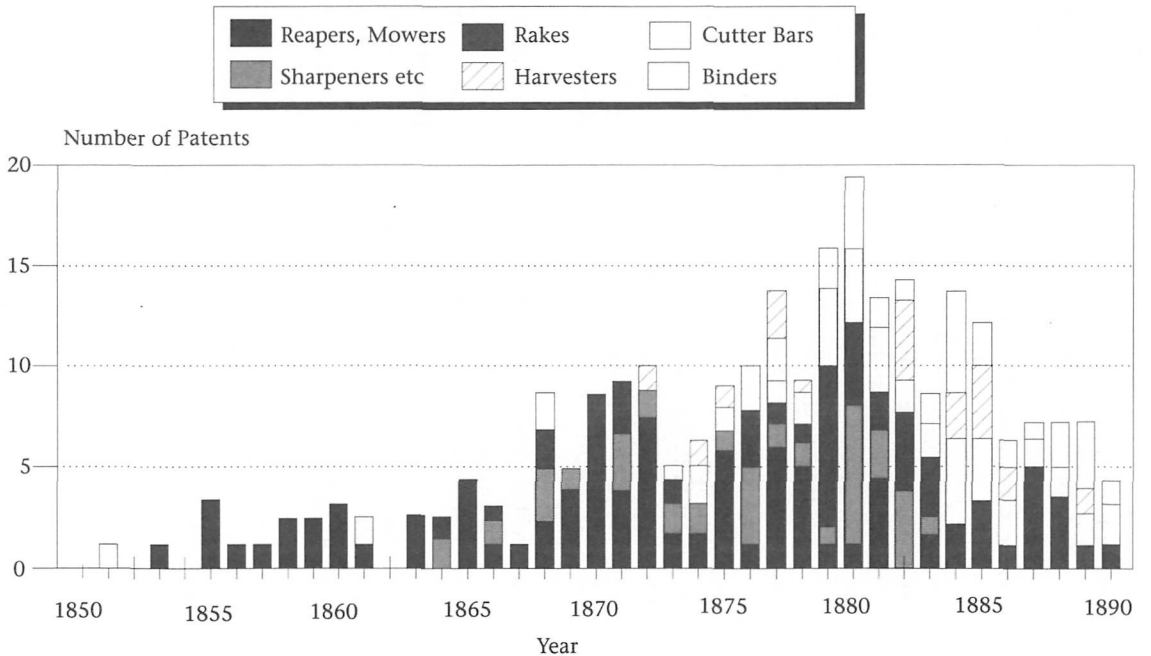
refers to an industry or firm reliant on foreign sources for many of the manufacturing sources, is not an appropriate term for this industry in this period.

But the surprising thing about the patent record in this industry is the number of Canadian patents. Despite a slow start, Ontario companies increased their share of North American patent activity in the late 1870s and in the 1880s (Figure 1). All the Ontario companies were represented in this activity. Indeed the Canadian patents taper off at the same time as American ones, indicating the same product cycle. By breaking down the harvester patents into classes of machine – reapers and mowers, self-rake reapers, knives and cutter bars for reapers, harvesters and binders, knife sharpeners, wire and twine making and attachments (Figure 4) – another pattern is revealed. The first Canadian patent on a self-rake machine was taken out in 1864, although Ontario manufacturers only began to make self-rakes in earnest at the end of the decade. Until 1876 there were no Canadian patents relating to harvesters and binders but this coincides with development of wire binders. So although there was a lag between American and Canadian patent activity on particular machine types, the lag time appears to have become shorter. By 1882 most of the patents were for aspects of harvesters and binders.

At first glance this indicates a flowering of Canadian inventive activity, but the Canadian patent record cannot be taken at face value. The increase in Canadian patents might be a large number of Canadian farmers reinventing the harvester, or patents taken out by the skilled workers of Canadian companies. The innovations may have constituted new harvester designs or improvements on old American designs or Canadian attempts to reproduce American harvester developments but under Canadian control. Each of these possibilities has different implications for our appraisal of Canadian innovation. Similarly, the fact that a large number of American patents were registered does not necessarily mean that these were all produced in Ontario. Taken on their own the total number of patents will not reveal the true status of Canadian innovation.

In order to resolve these ambiguities company product histories of Ontario firms and their connections with American product systems will be examined in detail. In the harvester industry the pinnacle of technical development was the perfection of a product system which was licensed to other manufacturers, and the development of an in-house innovative capacity which allowed

Figure 4
Canadian Harvesting Machinery Patents by Product 1850-1890.



Source: Canadian Patent Office Recorder

further development of the product system along the general lines of the industry with the minimum amount of external assistance. Effective technology transfer occurred when the licensee no longer paid royalties but generated product developments on its own. The A. Harris, Son and Company certainly meets these criteria, even though it enjoyed a close relationship with an American licensor.

7. A. HARRIS, SON AND COMPANY AND THE D.M.OSBORNE CONNECTION

D.M.Osborne and Company of Auburn, New York maintained a long and close association with A. Harris, Son and Company. The relationship is interesting because it appears that in the early 1880s Alanson Harris's son John was directly involved in developing a binder produced both by Osborne and Harris. The case represents the pinnacle of Ontario harvester innovation. The Harris company was one of the most innovative Ontario firms, for unlike the Massey Manufacturing Company it contributed to the development of its own twine binder, and built up a strong engineering department in the early 1880s.

Harris began making mowers in 1862 and introduced a hand-rake reaper in 1867 and a self-rake reaper in 1869. But their first patent on harvesters was not until 1875. In the period 1875-1892 the company came up with 10 patents on harvesters under the names of Alanson Harris, John Harris, Lyman Melvin-Jones, the superintendent, and J.Wedlake and J.Lucas who were skilled workers. This indicates the development of some innovative capability within the firm. This capability was seriously undermined by the death of John Harris in 1887. The company also obtained assignments from other firms and individuals around the industry. The patents were for changes to the frames, guards, rake adjustment, bundle carriers, coupling bars and drive gears of mowers, harvesters and reapers. These were improvements to the existing designs rather than major changes to the machines. The machines themselves were built according to the D.M.Osborne and Company Patents. Despite licence agreements extending back to 1862, Osborne could not take out his first Canadian patent until 1873. Thereafter patents related to harvesters, reapers and mowers were registered under the Osborne company's name until 1887. After 1890 the patents were for corn harvesters and disc harrows as harvester development was complete. The Osborne patents were

derived from various American sources, but this is by no means remarkable.

Invariably there was a delay involved in transferring the Osborne product innovations to the Harris company. The Kirby mower was first produced at Auburn, New York in 1857[49] but was not licensed to Harris until 1862 (when D.M.Osborne took on new partners at Auburn). The New York factory was making a hand-rake reaper in 1866 but Harris was licensed in 1867. Osborne went on an extensive European tour in 1872 seeking licensees. In 1875 D.M.Osborne and Company absorbed the Cayuga Chief Manufacturing Company headed by Cyrenus Wheeler and the Wheeler combined machine was added to the Osborne product line. These machines appeared in the Harris line after the registration of the Wheeler patents in Canada in 1877. Osborne took out rights to the Gordon wire binder in 1876 and in 1877 began manufacture of wire binders. Harris sold the Osborne wire binder in the Canadian west in 1878 or 1879,[50] and continued to produce Osborne mowers in the 1880s.

Harris paid royalties to Osborne for the right to produce his machines. The account books of the Harris firm for 1873-1887 reveal peak payments in the period 1875-1882 with a dramatic reduction thereafter (Table 2). The account covers both royalties and payments for parts imported from Auburn, New York, but it is not possible to separate these items out except for the period 1884-1887 when only $2,500 was paid in royalties. The dramatic increase in payments from 1874 to 1876 coincides with the introduction of the new Osborne mower and Wheeler combined reaper-mower (Table 2). The payment of $48,185 in 1876 must have covered the rights to these machines for after that date payments were very small. Indeed compared to the company's wage account the payments to Osborne became increasingly insignificant. The main reason for this decline was the switch in cutter bar sourcing to a plant in St. Catharines, Ontario. This factory was originally established by two Canadians but was purchased by the Whitman and Barnes Company, making it the only important U.S. branch plant in the nineteenth century. Whitman and Barnes supplied cutter bar parts to virtually every U.S. and Canadian harvesting machinery manufacturer in the 1880s. There was also a general shift in inputs to Canadian and particularly Ontario sourcing (Table 3). The Osborne patents of 1877 were only taken out for 5 years and by 1883 Harris was paying very little in the way of royalties. In the Harris case, the cost of the American techniques

Table 3
A. Harris, Son and Company Accounts:
Origins of Good Received 1875 and 1885.

State or Province	1875 Dollar Value	Per Cent of Total	1885 Dollar Value	Per Cent of Total
Britain	–	–	448	0.2
N.Y.	17,919	62.0	11,555	4.7
N.J.	666	2.3	85	0.0
Mass.	455	1.6	1,413	0.6
Ct.	–	–	347	0.1
R.I.	–	–	255	0.1
Pa.	–	–	1,381	0.6
Ohio	330	1.2	7,727	3.1
Ill.	–	–	773	0.3
U.S.A.	19,171	67.1	23,539	9.6
Que.	3,461	12.1	48,292	19.6
N.S.	–	–	10,488	4.2
Ont.	5,806	20.3	163,056	66.3
Man.	117	0.5	–	–
Canada	9,384	32.9	221,836	90.2
Total	28,556	100.0	245,823	100.0

Note: The dollar values have not been adjusted. In 1885 cord wood comprised $58,092 of the Ontario purchases and payments to Whitman and Barnes Mfg. Co. a further $48,957, but this leaves a further $56,007 (22.8%) worth of other materials purchased in Ontario.

Sources: A. Harris, Son and Company, Account Books, 1872-1887, Massey Ferguson Collection, Ontario Agricultural Museum.

Table 2
The A. Harris & Company Account Books 1873-1887:
The D.M. Osborne and Company Account
and the Wages Account.

Year	Payments to D.M. Osborne & Co. ($)	Wages Account ($)	Payments to Whitman & Barnes Mfg. Co. ($)
1872	–	408.26	–
1873	8,092.57	12,513.49	–
1874	9,486.23	13,370.53	–
1875	15,528.41	18,995.21	–
1876	48,185.94	19,331.37	–
1877	15,662.06	18,455.25	–
1878	16,605.06	24,800.34	–
1879	25,001.35	26,807.51	–
1880	25,399.31	38,701.18	–
1881	–	–	–
1882	18,182.64	52,543.59	19,182.94
1883	5,659.94	92,786.77	47,581.41
1884	2,571.45	78,265.83	32,052.53
1885	2,782.85	82,915.74	48,956.94
1886	445.63	95,735.30	35,418.65
1887	217.32	101,537.13	42,063.13

Note: The company moved to new factories in 1872 and 1881 and so there is no date for these years.

Source: A. Harris, Son & Co., *Account Books*, 1872-1887, Massey-Ferguson Collection, Ontario Agricultural Museum.

became less important to the Canadian company as production increased. Payments to Osborne represented 15 per cent of sales value in 1875, but less than 1 per cent in 1885. Production costs and royalty payments together, however, comprised 60 per cent of Harris' sales in 1875, but 78 per cent in 1885. The share of sales Harris took as net profit was cut in half over this decade. The difference is largely attributable to the shift to the more complicated harvester binders in the 1880s, increasing materials costs and increasing com-

petition in the Ontario market. These were far more important considerations for Harris than the costs of royalty payments.

Royalty payments in North America were usually set between 5 and 15 dollars per machine in the 1870s, depending upon the bargaining strengths of the parties, but it is difficult to establish their general effect on the profitability of firms. From 1865 to 1872 McCormick self-rake reapers had an average sale price of $200, and mowers sold for $130. McCormick made a net profit of $55 per machine or 35 per cent of the value of sales.[51] Other U.S. companies did not do so well. Their selling prices were $20 below McCormick's and their costs of production were probably higher. This suggests that the net profit of companies paying royalties must have been half McCormick's 35 per cent. For a small manufacturer with a local sales territory this might still be competitive. With a net profit of nearly 40 per cent in 1875 Harris did extraordinarily well.

In the late 1870s the situation for Harris and other small manufacturers must have remained about the same. McCormick's manufacturing costs per machine declined from $62 in 1876 to $38 in 1879. Declining materials costs are partly responsible but the figures would be higher if binders, introduced in 1878, were not counted as separate machines.[52] These were also depression years and the prices of machines were reduced. It was in the 1880s that Harris and other small manufacturers, particularly those paying royalties, began to be uncompetitive. All manufacturers faced higher costs of production,[53] and the new twine binders introduced stiff competition to the market, all of which must have cut into the profit margins of small firms manufacturing under licence. But until the mid 1880s, companies paying royalty fees remained competitive, especially if they sold in a small, protected market.

From the point of view of the firm granting the license, instead of paying tariffs and transport costs, arranging a sales organization and perhaps a branch plant, a constant stream of earnings, probably equivalent to or higher than the profits obtainable from direct sales, was received at no risk. Licensing could quickly extend the company's sales territory and provide income for domestic expansion. It also ensured market coverage and recognition of patent rights. The Osborne-Harris relationship represents long term cooperation with advantages for both parties. The true value of the relationship can be seen by examining the extent to which Harris became innovative.

It has been claimed that, after a visit to the American west in 1881, John Harris developed a twine binder with a steel frame and

the Appleby knotter: the "Brantford Binder" which the company first made in 1882.[54] Harris was granted a Canadian patent related to binders in 1885, and his first American patent for binders was registered in 1886.[55] Denison further claims that

> A large American implement company paid the Canadian concern an unprecedented compliment by purchasing a complete set of patterns [for the Brantford Binder][56]

There is no record of such a payment in the company's account books, although this does not disprove Denison's claim: there is a gap in the account books occasioned by the building of the new Harris plant in 1881, and a transaction may have occurred privately.

John Harris was involved in binder development, but exactly what the status of his contribution was is unclear. The most likely scenario is that Harris collaborated with Osborne in the development of harvesters and binders. Several things support this view. The Harris company had access to the Gordon wire binder patents through D.M.Osborne, but Osborne was slow to acquire rights to the Appleby or Gorham twine binder patents and in the meantime experimented with his own designs. He built twine binders for three years before he obtained a shop right (the right to manufacture the design in one factory) from Appleby in 1883, and during those three years, as well as after, Osborne relied heavily on his own patents for protection in twine binders.[57] Harris was able to defeat an infringement suit launched by the Gurneys based on claims of infringement of the Appleby patents. The Canadian patents taken out by Harris do not cover many aspects of harvester and binder construction but the two companies appear to have brought out twine binders at the same time and to have produced identical machines in the 1880s.[58] The Harris and Osborne companies appear to have collaborated on the development of twine binders in the face of the most successful attempt at a patent ring in harvesting machinery.

Despite the uncertainty over John Harris' role in binder development, there is undoubtedly truth to the implication of Denison's claim: A. Harris, Son and Company was quite innovative. The company's technical capabilities are confirmed by the introduction of the open-end binder in 1890. This improvement was introduced by the Brantford company, but it was by no means an important innovation. Denison described it in these terms:

Although Harris actually produced the first practical machine that would handle straw of every length, existing patents, some of which had been granted back in the days of early experiment, covered every feature and made the prospect of successful litigation negligible. ... The mechanical difference between the original "closed back" and the succeeding "open-end" or "wide-open" binder now seems trivial."[59]

All it required was a change in the alignment of the chain drive for the canvas and the elimination of the backboard. The idea was to allow straw to be cut to any length so as to increase the amount of straw available as fodder for cattle. This improvement was specifically designed for the British and European markets and two English manufacturers began producing the improvement. As an improvement it possesses all the usual features: problems with prior claims, rapid transmission through the industry, particular regional appeal, and modification to an existing machine.

The Harris company displayed signs of an emerging technical capability, a group of skilled workers registering patents, simultaneous introduction of the twine binder with a leading American company, and at least one acknowledged innovation, even if it was not of major importance. This capability was developed late in harvester development and for most of the company's history it followed the product developments initiated by its licensor. This relationship involved payments for royalties and parts, and Harris was not permitted to export to the U.S. This did not prevent the Canadian company from expanding sales throughout Canada and overseas. Nor did it prevent the company from product development on its own and in collaboration with the licensor. The company's switch in cutter bar sourcing to Whitman and Barnes, and the general shift to Ontario sources of materials indicates the emergence of a domestic infrastructure for harvester manufacture. The Harris case provides strong evidence for effective technology transfer as a result of licensing, both to the company itself and to the emerging Ontario industry.

8. THE CASE IN CONTEXT: THE ONTARIO HARVESTER INDUSTRY IN THE 1880S

A. Harris, Son and Company was not an isolated case. Most of the other Ontario companies introduced patents covering improvements to reapers and mowers, switched to Ontario sources of parts, and at least one other company developed an engineering depart-

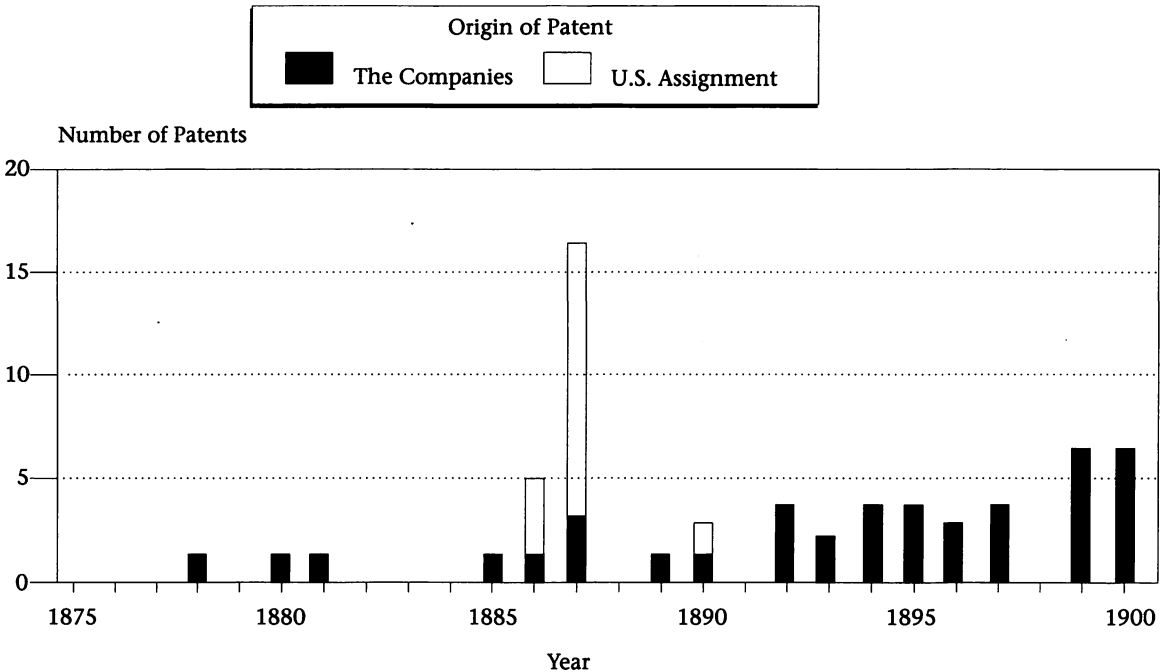
ment, but generally Harris was ahead of the pack. Apart from Harris, 14 other Ontario companies made the transition to harvester and binder manufacture, but most of these firms obtained licences from the large American companies. Four companies licensed by McCormick to make wire binders escaped from the royalty payments because McCormick failed to register his patents properly in Canada. Patent activity did not add up to an ability to develop products on their own. The Ontario industry had several firms which managed to procure new products despite poor relationships with American licensors, others which made the transition to harvesters and binders thanks to licences, and many which, despite efforts of their own, were unable to develop the new machines. A brief discussion of some of these firms will indicate the overall pattern of Ontario innovation.

John Watson and Company of Ayr made reaper and mower improvements, and took out patents on a binder.[60] John Watson himself took out a very early patent for improvements to the Wood mower, but later introduced Johnson's self-rake to his combined machines. Further improvements registered at the patent office appear to have been the result of, at best, collaboration between Watson and his staff and the Sweet brothers of New York. After what must have been unfruitful attempts to develop his own harvester and binder, Watson turned to the Deering twine binder in 1886, which incorporated a steel frame and the Appleby knotter. Unable to secure a long and close relationship with any American harvester company, Watson worked hard to develop his own machines. This is testimony to Watson's own technical abilities. However, the firm did not develop a pool of talented workers so, on the death of its founder, it was forced to move to products for which it could obtain licenses – washing machines, churns and warehouse trucks. The Watson company failed to develop an engineering department and thus failed to sustain what appears to have been a reasonably innovative record.

Until the amalgamation with Harris, the Massey Manufacturing Company was responsible for just ten patents mostly registered in the 1880s. Massey did not develop its own combined reaper and mower or binder despite its claim to the earliest Canadian harvester patent. It built under the Whiteley patents, which it secured in 1881 by buying out the Toronto Reaper and Mower Company. This company produced the Champion combined reaper-mower and after 1882 Massey continued to receive new Whiteley patents, including those for the new Champion twine binder.

During the 1880s Massey developed its own innovative capability as J.McLachlan of London and five Massey workers registered patents for the company. McLachlan, who patented improvements on binders for John Elliott and Sons in the 1880s, had an impressive record as a patentee. The new Massey-Harris company combined the inventive talents of these men with the staff of the Harris, Verity and Patterson works in the Canadian industry's first official engineering department. All the subsequent patents taken out by Massey-Harris to 1914, except a few for cream separators and a lawn mower, came out of this engineering department (Figure 5), which represents the ultimate achievement of technology transfer under American licensing in Canada. Massey-Harris tried to develop its own products rather than rely on further licences. The department devoted most of its attention to grain drills, corn harvesters and ploughs. This narrow product range indicates the weakness of the department: there were no patents on gasoline engines, tractors or other related products and only one patent on a production process. Developments in steel cutting and moulding, and new labour management techniques were borrowed from the U.S. F.W. Taylor's systematic management techniques were not introduced into Ontario metal manufacturing shops until the 1900s.[61] International Harvester's branch plant was in fact instrumental in introducing these techniques to Ontario. Even then Massey-Harris moved into the new products of the twentieth century by purchasing American plants with established product designs and engineering departments. The new techniques and the new products came with foreign direct investment or were available only to Canadian corporations. In addition to the achievements of Massey and Harris several harvester parts suppliers emerged in Ontario, showing the importance of licensing in developing domestic parts supply. At St. Catharines a Canadian firm began making reaper and mower knives and cutter bars in 1872. By 1879 it was producing $60,000 to $70,000 worth of knives for Canadian harvester manufacturers. In that year the company was bought by the American monopoly in reaper knives, Whitman and Barnes. The company provided virtually every Canadian manufacturer with knives until the 1890s.[62] Peter Hay of Galt took out patents for machine knife cutting and sharpening tools. His company, established in 1883, was a purely local affair.[63] In addition to these two knife and cutter bar manufacturers several malleable iron works, notably the Oshawa Malleable Iron Works owned

Figure 5
Canadian Patents of the Massey and Massey-Harris Companies 1875-1900.



Source: Canadian Patent Office Recorder

by Joseph Hall, were established to produce malleable iron finger bars for the cutting apparatus of reapers and mowers.

A number of companies moved towards specialist manufacturing but were handicapped by poor connections with licensors, conservative management, slow expansion of sales organizations and problems moving to steel construction. Noxon, Watson, John Elliott and Sons of London, Frost and Wood of Smith's Falls, D. Maxwell of Paris and Haggert of Brampton all fall into this category. Surprisingly the Canadian Binder Manufacturers' Association numbered 15 members in 1885, so half of the 31 firms making harvesting machinery in 32 establishments gained access to harvester-binder technology and patent rights. The Toronto Reaper and Mower Company, the only branch plant prior to 1901, and the two joint ventures, the North American Agricultural Implements and General Manufacturing Company of London and the Joseph Hall Manufacturing Company, had no domestic patent record. Apart from these three firms every one of the Binder Association's members took out patents on harvesters in the 1880s.

Certain individuals were involved in binder development. Two Canadians, J.M.Currier of Ottawa and E.C.Eells of London, bought into the Gordon wire binder patents, but their investment was intended to earn a weighty return from the sale of patent rights in the U.S. By the 1880s Canadian manufacturers were registering patents in the United States: David Maxwell claimed that McCormick purchased the U.S. patent rights to his low-down binder introduced to the Manitoba trade in 1884, for $105,000; and George Pye of Ottawa took out a U.S. patent on reaping and mowing machines.[64] J.McLachlan of London took out binder patents in Canada, but he was one of a very few.

These were the chief success stories. The failures of the licensing regime lie in the problems encountered by general foundries trying to move beyond reaper and mower production to harvesters after 1880. Many of these firms failed to develop their own product and in most cases they were unable to find a licensor. The usual practice was to move out of harvesters altogether and concentrate on other foundry lines: threshers and separators, traction engines, and washing machines.[65] The general foundries tended to remain general foundries.

One of the earliest cases of this pattern was J.Hall's abandonment of reaper production in the 1870s. Hall made Ball's "Ohio" reapers and mowers under license in the 1860s and early 1870s, and then secured a license to build "Champion" machines from

the William Whiteley organization of Ohio in 1875 after six years of negotiation.[66] Whiteley invested in the Hall company, and changes were made at the works, including the construction of Ontario's first malleable iron works to make finger bars. The joint venture allowed Hall to specialize in reaper and mower production, but Whiteley abandoned the venture in order to establish the Toronto Reaper and Mower Company in 1877.[67] The Hall company, its future seemingly assured in 1875, returned to general implement production, focusing on the threshing machinery market. By 1887 the company was bankrupt.[68] Without the American connection, and especially the profits that would have accrued from the new combined machines and harvester-binders developed by Whiteley, the Joseph Hall Company was forced out of the harvester market and eventually out of business. This demonstrates the importance of American licences to Ontario firms as well as the versatility of the foundry shop in switching products.

The era of licences ended in 1890, with the last known harvester licence going to the Noxon brothers from Seiberling of Ohio in that year. Apart from the transfer of a corn harvester from D.M. Osborne, Massey-Harris received no new licenses after 1890. With standardization of harvester design by 1890 Ontario firms which already made harvesters and binders did not require further technology transfer for these products. With competition between the leading firms taking place on a continental basis there was less incentive for American companies to grant local licences. The amalgamation of the eight leading harvester companies into I.H.C. in 1902 further reduced the field of companies from which licenses could be obtained. Only 2 new firms were started in Ontario after 1885 and by 1900 only 8 of the 31 harvesting machinery companies in 1885 remained in the business. The firms which did not enter harvester manufacture before 1885 found it difficult to do so afterwards, because of their lack of access to technology and because of the intense competition in the industry.

It is testimony to effective technology transfer that, in such complex products as harvesting machinery, at least two Ontario manufacturers emerged in the late 1870s and in the 1880s with the ability to follow American improvements through their own engineering efforts and at least under their own patent control. But there was a depth of technological development behind these industry leaders. All together 15 companies produced binders in Canada before 1900. That so many firms were able to acquire binder patent rights is surprising since, in this product, the window

of opportunity for small firms and late starters was virtually closed by 1885. A half dozen of these firms claimed to have contributed their own innovations and designs to their products. In harvesters a manufacturing industry was developed in Ontario which displayed innovative capabilities in keeping with what we should expect of American implement manufacturers and certainly ahead of comparable American late followers. Despite its late start the Canadian industry profited from technology transfer and by the 1880s was beginning to produce its own product innovations.

9. CONCLUSION: LICENCES, PATENT LAWS AND TECHNOLOGY TRANSFER

The Ontario harvester industry grew out of the moving frontier of foundry operations in North America. From the beginning it was part of a transfer of techniques, personnel and equipment from the state of New York west across the continent. In the 1850s reapers and mowers were developed as complete product systems in New York, Ohio and Illinois. These products commanded wide markets which no single manufacturer could supply and it became common practice to license other local manufacturers to produce for a specified sales territory. American companies also licensed British and Ontario plants in the mid 1850s. Licences were granted as part of the general expansion programmes of American companies. They were granted despite the Canadian governments' refusal to allow foreigners to hold patent rights. Indeed, licences reflected the fundamental principle of Canadian patent law: that there should be no absolute property right on invention. Licences were an effective way of avoiding the risks and costs associated with selling in distant territories while still retaining some control over the product and a portion of the profits.

Ontario manufacturers introduced American reapers, mowers and harvesters into Canada through a succession of licensing agreements. The result was that Canadian farmers bought Canadian-made American machines to harvest their crops. Ontario manufacturers paid royalties to and bought parts from American companies. They also faced a restriction on their sales area: they could not sell in the U.S. Product development was also conducted along American lines.

In a fundamental way, Canadian producers were dependent on American sources for product and process technologies. They paid licence fees to U.S. patent owners, bought parts from a U.S. owned

branch plant, and made U.S. machines with minor modifications. They had to position themselves carefully in the market for technology, which was a U.S. market, dominated by U.S. firms through litigation in U.S. courts. But this apparent domination of the Ontario harvester industry by American product systems should not be overstated.

Licences could lead to indigenous technical ability and in the long term could produce independent, innovative firms. Licensing and joint ventures were not like branch plants. Licensing presented a window of opportunity, limited by the product cycle and the shift to corporate organization, for technology transfer into Canada. Massey-Harris represented the achievement from this transfer. Canadian patent law was specifically designed to encourage domestic invention and to qualify the rights of all foreign inventors. It was in keeping with the small scale, multi-plant industrial organization of the early nineteenth century and the thinking behind the departments of agriculture, boards of industry and arts, mechanics institutes and expositions which characterized nineteenth century industrial policy.

There was effective technology transfer to Ontario companies. By the late 1870s Ontarians were patenting innovations on American designs. The chief successes were the development of a twine binder and a group of skilled workers responsible for innovations by A. Harris, Son and Company, John Watson's attempt to build a harvester, the creation of an engineering department at Massey-Harris in 1892, and J.McLachlan's patent activity in London. Most of the patents taken out by Ontario companies do not represent important or even original innovations, but they do represent attempts to claim ownership of product rights independent of licences. The Ontario industry developed an American style innovative capability in harvesters by 1875. Unfortunately this came late in the development of harvesters so no Canadian product systems can be identified, and there are no cases of Canadian firms licensing American companies – with the doubtful exceptions of Harris and Maxwell. The late start of the Canadian industry produced dependency relations but, of course, not all U.S. firms were technology leaders and the open market for technology and parts supported the operations of all U.S. manufacturers, including the majors. Canadian manufacturers were part of a U.S. production system but this does not constitute technological dependence in the senses that Williams and Naylor use. Ontario harvesting machinery firms were innovative and quickly ceased to

rent U.S. technology through licenses and branch plants. They should not be characterized as an inferior "instant industry" only intent upon renting U.S. technology. Until the establishment of the I.H.C. branch plant in 1903, no U.S. company was able to operate a successful branch plant to produce finished machines in Ontario. Canadian firms were late starters and therefore dependent on other foreign firms for technology, but this did not, inevitably, lead to domination by foreign companies through branch plants. Rather the branch plant economy that emerged after 1900 was the result of innovations which undermined both U.S. and Canadian producers because they were tied to new business institutions and were introduced without reference to the existing technology market.

The development sequence which has been described for reapers, mowers, harvesters and binders did not occur for all farm machinery products and sectors. In traction engines and threshers there were few licences, and domestic innovation began much earlier and was much stronger. It was also not the case in products of the twentieth century: tractors, combines and internal combustion engines. Changes in industrial organization and different production techniques meant that these products were difficult for Canadian firms to perfect and were transferred into Canada without reference to Canadian licensees. There were limits to the industries to which licensing was applicable and to the period over which licensing lasted.

NOTES

1 N.Rosenberg, 1982, *Inside the Black Box*, Cambridge, Cambridge University Press, p. 232.

2 The deficiencies of patent records are described by J.Lee as: not all inventions were patented; legal costs and fees may have deterred inventors from patenting; some inventors did not want the publicity entailed in patent issue; inventions were not of equal quality or economic importance; not all patents were worked so they do not necessarily measure innovation; and the patent office classification relates to technical not economic considerations. The Patent Office recorded patents date of issue and in this work all dates refer to the year of issue. J.Lee, "Inventive Activity in Southern Ontario, 1881-1911," in D.F.Walker and J.H.Bater (eds.), 1974, *Industrial Development in Southern Ontario*, Department of Geography Publication Series, No. 3, University of Waterloo, Waterloo, Ontario, 1974, 4-5.

3 R.L.Ardrey, 1894, *American Agricultural Implements: A Review of Invention and Development in the Agricultural Implements Industry of the United States*, Chicago, and L.Rogin, 1931, *The Introduction of Farm Machinery in its Relation to the Productivity of Labor in the Agriculture of the United States During the Nineteenth Century*, New York, reprinted. These are the standard works and the following description is based upon their works.

4 These machines were based upon the Sylla and Adams hinged bar patent of 1853 and the later work of Kirby, Forbush, Whiteley and others. Most of the important patents related to hinged bar mowers were pooled in the Hinged Bar Mower Pool.

5 For example, "During the late 1840s and throughout the 1850s, the McCormicks changed virtually every part of the reaper from year to year." D.Hounshell, 1984, *From the American System to Mass Production*, Baltimore, Johns Hopkins University Press, p. 159.

6 Neither Ardrey nor Rogin regarded the celebrated controversy over who invented the reaper as a useful question. The trial, the subsequent propaganda and later discussion have highlighted the actual nature of innovation in the industry (innovation as an incremental process) while also revealing McCormick's attempts at patent monopoly. R.L.Ardrey, *American Agricultural Implements*, op. cit. pp. 4-47, 78-93 especially 41-47; L.Rogin, *The Introduction of Farm Machinery*, op. cit. pp. 73-74; C.McCormick, 1931, *The Century of the Reaper*, Boston, pp. 17-28; H.Casson, 1908, *The Romance of the Reaper*, New York; J.F.Steward, 1909, *The Reaper: A History of the Efforts of Those Who Justly May Said To Have Made Bread Cheap*, New York, pp. 96-148; J.Pekar, "The Patent System and Agricultural Equipment," Society of Automotive Engineers, 1980, *An Historical Perspective of Farm Machinery*, SP-470, Warrendale, Pennsylvania, pp. 31-33.

7 A Vicas, 1970, *Research and Development in the Farm Machinery Industry*, Royal Commission on Farm Machinery, Ottawa, p. 3.

8 For example the vast majority of implement patents related to churns. On average a churn patent was taken out once every ten or twelve days in the U.S. during the nineteenth century. In other lines farmers were also important, but not so in reapers and mowers. Shannon lists the number of patents registered in the U.S. to 1899 as 12,519 on harvesters, 12,652 on ploughs, 9,156 on seeders and planters, 5,801 on harrows and diggers, and 5,319 on thrashers. There were other patents on dairy equipment, fences, vegetable cutters, fertilizer and other items. F.Shannon, 1945, *Farmer's Last Frontier*, 1945, p. 138-139.

9 Both Hussey and McCormick encountered difficulties when they tried to produce their designs and both licensed foundries to make their products on a regional basis in the 1840s. This resulted in the diffusion of the basic product technology to several small facilities. L.Rogin, *The Introduction of Farm Machinery*, op. cit., p. 78.

10 This insight was previously reached by John Weaver, 1982, *Hamilton: An Illustrated History*, Toronto, James Lorimer, and n.d., "The Location of Manufacturing Enterprises: The Case of Hamilton's Attraction of Foundries, 1830-1890", unpublished paper, Ontario Agricultural Museum. Other authors have described the process. See especially Paul Johnson, 1978, *The Shopkeeper's Millennium: Society and Revivals in Rochester New York, 1815-1837*, New York, which describes apprenticeship in the frontier Rochester of the 1830s; and M.Katz, 1975, *Hamilton: The People of Canada West*, Cambridge, Massachusetts. For similar relationships in the textile industry, see P.Scranton, 1983, *Proprietorial Capitalism: The Textile Manufacture at Philadelphia 1800-1885*, Cambridge, Cambridge University Press, and in the iron and steel industry, J.Ingram, 1978, *The Iron Barons*, Westport, Connecticut. It is also worth noting the effect of the passing of the frontier. Other authors have described patterns of adjustment made by farm families in the second generation as opportunities for owning land and supporting a family diminished. The alternatives included moving on, intensifying operations, or diversifying out of farming, sometimes into foundry operations. By extension these alternatives also characterized foundry "settlement" and development. See especially J.Lemon, 1972, *The Best Poorman's Country*, Baltimore, Johns Hopkins University Press, and P.Gagan, 1981, *Hopeful Travellers: Families, Land and Social Change in Mid-Victorian Peel County, Canada West*, Toronto, University of Toronto Press.

11 The most well documented case is that of Dr. Calvin McQuesten, of Brockport, New York who set up a foundry, later the L.D.Sawyer works, in Hamilton, Ontario in 1835. McQuesten financed the foundry through his lending activities in New York state, and arranged for the transfer of foundrymen and other skilled workers from New York works, especially the Backus and Seymour foundry at Rochester in which he held an interest. This mother-daughter or spin-off relationship was then repeated throughout southern Ontario as apprentices or partners in the McQuesten works moved on to establish their own independent

plants. See the McQuesten Papers, Ontario Provincial Archives, and the discussion of them in J.Weaver, "The Location of Manufacturing Enterprises," op. cit.

12 Several of the farm implement works were established in this way. For example John Watson established a foundry at Ayr in 1847 after serving a moulding apprenticeship at Shotts Iron Works, Glasgow, Scotland, and then working in several New York shops and the McQuesten foundry from 1842-1845. The Haggert brothers trained in the Gurney stove works, Hamilton, before moving to St.Mary's and then Brampton. From there they established a branch at St.Thomas. The Hall works at Oshawa is better described as a daughter plant of a Rochester firm than its branch plant, because it was managed by Hall's son-in-law, and combined Montreal, New York and local capital. The John Watson and Company, Haggert Brothers and Joseph Hall files, Ontario Agricultural Museum.

13 Both Hussey and McCormick made their machines available to other workshops in the 1840s, but it was after the 1847 McCormick patent extension case that licensing became common. L.Rogin, *Introduction of Farm Machinery*, op. cit., pp. 73-76. D.Hounshell, *From the American System to Mass Production*, op. cit., pp. 154-160.

14 Obed Hussey obtained royalties from virtually every manufacturer of reapers and mowers for the life of his patents on the knife and finger-guard. W.T.Hutchinson, 1935, *Cyrus Hall McCormick*, New York and London, Century Company, I, pp. 163-4, 449-542, II, p. 371.

15 The idea of product systems is drawn from Ardrey's attempt to establish criteria for determining the significance of patents in the 1850s and 1860s. He was faced with a growing number of patents which were "so complicated and so intermixed that it will be impossible to notice any more than such as seem to have been the beginning of certain systems or classes of reaping machines." (R.L.Ardrey, *American Agricultural Implements*, op. cit., p. 48). Ardrey does not use the idea in any formal sense but it is possible to identify at least thirteen separate systems of reapers and mowers developed over the two decades to 1870 from his summary of product development. There were other separate systems. To my way of thinking they were systems in three senses: they were systems of (interchangeable) parts constituting a complex product; they were systems of patents protecting the product; and the patents were also associated with networks of licensed or otherwise related plants all producing a similar product under the same patent protection, or product system.

16 R.L.Ardrey, *American Agricultural Implements*, op. cit., p. 52.

17 The best example of this in the U.S. was the firm of William Anson Wood, brother of Walter A.Wood. At his Youngstown, Ohio plant, Wood made over 40,000 machines in the 1870s. William Deering in partnership with the Marsh brothers also performed well. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, p. 571.

18 Although there were over 80 American patents for automatic binders before 1868, almost the entire industry based their wire binders on the Gordon designs and eighteen companies used the Appleby patents as the basis for their twine knotters so that five sixths of all binders were of the Appleby type. Almost all of the others were built by Walter A.Wood who made under the Holmes patent. McCormick organized a patent pool on binders based on the Gorham binder patents (which predated the Appleby rights) and forced other manufacturers to pay royalties in order to build any binder. Nevertheless the binder design was rapidly diffused through the industry. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, p. 540; L.Rogin, *Introduction of Farm Machinery*, op. cit., pp. 110-115.

19 Even McCormick did not produce more than 20,000 machines in any one year before 1880. But the Chicago works was producing around 50,000 machines by 1885 and nearer 100,000 in the early 1890s. These production increases were associated with the introduction of "American System of Production" techniques, the breaking of the International Molders' Union, the extension of moulders' hours and changes to the ratios of bucks, berkshires and moulders. D.Hounshell, *From the American System to Mass Production*, op. cit.; R.Ozanne, 1967, *A Century of Labor-Management Relations at McCormick and International Harvester*, Madison, University of Wisconsin Press.

20 W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, p. 571.

21 The most celebrated Canadian case concerns the McCormick wire binder. McCormick licensed four Ontario companies to make his wire binders for the Ontario market while he sold in the Canadian west through Wesbrook and Fairchild, an agent based in Winnipeg. The four Ontario firms, J.Elliott and Son of London, D.Maxwell of Paris, Frost and Wood of Smiths Falls, and the Noxon brothers of Ingersoll, have been accused of copying the McCormick machines, but the truth of the matter is that McCormick failed to register his American patents on binders in Canada within a year of his U.S. patent registration. Thus, under Canadian law, he forfeited patent rights in Canada. There may have been an earlier case of copying: Helm and Son of Cobourg made McCormick reapers without a license in 1848. R.T.Naylor, *History of Canadian Business*, op. cit., I, p. 43; W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, p. 649; A.E.Skeoch, "Technology and Change," unpublished PhD manuscript, Ontario Agricultural Museum, p. 145; S.Bennett, notes on *Project Report*, International Harvester Photographic Archives, Canadian Council of Archives, 1986/87, Ontario Agricultural Museum.

22 W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 411-440.

23 For example, McCormick hunted down farmer inventions, bought part shares in the patent rights or developed alternate patent rights to cover the same development. Other companies followed the same practice. Walter A. Wood spent $100,000 between 1869 and 1874, mostly buying patents, in order to develop a self-binder. The most successful patent

pool was McCormick's binder ring. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 530, 540-543, 555-558.

24 D.Noble, 1977, *America By Design*, Oxford, Oxford University Press, p. 85.

25 W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, p. 569.

26 Cf. wood turning lathes, where a monopoly was secured by protracted court action. See C.Cooper, 1991, *Shaping Invention: Thomas Blanchard's Machinery and Patent Management in Nineteenth Century America*, New York, Columbia University Press.

27 The classic example is the consolidation of the Cayuga Chief, Buckeye and Ball two-wheel, hinged-bar mower patent systems. R.L.Ardrey, *American Agricultural Implements*, op. cit., p. 94.

28 For example the Champion system in the U.S. consisted of three separate factories which in 1875 made a total of 30,000 machines on the basis of related Warder, Bushnell and Whiteley patents and with a central engineering department headed by William Whiteley. *The Canada Farmer*, 15 July 1875, p. 5.

29 Cf. L.R.Rogin, *Introduction of Farm Machinery*, op. cit., pp. 73-76. While early forms of harvester like the Hussey were made in blacksmith shops the products quickly became too complex for this. See D.Hounshell, *From the American System to Mass Production*, op. cit., pp. 154-160, and Rogin, for a discussion of the problems McCormick had in obtaining product quality and standardization.

30 McCormick continued to buy sickles and malleable iron finger bars from outside contractors for most of the period to 1890. He did erect his own cutter bars and knives from these parts. Ontario manufacturers bought their cutter bars ready made from Whitman and Barnes of St.Catharines after 1872. D.Hounshell, *From the American System to Mass Production*, op. cit., p. 157.

31 R.T.Naylor, *History of Canadian Business*, op. cit., II, p. 41. Of course this was not the first case of obtaining American implement designs. Massey had copied a thresher in 1847, and other founders, like McQuesten and Company of Hamilton, had also copied or been licensed to produce other commodities.

32 For example J.Forsyth's repair lists for machines made in 1871-1874 differentiated parts developed by Forsyth from those of the original "Ohio" machines. Forsyth recommended that parts from other Ohio machines and other manufacturers of the "Ohio" system could be substituted where appropriate. *Forsyth and Company, Manufacturers of Dominion Harvesters, Dundas, Ontario*, True Banner Press, 1874, Provincial Archives of Ontario, Pamphlet No. 15.

33 R.T.Naylor, *History of Canadian Business*, op. cit., II, p. 43.

34 The three were J.Dick of Oshawa's improved self-rake reaper known as "Dick's Harvester", the combined reaper and mower developed by E.Shupe of St.George, and the "Excelsior" combined reaper and mower. J.Dick is known to have been associated with the Hall works in Oshawa,

and E.Shupe with the Haggert brothers, both of which produced American machines.

35 L.D.Sawyer and Company, 1869, *Illustrated Catalogue*, Ontario Agricultural Museum, p. 9.

36 For example McCormick licensed Burgess and Key of Brentwood, Essex who subcontracted to European manufacturers. As in his early U.S. licensing agreements, McCormick encountered difficulties as the British firm developed its own improvements and became less interested in marketing or producing his machines. The Forbush patents were manufactured by John Palmer of Stockton-on-Tees. Hussey machines were made by at least four British manufacturers in the 1850s. W.A.Wood licensed W.H.Cranston of London who sold over 2,000 reapers between 1858 and 1862. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 411-414 and 440. See I, pp. 377-408 and II, pp. 405-447 for a detailed history of the American invasion of Britain and Europe in the 1850s and 1860s.

37 In 1853 William McDougall was sent to the U.S. to investigate American farm machinery and the possibilities of obtaining it for Canadian farmers. He advocated the extension of patent rights to Americans in order to encourage the licensing of Canadian manufacturers. In 1869 Professor Buckland was sent to England to secure farm implements for the new museum planned by the Ontario government. *Report of the Commissioner of Agriculture and Arts*, Toronto, 1853 and 1869.

38 *Report of the Commissioner of Agriculture and Arts of the Province of Ontario for the Year 1869*, Toronto, 1870, p. 216.

39 *Report of the Commissioner of Agriculture and Arts*, 1869, Appendix B, Mechanics' Institutes, pp. 215-231.

40 C.R.Young, *Early Engineering Education at Toronto, 1851-1919*, Toronto, pp. 72-73.

41 R.A.Jarrell, "Science and the State in Ontario: The British Connection or North American Patterns?" in R.Hall, W.Westfall and L.Sefton MacDowell (eds.), 1988, *Patterns of the Past*, Toronto, Dundurn Press, pp. 238-254.

42 Extensions became standard practice. Thus in 1887 the *Canadian Manufacturer* described patent practice as follows: "The Commissioner of Patents, however, has power to grant, upon petition filed before the expiration of the year, further time, not exceeding one year, within which to import the goods. It is the practice of the office to grant not more than six months at a time. The law also requires that Canadian patents must be put in operation within two years of their date on pain of voiding the grant, but it empowers the Commissioner of Patents to extend the time upon petition filed before the expiration of the two years. This privilege is used somewhat extensively, a year being granted upon one petition.", *Canadian Manufacturer*, 7 October 1887, p. 228.

43 R.T.Naylor, *History of Canadian Business*, op. cit., II, pp. 42-43.

44 R.T.Naylor, *History of Canadian Business*, op. cit., II, pp. 38-64.

45 E.T.Penrose, 1951, *The Economics of the International Patent System*, Baltimore, Johns Hopkins University Press.
46 R.T.Naylor, *History of Canadian Business*, op. cit., II, p. 47.
47 The *Canadian Patent Record* registers only assignments, that is transfers of patent rights, not licenses (the sale of shop rights by a holder of patent rights). Since Deering, McCormick and W.A.Wood and other U.S. companies took out patent rights in Canada their licensees, like Frost and Wood and John Watson are not listed in the record. When patent rights for the country were transferred to a Canadian company, as with the assignment of rights by William Whiteley to the Toronto Reaper and Mower Co. and later Massey, the transfer is recorded as an assignment.
48 R.T.Naylor, *History of Canadian Business*, op. cit., II, p. 46, Table X(1).
49 This and other information on the Osborne company's product development used here are from R.L.Ardrey, *American Agricultural Implements*, op. cit., pp. 224-228.
50 M.Denison, 1949, *Harvest Triumphant*, Toronto, Collins, p. 86.
51 W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 475, 607, 618 and 699.
52 Binders and harvesters were counted as separate machines. This deflated the production costs per machine. For example in 1878 18,401 machines were sold, including 6,084 binders. If the binders are not counted as separate machines, the average production cost per machine rises form $38.77 to $57.92. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 475, 607, 618 and 699.
53 McCormick's production costs per machine increased to between $41 and $45 in the early 1880s, from $38 in 1878 and 1879. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 607 and 699.
54 M.Denison, *Harvest Triumphant*, op. cit., pp. 86-88.
55 John Harris and J. Lucas of Brantford Ontario took out U.S. patent #349,994 on a harvester-binder in 28 September 1886. *Canadian Manufacturer*, 8 October 1886, p. 592.
56 M.Denison, *Harvest Triumphant*, op. cit., p. 87.
57 Osborne bought into the Gordon patents in 1877 and again in 1880, then filed suits against McCormick for infringement. These suits were eventually settled in 1884. McCormick paid Osborne a $6.00 royalty: a total of $225,000. Osborne bought a half interest in the Spaulding binder patent and was protected by the patent of Allen Sherwood of Auburn, New York. These were early patents and constituted poor protection. He never purchased a license from Appleby, only a shop right. W.T.Hutchinson, *Cyrus Hall McCormick*, op. cit., II, pp. 546-551.
58 This may not mean a great deal. The absence of a Harris patent for the binder may also be inconclusive but there must be a great deal of doubt cast on Harris's claim to have developed the Brantford binder.
59 M.Denison, *Harvest Triumphant*, op. cit., pp.115-116.
60 I am indebted to Mr. B.Lovett of the John Watson Company, Ayr, Ontario for permission to view and reference his company's catalogues. Mr. Lovett is to be commended for the care he has taken to preserve the

company documents extant after the 1920 factory fire. A number of account books of the 1890s and early twentieth century as well as extensive records of the post war period are held in the company office at Ayr. In addition there is a collection of catalogues, copies of which are now held in the Ontario Agricultural Museum, Milton, Ontario. See also *Canadian Manufacturer*, 29 June 1883, pp. 2, 14 and 465; *Canadian Farmer's Manual of Agriculture*, 1876, pp. 469-471, 479, 565, 561.

61 C.Heron, "The Crisis of the Craftsman: Hamilton's Metal Workers in the Early Twentieth Century", *Labour/Le Travailleur*, 6, 1980, pp. 5-48.

62 The company's 1892 catalogue lists every manufacturer in Quebec and Ontario and the styles of cutter bars, sickles and knives Whitman and Barnes had sold them. In 1884 they manufactured 60,000 knives, 15,000 cutter bars, 300,000 extra sections and 500,000 guard plates. Collinson and Burch, the founders, remained as managers under the new American ownership. In 1887 the plant sold $250,080 worth of drop forged products, cutter bars, knives, woodworking and paper making knives, thresher teeth, and wrenches. Directory of St. Catharines Manufacturers, St. Catharines Historical Museum; *Canadian Manufacturer*, 4 May, 1883, pp. 322, 328-329; *The Whitman & Barnes Mfg. Co. St. Catharines, Ont., 1892 Catalogue*, 1892, Ontario Agricultural Museum; *Canadian Manufacturer*, 2 January, 1885, p. 872; "The Whitman and Barnes Manufacturing Company", *The Standard*, Special Souvenir Edition, 1907, p. 17, St. Catharines Museum.

63 A.H.Blakeby, "Report of A.H.Blakeby on the State of the Manufacturing Industries of Ontario and Quebec," *Sessional Papers*, 48 Victoria, A1885, p. 37.

64 Pye's patent was U.S. patent #351,400. *Canadian Manufacturer*, November 16 1883, pp. 2, 24, 839 and November 5 1886, p. 646.

65 For example L.D.Sawyer, which moved into traction engines, and the Meaford foundry, which turned to water turbines.

66 *The Canada Farmer*, 1875, quoting the *Oshawa Vindicator*.

67 This plant did however involve some Canadian capital and it was managed by Fassler and Kelly, two of Whiteley's Ohio partners. R.L.Ardrey, *American Agricultural Implements*, op. cit., p. 212 and M.Denison, *Harvest Triumphant*, op. cit. pp. 81-82.

68 In 1883 it advertised a new line of threshers, horse powers and trucks, and sold the malleable iron plant. *Canadian Manufacturer*, 24 August 1883, 2, p. 18; 14 December 1883, 2, p. 26; 20 March 1885, 4, 6, p. 1063; 6 May 1887, 6, 9, p. 269; 5 August 1887, 13, 3, p. 85.

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BIOGRAPHICAL NOTE

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