Regional Studies, Vol. 31.3, pp. 267–280

Popeism and Fordism: Examining the Roots of Mass Production

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(Received June 1996; in revised form September 1996)

NORCLIFFE G. B. (1997) Popeism and Fordism: examining the roots of mass production, *Reg. Studies* 31, 267-280. Although recent literature ascribes a unique role to Henry Ford in the development of mass production methods, in fact there was considerable continuity between pre-Fordist systems of mass production and what followed. Pre-Fordist production is explored through a study of the Pope (bicycle) Manufacturing Company which was innovative in its labour process, functional specialization and vertical integration, its use of patents, of interchangeable parts and promotion of mass consumption, and its nurturing of a specific corporate culture. Many continuities between 'Popeist' bicycle production and automobile production are evident.

Fordism Popeism Mass production Bicycle Manufacturing Interchangeable parts Corporate culture

NORCLIFFE G. B. (1997) Popeisme et Fordisme: une analyse des origines de la production en série, *Reg. Studies* 31, 267-280. Quoique la documentation récente attribue un rôle unique à Henry Ford pour ce qui est du développement de la production en série, en effet ce développement-là se poursuivait de façon continue entre les méthodes de production en série préfordistes et celles qui les ont suivies. On examine la production préfordiste à partir d'une étude de la société Pope (fabricant de bicyclettes) qui était innovatrice quant à l'emploi, à la spécialisation fonctionnelle et à l'intégration verticale, à l'emploi des brevets, des pièces interchangeables et de la promotion de la production en série, et à la culture d'entreprise toute particulière qu'elle a encouragée. Il est évident que nombreux sont les liens entre la production de bicyclettes 'popeiste' et la production d'automobiles.

Fordisme Popeisme Production en série
Bicyclette Fabrication Pièces interchangeables
Culture d'entreprise

NORCLIFFE G. B. (1997) Popeismus und Fordismus: Eine Untersuchung der Wurzeln der Massenproduktion, *Reg. Studies* 31, 267-280. Oschon die neuere Literatur Henry Ford eine einzigartige Rolle in der Entwicklung der Methoden der Massenproduktion zuschreibt, bestand in Wirklichkeit beträchtliche Kontinuität zwischen den Vorläufern von Fords Massenproduktion und seinen Nachfolgern. Vor-Fordische Produktion wird am Beispiel der Popeschen (Fahrrad) Manufacturing Company untersucht, die Innovationen eingeführt hatte auf den Gebieten des Arbeitsprozesses, der funktionellen Spezialisierung und vertikalen Integrierung, ihrer Ausnutzung von Patenten, von austauschbaren Teilen und der Förderung des Massenverbrauchs, sowie der Plege einer spezifisch korporativen Kultur. Vielerlei Fortsetzungen der Popeschen Fahrradherstellung tauchen in der Automobilherstellung auf.

Fordismusm Popeismus Massenherstellung
Fahrrad Herstellung Austauschbare Teile
Korporative Kultur

INTRODUCTION

In their book *Thinking for a Living*, Ray Marshall and Marc Tucker demonstrate just how explosive the growth of American industry was between 1870 and 1920. They write:

> It must have seemed to others that America came out of nowhere to capture the flag as the world's leading economy. In the 1870s, Germany and Britain were the undisputed economic and technological leaders of the world. Then, suddenly, we appeared in the vanguard. In 1926, we produced about 45 percent of the world's industrial output, including 80 percent of the world's automobiles and 50 percent of its steel, electricity, and crude oil. We were the world's leading exporter. We had already become, thirteen years earlier [1913] the world's largest and wealthiest market for manufactured goods (MARSHALL and TUCKER, 1992, p. 3).

What is most striking is the fact that a significant part of this period of economic growth predates the First World War (HESSION and SARDY, 1969) whereas much of the recent literature in industrial geography, fostered by GRAMSCI's, 1971, essay on 'Americanism and Fordism', focuses on the period following the First World War. The two foundational events that are noted most frequently in this literature are the publication of Frederic W. Taylor's *Principles of Scientific Management* (TAYLOR, 1911), and the opening of Henry Ford's

0034-3404/97/030267–14

first moving assembly line at Highland Park in 1913. Both these events occurred well into this period of rapid growth. Moreover, the regulationist literature suggests that Fordism did not become fully established as a regime of accumulation in the United States until after the Second World War (LEBORGNE and LIPIETZ, 1991). The implication is that something of a lacuna exists in the geographical literature on mass production. The growth of mass production after 1911 is well recorded, but the pre-1911 period is less well understood even though substantial productivity growth was evidently being achieved by investment in *pre*-Fordist methods of mass production. In short, rapid industrial growth had been underway in the United States for at least three decades before the date when the literature usually picks up the story.

An indication of when this phase of growth in US manufacturing began is provided by KENDRICK, 1961, in his study of long term changes in US productivity. He finds that the average annual increase of total factor productivity was 1·2% for 1869–78, 1·3% for 1889–1919, rising to 2·1% for 1919–57. These data indicate that, although growth of productivity was greater in the period after the First World War associated with the rise of Fordism, even in the late nineteenth century factor productivity (a good measure of innovation in embodied and disembodied technology) rose quite rapidly. The conjunction of this growth of productivity with a high rate of new investment in manufacturing accounts for the US eclipsing British and German manufacturing.

I want to explore this interesting period at the latter part of the nineteenth century when manufacturing in the US was already making impressive strides. In particular, I will examine the contribution of the Pope Manufacturing Company, at that time the world's largest producer of bicycles, to the development of mass production. Given the magisterial survey in HOUNSHELL's, 1984, *From the American System to Mass Production*, and especially the fifth chapter examining the American bicycle industry in the nineteenth century, the ground work is well laid for the project to be attempted here.[1] However, Hounshell is more circumspect in his overall assessment of Pope's contribution to mass production. He views the manufacturing methods of Pope, and of armament manufacturers such as Remington, Iver Johnson, Winchester, Colt and the John P. Lovell Arms Company (all of whom also made bicycles) as rooted in a conservative New England armament manufacturing tradition, which was not very innovative. He concludes: 'Unlike the Ford Motor Company fifteen years later, Pope's approach to assembly did not cause a revolution in manufacturing and work. Nevertheless, Pope's methods in testing and quality control proved to be of major importance for the automobile industry' (*ibid.*, pp. 206–7).

It will be argued here that Pope's overall contribution to the system of mass production was of greater importance. Within the technical definition of mass production that Hounshell addresses, an important qualification will be added, but the main argument is that Pope's vision of mass production was quite broad in its scope – perhaps not as all encompassing as the 'regime of accumulation' proposed by French regulationists – but nevertheless a system that involved advances in functional specialization and vertical integration, considerable technological innovation, major advances in the interchangeability of parts, innovative use of advertising and promotion of mass consumption, and the development of a corporate culture that sustained the system.

I will not attempt to insert Pope's system into a progression of regimes of accumulation of the kind identified by regulationists (AGLIETTA, 1979; DUNFORD, 1990; BOYER, 1990), evolving from artisanal production through machinofacture and Fordist mass production to flexible specialization. Such an approach has been roundly criticized by MARDEN, 1992, for its technological determinism. Here, a different discourse is developed which focuses upon the recursive and opportunistic nature of mass production. The evidence surviving in the Pope archives and other sources indicate that Pope had anticipated a number of the key features of mass production attributed to Ford. Moreover, at different stages in the development of his industrial empire he adopted methods that might today be labelled flexible, or Toyotist, or even Taylorist. Like Ford (and here I concur with WILLIAMS *et al.*, 1992, critique of metatheories such as Fordism), Pope did not linearly develop a specific mode of production since he had to contend with a succession of changes in the external trading environment, in regulatory frameworks, and in the standing of his own firm – its liquidity, its production priorities and its ability to set prices. Certain tendencies, such as automation, reduced labour inputs, and product innovation, were consistently pursued, but in other respects Pope tacked and weaved to maximize his competitive advantage. For instance, within a relatively short period of time he switched from sub-contracting to vertical integration of production, and from free-trading to building combines.

The goals of this paper are threefold. Since the story of Pope is not well known, I will first provide a brief summary of the life and industrial activities of Colonel Albert Pope, who became the world's largest mass producer of bicycles in the 1880s and 1890s; his production methods are here dubbed 'Popeism'. This neologism is not intended to be facetious. Pope has good claims to be ranked close to Ford and Taylor as a pioneer in the development of mass production. Second, I will examine several aspects of Popeist mass production, all of which are mentioned in the recent literature, the aim being to show that their roots go back further than is commonly supposed. Finally, I will interpret Popeism as part of the march of industrial modernity.

ALBERT POPE AND THE POPE MANUFACTURING COMPANY

Albert Augustus Pope was born in Boston, Massachusetts in 1843 to parents of impeccable New England settler ancestry. However, his father, a merchant and real estate operator, suffered financial reverses in the 1850's and 'lost his comfortable competency,'[2] an event which seems to have left a lasting impression on the young man who might otherwise have aspired to attend an ivy league university before entering his father's business; instead, at 16 years of age he was forced to start work.[3] Perhaps anxious to erase the memory of his father's failure, Pope spent most of his life amassing a large fortune as one of America's first venture capitalists; few anticipated that he, too, would suffer a setback in his later years, although he still had a sizable fortune at the time of his death.

It was probably through family connections that he was able to enlist in 1862 as a second lieutenant in the Thirty-Fifth Massachusetts Volunteer Infantry Regiment at the age of 19. One could say that he had a 'good civil war' since he was brevetted lieutenant-colonel by the end of the war in 1865. He used the title 'Colonel' thereafter, and cultivated connections with his regiment and the senior officer class for business and personal reasons.

The next 12 years were spent building up a successful small business making slipper decorations and shoe-findings. In 1876 he saw a high bicycle (now popularly called a pennyfarthing) at the Philadelphia Centennial Exposition, and decided to import eight of them from England. Largely imitating one of the imported models – the Duplex Excelsior – he set about designing his own improved bicycle. Pope consulted a patent lawyer, Charles E. Pratt, taking out patents on his design and trade name (Columbia Bicycles) in the fall of 1877. On the advice of this lawyer, he sub-contracted the manufacture of his first order to the Weed Sewing Machine Company of Hartford, Connecticut. This firm reluctantly accepted the order, a reluctance that soon turned to regret as they had to solve numerous technical problems in making the first batch of 50 bicycles. Priced at $95, compared to $112·50 for imported English bicycles, they sold sufficiently well that Pope returned the next year to Weed with a larger order. Weed continued to manufacture high bicycles for Pope through the 1880s, as he steadily built up the name of Columbia bicycles. He also pursued in the courts competitors who infringed his patents. In particular, in 1884 Pope began a dispute over patents with the Overman Wheel Company, manufacturer of the Victor bicycle, leading in 1886 to an injunction by Pope prohibiting Overman from selling bicycles. Overman appealed to the courts and won but there were further acrimonious exchanges between Pope and Overman during the 1890s over disputed advertising claims (ADAMS, 1996, pp. 127–8; ANON, 1969). These anecdotes indicate that Pope was very conscious of the protection these patents afforded his company, and of the importance of advertising and the image of his company.

Pope launched his first hard tyre safety bicycle, the Veloce, in 1888, and within two years production of the high bicycle had ceased. There followed, in successive years, a series of new safety bicycle models and innovations, including the chainless (shaft drive) bicycle of 1898. Bicycle tyres also changed rapidly: by 1891, cushion tyres were in fashion, giving a somewhat more comfortable ride than the solid tyre. By 1894 Dunlop's pneumatic tyre had eclipsed all other forms of tyre.[4] Well before this date, Pope had purchased an interest in the Weed Sewing Machine Company, and then bought it outright, adding to it a series of related activities to create in Hartford, by 1894, an integrated industrial complex (ANON, 1894). He was thus well poised to benefit from the bicycle craze of 1895–97.

Throughout this period, Pope had been very active in three public spheres that lay outside his direct corporate interest, but which nevertheless promoted bicycling. In 1880 he provided a security of $60,000 to cover the start-up costs of the *Wheelman* magazine, which was later merged with *Outing* to include a number of other outdoor pursuits. Both magazines achieved a wide circulation. Pope also argued that bicycling should be allowed in public parks, most notably Central Park, New York. An ordnance of 1880 which had specifically banned bicycling and tricycling from Central Park was challenged via a contrived infraction in 1881. There followed a series of appeals to the New York Supreme Court which were at first unsuccessful but which, by an 1887 Act of New York State, did eventually succeed; bicycles were declared carriages, and therefore subject to the same rights and restrictions (including access to Central Park) – see WIEDMAN, 1995. Pope contributed 'thousands of dollars' to the legal costs resulting from this litigation.[5] Pope also invested a huge amount of energy in promoting road improvement. He lectured across the United States on the commercial advantages of improved roads, invariably receiving favourable press coverage which he assiduously collected in his clipping files.[6] All this was free publicity for his bicycles, and at the same time helped redefine public spaces as 'on limits' for bicyclists.

The final phase of Albert Pope's business career began in 1895 with the creation of a motor-carriage department at the Hartford bicycle factory which evolved into the Columbia Electric Vehicle Company in 1896 (MAXIM, 1937). Pope experimented with gasoline, steam and electric carriages, eventually deciding to concentrate on the electric (battery driven) vehicle. Early this century Pope controlled vehicle factories producing gasoline cars at Toledo, and at Hartford, and electric cars at Indianapolis (MALONE, 1935, vol. 8, p. 74). With other automobile manufacturers, he formed the Automobile Trust, which

obtained the Selden patent on the internal combustion engine. However, a former bicycle mechanic and small-time automobile manufacturer named Henry Ford infringed this patent, and was sued – successfully in the first instance – by the Trust. But Ford appealed and eventually, in 1907, obtained a ruling in his favour (MAXIM, 1937, p. 73). In the same year the Pope Manufacturing Company and the Electric Vehicle Company reorganized, both being severely overcapitalized (they represented the larger part of their nominal assets in patents: NEVINS and HILL, 1954, p. 321). Pope was still restructuring these companies when he died at his summer residence at Cohasset, Massachusetts in 1909, aged 66.

THE LABOUR PROCESS UNDER POPEISM

Although the division of labour under systems of mass production was a particular focus of Frederick W. Taylor (TAYLOR, 1911), the economic advantages of labour specialization had been demonstrated almost a century earlier by Adam Smith, and applied to a range of industries throughout the nineteenth century.[7] There was, therefore, no great novelty in either Pope or Ford organizing production and factory space according to an elaborate division of labour. But Pope took the process further than it had been taken hitherto. Indeed, there were 840 parts in a man's bicycle of 1894, and almost exactly 1,000 in a woman's.[8] Production of these required:

> ... forge buildings, test rooms, brazing, inspecting, buffing, polishing, tool and assembly rooms; machine, stock, nickel plating, and case hardening departments; tubing works, rubber works, and many other divisions. The volume of business [at Pope's works] is three times that of the nearest competitor ... One can readily imagine that a very fine division of labour must be employed in such a manufactory; and yet one is scarcely prepared to be told on entering some huge rectangular room, nearly two hundred feet in length, bristling down its long perspective with a wilderness of vertical belts and whirring machines, that this shop is entirely devoted to the production of two or three insignificant screws or bolts ... Another deep impression of the extraordinary extent to which the division of labour has been carried here is given by the great variety of machines and tools that are employed in making a wheel – ranging from swarthy blacksmith shops, Titanic drop forges and steam hammers dealing blows measured by the ton, to instruments whose fineness might make them not out of place in a watch factory.[9]

Such was the division of labour, over 500 inspections were made in the manufacture of one bicycle.

As a consumer luxury, bicycle production was subject to the fluctuations of the business cycle. There were times of layoffs, and times of double shift production, suggesting a degree of numerical flexibility in the size of the workforce that was later re-discovered in the age of flexible production (ATKINSON, 1987; WOOD, 1989). For example, the workforce at Pope's Hartford factories dropped from 1,500 in the relatively prosperous year of 1893 to 1,200 the following year of recession.[10] The labour force seems also to have fluctuated seasonally; it varied between 2,000 and 3,400 in 1896, suggesting that there was a core workforce, with additional workers recruited to meet the peak demand of late spring and early summer. Pope's factories at times worked shifts to meet demand; the Hartford Rubber Works was operating 24 hours a day (2 shifts) in the summer of 1892 to keep up with the demand for the newly introduced pneumatic tyre.[11] By 1895, when the bicycle craze was underway, Pope's factory at Hartford was running day and night with three 'gangs' (presumably shifts) of men, making 150,000 finished parts requiring 500,000 operations every 24 hour.[12]

Pope was most innovative in the substitution of capital for labour, pushing this further than his rival producers in the US and Europe. A reporter from the *Scottish Cyclist* was given a tour of Pope's factories in 1893 and reported: 'From there I went to several great flats where lathes, drills etc were to be numbered by the hundred, the most striking feature being the remarkable **adaptations of machinery for labour-saving purposes** [original bold]. Everywhere, automatic machinery abounded'.[13]

There is ample record of Pope's awareness of the effects of mechanization on the workforce. The stimulus to Pope's most explicit comment on the subject was an address given by Bishop Potter at the 1897 Annual Supper of the Church Association for the Advancement of the interests of Labour in New York City. The Bishop remarked that:

> 'The great causes of the general ill-feeling and uneasiness among laboring classes in the United States to-day may be divided into two classes – machinery, and the manner in which the capitalist looks down upon the men who labor for him. Chief of these two is machinery. It is doing away with intelligence in labor. It is turning the laboring man into a simple idiot.'[14]

The Bishop proceeded to recount the repetitive work he saw a young man doing during a factory visit, suggesting that it had a negative effect on family life. As a leading industrialist, Colonel Pope was invited by the journal to respond, a challenge which he accepted:

> ... the bishop is doing a great harm by widening the breach between labor and capital ... The drudgery must be done ... Oftentimes men of education do work as monotonous and hum-drum as the daily labor of this young man who tended the piece of machinery ... This young man who tended the machine is not obliged to stay there all his life; if he has the right kind of fibre in his make-up, he can develop and rise to better and larger things ... as a boy I, myself, worked under the sidewalk in a dark hole stirring up barrels of varnish. It was monotonous and exceedingly tiresome, but ... I do not

> know that any harm has come from it ... the condition of the working class is better now than ever before ... Before the good bishop continues to talk in this strain, I wish he would pay a visit to our factories, and see the manner in which we care for the men there.
>
> It used to be inferred that the multiplication of inventions and the perfection of machinery lessened the number of employees, but experience shows that the greater the number of inventions, the higher is the rate of wages and the larger the number of men employed ... in the old countries of Europe, where there is little or no machinery, and where most of the work is done by hand, the condition of the working man is far worse than in the countries where there is modern machinery ...[15]

Two years later, as the bicycle combines were formed, Pope was less optimistic about the impact of mechanization. Faced with a 50% cut in the selling price of bicycles as the boom came to an end (see Table 1), he insisted that bicycle production costs had to be reduced, and to do this the number of employees had to be cut;[16] in effect, he called for lean production nearly a century before the term was coined (WOMACK *et al.*, 1990; HARRISON, 1994).

Pope felt that the divergence in labour practices between Britain and the US was due to the absence of unions in his plants, and their presence in British bicycle plants. British unions had the strength to oppose the introduction of labour saving devices, whereas in the US they lacked the required strength. The result, in Pope's view, was that the US produced a better bicycle for the same amount of money with fewer workers.[17]

FUNCTIONAL SPECIALIZATION AND VERTICAL INTEGRATION

The Fordist factory is characterized in the literature as an operation composed of a series of specialized departments which are geographically clustered together in a large, vertically integrated industrial complex. Economies of scale are achieved by manufacturing goods in large quantities. The firm's head office and management operations may also be located in the same grouping. Production in a flexible firm, in contrast, is likely to be vertically disintegrated, with various components and sub-assemblies produced by subcontractors or in the firm's own branch plants located at some distance from the parent plant. Departments may be less specialized, and employ team work to produce a variety of parts and sub-assemblies. This may be accompanied by a geographical division of labour extending as far as low wage regions in developing countries.

The record of Pope's production arrangements is one that begins with a flexible pattern of sub-contracting (at a time when the Pope Manufacturing Company was poorly capitalized), followed by progressive backwards integration as the firm bought out its suppliers, and built new factories at its main complex at Hartford, Connecticut. From the beginning there was an implicit departmental structure, although in the first instance the departments were suppliers of particular parts – tubing, wheels, rubber tyres, saddles and so on. By the end of the bicycle boom in 1897, Pope owned one of the largest vertically integrated industrial complexes in the world. Pope subsequently played an active role in the creation of a series of combines (i.e. monopolies) designed to maintain the prices of bicycles, tyres, steel tube, wooden rims and saddles so as to stave off financial collapse of the industry after the bicycle boom gave way to a slump. Henry Ford visited Pope's bicycle factories in Hartford several times before he started to manufacture cars.[18] He also worked as a bicycle mechanic for one of Pope's competitors. Ford was thus well aware of the system of bicycle manufacture.

Albert Pope found it prudent to launch his bicycle business in 1878 by sub-contracting his entire production to the Weed Sewing Machine Company which had spare capacity at its plant in Hartford, Connecticut, and was willing to undertake this risky contract. Adapting the drop forging and machining technology – the American system – developed by New England's antebellum arms industry,[19] the Weed Sewing Machine Company made these bicycles with substantial labour inputs; 'it is doubtful whether the Weed Company initially built or bought any special-purpose machine tools for machining bicycle parts' (HOUNSHELL, 1984, p. 194; see also ANON, 1897b, p. 292). Fortunately for Pope, Columbia bicycles sold well, and sometime in the early 1880s he purchased a minority (one sixth) interest in the Weed Company which had a capital of $240,000. In 1889 Pope bought all of a stock issue by the Weed Company to own one-third, and a year later he bought out the other shareholders to own the company outright.[20] The Weed factory then became the main site for production of Columbia bicycles: the production of sewing machines ceased, and 'significant innovations immediately began to appear' (HOUNSHELL, 1984, p. 202).

Up to 1892 Pope imported the tubing used to make his bicycles from England where the technology had been developed. He then built a new seamless tubing factory in Hartford adjacent to his bicycle factory with an annual capacity of 1 million feet.[21] This tubing operation was subsequently enlarged in 1894.[22] Also in 1892, Pope took the vertical integration of his operations a step further by buying out and greatly enlarging the Hartford Rubber Works, which thereafter manufactured solid, cushion and pneumatic tyres for Columbia and Hartford bicycles, and for the Chicago bicycle firm, Gormully & Jefferies.

The main bicycle assembly factories in Hartford were enlarged a number of times. A major step was taken in 1895 when Pope decided to add the lower-priced Hartford Bicycle marque to his top-of-the-line

Table 1. New models of Columbia bicycles, 1878–1900

Year	Model	Type	Price $	Details	Year	Model	Type	Price $	Details
1878	Columbia	O	95		1891	Columbia Light Roadster	H	135	Safety w/ cushion tyres
1879	Nothing new					Columbia Racing Safety	H	NA	Men's
1880	Special Columbia	O	127·50	Half bright	1892	Century Columbia	P	150	Men's
			137·50	Half nickel		Century Road Racer	P	150	Men's
			152·50	Full nickel		Columbia Racing Safety	P	175	Men's
	Standard Columbia	O	95	Half bright	1893	Century Columbia Model 32	P	150	
			105	Half nickel		Century Model 32 Road Racer	P	150	
			120	Full nickel		Columbia Model 30	P	150	
	Ordinary Columbia	O	75			Century Columbia Model 29	P	130	
	Youth's Columbia	O	55	28″ wheel		Columbia Light Roadster	H	110	
	Mustang	O	65	46″ wheel		Columbia Safety Model 27	P	125	
	Youth's Mustang	O	55	28″ wheel		Ladies Columbia Model 31	P	150	
1881	Challenge No.2	T	130	Imported		Ladies Columbia Safety Model 28	H	110	
	Triocycle	T	250				P	125	
1882	Expert Columbia	O	130	Half nickel	1894	Columbia Model 34	P	125	Light roadster
			145	Full nickel		Columbia Model 35	P	125	Ladies'
	Folding Challenge No. 2	T	145			Columbia Model 36	P	125	Century
	Challenge No. 6	T	140			Columbia Model 37	P	150	Semi-racer
1883	Royal Salvo Men's	T	150			Columbia Model 38	P	125	Tall frame
	Royal Salvo Ladies'	T	145			Columbia Model 39	P	140	34″ wheels
	Royal Salvo Sociable	T/TN	190	Side-by-side		Columbia Model 33	P	160	Racer
	Columbia Racer	O	155		1895	Columbia Model 40	P	100	Men's
	Columbia Tricycle	T	180			Columbia Model 41	P	100	Ladies'
1884	Nothing new					Columbia Model 42	P	100	26″ wheels
1885	Columbia Light Roadster	O	137·50	53″ standard nickel		Columbia Model 43 Tandem	P/TN	150	
			152·50	Wheels enamelled		Columbia Model 44	P	100	Racer
			152·20	Felloes enamelled	1896	Nothing new			
	Columbia Two-track	T	160		1897	Columbia Model 45	P	NA	Men's
1886	Columbia Tricycle	T	NA	Now called Columbia three-track		Columbia Model 46	P	NA	Ladies'
						Columbia Model 47	P/TN	NA	Diamond frame
	Columbia Racing Tricycle	T	NA			Columbia Model 48	P/TN	NA	Loop/diamond
	Columbia Safety	HS	140		1898	Columbia Model 49	P	75	Mens
	Columbia Semi-Roadster	O	90	50″ wheel		Columbia Model 50	P/S	125	Men's
						Columbia Model 51	P/S	125	Ladies'
	Ladies' Columbia Two-track	T	175		1899	Columbia Model 57	P	60	Men's
1887	Columbia Light Roadster Tricycle	T	165			Columbia Model 58	P	60	Ladies'
	Columbia Tandem	T/TN	250			Columbia Model 59	P/S	75	Men's
1888	Volunteer Columbia	O	100			Columbia Model 60	P/S	75	Ladies'
	Veloce Columbia	H	135			Columbia Model 61	P	60	30″ wheels
	Surprise Columbia Tricycle	T	150		1900	Columbia Model 63	P	50	Men's
1889	Columbia Light Roadster Safety	H	135	Men's		Columbia Model 64	P	50	Ladies'
						Columbia Model 65	P/S	75	Men's
	Columbia Tandem Safety	H/TN	200			Columbia Model 66	P/S	75	Ladies'
1890	Columbia Ladies Safety	H	135						

Key: O = ordinary (highwheel) bicycle; H = hard tyre safety; P = pneumatic safety; T = tricycle; HS = highwheel safety; TN = tandem; S = shaft drive (chainless).

Source: Catalogues published by the Pope Manufacturing Company of Columbia Bicycles (various dates). Table abstracted by Ross Hill.

Columbia marque. This move to horizontal integration required two separate assembly lines in adjacent factories, served by the same set of suppliers.

The final step in the vertical integration of production took place in 1894. Prior to that the Pope Manufacturing Company's headquarters had been located in Boston. As late as 1892, Pope had constructed a substantial new office building on Columbus Avenue in Boston which was then considered one of the most modern buildings in that city. The ground floor was a salesroom, the second had accounts, advertising and management offices. The next two floors were

occupied by stockrooms and repair shops, while the top floor had a riding academy patronized by Pope's clients, with women from Boston society forming the largest group; an Otis electric elevator – the first industrial use of this innovation (POPE, 1995) – took clients and their bicycles up to the riding academy.

Only two years later, Pope moved the company headquarters from Boston to Hartford where he built another very modern office building which was connected to the main bicycle assembly factories.[23] The reason for this move appears to have been the very rapid growth of the Pope Manufacturing Company between 1892 and 1894 as the bicycle craze gathered steam; Pope's vice-President, George Day, attributed the move to the difficulty of co-ordinating the details of production from Boston.[24]

With the consolidation of the Pope Manufacturing Company's head office with the main production facility, Pope had created a fabrication and assembly facility that served as a prototype for the Fordist plant. A commentator wrote: 'There is possibly no larger plant devoted exclusively to any one industry than the immense area of factories under the control of the Pope Manufacturing Company situated in the city of Hartford, Ct. For almost a mile, these buildings extend along the line of the New York, New Haven and Hartford Railroad.'[25]

The final stage in the vertical integration of the bicycle industry, going beyond the main subject of this paper, was the horizontal integration of nearly all bicycle manufacturers into a 'bicycle trust', or combine, initially named ABC (the American Bicycle Company), which went into receivership in 1902 and was resurrected as the American Cycle Manufacturing Company (OLIVER and BERKEBILE, 1974). This outcome was not especially surprising; although the industry had claimed for many years to be competitive, in practice it was quite oligopolistic, indeed only during the bicycle craze of 1895–97, when more than 300 companies produced over a million bicycles a year did the industry become quite competitive. Pope certainly claimed that the industry was competitive. He would point out that, of the companies formed in the first four years of the bicycle age, only one (his own) survived, and of those formed in the first 10 years (1877–87) 55 had failed, this being 'the most eloquent kind of testimony of the fallacy of the prevailing idea that the bicycle business is a business of large margins and profits'.[26] In truth, the industry was strongly protected by patents, and Pope had admitted only three years earlier that 'bicycle prices will drop when the patents run out, as did the price of sewing machines.'[27] It is revealing that the very first step Pope took on entering the industry was to engage a patent lawyer. Pope then bought up all the velocipede patents he could, including the crucial Lallement crank patent (for $300), and thereafter collected a royalty of $10 on every bicycle imported and manufactured in the United States, until these early patents ran out between 1883 and 1886. In spite of Pope's remarks, there are indications that the industry was oligopolistic, with manufacturers reaping substantial profits, especially when protected by patents.

PATENTS AND INNOVATION

Between 1878, when Pope made his first high bicycle, and the turn of the century, the bicycle evolved in a quite remarkable way. It served as a minor carrier wave (HALL and PRESTON, 1988) bringing in its wake a whole host of technological innovations that paved the way for the automobile era. Indeed, excepting the internal combustion engine, almost every technological breakthrough required for the car had previously been either adapted to, or specifically developed for bicycles. Moreover, the first autos were a logical evolution of the bicycle; Ford's first car which was launched in 1896 and significantly named the Quadricycle, included many bicycle parts. Included amongst these innovations were the pneumatic tyre, hollow metal rims, tangent spoked wheels, the axle differential, gears, shaft and chain drive, brakes, wheel bearings, spring suspension and lighting. Equally important were innovations made to the production process, rather than to the product; advances in metallurgy included cold drawn steel, case hardening, swaging, annealing, electric welding, die making, and stamping and pressing.[28]

HOUNSHELL, 1984, identifies two innovation cultures within the bicycle industry, a New England tradition growing out of the manufacture of arms, sewing machines and similar small manufactured items (he labels this the 'Yankee armory tradition'), and the western bicycle manufacturers whose roots lay mainly in building big machines such as carriages and wagons, and agricultural implements, but also wooden toys. In the final analysis, the western tradition, which developed stamping and pressing methods, was to be more successful, and in 1896 – at the peak of the bicycle craze – Pope's production was actually surpassed briefly by the Western Wheel Company of Chicago. Soon after, Pope also adopted stamping and pressing methods.

This stream of innovations had several effects. First, in order to gain competitive advantage, the innovations were protected by patents which were sometimes bought and sold for high prices and became major assets of some bicycle companies. Second, leading firms invested heavily in inventive activities (and some in industrial espionage) to keep abreast of their competitors. And third, the rapid evolution of bicycle technology made older bicycles obsolete in short order.

An insight into the importance Pope attached to patents is provided by the micro-geography of the new general office building his company occupied at Hartford in December 1894. The Patent and Law Department was located immediately adjacent to Pope's own office and that of the vice-President on the third

floor. From the moment of his entry into the bicycle industry, Pope had understood the importance of owning patents, and enforcing them to generate revenue directly, through licences, or indirectly by maintaining bicycle prices higher than would be the case in a fully competitive market. Pope's first action, having decided to manufacture bicycles, was to buy up all the old velocipede patents still available and particularly Pierre Lallement's crank patent.[29] Having gained control of this key patent, Pope lowered the licence fee from $25 per bicycle manufactured or imported to $10; he wanted to popularize the bicycle, not price it beyond the reach of most young men.

Throughout the period, until his interests shifted to automobiles, Pope continued to apply for bicycle patents, and to purchase key patents that were not the product of his own company's invention. Some, including the Mannesmann patent on seamless steel tubes, were process patents, whereas others, such as the Columbia adjustable bearing and the chainless (shaft drive) bicycle (ANON, 1897a) were product innovations. When the various bicycle manufacturers merged into the combine known as the American Bicycle Company, collectively they held about 1,400 patents, with the Pope Manufacturing Company accounting for the largest share of these.[30]

Not only did Pope assiduously guard his interests through patent protection, he kept a sharp eye out for the activities of his competitors as, in their turn, did they. Indeed, one of his first acts, having decided in 1878 to enter the bicycle industry, was to make a trip to Europe 'to study the bicycling situation'. Accompanied by his technical advisors, he visited the factories of leading British and European bicycle and bicycle component manufacturers to observe their techniques. According to POPE, 1995, p. 95, having been refused entry at one factory, 'he and his cohorts dressed as workmen and gained access to the plant in question'. It is clear that Pope's early bicycles and production methods involved a high degree of imitation.

The Pope Manufacturing Company also took the job of invention and innovation seriously, and by this method moved from the early imitation stage to become an innovator in the industry. The Columbia adjustable bearing, which he patented in 1880, was important since it freed him from dependency on the Bown bearing imported from Britain. Through much of this period, Pope employed Mr C. E. Hawley, a consulting engineer, who 'occupies his whole time on technological improvements for the bicycle, and the machinery of production'.[31] Mr Hawley travelled extensively, in Britain, Europe and the US keeping an eye out for new developments in the industry.

Pope was very aware of the importance of reducing production costs by automation. In 1893, for instance, his factories at Hartford were amongst the first to switch from coal to kerosene for heating and steam generation.[32] His maxim was that 'the perfection of machinery lessened the number of employees'.[33] Mass production at the Hartford works was advanced by mechanization and automation, wherever feasible. POPE, 1995, p. 97, reports that his great-grandfather employed Edison to build at Hartford the first electrified continuous production assembly line in the US (visited and admired by Henry Ford, and many others).[34]

Mass production, of the kind Pope sought to establish, needed to be matched by mass consumption, but generating such a mass market required sustained effort. The product needed advertising, and few people had more success in gaining publicity than Pope. The product needed to be affordable, so Pope lowered his prices when he was ready to expand his market (see Table 1). And the product needed to be new, hence Pope's investment in innovation to ensure that a steady stream of new bicycle models appeared which made older models obsolete. Table 1, giving the sequence of new models that Pope introduced between 1879 and 1900, is an impressive record of technological progress, comparable to the evolution of the micro-computer a century later. Out of this series of technological innovations came the means to mass produce bicycles, to lower unit costs (see Table 1) and to innovate frequently to create new demands which sustained a mass market.

INTERCHANGEABLE PARTS AND MASS PRODUCTION

The moving assembly line, usually linked with the name of Henry Ford, is commonly identified as being the essential element of mass production. Yet WOMACK *et al.*, 1990, pp. 26–7) write: 'The key to mass production wasn't – as many people then and now believe – the moving or continuous assembly line. Rather, it was the complete and consistent interchangeability of parts and the simplicity of attaching them to each other'. Ford certainly insisted on 'working to gauge' in every part of the manufacturing process, but he was by no means the first to do this. Nor was Pope the first – other mass produced goods developed earlier in the nineteenth century including armaments, agricultural machinery and sewing machines were produced to accurate specifications. But Pope certainly took the process further than it had previously been taken:

> Another event having an effect on the designing and manufacturing of machinery entirely unlooked for at the time of its inception was the manufacture of the bicycle. This event ... demonstrated to the world that [American mechanics] were capable of designing and making special machinery, tools, fixtures, and devices for economic manufacturing in a manner truly marvellous; and has led to the installation of the interchangeable system of manufacture in a thousand and one shops where it was

formerly thought to be impractical (WOODWORTH, 1905; quoted in HOUNSHELL 1984, p. 189).

Pope seems to have identified the importance of interchangeable parts on his initial trip to British bicycle factories in 1878, since he 'proceeded to manufacture on a large scale and according to the best methods on the interchangeable plan'[35] from the time of his initial sub-contract to the Weed Sewing Machine Company. The advantages of interchangeability were noted frequently in Columbia bicycle advertisements and catalogues. JARDIM, 1970, p. 5, reports that, by the turn of the century the Pope Manufacturing Company could machine the bevel gear (used on the chainless bicycle introduced in 1898) to tolerances of 1/2,000 inch, whereas as late as 1903, Ford had to be content with tolerances of 1/64 inch. Pope achieved such accurate specifications by investing heavily in metallurgy and precision machines, and by inspecting the products at frequent intervals, thereby building on the precision achieved by New England arms manufacturers.[36]

There are two main elements to the use of interchangeable parts in mass production. First, they must be manufactured to fairly exact specifications and tested for accuracy at every step. VANT, 1993, and VANT and DUPUIS, 1993, in their study of the cycle industry of St Etienne, note that the leading French manufacturer, La Manufacture Française d'Armes et Cycles de Saint-Etienne (MFAC), also benefited from an armory tradition used to working to exacting specifications. Like Pope, MFAC began by importing British-made bicycles but then, in 1888, made the transition to manufacturing them. It is of interest that Henri Fayol, seen by HARVEY, 1989, p. 128, as a figure comparable to F. W. Taylor, and who was educated in the mining school of St Etienne, played a role in the organization of production '*avec précision, rapidité, et économie*' at MFAC (VANT, 1993, p. 136). Pope initially achieved this precision using milling and machining technology, coupled with careful inspections. The stamping and pressing technology that he introduced later almost guaranteed standard specifications. Pope also kept strict quality control: in 1894, for instance, it was reported that Pope employed 24 skilled inspectors who collectively made over 500 inspections of one bicycle.[37]

Second, interchangeability worked best if the same parts were used across a wide range of models. For instance, agreed upon sizes were achieved with bicycle wheels and tyres. Pope's adjustable bearing and the bevelled-gear shaft drive mechanism were used on a wide range of bicycles. This standardization went furthest during the bicycle craze of 1895–97 when many small bicycle manufactures were, in practice, assemblers who simply made their own frames to which they attached Kelly handlebars, Christy saddles, Hickory wheels, Powell and Hamner lamps, and diverse other parts and accessories.

ADVERTISING, SALES AND PROMOTION

Mass production and mass consumption form two inseparable sides of the same coin, yet many aspiring mass manufacturers have failed to grasp this essential connection. Albert Pope was not one of this group, indeed he built up a mass market for his bicycles before he acquired his own manufacturing operations. His initial system bears comparison with the flexible arrangements that DONAGHUE and BARFF, 1990, describe in their study of the Nike sports footwear empire. Nike today is essentially a flexible research and marketing operation which sub-contracts all its production to East Asia; in the 1880s, Columbia's parent firm could more accurately have been called the Pope Marketing Company!

Albert Pope promoted his firm's products with panache. He was quite explicit about this: 'I believe in advertising; without it we could not have built up the largest bicycle business in the world'.[38] Even more revealing is Pope's response to an interviewer's question about his best employee:

> He is the most faithful fellow in the world. He has been in my employ for seventeen years, yet he has never even asked for a holiday. He works both day and night, is never asleep or intoxicated, and though I pay him more than $250,000 a year, I consider that he costs me nothing. His name is Advertisement.[39]

The annual catalogues produced by Columbia bicycles are classic examples of well written and cleverly illustrated brochures. The first of these was issued in 1878, the year he launched the Standard Columbia; thereafter new catalogues were published annually, and sometimes more than once a year. They usually appeared in spring in time for the early summer boom in bicycle sales. But it was not just in formal advertising that Pope was so effective. It was said of him that when he did any public act, 'whether it was charity ... or good work of any kind, there was always an advertisement closely shadowing the act'.[40]

The scope of Pope's informal promotion of bicycling in general, and Columbia bicycles in particular, is quite extraordinary. Soon after he had helped to found the bicycling organization known as the League of American Wheelmen, Pope provided a $60,000 line of credit to create a bicycling magazine called *The Wheelman* which did a great deal to popularize the sport. Thereafter Pope's company received favourable treatment in this journal. Long distance rides on Columbia bicycles were also publicized. For instance, it was widely broadcast that the first person to bicycle round the world, Thomas Stevens, used an Expert Columbia. Since bicycle races sell bicycles, Pope's company sponsored racers and races, assiduously keeping a note of records set on Columbia bicycles. In 1889, with a group of other entrepreneurs, he purchased a large tract of land on the Back Bay in Boston to develop

into an athletic park including a half-mile bicycle race track with a grandstand for spectators. Three years later, the head office of the Pope Manufacturing Company in Boston was designed (as already noted) with a bicycle riding school on the fifth floor, accessed by electric elevator. This was the largest riding school in Boston; the majority of its patrons were women anxious not to be seen in public before they had mastered the technique. The success of this school during the bicycle boom is recorded: whereas in February 1894 there were 211 lessons given, in February 1895 this increased five-fold to 1,012 lessons![41] Never one to miss good publicity, following the adoption of pneumatic tyres, Pope announced the availability, at no charge, outside the 'Vatican' (as the Pope offices in Boston came to be known), of the 'finest quality of air, compressed by electricity, and stored in a brass tank'.[42]

Pope was equally active in promoting new spaces in which to ride, especially the public parks from which bicycles had been largely excluded. The case of Central Park, New York, has already been noted, but there were others including South Chicago Park, and Fairmount Park, where Wheelmen (with Pope's encouragement) lobbied for the admission of bicyclists.

The continued expansion of bicycling depended upon the identification of new markets, and then persuading those identified of the value of bicycles. At first, the target was young men who formed militaristic Wheelmen clubs in most American towns. Pope later focused particularly on two other markets: women, and the military. Women rarely rode high bicycles; they were simply too dangerous, and it was socially unacceptable. With the arrival of safety bicycles, half of humankind had to be alerted to the advantages of bicycling. Pope spoke frequently on the subject; 'Some of the first ladies of the land in Europe appreciate the health-giving exercise and charming recreation which the bicycle affords, and now that the graceful machines are made with such lightness and ease of manipulation even delicate girls can cover miles without exhaustive fatigue'.[43] One problem to be overcome was the question of identifying acceptable dress for women cyclists. Characteristically, Pope hit upon a simple solution to this, at the same time promoting bicycling by the upper classes (his primary target prior to the bicycle craze). At that time, during Lent, New York society dropped frivolous activities, and paid penance through charitable works including dressing dolls for an annual Lent show held at the Waldorf Hotel. Pope donated $100 for the best doll dressed in a woman's bicycle costume; this ploy simultaneously helped promote acceptance of bicycling amongst the elite, while allowing the elite itself to define what was acceptable clothing for women bicyclists.[44] For this, Pope received favourable write-ups in almost every daily newspaper in the Eastern United States, all for a $100 outlay.

Pope advocated the use of bicycles to conduct several public activities including policing, fire protection, post and telegraph delivery. But the largest market he saw was the military: 'I venture to say that in the next war, cyclists will play a very important part'.[45] He wrote to the chief of the Massachusetts militia, General Samuel Dalton, in 1894 pointing out that several states had purchased bicycles for their militia, enclosing pamphlets on *The Bicycle in the Army*, and *Cyclists Drill Regulations*.[46] In July 1895 he took General Nelson Miles (who was due to become commander-in-chief of the US Army four months later) to the Astbury Park bicycle races hoping to demonstrate the advantages of military bicycles.[47]

Pope also responded to the charges frequently made by clergymen that bicycling on the Sabbath was sinful. For the working person, Sunday was the only day when bicycling could be enjoyed. His response was along two lines. First, he urged churches to build 'bicycle stables' so that bicyclists could attend more services and increase church attendance. And second, he stressed the links between godliness and good health, and good health and bicycles. The syllogism was never formally completed, but the conclusion, that God looked favourably upon bicycling, was very obvious.

As PETTY, 1995, stresses, these strenuous efforts in advertising and promotion bore their fruits in the form of a mass market which permitted mass production of bicycles. In order to deliver to this market, Pope developed a network of sales agents. HOUNSHELL, 1984, p. 203, finds Pope's marketing strategy quite conservative: he did not integrate forward into marketing by establishing stores as did Singer with sewing machines, and Ford with automobiles. Pope established 'branch houses' in major cities – New York in 1882, Chicago in 1884, with houses in Providence (RI), Rochester and Buffalo (NY), Detroit (MI), St Louis (MO), Portland (OR), San Francisco (CA), New Orleans (LA), Pittsburg (PA), Washington (DC), Milwaukee (WI), Louisville (KY), and Springfield (MA) by 1898. As early as 1879, Pope had created a network of selling agents (selling at fixed prices); by 1897 it numbered 2,000 agents. Pope's system clearly had its merits. At a time when he was undercapitalized he did not have to invest in a chain of stores. Moreover, the sales network system was one where he could easily practice numerical flexibility during a slump in sales by simply laying off some of his agents. In the context of the recent literature on flexible specialization, Pope might be labelled innovative rather than conservative.

THE CULTURE OF THE FIRM

A number of researchers have found the operating culture of a firm to provide important insights into its production strategy, including questions of location, form of production, labour relations, linkages with outside firms, and impacts on the town or region in which the firm is located (SCHOENBERGER, 1991; MARKUSEN, 1994). However, adopting such an

approach to interpret the production strategy of a firm that was in business over a century ago is not easy, particularly since interviews with corporate decision makers are not possible. Also, the surviving record of the Pope Manufacturing Company is fragmentary, although enough survives to allow at least a sketch of its corporate culture to be drawn.

Albert Pope viewed his employees as members of an extended family – he often used the term 'a contented family' himself.[48] He did not create a social department as Ford did, but he fostered a paternal relationship between his firm and its employees. Examples of this include his presenting a cash bonus as a Christmas gift to his workers,[49] sending cheques to sick employees and to bereaved wives of former workers, and awarding shares in his company to its employees. He apparently took great pleasure when his workers presented him, on his 50th birthday, with a souvenir autograph album containing signatures of all the officers and employees of the company as 'an expression of the love and esteem borne by them towards Colonel Pope'.[50]

Having moved his entire production operations to Hartford, in 1892 Colonel Pope purchased the neighbouring Bartholomew Farm (about 100 acres) on which he built model homes for his workers. The plan was to build 416 homes at cost (this implies a lot sized roughly 80×100 feet for each dwelling) with the whole development attractively landscaped. Workers were expected to put down a payment of between $100 and $200, and pay monthly instalments on the balance. A gushing commentator writing on this project in a Hartford daily newspaper wrote of 'the humanitarianism of the man, arising from his kindness and extraordinary generous nuture'. This comment misses the point, on which Pope himself was perfectly frank, that 'contented labor emigrates with hesitation . . . when they get a man who looks for a garden at the start, that man is permanent'.[51] Pope was criticized for being too generous in his land allocations to employees but, like Ebenezer Howard in England, he consciously pursued the 'garden cottage' model, with a view to retaining the human capital invested in his skilled workforce: 'the little garden is a loadstone (sic) to the higher nature of him who works hard, and can only get a few minutes in the twilight or at early dawn to drink in what little Nature has set before him, but which is his own'.[52]

This concern to build a contented workforce extended inside the factories of the Pope Manufacturing Company. His workers were provided what seems to have been a very substantial lunch in his company dining rooms at nominal cost (7½ cents in 1893). After hours, workers had access to a company library, in conformity with the self-improvement model that was advocated. In addition, Pope insisted that his workers take two weeks (unpaid) continuous vacation each year.[53] Also, Pope anticipated Ford in one other respect: during a Sunday afternoon lecture he gave in 1892, he remarked 'everyone should sympathize with the workingman, for the better his wages, the more he has to purchase the goods of the merchant and the manufacturer'.[54] HARVEY, 1989, p. 126, notes that two decades later Henry Ford pursued a similar strategy, reasoning that it was in his own interest that his employees should also be potential customers for his cars. Both industrialists appreciated the necessary connection between mass production and mass consumption.

Corporate culture, for Pope, also extended to the community. Thus in 1892 Pope presented 73 acres of land he had been assembling to the City of Hartford for a public park, subject to minimal conditions (bicycling was not to be prohibited). Such philanthropy (the land was valued at $100,000) forms part of a corporate culture that has recently been associated with Japanese firms but which, in practice, has a longer history.

CONCLUSION

I have sought to show in this paper that Albert Pope was an important figure in the development of mass production. He may not match Henry Ford's standing as an innovator (LEWIS, 1976), but he certainly ranks close behind as an *eminence* of late nineteenth century manufacturing. If mass production is defined, as Hounshell does, strictly in terms of process technology, then Pope was not a great innovator, although even here his contribution has been undervalued since it is reported that Edison installed an electrified continuous production assembly line in Pope's Hartford factory (which Ford visited and admired). However, if mass production is defined as a much broader system connecting with consumption, institutions and the environment of regulation, then Pope indubitably made a major contribution.

Pope advanced mass production on several fronts. He took the division of labour further than bicycle manufacturers had previously taken it. He built up, in the process, a vertically integrated industrial complex in Hartford, Connecticut, that exceeded by far, the employment of any bicycle firm located in Coventry, England, or St Etienne, France. He played a wily patent game, and was innovative in many respects, but above all in introducing new models at frequent intervals that made older models obsolete. History may judge, however, that his most important contributions were to the interchangeability of parts, and his promotion of mass consumption.

The danger in examining past geographies of production in stages (such as Fordism) is that it ignores the historical continuity between one stage and the next. It is more useful to view the many innovators to mass production as players in the game of modernity. During the nineteenth century, the march of modernity was very clearly expressed not just on the streets of Paris and St Petersburg (BERMAN, 1982), but also in the

factories of Europe and America that were engaged in the project to produce more, faster and cheaper. Although the geographical literature has focused above all on the contributions of Frederick Taylor and Henry Ford, there has, in practice, been a stream of developments advancing industrial modernity. LOVERING, 1990, debates the form of 'Ford's unknown successor' but equally, there is a need to examine 'Ford's unknown predecessors'. Besides Hounshell's noted contribution, there have been only a few studies of preFordist mass production; CRONON, 1991, has described the huge meat packing industries of nineteenth century Chicago, while NORCLIFFE, 1993, has examined the creation by Tony Garnier of a similar abattoir and urban complex at Gerland (Lyon), complete with a '*cité jardin*' and a Fordist-like disassembly line.

Albert Pope and Henry Ford were both innovators and imitators. Neither seems to have had any compunction about spying on the activities of his rivals. Ford took considerable interest in Pope's operations, and learned from them. They fought over the Selden patent, with Ford the eventual victor. But by then Pope had long made his major contributions to advancing industrial modernity. Mass producers of bicycles paved the way for the automobile era, and among these pioneers of mass production Albert Pope stands out for the breadth of his vision of what mass production was all about.

Acknowledgements – I am grateful to Ross Hill, Librarian to the Wheelmen, for compiling Table 1 from library files, and Albert Pope for commenting on a draft of this paper.

NOTES

1. There are a number of useful studies of bicycle production, including ALLEN, 1966; HARRISON, 1969; MILLWARD, 1990, 1992, but unlike Hounshell, they do not situate bicycle production in the progression of mass production.
2. *St Botolph* (New York), 3 June 1893. Pope's ancestors had arrived in the Massachusetts Bay Colony in the 1630s. Later generations became sea captains and merchant venturers in the Yankee tradition. Due to the loss at sea of several members of his grandfather's generation, his father was encouraged to pursue a shore-based career.
3. His younger twin sisters were among the first women to attend medical school in the United States, and both went on to become pioneering physicians in Boston, suggesting the presence of a radical streak in the family. Pope described himself as an 'independent of the most radical type' (Pope archives: letter to Fred C. Floyd, Boston, 4 December 1893).
4. *Bicyclist and Motorcyclist*, October 1969, reports that in 1890 98·6% of new tyres were solid tyres, in 1891 54·2% were cushion tyres, while in 1894 89·5% were pneumatic.
5. *The Mercantile Financial Times*, 25 June 1892. PRATT, 1891, puts the cost to Pope at $8,000.
6. The League of American Wheelmen, formed in 1880, listed among its founding purposes 'the improvement of public roads' (NEVINS and HILL, 1954, p. 256). Pope helped to: found the *Good Roads Magazine* in 1892; present a monster petition to Congress for federal action to improve roads in 1893; and create the National League for Good Roads in 1892.
7. DESMOND and MOORE, 1991, state that Darwin's ideas on natural selection and niches were influenced by the division of labour he observed at Wedgewood pottery factories.
8. *Review of Reviews* (Advertising Supplement), April 1894, p. 15.
9. *ibid*. pp.15–16.
10. *The Courant* (Hartford), 26 May 1894.
11. *The Courant* (Hartford), 29 August 1892.
12. *The New York Recorder*, 10 March 1895.
13. *The Scottish Cyclist*, 11 October 1893.
14. *Hardware* (New York City), 25 May 1897.
15. *Ibid*.
16. *The Post* (Hartford, Connecticut), 12 June 1899.
17. *Industrial World* (Chicago), 23 September 1897. Pope's workforce was subsequently organized by the Mechanics Union (Albert Pope, personal communication).
18. Personal communication, Albert Pope.
19. Drop forging technology involves casting a metal piece, and then milling and machining metal off the forging. Stamping and pressing does not involve these work-intensive methods; the desired piece is stamped out and in several steps pressed into the desired shape.
20. *The Times* (Hartford, Connecticut), 2 April 1890. Pope offered $15 for each $10 share, which all the other stockholders accepted.
21. *The Post* (Hartford, Connecticut), 1 June 1892.
22. The enlarged firm was re-incorporated under the title Pope-Mannesmann Company. Mannesmann was brought in because it held the patent on a new advanced process of seamless tube manufacture. In return Pope obtained exclusive use of the process in the United States. The restructured firm made not just bicycle tubing, but also a wider range of larger diameter tubes used in steam boilers (*The Hartford Daily*, 13 September 1894).
23. Pope purchased the Boston office building from his company as a personal real estate investment.
24. *The Hartford Courant*, 26 May 1894.
25. *The New York Recorder*, 26 January 1896.
26. *The Bicycling World*, 18 June 1897.
27. *The New York Record*, 17 July 1894.
28. The adoption of stamping and pressing was first done by the Western Wheel Works of Chicago, makers of the Crescent Bicycle, and not by Pope. HOUNSHELL, 1984, p. 202, stresses that, as far as production methods go, the New England arms and sewing machine manufacturers who also made bicycles 'developed few noteworthy new techniques'. Only when Pope bought out the Weed Sewing Machine Company did the rate of innovation in the production process speed up.
29. This important patent was held half by Richardson McKee & Company (makers of baby carriages and child's velocipedes) and half by the Montpelier Manufacturing Company. The story goes, having checked train timetables, Pope persuaded Richardson McKee to sell him one half of their half share in the patent. This done, he

hurried to Boston Station to catch the first train to Montpelier, Vermont, where he persuaded the other patent holders to sell him their part before news of his earlier purchase arrived in the mail the following morning.

30. *The Post* (Hartford, Connecticut), 6 June 1899.
31. *The Scottish Cyclist*, 11 October 1893.
32. *Ibid*.
33. *Hardware* (New York City), 25 May 1897.
34. Pope does not report the date of this installation.
35. *Cycling* (Philadelphia), 5 January 1894.
36. Pope had created a metallurgical laboratory at Hartford in 1892 (NEVINS and HILL, 1954, p. 133).
37. *Review of Reviews* (Advertising Supplement), April 1894, pp. 15–20.
38. *Publicity* (Boston), April 1892.
39. *The New York Recorder*, 6 February 1895.
40. *The Wheel*, 21 May 1897.
41. *The New York Recorder*, 10 March 1895.
42. *Time and the Hour* (Boston), June issue, 1897.
43. *Review of Reviews* (advertising supplement), April 1894.
44. The doll competition was sponsored by *Vogue* magazine, who reported the results in *Vogue* (New York), 22 April 1897.
45. Pope's address to the annual banquet of the League of American Wheelmen, 31 May 1892.
46. Letter to General Samuel Dalton, 9 February 1894.
47. *The Hartford Times*, 13 July 1895.
48. *The Wheel*, 21 May 1897.
49. *The Globe* (Boston), 25 December 1889, reported the Colonel expressed his 'sympathy with the gift-giving custom' by presenting his employees with a Christmas gift of $1,200 (and advertising the fact).
50. *The Boston Post*, 22 May 1893.
51. *Hardware* (New York), 25 June 1892.
52. *ibid*.
53. *The Union* (Manchester, New Hampshire), 8 September 1894.
54. *The Boston Globe*, 28 March 1892.

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