THE UK & JAPANESE AUTOMOBILE INDUSTRIES: ADOPTION & ADAPTATION OF FORDISM

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SOMMAIRE

1. INTRODUCTION **71**

2. THE CURRENT SITUATION - UK AND JAPANESE AUTOMOBILE INDUSTRY **72**
2.1 The UK-Japan Difference: Manufacturing Performance **72**
2.2 The UK-Japan Difference: Manufacturing Practice **73**

3. THE FORD PRODUCTION SYSTEM **76**
3. 1. Fordism **76**
3. 2. Taylorism **77**
3.3. Neo-Fordism **78**

4. THE ADOPTION OF FORDISM IN THE UK **78**
4.1 Pre-War Context **78**
4.2 Post-War Experience **82**

5. THE ADOPTION OF FORDISM IN JAPAN **86**
5.1 Pre-War Japanese Auto Industry: Impact of Fordism **86**
5.2 Toyota's Post-War Experience: Between 1945 and 1960 **90**

6. THE COMPARISON **96**
6.1 The Pre-War Comparison **96**
6.2 The Post-War Comparison **99**
6.3 Models for Adaptation of Fordism **101**

CONCLUSION **104**

BIBLIOGRAPHY **106**

1. INTRODUCTION

The purpose of the paper is to examine how Fordism was introduced to the U.K. and Japanese automobile industry in different ways. In Japan, Toyota is chosen as a typical case, and Austin and Morris (now Rover) in the UK. The discussion covers both the pre-War and early post-War periods.

The UK and Japanese auto industries have at least one thing in common: both tried to adopt Fordism directly or indirectly. In both cases, though, the auto firms could not apply Fordism directly to their production system, and thus had to adapt it to their domestic situations. In Japan, both Ford and GM built knock down assembly plants and dominated the market in the 1920s, but the transportation of full scale Fordism factories was virtually prohibited by a strong protectionist regulation by the military and the government in the mid 1930s. Toyota, Nissan and other Japanese makers of those days did not introduce the Ford production system as a package. In the U.K., Ford attempted to transplant Fordism to its Manchester Plant (1911) and then Dagenham plant (1931), but direct transfer of the American system was unsuccessful due to differences in market conditions and subsequent resistance of trade unions.[1]

How the Ford system was modified was very different between the two countries, though. The performance results, as measured in the 1980s, were also strikingly different. For example, assembly productivity was generally lower in the UK mass producers than the US mass producers, and even most of the producers in continental Europe. In contrast, the manufacturing performance of the Japanese auto companies was on average higher than the US during the same period. This striking difference seems to be caused partly by such environmental factors as patterns of labor markets and product markets, and partly by the difference in timing.

This paper examines how the differences in historical patterns of industrial evolution between the UK and Japan affected the present competitive differences. We focus particularly on the formative pre-War period. In Section 2, we will first summarize the present situation of international competitiveness of the British and Japanese auto industries. Section 3 will outline the concept and practice of Fordism in America. Sections 4 and 5 will than examine the pre-War and post-War evolution of the British and the Japanese auto industry with special emphasis on the adoption and adaptation of Fordism. Next, the patterns of historical development will be compared between the two countries in both the pre-War and post-War periods. We will introduce such concepts as 'technology push versus demand pull', 'forward adaptation versus backward adaptation', and 'compressed versus retarded' life cycle, in order to explain why the differences in the patterns of industrial evolution may affect competitiveness.

[1] Lewchuck (1987) & Womack, Jones & Roos (1990, Chapter 8) emphasize the former reason, while Tolliday (1986) emphasizes the latter

2. THE CURRENT SITUATION - THE U.K. AND THE JAPANESE AUTOMOBILE INDUSTRY

2. 1. The U.K.- Japan Difference: Manufacturing performance

As basic characteristics (i.e., size and concept) of the automobiles started to somewhat converge in America, Europe and Japan and international competition among them intensified in the 1980s, researchers and practitioners in this industry started comparative studies of international competitiveness. The studies in the early 1980s focused mainly on manufacturing cost and assembly productivity between he Japanese and the U.S. auto makers.[1] The comparative studies in the late 1980s generally expanded the scope of the research geographically by including European makers, or functionally by including product development and marketing, as well as elaborating the method of comparison.[2]

Overall, the studies repeatedly indicated that the average performance of the Japanese automobile assemblers was significantly higher than the North American and European counterparts in terms of assembly productivity, manufacturing quality, product development lead time and productivity, dealer satisfaction (in the U.S.), and so on. Although the competitive gap between the Japanese and the Western averages narrowed in such indicators as cost, manufacturing quality and development lead time by the early 1990s due partly to the appreciation of the yen, catch-up efforts of some of the Western auto makers, the Japanese on average maintained its competitive advantage throughout the 1980s.

Also, the studies gradually revealed that the source of the Japanese competitive advantage was not a simple sum of individual techniques and technologies (e.g., Kanban, Just-in-Time, quality control circle, automation, Keiretsu, simultaneous engineering, quality function deployment, etc.), but the total system that integrated such elements for competitiveness. MIT's International Motor Vehicle Program (IMVP), for example, called it the 'lean production system', which is essentially similar to the Toyota Production System.[3]

The studies of the 1980s also revealed that the European makers on average lagged behind not only the Japanese, but also the US makers in assembly productivity. The IMVP report, for example, shows that average productivity of the sample assembly plants was 17 hours per vehicle in Japan, 25 in North America, and 35 hours in Europe.

The IMVP data does not reveal data for individual plants, but it is generally known that the UK assembly plants are among the least competitive in Europe. According to Ford data, for example, productivity of Ford Halewood plant in the U.K. is about half of the Ford Saarluis plant in Germany: 40 hours per vehicle versus 21 hours per vehicle.[4] The decline of the U.K auto industry can be also inferred by production statistics: production volume of the U.K. auto industry peaked at the level of 2.3 million in 1972, and then decreased to nearly one million in the early 1980s. The share of imported vehicles surpassed 50% of the domestic market. The industry somewhat recovered during the 1980s, due partly to rationalization programs of the

[1] See, for example, Albernathy, Clark et Kantrow (1983)

[2] A comprehensive comparison of manufacturing performance among auto makers in Japan, U.S. and Europe is presented in Womack, Jones & Roos (1990). For product development, see Clark & Fujimoto (1991). For supplier systems, see Nishiguchi (1994)

[3] Womack, Jones & Roos (1990). *The Machine that Changed the World.*

[4] A report by Saarland government, Germany, 1992.

domestic makers and management transfers from some Japanese auto makers, but its production volume has never surpassed the 1970s.

In 1986, Nissan Motors U.K. started to produce cars at its plant in Washington, near Newcastle. According to Nissan, the productivity level of the U.K. plant as of 1992 is almost the same as that of the Japanese 'mother plant' (Oppama), although the relatively high performance of the UK plant is explained partly by its simple product mix. Toyota and Honda have also recently begun to assemble cars in the UK, and Isuzu is making trucks through a joint venture with Vauxhall (GM). Thus, performance of the transplants of the Japanese companies is generally high so far. This contrasts with the rather poor performance of existing British automobile plants, including Ford UK factories, which were essentially transplants of Ford US.

2. 2. The UK-Japan Difference: Manufacturing Practices

Behind the performance gaps between the Japanese and the British automobile industries was a difference in manufacturing practices and organization. Although the industries in both countries attempted to introduce certain elements of American Fordism while adapting them to their respective domestic environments at one point in history, they evolved into two very different systems (Table 1).

Table 1. Mass Production in the UK and Japan, circa 1980

JAPAN	UK
Small lot production	Large lot production
Low inventory level	High inventory level
Stable & close supplier relations	Market relations with many suppliers
Multi-skilled workers in teams	Single-skilled & craft workers
Skill-based wage	Piece-rate (until recently)
Company unions including supervisors	Many trade unions
Standard operating procedures, constantly revised	Standard operating procedures unchanged & often ignored
Low cost, simple automation	Expensive, sophisticated automation
Quick machine set-up & changes	Emphasis on machine utilisation
On the spot inspection	Specialist inspection
Continuous improvements, involving all workers	Engineers improve, workers follow

The Japanese auto makers, Toyota in particular, had established a distinctive system of production, purchasing, sales and product development that combined the idea of the Just-in-Time paradigm and Total Quality Control (TQC) by the end of the 1970s. It has also been referred to as the Toyota production system or lean production system, although there are slight differences between these. Whatever it is called, the Japanese system has emphasized continuous improvement of productivity, quality, lead time and flexibility simultaneously, by: (1) building in mechanisms that systematically eliminated waste and slack resources (eg. work-in-progress inventory and non-value-added activities) and thereby revealing manufacturing problems early on; and (2) involving shop floor supervisors and teams of rank and file workers in decisions and suggestions for improvements, and thereby solving the problems collectively on

the shop floor. The system also emphasized cross-functional communication within the company as well as external communication with customers and suppliers.

While introducing and digesting certain essential elements of American mass production, such as moving assembly lines, Detroit-type automation, Tayloristic work standardization and basic techniques of industrial engineering and statistical quality control, the Japanese automakers did not follow the extreme specialization that the original Fordism pursued both horizontally and vertically. For example, Toyota developed a multi-skilled work organization, in which workers were trained to carry out multiple tasks around their work stations and teams. Also, supervisors and workers on the shop floor were made responsible for decisions and continuous improvement, thus avoiding the vertical separation of elite engineers and single skilled workers, characteristic of Typical American factories of the 1970s.

In addition, the Japanese system did not follow the large lot mass production that the American system pursued to an extreme. Instead, it emphasized small lot production, quick set-up changes, mixed model assembly and flexible automation for improving productivity while handling a growing product variety at the same time. Short term stabilization of total production volume and product mix (Heijunka) and long term growth of total demand also helped the Japanese system solve the challenging problem of simultaneously increasing productivity and variety.

The Japanese automobile production system was developed over time through significant efforts and insights of managers, engineers and workers of the companies, but it should be noted that historical imperatives also appear to have played a major role in shaping the capability of the system. For example, it seems to be the case that the Japanese makers avoided over specialization not so much because they deliberately calculated the long term consequences, but because they were almost forced to do so: they had to grow rapidly without sufficient capital and labor resources during the early post-War period, and therefore could not afford to extreme specialization. Also, the Japanese auto makers could not enjoy the benefit of large lot production after the 1960s because total volume growth and product proliferation occurred at the same time, unlike the American market in its high-growth period. In fact, lower specialization and small lot production was long perceived by the Japanese practitioners as a weakness against the giant American firms.

In the UK, the situation was very different. While a certain part of Fordism was introduced directly (through Ford UK), and indirectly (to the domestic British mass producers) as early as the 1910s, some of the essential elements of Fordism, such as direct shop floor control, machine pacing and time-based wage system were introduced much later, after the War. For example, at British Leyland piecework was not replaced by measured daywork until the early 1970s, and other aspects of Fordism were not introduced until the early 1980s.[1] As a result, the comparison between the Japanese and British production systems (Table 1), is in many senses similar to that between the Japanese and traditional American system, which many researchers studies throughout the 1980s. One major difference between today's American and British organizations, besides their size, is industrial relations: the traditional British makers deal with multiple trade unions, whereas American makers negotiate with a single industry-level union, the U.A.W.

[1]Totsuka, et al (1987, Chapter 2) reports, in their detailed field study of British labour relations, that two anonymous BL factories (one for assembly, the other for body) in the Midlands converted their wage systems from piecework to measured daywork in 1971. This apparent inconsistency in the introduction of the daywork system suggests that the date of introduction differed widely across BL factories, or that there were some swings back and forth between the old and new systems.

To some extent the differences in performance can be explained by differences in capital investment and manufacturing practices.

Throughout the 1970s, the capital investment and value-added per employee in the UK was consistently among the lowest in Europe. The ratio of value-added to fixed assets was not significantly different in the UK and US, but lower levels of investment reduced the productivity of the British plants. In 1981, each worker at Ford's plant at Saarluis, Germany was producing almost four Escort cars per month, whereas at Ford's plant at Halewood in the UK, each worker produced just two Escort cars per month (Waymark, 1983). German productivity was still almost double that in the UK, which despite higher labour costs in Germany, resulted in significant cost savings.

Table 2: Fixed Assets and Value-Added per Man, 1974

	Fixed Assets £	Valued-Added £	Fixed Assets
Ford (US)	5 602	7 966	1.42
GM (US)	4 346	8 600	1.98
Ford (UK)	2 657	3 901	1.47
Vauxhall (UK)	1 356	2 560	1.89
BL (UK)	920	2 129	2.31

Source: *Derived from Dunnett,* 1980.

In the UK, overmanning, trade demarcations and component and material quality depressed productivity during the 1970s. For example, in one case, final assembly area employed 665 men on the Continent, but required 940 in the UK; 650 men were required for plant maintenance in the European plant, but 1 200 in the UK. There were cases where a breakdown in the British plant would require six maintenance men to repair it, representing different trades; finally, the incidence of quality faults was much higher in the UK, resulting in twice as much time lost as on the Continent. More detailed analysis suggests that the largest discrepancies were in 'non-standard' times, caused by machine breakdown, materials shortages and rework. In many cases industrial disputes and absenteeism also contributed to lower productivity in the UK.

By 1970 Ford, Vauxhall and Chrysler had changed over to a day rate system, but BL (now Rover) continued to work on a piece rate system. Labour relations problems were commonplace during the 1970s. In 1971 an eleven week strike at Ford UK convinced Ford US to scrap a planned £30 million engine plant. It is estimated that in 1972 10% of potential production was lost through industrial action, 20% in 1973, and 26% in 1974 (Dunnett, 1980). Much of this lost production was due to strikes at suppliers. In 1970 more than a third of the UK motor industry's workforce was laid off following a strike at GKN, a major supplier of car wheels. To help overcome these supply problems, firms adopted two policies. First, the manufacture of 'crippled' cars which were incomplete. The missing components would be fitted later. This made production scheduling problematic. Secondly, firms adopted dual sourcing of vital components to prevent major disruption should a supplier strike. British car manufacturers were not vertically integrated, and predatory tactics were common. For example, Ford would award profitable contracts to suppliers who would be encouraged to abandon other customers. Once dependent on Ford, Ford would then squeeze the suppliers profit margins.

The early 1980s was a period of severe restructuring of the UK automobile industry. British Leyland attempted to simplify industrial relations, improve productivity by changing demarcation lines and increase invest in automation. Between 1977 and 1981 the workforce was cut from 104 000 to 53 000; a new and highly rationalised product range was introduced, consisting of two families; and collaboration with foreign manufacturers such as Honda and VW. Vauxhall placed greater emphasis on new management practices. Similarly, in 1979 Ford of Europe launched its four year 'After Japan' programme in the UK. The main areas were: demanning (a reduction of 40% of the workforce); easing of demarcation lines; more flexible working practices; and investment in advanced manufacturing technologies. Clearly, there are considerable similarities between recent developments at BL and Ford UK. In both cases the emphasis appears to have shifted to more flexible forms of working and automation.

Japanese manufacturing practices have had both a direct and indirect affect on the British auto makers. Increasing competition from Japanese manufacturers during the late 1970s and early 1980s generated a great deal of interest in so-called 'Japanese' management practices. More recently, direct investments by Nissan, Toyota and Honda have had a demonstration effect on British manufacturers, confirming the effectiveness of Japanese manufacturing practices in the UK environment. Nevertheless, few British firms have adopted all components of 'lean production' as a coherent system. Instead, they have focused on specific techniques such as quality management or just-in-time scheduling. In this respect, there may be important parallels with the earlier adoption of Fordism.

Table 3: Introduction of Japanese-style Work Organisation in the UK

	First Introduced	Median Date
Statistical Process Control	1948-52	1983
Flexible Working	1958-62	1981
Work Groups/Teams	1958-62	1983
Quality Circles	1973-77	1983
Just-in-Time Production	1973-77	1986

Source: *Oliver & Wilkinson*, 1988

3. THE FORD PRODUCTION SYSTEM

3.1. Fordism

According to Hounshell (1985) 'the rise of Ford marks an entirely new epoch in the manufacture of consumer durables in America. The Ford enterprise may well have been more responsible for the rise of "mass production"... Ford sought to manufacture the lowest priced automobile and to use continuing price reductions to produce ever greater demand' (page 5, emphasis in original). Fordism linked product, process and market. The dominant production paradigm was standardisation: a standard product; standard, interchangeable parts; special-purpose machines; and standard tasks, allowing the extreme division of labour.

The moving assembly line has become the symbol of Fordism, but in practice this was only one aspect of the total production system. Ford exploited developments in high-precision metal-cutting technology to produce truly interchangeable parts, adopted an unprecedented number of highly specialised machine tools, and instigated the famous 'five dollar day'. Workers were paid a standard day rate, rather than a piece rate. Ford had never paid piece rates, as he believed that

it was an ineffective means of control, which also encouraged the production of defective products.

The first experimental assembly line was installed at Ford in 1913 for the assembly of the flywheel magneto. This decreased assembly time from twenty man-minutes to just five. Within a year three more lines were in operation at Ford, reducing chassis assembly time from some twelve and a half man-hours to a little more than one and a half man-hours (Hounshell, 1985). Over a five year period Ford reduced the production cost of the Model T by a half. Falling costs stimulated demand, allowing further increases in production, and further cost reduction. Annual production reached two million cars.

However, during the 1920s Ford's share of the US automobile market fell from 55% to just 15%, with annual sales of the Model T falling to 800 000. Thus in 1927 Ford was forced to announce a replacement for the Model T: the Model A. However, the inherent rigidity of the mass production system made this costly and time-consuming: the model changeover required the scrapping of the quarter of the 32 000 machine tools; the rebuilding of half of the remaining machine tools; and the purchase of 45 000 new machine tools. Thus, according to Hounshell, 'mass production as Ford had made it and defined it was, for all intents and purposes, dead by 1926... Automotive consumption in the late 1920s called for a new kind of mass production, a system that could accommodate frequent change and was no longer wedded to the idea of maximum production at minimum cost...Ford had learned painfully and at great cost that the times called for a new era, that of "flexible mass production"' (pages 12-13).

3. 2. Taylorism

Ford differed from Taylor and his principles of 'scientific management', as Ford aimed to reduce labour by means of automation, whereas Taylor and his followers took a given production process and attempted to improve it by means of work study. Taylor took the production technology as a given and sought to improve the work organisation; Ford engineers mechanised the work processes and used workers to feed and operate the machines. Thus the Marxist labour process writers are careful to distinguish between Taylorism and Fordism: ' Fordism is a stage that supersedes Taylorism... the characteristic labour process of Fordism is the semi-automatic assembly line production' (Aglietta, 1979, pp. 116-118).

Taylor published his now famous text Shop Management in 1903, and eight years later his most influential work, Principles of Scientific Management. Taylor advocated the abandonment of 'military-type' management in favour of what he called 'functional management'. Functional management consisted of dividing the work of management so that managers at each level were responsible for as few functions as possible. Moreover, workers were to be entirely relieved of all planning and other 'brain work'.

The division of labour was not new, but Taylor added the measurement and standardisation of tasks. Under scientific management the work of every workman would be fully planned in advance by management and each worker given precise written instructions of the best means of performing his task. The detailed specification of tasks by management was central to scientific management, and was based on explicitly designed experiments to identify the 'best' way to perform a given task. Taylor performed painstaking efforts to breakdown jobs into simpler tasks which could be simplified and specified in detail. Method study and work measurement became the tools of scientific management. Standard times were established for basic worker motions,

and aggregated to determine the 'allowed time' for specific jobs. These were used to estimate costs and loads, to make efficiency comparisons, for line balancing, and formed the basis of budgetary control systems and worker incentive schemes.

Ford applied scientific management to the production of the automobile in order to build a complex product using a diverse, largely unskilled workforce. According to Henry Ford's own account, more than half of the 8 000 jobs did not require 'full physical capacity', and 43% required less than a days training, and a further 36% less than a week (Ford and Crowther, 1924). This unprecedented division of labour increased productivity, and in turn facilitated automation by special-purpose machines.

3. 3. Neo-Fordism

Hounshell's account suggests that Fordism ended in the US sometime during the late 1920s. However, for all practical purpose Fordism remained the dominant paradigm for production for another fifty years. The emergence of so-called 'Neo-Fordism' is associated with changes in markets, technologies and work organisation during the 1970s:

Saturated Markets - Increased international competition, together with greater affluence in the developed economies, resulted in fears of saturation of traditional mass markets. Consequently, many manufacturers attempted to serve new market segments, and competition began to switch from price to quality and design.

Programmable Technologies - The development and widespread adoption of micro-electronics based manufacturing technologies such as flexible machining systems (FMS) and robotics, had the potential to improve the flexibility of mass production (Tidd, 1991).

Japanese-style Management - Manufacturers in Europe and North America became increasingly aware of differences in work organisation in Japanese companies. In particular, total quality management (TQM) and just-in-time (JIT) production management became popular. More generally, there were attempts to introduce more flexible working arrangements, in both functional and numerical terms. The most recent development in work organisation has been 'lean production' (Womack et al, 1990).

4. THE ADOPTION OF FORDISM IN THE UK

4. 1. Pre-War Context

The poorly-developed shipping systems of the early twentieth century made the transportation of fully assembled automobiles from the US to Europe too expensive. In addition many European countries imposed high tariffs on car imports. For example, 45% in France and 33.3% in the UK. Therefore American auto companies like Ford and General Motors were encouraged to establish final assembly plants nearer to final markets. By 1929 Ford was assembling automobile in twenty-one different countries, and its new rival General Motors had assembly plants in sixteen countries. In 1911 Ford opened its first factory in the UK, at Old Trafford, Manchester. The plant assembled Model Ts from chassis, engines and other components imported from the US, and by 1913 was assembling 6 000 cars a year. Ford did not establish at fully-integrated manufacturing plant in the UK until 1931, when it opened its plant at

Dagenham, East London. The Dagenham plant was modelled on the Ford River Rouge plant in Detroit. General Motors chose to acquire existing local facilities, and in 1925 bought the British company Vauxhall Motors.

Pre-War Markets

The British and German economies were the most open to foreign inward investment at that time, and both countries benefited directly and indirectly from the establishment of US-owned auto plants. The American investment began to diffuse mass production techniques in the UK, and by demonstration helped domestic manufacturers acquire knowledge of international 'best-practice'. However, no auto plant in Europe was able to achieve the productivity of its American parents, and were therefore at a cost disadvantage despite lower wage and transportation costs. The main reason was the highly-fragmented national markets in Europe prior to World War II. The European plants simply could not achieve the required volume to fully exploit the benefits of mass production.

The nature and size of the British car market changed significantly during the 1920s. Relatively inexpensive, lightweight cars such as the Austin Seven and Morris Cowley began to dominate the market, and total annual car sales increased fourfold, to more than 400 000 units. By 1930 the British market was dominated by Morris and Austin, which together accounted for almost 80% of sales. Morris, at Cowley in Oxford, was the most advanced domestic firm in terms of production systems. It was the UK price leader, and had adapted American manufacturing methods to suit the British organisational and market context. In contrast, Austin benefited from government contracts, and concentrated instead on capital investment.

But smaller British companies were less successful. Rover had some success in the early 1920s, but sales fell when Austin and Morris introduced their new, cheaper models. Rover was a traditional, engineering-led company, with little knowledge of market requirements. Prices were determined by traditional 'cost-plus' methods, adding a profit margin to production cost, whereas Ford and GM determined a target market price, and reduced costs to achieve this. Rover's existing product was simply too expensive for the emerging mass markets. Therefore in the 1930s Rover decided to leave the volume car segment and shifted to the specialist car segment, specifically the four wheel drive Land Rover.

The American transplants also experienced problems. Initially, Ford attempted to impose US-designed products on its British operation. The Model T was large by British standards, and up to 1923 Ford even imposed left-hand drive models on the (right-hand drive) UK market. Consequently, despite an extensive dealer network and vigorous marketing Ford's share of the UK market collapsed from 24% to 4% between 1913 and 1929. Finally, in response to falling market share, in the early 1930s authorised Ford UK to develop its own products for the British and European markets.

Table 4: UK Market Share of British Manufacturers, 1929-1939

	1929	1931	1933	1935	1937	1939
Morris	51.0	38.5	27.2	33.6	27.6	26.9
Austin	37.3	34.2	28.8	24.3	22.8	24.3
Ford (UK)	5.7	3.5	18.9	17.4	22.3	14.7
Rootes	n.a	6.8	9.1	8.3	9.5	10.9
Standard	4.9	10.6	8.9	7.8	9.7	12.8
Vauxhall(GM)	1.1	6.4	7.1	8.6	8.1	10.4
Total Market (x1000 units)	182	159	221	312	390	305

Source: *Maxcy & Silberston*, 1959.

An important development in the early British car market was a shift from price competition, to increased emphasis on model variety and quality. Throughout the 1930s annual price changes were typically less than 5%, and were associated with equipment changes or new model introductions. The number of models in production by the ten largest UK manufacturers increased from 46 in 1929, to 64 in 1933 (Maxcy & Silberston, 1959). But this diversity of models was not designed for export markets. In 1937, the best pre-war year for exports, only 14% of cars were exported. British models were still designed for the particular needs of the domestic market: a temperate climate; undemanding roads; and short distance travel.

Also, Austin and Morris had failed to consolidate their early dominance of the UK motor industry. Competition from the American transplants, and the proliferation of new models introduced by domestic firms had further fragmented the UK market. Moreover this, together with a focus on home markets, had to a great extent offset any potential advantages of scale economies due to the rapid growth in demand. British manufacturers established a pattern of laying off workers during the summer months to prepare for the launch of new models at the autumn Motor Show. This, together with seasonal fluctuations in demand, set up a pattern of boom and slump in car production. For example, in 1936 Ford employed 11 530 workers, but by 1938 this had fallen to 7 983. Instability seemed to be endemic in the British car industry.

Pre-War Production Systems

Fordism had to adapt to conditions in the UK. Unlike the US, production levels were erratic and capacity utilisation low; component supplies were irregular and of uncertain quality; and interruptions to production frequent. In such circumstances Fordism was simply too inflexible. Ford was consistently frustrated at the failure of its British plants to replicate American practice. In particular, Ford was critical of the British management and their 'stiff white collars' (quoted in Tolliday & Zeitlin, 1986).

Ford opened its new Dagenham plant in 1931, and took advantage of the recession to launch its new car, the Ford Eight (later 'Popular'), at just £100. Despite these price reductions, pre-war demand was never sufficient, and the new plant typically operated at half capacity. Other British car firms began to adopt some aspects of American manufacturing techniques during the 1920s. Morris and Austin were most successful at adapting the system to local conditions. For example, Morris produced a single model at its Cowley plant, and annual production increased from 3 000 cars in 1921 to 55 000 in 1925. Morris had used an assembly line since 1914, with cars being wheeled between work stations along a track by hand. However, a moving assembly line was not introduced until much later, in 1933. Morris also experimented with transfer lines at its

engine plant in 1923, but quickly abandoned these as the new technology was considered too rigid. Instead, Morris concentrated on improving work organisation. Aspects of Taylorism were adopted in the 1920s, including the detailed division of tasks and work measurement. As a result labour productivity almost doubled between 1924 and 1934 (Tolliday & Zeitlin, 1986).

Morris was essentially just an assembly operation, and was responsible for the development of an automotive components industry. Morris was the first British car company to buy a high proportion of components from external suppliers. The industry had traditionally manufactured most of its components in-house. Initially, Morris had to purchase many components from the US, because no British supplier was able to produce standardised parts in sufficient volume. For example, Morris was able to source an engine from the US at half the cost that local UK suppliers were able to manufacture (Turner, 1963). Most British component suppliers could not manufacture the volumes demanded by Morris. In such cases Morris would often buy the supplying company in order to secure the required increase in production. Nevertheless, by placing orders for long runs of standard components Morris slowly established a network of large domestic suppliers: Smiths provided instruments; Lucas electrical equipment; and Dunlop tyres.

Austin was the first to develop a standard, relatively inexpensive car, the Austin Seven. Launched in 1922, the 'baby' Austin was initially sold for £225. A year later the price had been reduced to £165, and in 1929 to £130. Austin was also the British pioneer in the use of automatic transfer machines in the UK, although Ford and Vauxhall were the first to adopt the technology. Austin had to build its own transfer lines, as no British machine tool company would do so. The first transfer machine was used to make cylinder blocks. It replaced thirteen conventional machine tools, increased output and reduced floorspace by 26% and labour costs by 85%. As a result costs per unit of output fell by almost 30% (Maxcy & Silberstone, 1959). The cost advantage of transfer lines was not based on the elimination of labour. The main savings came from the increase in the rate of production made possible by the reduction in handling, loading, and unloading work from machines. For example, the adoption of transfer machine reduced costs by increasing machine utilisation, reducing work in progress, and as well as labour costs. In 1939, Austin employed 19 000 workers in a 52.5 hour week, and produced 1 700 vehicles a year; by 1960, 23 000 workers on a 42.5 hour week produced 6 750 vehicles (Turner, 1963). Ignoring changes in the working week, this represents a three-fold increase in productivity.

Nevertheless, there were still significant differences between the performance of plants in the US and UK. It has been estimated that in 1935 the number of vehicles produced per worker in the US was 8.8 per year, compared to 2.8 in the UK. This suggests American productivity was three times that of the British in the pre-War period. Clearly, higher production volumes and lower cost of capital in the US allowed greater levels of mechanisation. Based on horsepower per worker, it is estimated that automation was between five and four times as great in the US (Maxcy & Silberston, 1959). This suggests that the capital productivity was similar in the UK and US, but that their was simply greater capital investment in the US. Consequently, the labour productivity was much lower in the UK plants.

In addition, British car manufacturers had rejected other aspects of the Fordist system, specifically machine-pacing and day-rates. Piece-work continued to be the industry norm, which worked well provided management was able to retain control of wage rates, manning levels and job standards. However, the piece work system became problematic when unions and shop stewards used it to increase their bargaining power.

Pre-War labour relations in the car industry were of the 'hire and fire' type. Ford had traditionally been opposed to unions, and was almost union-free until the opening of its Dagenham plant. In general the British car industry was characterised by little union organisation: it was estimated that in 1939 as little as one in fifty assembly line workers were members of a trade union (Beynon, 1973). Ford had chosen to build its plants away from the traditional engineering region in the Midlands, and instead chose Liverpool and London. For example, at the Halewood plant in Liverpool, inexperienced labour was favoured in recruitment. More than sixty per cent of new recruits had no experience of factory work.

Government labour policy changed industrial relations in the UK car industry in two ways. Firstly, legislation was introduced during the War which allowed the unions into car plants. In many cases the unions were imposed on non-unionised firms, which created considerable scope for poor management-labour relations. For example, at the time neither Ford nor Vauxhall recognised unions, but by 1941 both companies were forced to negotiate with them. Secondly, when labour relations broke down the government set up courts of inquiry to examine the problems and make recommendations to firms. This often set national precedents on the basis of local disputes. These developments resulted in a very rigid labour relations systems, introduced under the conditions of war, which was unlikely to be appropriate in the post-war period of seasonal and cyclical demand. Nevertheless, it is easy to overstate the affect of poor labour relations on the poor performance of the British car industry. More serious structural problems emerged during the post-War period.

4. 2. Post-War Experience

Post-War Markets

The market conditions of the 1950s were very different to those of the 1930s. After the War, European manufacturers faced a sellers market, with buyers starved of cars. European auto manufacturers continued to tailor their products to the requirements of their own, diverse, market conditions. Consequently, there were no standard vehicle configurations or designs in Europe: front-wheel drive competed with rear-wheel drive; unit bodied competed with chassis-on-frame; large, multi-cylinder engines competed with small four-cylinder engines. This diversity prevented European manufacturers from achieving the required scale-economies. Nevertheless, tariff barriers began to fall in the late 1950s intra-European trade increased dramatically: from 200 thousand cars in 1950, to more than 2 500 thousand cars by 1970 (Altshuler et al, 1984). By the early 1970s the total European market was equal to that of North America.

Table 5: UK Automobile Production & Exports, 1937-1957

Year	Production (1000 units)	Exports (1000 units)	Exports (%)
1937	390	54	13.4
1947	287	126	43.9
1949	412	219	53.2
1951	476	309	64.9
1953	595	264	44.4
1955	898	322	35.9
1957	861	378	43.9

Source: *Maxcy & Silberston*, 1959.

Nevertheless, each national market within Europe continued to have different characteristics. In the UK the low taxation of company cars created a strong demand for the medium-size 'salesman car', which accounted for some 45% of the market. In the 1960s the Ford Cortina was a typical example of this market segment, later dominated by the Ford Sierra. In addition, the UK market between 1945 and 1952 was characterised by excess demand. Manufacturers were able to ration supply, and could sell almost any model, including many pre-war designs. The apparently huge potential domestic demand encouraged UK manufacturers to neglect the needs of export markets. Thus each nation's market developed around a small number of dominant designs. Consequently firms were able to practice significant pricing discrimination. Domestic markets were considered to be the most important and were the main source of profits. Export markets were secondary, and prices were often set below costs in order to make some contribution to fixed costs. During this period British manufacturers made large profits. In the UK competition was on non-price criterion. Price cuts and price wars were virtually unknown in the UK. However, unlike the 1930s, firms no longer had to stimulate demand by introducing new models. Instead, manufacturers competed through equipment levels, service networks and advertising. Until 1956, car dealers were obliged by law to be tied to specific manufacturers. This also encouraged each manufacturer to offer a full range of products.

This resulted in very stable market shares between the major European producers: Ford accounted for around 12% of the European market throughout the 1970s; General Motors accounted for around 10%; and British Leyland (Austin, Morris & Rover) just 4%. In the UK there were still dozens of small specialist car manufacturers, although the market was dominated by the 'big six': Austin, Morris, Rootes, Ford and Vauxhall (Table). This proliferation of manufacturers, and the focus on the home market, resulted in a highly fragmented domestic market in which none of the firms achieved optimum economies of scale. It has been estimated that in the late 1940s the minimum efficient scale (MES) for car production was around 150 000 bodies per year, based on existing pressing technology; by the 1950s the switch to unitary body construction and adoption of automatic transfer machines increased the MES to around 500 000 units per year; by 1960 the MES was estimated to be close to a million. This suggests that even the largest UK car manufacturer was operating at half MES throughout the post-war period.

Table 6: Number of British Models by Manufacturer & Segment, 1975

	Market Segment						
	MINI	SMALL	MEDIUM	LARGE	EXECU-TIVE	LUXURY	SPORT
BL	1	3	3	2	2	2	5
Ford	0	1	1	3	0	0	0
Vauxhall	0	2	0	0	0	0	0
Chrysler	1	1	1	0	0	0	0

Source: *Whipp & Clark*, 1986

Table 7: UK Market Shares of British Manufacturers, 1947-1978

Company	1947	1954	1960	1974	1978
Morris (BL)	21	38	36	48	50
Austin	19	-	-	-	-
Ford (UK)	15	27	30	25	27
Rootes(Chrysler)	11	11	11	11	16
Vauxhall (GM)	11	9	11	9	7
Total Market (x1000 Units)	287	769	1352	1543	1315

Source: *Dunnett,* 1988
Note: Morris merged with Austin in 1952;
and with Jaguar, Standard & Rover in 1974.

In the early 1970s import tariffs were reduced under the Kennedy Round agreements, and in 1973 Britain entered the European Economic Community. This greatly increased the potential for international trade. However, the 1960s had left the British car industry poorly positioned to exploit these changes. The industry was characterised by outdated products, low investment and low productivity.

Post-War Production Systems

Austin and Morris merged in 1952. Austin had a single large plant at Longbridge which was as advanced as any in Europe. However, Morris had numerous smaller plants, the largest being at Cowley. However, the new company, British Motor Corporation (BMC), failed to achieve the necessary rationalisation of production and product range.

Rover was typical of British manufacturers in the 1950s. The company introduced its first assembly line in 1946, but this was essentially just a mechanism to link small work areas. Most production was still small batch. Even final assembly was divided into smaller zones. Production processes and work organisation was not standardised to any extent. Despite these shortcomings, Rover was a successful volume car producer in the soft markets of the 1950s. Average annual sales were 35 000 units, sales of the Land Rover continued to grow, and a new saloon car, the P4, was introduced in 1946. The company became the epitome of British engineering excellence. However, plans for the successor to the P4 revealed structural changes in the industry: increases in raw material, die and machinery costs increased the cost of new model development fourfold. Moreover, production costs were still too high.

Rover launched the highly successful P6 in 1963. The P6 was a technologically-advanced 'executive saloon', and required more than £10 million of re-tooling and an additional 250 000 square feet of assembly area. New assembly lines were commissioned, and almost 2 000 new, lower skilled workers were recruited to man the lines. The sequence of assembly was changed so that the outer skin was added after the drive train had been fitted to the floorpan. Weekly output almost doubled from 300 to 550 units (Whipp & Clark, 1986).

During the 1960s the British Government offered interest free loans to automobile companies locating in designated regions of high unemployment. As a result, BMC invested £50 million in new facilities in Scotland, Wales and Merseyside. Similarly, Ford invested £30 million in a new,

fully integrated plant at Halewood, Liverpool. Vauxhall built a new plant at Ellesmere Port. Ford employed 57 000 worker in the UK, 37 000 of which were at Dagenham. The new plant at Halewood was to employ 8 000 workers. In total, more than 50 000 new jobs were created in the industry, and annual capacity increased from around two million units in 1960, to almost three million in 1962. However, market demand could not justify this expansion. Consequently the 1960s were characterised by over-capacity, low profits, constant redundancy and short-time working. Labour relations deteriorated further. By the late 1960s the morale of the management and labour was low, few new models had been developed and criticism of the quality of British cars had increased. There was little investment in new plant or models during this decade of over-capacity and low profits. By 1970 Britain's share of world markets had fallen by half, from 25% in 1960.

In 1968 BMC and Leyland merged to form British Leyland (BL). The new company compared well with its European competitors in terms of sales, but had inherited many outdated plants, and a broad, but inadequate product line. The company had fifty-five factories. It produced twice as many different models as GM in the US, but at only one-fifth the volume. BL was making twenty different body shells, fourteen saloons and six sports cars. Capital and sales per worker at BL were among the lowest in the world. In addition, BL had serious management and labour problems.

Management control was by means of a combination of piece work, incorporation of trade-unions and paternalism. In common with other British firms, management relied on cultural and ideological forms of authority. In contrast, in the US Ford relied on formal rules and technological pacing. In the UK, Ford had successfully imposed day rate payment, rather than piece rate payment. However, elsewhere in the UK piece-work was well established. The piece rate system was increasingly unsatisfactory for several reasons. Firstly, it made it difficult to control costs as the system was difficult to monitor; secondly, it encouraged demarcation disputes because different jobs had different piece rates; and thirdly, any new work practices or technology which improved efficiency required new piece rates to be negotiated. Cycle times were relatively long by American standards, typically more than six minutes, and the setting of piece rates was by estimated rather than systematic time study. The introduction of assembly line methods disrupted the piece rate system in two ways. Firstly, rates had traditionally reflected skills and the bargaining power of the groups, but the new unskilled, assembly workers complained that their piece rates were lower than existing rates. Secondly, output and disturbances to the lines which were out of the worker direct control, such as a delay in materials, affected their earnings.

The workforce was divided internally into eight different trade unions. There were no joint committees for negotiation, and little collective action. For example, the Amalgamated Union of Engineering Workers (AUEW) represented component workers, and the National Union of Vehicle Builders (NUVB) represented workers in the body, trim and paint shops. These traditional trade unions refused to accept the newly-recruited workers because of the low skills associated with assembly line work. Consequently, the Transport and General Workers' Union (TGWU) recruited the new assembly line workers. By 1970 BL had to negotiate with more than thirty unions, and Ford with twenty-two. Moreover, the shop steward, rather than the local union officials, acted as representative of the shop floor workers, adding further potential for conflict between workers, unions and management. Car companies preferred to deal with the national representatives of the unions, whereas shop-floor workers favoured their own elected shop stewards. This resulted in tension between union officials and shop stewards, on the one hand, and national and local representatives on the other. There were four hundred shop stewards at

Ford which were given little official power. Consequently, many strikes were local, and 'unofficial'.

This complex system of labour relations clearly had an adverse effect on the cost structure of the industry. Distrust and insecurity encouraged strict adherence to demarcation, and a reluctance to allow the introduction of new technologies. In this environment of poor industrial relations and low market growth British trade unions feared any moves to improve efficiency or adopt automation which might eliminate jobs. For example, when Austin attempted to introduce a new spindle cutter which would increase productivity by 140%, but this resulted in a strike which closed down the entire factory.

Table 8: Post-War Industrial Disputes in the UK Automobile Industry

Annual Average of three year period	Strikes	Workers involved	Working days lost
1947-49	10	9 000	25 000
1950-52	14	25 000	131 000
1953-55	14	42 000	137 000
1956-58	31	82 000	322 000
1959-61	75	116 000	307 000

Source: *Beynon*, 1973.

Industrial relations continued to be a problem in the British car industry throughout the late 1960s and early 1970s. On the one hand, the traditional paternalistic approach of many British companies was ill-suited to complex labour negotiations. For example, neither Ford nor Rover had specialist staff responsible for industrial relations until the 1960s. On the other hand, increased inter-union rivalry made agreements difficult. This was aggravated by major fluctuations in the market, which made employment uncertain. Thus the industry was plagued by strikes and low productivity. There appears to be an inverse relationship between strike activity and production: periods of high production were characterised by few strikes, and vice versa. Often, a fall in demand would result in layoffs which would in turn trigger strike action. In 1965 the number of working days lost through strikes was more than double those of the previous two years. Often, these were 'unofficial', local stoppages called by shop stewards. In 1958 Ford recorded 25 stoppages; in 1959, 44; and in 1960, 79.

Table 9: Motor Vehicles Produced per Employee per Annum, 1955-76

	UK	GERMANY	US
1955	4.1	3.9	19.8
1965	5.8	6.4	25.0
1970	5.6	7.5	19.6
1973	5.8	7.7	25.0
1976	5.5	7.9	26.1

Source: *Jones & Prais*, 1978

5. THE ADOPTION OF FORDISM IN JAPAN

5.1 Pre-War Context

Knock-down (KD) assembly of foreign automobiles, as well as imports of complete vehicles (mainly European makes) already existed around 1920, but the number was extremely small. The Japanese government tried to protect the domestic automobile industry by the military subsidies act of 1918, but the actual number of trucks actually produced never exceeded 100 per year before 1925.[1] The cumulative number of vehicles produced before 1925 was only 259.[2]Clearly, the influence of American mass-production system was negligible during this early period.[3] The first significant attempts at automobile production in Japan were KD assembly operations by Ford and GM in the mid 1920s.

Pre-War Markets

The original plan of Ford before the earthquake was to build a KD plant in China, which Ford had regarded as more promising market than Japan. In response to the major earthquake of 1923 that destroyed trolleys and railways in Tokyo, the municipal government imported 800 chassis of Ford Model T for bus use, which demonstrated the effectiveness of automobiles as an alternative transportation mode. As the demand for automobiles expanded quickly, particularly for imports from America which tended to offer shorter delivery time than the European vehicles, Ford decided to establish Ford of Japan, a 100% subsidiary, in 1925 and to build a KD assembly plant in Yokohama. Although it was a small and temporary one from Ford's point of view, the plant, equipped with chassis and body conveyer lines, was threatening enough to the Japanese domestic industry. Similarly, General Motors established its Japanese subsidiary in 1927 and started KD assembly in Osaka. In 1927 and started KD assembly in Osaka. According to a brochure in 1935, the GM Osaka plant employed 900 people (700 in production) and assembled 50 vehicles per day at capacity (8 car models and 4 truck models). Chrysler and other American models were also assembled by Japanese companies in smaller quantities.

Overall, the American cars and trucks dominated the Japanese market between 1925 and 1935. The peak year of KD plants was 1934, when 33 458 KD kits, or about 92% of the total domestic demand, were imported and assembled (imports of chassis and complete vehicles was about 5%). Domestic brand occupied only 3% of the market, or about 1000 units, in the same year. There were two main groups in the domestic sector: three Japanese companies that were producing mid-size trucks under the military subsidiaries Act, and about 20 three-wheeler makers. Both groups deliberately avoided direct competition with the American subsidiaries, which were mostly making 1 - 1.5 ton trucks.

This was the time when the direct transfer of Fordism by the American auto makers was about to start. Ford had planned to build a new and much larger plant in Japan, but was prevented by the protectionist and militaristic Japanese government which introduced the Automobile manufacturing Enterprise Act in 1936.[4] This Act essentially prevented the operation of foreign auto makers in Japan, and effectively subsidized three licensed domestic companies, Toyota, Nissan and Isuzu (then called Diesel Jidosha), for producing trucks, while ousting the American subsidiaries from the Japanese market. Toyota and Nissan virtually took over the domestic

[1] See, for example, Cusumano (1985) *The Japanese Automobile Industry*, pp.15-16
[2] Nakamura, Seiji (1983) *Gendai Jidosha Kogyoron*, p.134.
[3] Oshima & Yamaoka (1987) *Jidosha*, Chapt. 6; Tomiyama (1973) *Nihon no Jidosha Sangyo*, p.43.
[4] See, for example, Cusumano (1985), p.17.

market, which ranged roughly from 30 000 to 40 000 units per year then (Isuzu specialized military trucks). In this way, the process of direct transfers of the Ford production system abruptly stopped.

Table 10: Automobile Market in Japan, 1929-1939

Year	Domestic Production	Vehicle Imports	Knock-Down Set Imports	Total Units
1929	437	5 018	29 338	34 793
1930	458	2 591	19 678	22 727
1931	436	1 887	20 199	22 522
1932	880	997	14 087	15 964
1933	1 681	491	15 082	17 254
1934	2 787	896	33 458	37 141
1935	5 089	934	30 787	36 810
1936	12 186	1 117	31 058	44 361
1937	18 066	1 100	31 839	50 994
1938	24 388	500	18 093	42 981
1939	34 515	----	----	34 515

Source: *Cusumano*, 1985

After 1936, the main recipient of Fordism in Japan changed from the American subsidiaries to the Japanese makers, mainly Nissan and Toyota. Although they both belonged to new or local Zaibatsu (financial clique) that attempted the entry into the auto industry, these companies generally lacked sufficient technological and financial resources to carry out large scale production. As a result, their adoption of Fordism had to be selective, taking the limits of the domestic market and existing production systems into account.

Pre-War Production Systems

The basic pattern of technology transfer differed between Toyota (then Toyoda Automatic Loom) and Nissan (Cusumano, 1985). Nissan's original plan was to make a formal tie-up relation with Ford directly. Nissan was therefore rather reluctant to get a licence under the new law, but decided hastily to participate in the arrangement after it found that Toyoda obtained a license. Because Nissan was not well prepared to start the auto business without the American alliance, it had to rely heavily on imports of equipment, such as press machines, forging machines, and the entire engine machining line and the casting facility from Graham Page, a smaller U.S. company which had abandoned its plan to produce trucks.[1] Nissan also bought a right to manufacture a semi-cab-over truck model designed by Graham Page. Thus, Nissan tended to purchase a package of product and process technologies from a small American company.

Toyota, a spin-out company from Toyoda Automatic Loom, relied more on existing production technologies and mix them with unbundled technologies imported from America and Europe. Toyota's original project, lead by Kiichiro Toyoda (son of Sakichi Toyoda, inventor-founder of the Toyota group), was to develop passenger cars, but it quickly switched to truck production after it learned the government's regulation. We will focus on Toyoda, which was more active

[1] Japan Automobile Manufacturers Promotion Association (1979) *Nihon Jidosha Kogyo-shi Gyosei Kiroku-shu*, p.79.

than Nissan in absorbing the unbundled American technologies while infusing them into their own production based.

Kiichiro Toyoda of Toyoda Automatic Loom started engine research and phototyping a small corner of its facility around 1931, five years before the protectionist law was launched. Ford and GM were dominating the domestic automobile market at that time. Kiichiro started with reverse-engineering the 'Smith motor', a small engine commonly used for motor cycles and three wheelers, and completed a 4 hp prototype engine. Kiichiro's business concept at this early stage was as follows:[1]
(1) Develop a 3 000 cc class automobile and compete directly with the American models both the American models both in price and performance;
(2) Learn from the American system of mass production, but take into account situations of the Japanese market that would limit the production volume to only several hundred units per month, and modifies the system accordingly.

Kiichiro's vision to compete directly with Ford and GM was a quite ambitious one considering that it was made when the American KD vehicles were still dominating the market. On the other hand, Kiichiro did not try to introduce Fordism directly, but to adapt it to the Japanese conditions (small market, bad roads, etc.), both in product and process technology.[2]

After getting top management approval of starting the Automobile Division in Toyoda Automatic Loom, Kiichiro and his staff ordered machine tools for prototype building from Germany and the U.S., purchased a Chevrolet car, reverse-engineered it, sketched the decomposed parts, and estimated materials used. Thus, Toyoda decided to design the first prototype by combining designs of the Chevrolet engine that had been regarded as fuel efficient and the Ford chassis that was robust enough for Japan's bumpy roads.

Pre-War Production Systems

In 1934, Toyoda started building a prototype plant. As it could not find appropriate suppliers of special steel, Toyoda built its own steel mill next to the prototype shop, imported an electric furnace from the U.S., and invited American engineers for its operation. At the same time, Kiichiro told his staff to go to the U.S., purchase machine tools for commercial production, and learn from the American mass production system by visiting their factories for half a year. After considerable trial and error, the first prototype engine was completed in the fall of 1934. As for the body, Kiichiro decided to adopt a streamline design that was contemporary at that time. Like the engine, Toyoda bought Chrysler and Chevrolet cars, disassembled it, sketched the body components, made life-size drawings and gauges, and built prototype bodies mostly by hand. It invited some craftsmen from outside repair shops, from whom Toyoda's technicians learned how to make bodies by hand. Genuine parts of Ford and other American makers were used for most of the chassis and gear parts of the prototypes. In May of 1935, about one year after starting the body prototyping, Toyoda completed the first several prototypes of the A1 model, a 5 passenger sedan with a 3 400 cc engine.

Thus, Toyoda Automatic Loom started its automobile business under the leadership of Kiichiro Toyoda when the American auto makers were still dominant in the Japanese market. While its initial attempts were more or less imitation and a patchwork of unbundled American automobile

[1] *Toyota no Ayumi*, p.41.
[2] Kiichiro's vision could be regarded as an example of 'entrepreneurial imagination' in Okouchi's concept. See Okouchi, Akio, *Keiei Kosoryoku.*

technologies both in product and process, Toyoda was active as the receiver of the technologies in combining them and adapting them to the Japanese conditions.[1] Toyoda's Kariya Assembly plant was completed in 1936. Its capacity (150 units per month) was quite small compared with American standard.[2] Based on Kiichiro's goal 'to match Toyoda's unit cost of producing 20 000 to 30 000 units per year with that of American's producing several hundred thousand units per year'.[3] Therefore Toyoda modified the Ford production system for small volume production. For example, it replaced a part of body stamping processes with manual jobs in order to save fixed cost for tooling.

In 1937, Toyota Automatic Loom separated its Automobile division and established Toyota Motor Manufacturing Corporation (hence called Toyota). In the same year, as production at Kariya plant became full, Kiichiro ordered construction of a much bigger assembly plant in Koromo, completed in 1938. The planned size of Koromo plant (2 000 units per month, 5000 employees) was still much smaller than that of average American factory. Thus, Toyota continued to select production technologies deliberately, considering the limited scale of production.[4] For example, it purchased only several press machines in the door panel process, where American makers would have installed several dozens of the machines. Toyota also kept its machining operations somewhat flexible by introducing six spindle balling and horning machines that were adjustable to design changes, unlike standard Detroit-type machines. It also made the machine shop flat so that its process layout could be changes easily. In this way, the small scale of Toyota's production forced the company to chose flexible production systems deliberately.

Toyota relied on foreign technology and parts initially. In the Koromo pant alone, Toyota imported over 500 machine tools from Germany and the U.S. As the Japan-China war started in 1937, though, it became gradually difficult to import special purpose machines. To fill the gap, Toyota established a its own machine tool shop in the site of Koromo plant and started making multi-spindle lathes, balling machines, small press machines and so on. The tool shop became an independent company, Toyoda Machine Tool, in 1941. Similarly, the cost of foreign parts procurement decreased to about 12% of unit manufacturing cost, or about one-fifth of parts procurement cost, by November 1936, but it was not until 1943 that Toyota's supplier organization, Kyoho-kai, was established.[5]

While Toyota was trying to introduce American mass production system in the new Koromo plant, the traditional craft system persisted in some production processes, according to some anecdotes by employees of those days:[6]

'Many elements of craft production persisted, and craft skills were required in job shop environments. Workers machined a variety of parts, while sharpening their own cutting tools. Process flows were often disturbed, work-in-process inventories piled up, and lack of balance in machine utilization occurred' (machine shop).

'There was a team of five workers for each hammer machine: one for heating, one for rough hammering, two for shaping, and one for finishing. One in the hammer was called 'bo-shin', who

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1 Cusumano (1985, Chapter 1) characterized Toyoda's initial attempts as 'indirect technology transfer', and contrasted it with Nissan's 'direct technology transfer'.

2 According to Abernathy (1978, p.138), capacity of a standard Ford assembly plant was about 400 to 500 units per hour, or about a one minute cycle time, since the mid 1910s.

3 *Toyota no Ayumi*, p.60.

4 *Toyota no Ayumi*, p.85.

5 *Toyota no Ayumi*, pp.63-64.

2 *Toyota no Ayumi*, pp.92-95.

led the team as master and was responsible for production volume and quality. It was said that it would take three years to master heating and five years to master hammering. Craftsmanship of the forging workers was remarkable'(forging plant).

5.2. Post-War Developments

Post-War Markets

In September 1945, soon after the end of the World War II, GHQ (General Headquarters) approved Toyota's production of trucks. Relying mostly on old equipment dating back to the 1930s, Toyota's production activity was severely limited by financial and capacity constraints. Its annual production finally surpassed the prewar peak (about 16 000 units) in 1953.[1] Taiichi Ohno estimated that the productivity of the American plants to be ten times as high as that of Toyota right after the War.[2] According Ohno, Kiichiro launched an ambitious plan to catch up with the American's within three years.[3] Although this goal proved to be too ambitious, Toyota did increase productivity ten-fold between 1945 and 1955, according to Ohno. When Ohno visited Ford and GM engine plants in 1956, he found that the American plants had not improved productivity since the 1930s, and that productivity at Toyota's engine plant at that time was already higher than them in gross terms (i.e., unadjusted for product and process characteristics).

Despite such improvements in productivity, Toyota faced a crisis during the 1948-49 recession. With many finished goods inventories piling up, Toyota, on the verge of bankruptcy, had to rely on emergency loans from banks and separate Toyota Motor Sales Company. It also fired 2 000 employees, which triggered a series of strikes by the union.[4] Two lessons that Toyota learned from this crisis, among others, were 'limited volume production' (Genryo Seisan), and human resource management with long-term stabilization of employment.[5] According to Ohno:[6]

'We got a lesson from the crisis that productivity increase and cost reduction had to be accompanied by 'limited volume production', which meant that we had to produce just enough to sell and just when we could sell. We learned that productivity increase for the sake of itself was no good, and that we should not simply imitate the American style mass production.'

As Toyota was preparing its restoration plan, The Korean War broke out. The special orders of trucks from the U.S. Army (APA) helped Toyota recover from the crisis quickly. Although Toyota increased production capacity in response to the Korean War special orders, it carefully avoided adding employees for the expansion, as the memory of the labor crisis was still fresh. Toyota also had to expand the capacity while using the old machines. As a result, productivity increased almost automatically by expanding production scale while maintaining the number of workers. Thus the pattern of production expansion without significant increases in employees, and reduction of finished goods inventory (ie limited volume production), was installed at Toyota.

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[1] Cusumano (1985), p.61 & p.75.

[2] This was based on his estimation around 1935 that the U.S. productivity in spinning operations would have been nine times as high as that of the Japanese.

[3] Interview with Ohno by Shimokawa and Fujimoto, July 16, 1984.

[4] For labor movements at this stage, see, for example, Cusumano (1985), Chapter 3.

[5] The number of permanent workers was limited to a minimum to avoid firing in the slump period. Toyota also started to hire temporary workers in the mid-1950s to respond to the growth of production volume.

[6] Interview with Ohno by Shimokawa and Fujimoto, July 16, 1984.

Table 11: Japanese Automobile Production 1946-1954

Year	PRODUCTION (Vehicles)		
	Trucks	Cars	Total
1946	14 914	0	14 921
1947	11 106	110	11 320
1948	19 211	381	20 367
1949	25 560	1 070	28 700
1950	26 501	1 594	31 597
1951	30 817	3 611	38 490
1952	29 960	4 837	38 966
1953	36 147	8 789	49 778
1954	49 852	14 472	70 073

Source: *Cusumano*, 1985

Post-War Production Systems

Many elements of craft production remained even after World War II, but they were gradually replaced by standardization of operations, product-focused layout, and multi-skilled workers handling more than one standard job. Taiichi Ohno, the champion of Toyota's Just-in-Time system, recalls the situation when he was assigned to section head of Toyota's machine shop in 1946:[1]

'Improvement of productivity from 1945 to 1950 was relatively easy. For example, there were three or four workers around one machine, particularly when it was an important one, prior to the war. So simply assigning one worker to one machine increased productivity by three, four times. Workers with craftsmen's mentality resisted to such measures, but labor saving was relatively easy as turnover ratio was very high at that time.'

'The first thing that I did was standardization of jobs. The shop floor of those days was controlled by foremen-craftsmen. Division managers and section managers could not control the shop floor, and they were always making excuses for production delay. So we first made manuals of standard operation procedures and posted them above the work stations so that supervisors could see if the workers were following the standard operations at a glance. Also, I told the shop floor people to revise the standard operating procedures continuously, saying, 'You are stealing money from the company if you do not change the standard for a month.'

In this way, the shift from craft production to Taylor-type standardization made progress in the late 1940s, at least at Toyota's machine shops, despite some resistance from traditional crafts people. It should be noted, however, that the seemingly Tayloristic movement of work standardization at Toyota was accompanied by continuous improvements of the standards themselves. Thus, unlike the Fordism in America, in which work standardization tended to mean freezing of standard operations and vertical separation between single-skilled workers and elite industrial engineers, standardization under Ohno's leadership emphasized continuous improvements at the shop floor.[2]

[1] Interview with Ohno by Shimokawa and Fujimoto, July 16, 1984.

[2] On the transformation of the Ford system from that of the dynamic experimentations to a static system of fragmented jobs, see, for example, Abernathy, Clark & Kantrow (1983) *Industrial Renaissance*, Chapter 6, and Shimokawa, Koichi (1991) 'Ford System kara Just-in-Time System he', in Nakagawa, Keiichiro, ed., *Kigyo Keiei no Rekishiteki Kenkyu.* Iwanami.

The idea of Just-in-Time (JIT) was created by Kiichiro Toyoda in the 1930s, but the Kanban system, a formal mechanism that materialized the idea, started in the late 1950s under the leadership of Taiichi Ohno.[1] The system was originally called 'supermarket system', in that the downstream station had to come to the upstream to pick up just enough parts, whereas the latter had to produce just enough to replenish what was taken by the former . The system, which linked the upstream and the downstream by standardized returnable containers and reusable slips called Kanban, had already been articulated around 1949, according to Ohno, but the Tax Office did not allow this arrangement until the mid 1950s on the ground that the system did not document accounting records for each transaction.

Ohno introduced Kanban system first in the body welding line, in which small lot production was a key: The welding people tended to make bodies in large batches as they tended to be influenced by relatively large lot operations in the upstream stamping process, whereas it had to supply bodies to the small lot operations of the downstream assembly line. Kanban system was then introduced to the upstream press operations, and then such component as engine oil pans and tappet covers. It was also installed at Motomachi assembly plant upon its completion in 1959. In the early 1960s, Ohno became the main plant manager, when he introduced Kanban to casting, forging and heat treatment, the most difficult processes for small lot production.[2]

There were similarities between Kiichiro's 'Just-in-Time' concept and 'Fordism'. As Shimokawa (1991) points out, Toyota's Just-in-Time and Fordism of the early days (the era of Highland Park experiments) had much in common in that both pursued synchronization of upstream and downstream processes.[3] Fordism synchronized the work stations by physically linking them by continuous conveyers; Just-in-Time created pressures for synchronization by eliminating buffer stocks between the stations. Although it was after World War II that Toyota introduced conveyer systems on a large scale, it likely that Kiichiro had the Ford system in his mind when he advocated the Just-in-Time idea.

Another important source of Toyota Production System seems to be production experiences of Toyoda Spinning and Weaving, which was transferred by Taiichi Ohno. Ohno started his career at Toyoda Spinning and Weaving in 1932.[4] When Ohno was working as supervisor at the spinning factory of this textile company, he realized that its rival, Nichibo (Japan Spinning) was outperforming Toyoda in productivity through a benchmarking study. Further studies revealed that the production system of Nichibo was very different from that of Toyoda Spinning and Weaving. Toyoda had separate buildings by process steps; Nichibo had adopted the line layout along the process flow. Toyoda moved yarns in large lots; Nichibo conveyed them in small lots. Toyoda had emphasized skills of rework (yarn tying) at the downstream step; Nichibo had emphasized making good yarns at the upstream and eliminating rework at the downstream. In this way, Taiichi Ohno obtained some of the ideas of Toyota Production System, including product-focused layout, small-lot production, and 'doing things right the first time', thorough the benchmarking study in the textile industry. When Ohno moved to Toyota Motor Manufacturing in 1943, his first impression was that:

'It would be easy to raise productivity of the automobile business by three to five times by simply introducing the production system adopted by Toyoda Spinning and Weaving. Also, it

[1] The term 'Kanban' was coined as a catchy word when Toyota challenged the Deming Award in 1965.
[2] Interview with Ohno by Shimokawa and Fujimoto, July 16, 1984.
[3] Shimokawa, Koichi 'Ford System kara Just-in-Time System he', in Nakagawa, Keiichiro, ed., *Kigyo Keiei no Rekishiteki Kenkyu.* Iwanami.
[4] For the early career of Taiichi Ohno, see, for example, Cusumano (1985), pp.267-269.

was the lesson from Toyoda Spinning and Weaving to standardize the work system so that trainees could perform as efficiently as skilled craftsmen.'

In the first five years of the post-war restoration, Toyota was forced to increase productivity and achieve the goal of 1 000 truck production per month without sufficient funds and equipment. Therefore, the improvements of Toyota's production system during this period tended to rely on such 'soft' methods as work standardization, changes in layout, job assignment, as well as investments on relatively inexpensive jigs.

Taiichi Ohno took charge of Koromo assembly plant in 1945. While some managers advocated that Toyota should use cheap suppliers with Just-in-Time delivery to lower cost just like bicycle manufacturers, Ohno insisted that Toyota should make small lot (i.e., high cost) items in-house and buy large lot standard items from outside in order to impose pressures to increase productivity and reduce cost on itself. Ohno also emphasized factors other than machines as he had observed a large productivity gap between Toyota and the Western makers, despite the fact they were using similar equipment. Here we find certain philosophies of subsequent Toyota Production System, that emphasize mechanisms to reveal problems purposefully, as well as total system improvements, rather than mechanization. As Ohno had been constantly requesting levelization of production to the upstream processes, he was told 'Then you do it,' and was assigned to the upstream machining section in 1946, where he promoted levelization of production volume, Just-in-Time (Kanban) system, product-focused layout, and multi-task job assignment, as well as work standardization.

The engine machining factory had already adopted product-focused machine layout (i.e., installing machine tools according to process sequence for a particular product group), but the transmission and suspension factories were still organized by types of machines (e.g. balling, lathe, milling, grinding).[1] Consequently the level of in-process inventories was high. It took Ohno and his staff two years to convert the layout to product-focused.

In Ohno's machine shops, work standardization mentioned earlier and training of multi-skilled workers were carried out in parallel. In other words, decomposition of craft jobs into standardized tasks and re-combination of the tasks to multi-skilled jobs occurred at the same time. Unlike American Taylorism-Fordism that essentially created single-skilled workers, Toyota in the late 1940s replaced traditional craft jobs with multi-skilled jobs. It should be noted, here, that multi-skilled workers are different from traditional crafts people: the former did a series of standardized tasks along the process flow; the latter were all round players who did everything related to their trade regardless of process flow or work standards.

Also, to overcome the 'end-of-the-month' problem, during which most parts were delivered by suppliers, creating scheduling problems, Toyota needed levelization (Heijunka) of production both in assembly and parts manufacturing. According to Ohno, this goal was achieved around 1950.[2] Overall, Ohno claims that Toyota increased productivity by 5 - 6 times by 1950 while relying mostly on old machines of the 1930s.

Toyota planned to modernize and to expand the monthly production scale to 3 000 units. Eiji Toyoda and Shoichi Saito, who eventually became leaders of Toyota, went to America and visited Ford's River Rouge Factory and other facilities. Their study of the American automobile factories was intensive and lasted for three months. Eiji was particularly impressed by the

[1] As for the change of machine layout in early Fordism, see, for example, Hounshell, David A. (1984) *From the American System to Mass Production*, 1800-1932, pp.221-222.

[2] Interview with Ohno by Shimokawa and Fujimoto, July 16, 1984.

conveyer system at River Rouge factory, and told his staff to adopt conveyers extensively on his return from America. He also standardized pallets and containers, which may have subsequently facilitated the introduction of the Kanban system. Although Toyota was suffering from a severe shortage of cash, Toyota managed to carry out 4.6 billion yen investment between 1951 and 1955. The equipment introduced during this period included continuous casting lines for engine blocks, 2 000 ton press machines, and multiple spot welders.

Transfer machines, a typical Detroit-type automation that links a series of single*f*purpose machine tools by automated transfer devices, was introduced to part of the engine machining process in the late 1950s. The first machine, developed jointly by Toyota and Toyoda Machine Tools, was installed in 1956. Although it is likely that Toyota studied the transfer machines in Detroit, the machines themselves were developed and built by the Japanese companies including Toyota itself.

They were also impressed by the Ford suggestion system (i.e. workers make suggestions for improvements on various technical and organizational issues). Soon after they came back to Japan, Eiji and Saito started the 'Idea Suggestion System' (Soui Kufu Teian Seido) in 1951, which subsequently became a core element of Toyota's TQC (Total Quality Control) and Kaizen (Continuous Improvement) systems. Toyota recognized the suggestion system as a competitive weapon from the beginning:

'In order to survive in the competition with foreign automobiles in future, we have to reduce manufacturing cost by making use of our suggestions' (comment by Sato, 1951).[1]
Another important system that Toyota introduced from America was formal training of 'scientific management' for supervisors, called Training within Industry (TWI). TWI, introduced to Toyota in 1951, was applied to general foremen (Kakaricho) and managers above them. Among other things, TWI included training of improvement activities by supervisors. Supervisors subsequently played a leading role in Kaizen activities at Toyota.[2] It should be noted that both the worker suggestion system and improvements by supervisors, the core elements of Kaizen system which attracted attention of the Western manufacturers in the 1980s, were both imported from America in the 1950s.

Nevertheless, compared with the case of productivity, Toyota was rather slow in improving manufacturing quality of its products. During the prewar era, both Toyota and Nissan trucks were often blamed by the Japanese army for their low reliability and durability compared with the Ford and Chevrolet counterparts.[3] As the army emphasized rigorous inspection for quality improvements, Toyota responded by centralizing the inspection function which had been scattered at each production unit, and in 1949 adopted Statistical Quality Control (SQC) from the U.S. However, its quality level was still unsatisfactory to the U.S. military. Against this background, Toyota introduced Total Quality Control (TQC) in 1961. According to Eiji Toyota:[4]

'Improvements in quality did not progress as fast as improvements in efficiency. Also, the problems of newly recruited workers, insufficient education programs, lack of managers' capabilities and skills, and poor coordination across functions surfaced.'

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[1] *Toyota no Ayumi*, p.181.
[3] Nemoto, Masao (1992) *TQC Seiko no Hiketsu 30-kajo*. Nikka Giren Shuppansha, Tokyo.
[3] Oshima, Taku & Shigeki, Yamaoka (1987) *Jidosha*, pp.73-93.
[4] *Toyota no Ayumi*, p.251.

TQC emphasized clarification of quality goals, communication of the goals to the shop floor, involvement of all the employees, education of shop floor supervisors, diffusion of quality and cost consciousness, making good product the first time (Tsukurikomi), cross-functional coordination, coordination with suppliers and dealers, smooth implementation of model changeover, and so on. In 1963, model changeover of Corona (a small passenger car) was chosen as a company-wide theme for TQC, and in 1965 Toyota received Deming Implementation Prize. Hardware developments also supported JIT-TQM. 'Jidoka' (Autonomation), which consists of machines that automatically detect defects and stop operations, started to be introduced in the late 1960s,[1] as the sophistication of sensor technology improved.[2] By the early 1980s, conformance quality of Toyota's products became one of the best in the world, according to surveys in the U.S.[3]

Toyota's Motomachi Plant, the first assembly plant in Japan specializing in passenger cars, was completed in 1959. An integrated assembly plant with stamping, welding, painting and final assembly, its initial production capacity was 5 000 units per month, but the plant was designed so that it could be expanded to a capacity of 50 000 units per month in five years. This was the first assembly plant in Japan that could match standard American plant capacity. The Takaoka plant was completed in 1955, which is now believed to be one of the most productive plants in the world. Thus, Toyota's catch-up process to the Fordism production system apparently came to a conclusion in the 1960s.

6. THE COMPARISON

6.1 The Prewar Comparison

Markets and Government Policies: Compared with America, the market size was limited in both countries. In Japan, the prewar peak was about 50 000 units per year. The U.K. market was much larger, about 390 000 units per year. However, these quantitative differences were less important than qualitative differences between the two markets. The U.K. was an advanced market for luxury cars, where customers tended to emphasize design quality, workmanship and product variety. The Japanese market was hardly developed. The market consisted mainly of trucks, buses and three-wheelers. Except for a small number of luxury car imports, the Japanese automobile market was virtually created by Ford trucks and buses in the early 1920s. Ford and Chevrolet trucks were the de facto dominant designs in this market in the 1920s and 1930s. The standard of quality and performance, even for the military, was virtually set by American vehicles. Therefore it would have been thus easier for the large American makers to compete effectively in the Japanese market than in the U.K., despite the small market size.

The government policy for the auto industry of the two countries show a sharp contrast. The British policy was to open the market both in terms of component trade and foreign capital, although a relatively high tariff was imposed on imports of complete vehicles after World War I. The Japanese market was also open except for a small segment for military use until 1936, when the Automobile Manufacturing Enterprise Act virtually prohibited foreign capital and imports of vehicles.

Ford versus Domestic Makers. Ford started with knock down assembly both in the U.K. (Manchester, 1911) and Japan (Yokohama, 1925). The U.K. plant made passenger cars, while

[1] For the concept of Jidoka, see, for example, Monden (1983).
[2] Interview with Ohno by Shimokawa and Fujimoto, July 16, 1984.
[7] See, for example, Consumer Report Magazine and J.D. Power reports.

the plant in Japan concentrated on truck production. The scale of both plants was rather small due to the limits of the market size: the Manchester plant produced about 8 000 cars per year in 1914; Yokohama plant assembled about 12 000 vehicles at the peak year (1931). Ford gradually integrated operations or localized parts manufacturing in the UK, whereas localization of parts for Ford and GM assembly was limited in Japan.[1]

The market performance of the Ford plants were very different between the two, though. In Japan, Ford occupied about 50% of the Japanese automobile market (except three wheelers), and was the largest motor vehicle assembler in Japan in the early 1930s. Besides, its product choice (i.e., small trucks) hit the very center of the Japanese market at that time. The Japanese domestic producers were so weak that it had become obvious that they would not match the Americans unless they found niche segments (eg three-wheelers) or obtained strong protection from the government. As a result, Ford's plan to build a large plant in Japan was blocked by the Japanese government and the military by the law of 1936.

In the British market, by contrast, Ford did not prosper before World War II. British Ford was the largest car maker in the early 1910s with over 20% market share, but it had fallen down to 4% by 1929. Instead, British mass producers such as Morris and Austin, dominated the domestic market during the inter-War period. Ford regained the share with the introduction of cars designed for the British market and the construction of the Dagenham plant, but it could never run the plant at full capacity before the war. The poor performance of Ford in the 1920s seems to be ascribed partly to the wrong product mix (ie reliance on a single American model, T-type, which was generally too large for British customers), and partly to inflexibility of the Ford production system for the market that emphasized variety and design quality.

Thus, the original Ford system never became a dominant production system in either country during the inter-War period, but the major reasons for it were very different between the two. In Japan, only strong protectionism by the government could stop the dominance of Ford of Japan. Even after Ford withdrew from Japan, the memory of Ford as a strong competitor seems to have persisted among the Japanese players. For Toyota, at least, Ford continued to be the reference point or the target of competitive benchmarking.

In the U.K., by contrast, domestic mass producers such as Morris and Austin could effectively compete with Ford without protectionism due mostly to the nature of the British market that emphasized change and variety. While introducing certain technical elements of Fordism, they focused on smaller cars, emphasized product variety and change, modified machines to make them more flexible, cautiously constrained mechanization, and relied on indirect control of workers and piece-rate incentive systems. Thus, the notion that the 'British System of mass Production' (Lewchuk) would be more competitive in the British market than the original Ford system seems to have been prevalent among the British industrialists of the pre-War era. Ironically, the very strength off the British domestic makers in the prewar home market may have caused their delay in introduction of the full scale American mass production system when international competition intensified after the war.

International Competitiveness: Although neither British nor Japanese auto industry was internationally competitive before the War, the British could compete effectively at least in their home market, while the Japanese could not.

[1] Local parts purchased by Japan GM were only about 10% of wholesales proce around 1930 (See Nakamura, 1983, p.137).

Productivity of the British and Japanese industry was far behind the U.S. level, although the British were doing better. In 1935, labor productivity of the British motor vehicle industry (2.9 units per employee) was about a third of that of the U.S. (8.8 units per employee) (Lewchuk, pp. 188). Although it is difficult to make accurate comparison without adjustment for product mix and vertical integration, Ohno estimated that Toyota's productivity was about one-tenth of that of Ford. After significant improvement after the War, the productivity level as of 1950 was still about 2 units per employee in both Toyota and Nissan, according to Cusumano (1985, pp. 396). Taking Ohno's comments into account, it is likely that the productivity level of the major Japanese motor vehicle manufacturers was below 1 unit per employee in the pre-War era. This number is roughly consistent with Ohno's estimate that European producers were three times as productive as Toyota in the same period.

In quality, as well, the Japanese fell far behind the American level both in design quality and manufacturing quality, while the British domestic makers did well at least in design quality for domestic customers. The trucks made by Toyota and Nissan were often blamed by their principal user, the Japanese army, for frequent troubles.[1] As the domestic trucks were directly comparable with the American-designed vehicles, the quality gap against the U.S models was quite obvious.

The quality of British motor vehicles was less problematic. The British mass producers, including Morris and Austin, had developed car designs that fitted the domestic market better than American models (e.g. Ford Model T). Even Ford had to develop a small car design for Europe, Model Y, in the early 1930s. Thus, the difference in consumer tastes and product concepts effectively created a barrier to entry to the British market.

To sum up, while both the British and the Japanese automobile plants were less competitive than the U.S. Fordism factories internationally, the former were at least competitive in the home market. The Japanese makers were obviously less competitive than the Americans even in the Japanese market. The U.S.-Japanese competitive gap seems to have been keenly perceived by Toyota at least, which exerted imaginary pressure even after the Americans withdrew from Japan.

Production and Labor Systems: Although both Japanese and British per-War automobile plants were influenced significantly by the Ford production system, it had to be modified to the conditions of the domestic product market and labor organizations. Ford's attempts to transfer the American system directly to its British transplants proved to be generally unsuccessful for competitive reasons; its attempt to build a large scale Ford system in Japan was blocked by the Japanese government. In order to adapt Fordism to small and fragmented market environments, major domestic producers such as Morris and Toyota carefully selected certain elements of Fordism and modified them where necessary. In fact, the production systems of Morris and Toyota between the 1930s and 1950s had much in common: moderate mechanization, flexible machines, incremental improvements, heavy use of outside suppliers, increase in output without increasing the size of workforce, Tayloristic work standardization, and significant increase in productivity.

However, the patterns of adaptation to the labor market were somewhat different between the British and the Japanese makers. While both had the craft tradition of indirect shop control by foremen-craftsmen as an incumbent system when Fordism was transplanted, the British System

[1] The problems with Nissan's Type-80 trucks were caused mainly by the fact that Nissan bought an unproven semi-cab-over design from Graham Page in America. Also, Toyota's choice of casting technology for crankshaft resulted in durability problems. See Oshima & Yamaoka (1987, pp.73-93) for further details.

of Mass Production retained many of the traditional practices, including indirect control and piece-rate incentives, whereas Toyota's production managers were more active in pursuing direct control of the shop floor, although actual work standardization occurred after the War.

The argument that the incumbent craft unions resisted direct shop control and machine pacing of Fordism is a myth: The prewar British auto factories were mostly union-free, and the vast majority of the workers were semi-skilled. It is more likely that the management chose to rely on traditional indirect shop control because the managers judged that it would be more effective. At Toyota, resistance against work standardization and productivity improvement was observed during the 1940s, but the Toyota production managers (i.e. Ohno) were more determined to assume direct control over the shop floor, standardize work designs, and blend the Tayloristic-Fordistic system with multi-skilled work organization.[1] To sum up, the major difference between the pre-War Japanese and the British labor organizations seems to have existed in attitudes of production managers, rather than the relative strength of craft unions and traditions. At this stage, though, the difference had not yet been translated into any competitive results; the British motor industry were still out-performing the Japanese.

6. 2. The Post-War Comparison

Production Growth and Government Policies. The post-War Japanese auto industry was characterized by a high growth of domestic and export markets, proliferation of models, and a dramatic improvement in competitiveness, both in productivity and quality. Annual domestic production grew from about 50 000 in 1953 to about 0.5 million in 1960, 2 million in 1965 and to 5 million in 1970: about 100 times in less than twenty years. The focus of production shifted from trucks to cars, and models proliferated. Exports started to grow rapidly in the 1970s.

Production in the U.S. grew from about 50 000 in 1907 to 2 million in 1922, due mostly to the growth of a single model, Ford Model T. The British produced about 50 000 units in the 1910s, about 0.5 million in the late 1930s, and 2 million in the early 1960s. Thus, both Japanese and British motor industries grew steadily and reached about 2 million level in the 1960s. The Japanese continued to grow. However, the British production levelled off there and then declined during the 1970s.

As for the government policy, the Japanese government continued to protect the domestic auto makers through restrictions on foreign direct investments and vehicle imports until the early 1970s. Tariffs on cars and trucks became zero after 1978. Restrictions on foreign investments were lifted in 1973.

Competitive Performance: If the productivity of the British motor industry was much higher than the major Japanese right after World War II, and if the Japanese had by far outperformed the British by the 1980s, a question arises as to when the Japanese surpassed the British in productivity.

Although precise comparison is, again, difficult due to differences in product mix and vertical integration, it is estimated that the crossover point in productivity was between 1955 and 1960. According to the calculations by Cusumano (Japan) and Lewchuk (U.K.), the productivity

[1] This does not mean that Ohno was an entrepreneur himself, although he was at least a champion of the emerging production system. Ohno did not regard himself as the inventor of the Toyota production system, but recognized Sakichi Toyoda and Kiichiro Toyoda as the sources of the concepts of Jidoka and Just-in-Time respectively.

levels, measured by annual unit per employee in 1955, was 4.5 in the British motor industry, 3.8 in Toyota, and 3.4 in Nissan; in 1960, the figure was 5.4 in the British, 14.8 at Toyota and 11.8 at Nissan (12.4 in the U.S. auto industry, although differences in product size and vertical integration has to be at least taken into account).[1]

It is important to note here that the first generation of large scale assembly plants (Toyota's Motochi, Nissan's Oppama, etc.) were built around 1960, and that the phase of rapid growth started only after this. Also, at Toyota, the first large scale investment for mechanization occurred between 1955 and 1960. Thus, the major Japanese auto makers had surpassed the British in productivity even before the former started to exploit economies of scale. Mechanization and automation played an important role during this critical period.

The catch-up of the Japanese in manufacturing quality apparently lagged behind that of productivity. As of 1960, for example, Toyota's trucks had been criticized by the U.S. army (APA) for poor quality. It was during the 1960s and 70s that the Japanese auto makers introduced TQC and dramatically improved manufacturing quality.

In the UK, by contrast, the competitiveness of the motor industry declined after the late 1960s. The productivity level of British Leyland in fact decreased between 1968 and 1980 from 5.6 vehicles per employee to 3.7; Productivity (unadjusted) at Toyota for the same period doubled from 30 to 61.[2]

To sum up, productivity increased in both Japan and the U.K. between 1945 to 1965, but the Japanese productivity surpassed the British as the rate of productivity growth of the former was much higher than the latter. The gap widened dramatically as both the competitiveness and production volume of the British declined during the 1970s, whereas the Japanese continued to grow.

Production-Labor Systems: Researchers tend to ascribe the decline of the British motor industry after the 1960s to the labor problems caused by Americanization of the British system of mass production. Lewchuk, for example, points out that the 'belated shift to Fordism' through direct shop control, machine pacing and day rate payment created tension with trade unions and shop stewards, which in turn caused the decline of the competitiveness of the British auto companies through wildcat strikes, absenteeism and so on.[3] Again, it is important to note that the labor problem became serious after the 1960s; it was not the serious issue throughout the pre-War period.

The power of multiple trade unions accumulated during and after World War II, for example.

The remote cause of the post-war tension, however, seems to be the decision of the pre-War automobile managers to adopt the traditional labor organization of indirect shop control, and thereby postpone the adoption of Fordism in their production institutions. This seems to indicate that one of the root causes of the decline of the British competitiveness was managers' compromise to adopt indirect shop control, which hid the potential inconsistencies between American production technique and British production institutions. The domestic companies did not perceive this problem seriously in the pre-War era as they were reasonably competitive in the relatively isolated British auto market. The sellers' market after the War also concealed it.

1 Cusumano (1985), p.396; Lewchuk (1987), p.188.
2 Lewchuck (1987), p.215; Cusumano (1985), p.396.
3 Lewchuk (1987), Chapter 9.

The problem was finally revealed as international competition intensified and the British started to mechanize their automobile production system in the 1960s.

In contrast, Toyota had already installed most of the elements of the subsequent Toyota Production System and improved productivity even before it started to grow rapidly with modernized factories. For example, it had established Tayloristic-Fordistic direct shop control and work standardization by the 1950s. Toyota then recombined the standard tasks to create multi-skilled work organization, as well as delegating certain responsibilities for improvements back to the shop floor through suggestion systems and TQC. It also established stable employment policy and cooperative relations with the company union after experiencing the strikes in 1950. Other major elements of Just-in-Time system, except TQC, were already there when Toyota built the first mass production factory in 1959. In other words, Toyota had already blended the elements of Fordism and indigenous Toyota system (and even some of the craft elements) before the 1960s, which enabled it to fully exploit the economies of scale throughout the subsequent era of rapid expansion.

It is paradoxical that Toyota, while enjoying the well protected domestic market, made such intense efforts to improve competitiveness between the 1930s and 1950s. As is clear in Kiichiro Toyoda's comments mentioned earlier, the major American auto makers, particularly Ford, were constantly an imaginary rival and the target for the benchmarking studies for Toyota. This seems to indicate that, even in strictly protected market like Japan between the 1930s and 60s, imagination on the side of managers can trigger significant efforts to improve competitiveness.
There seems to be a clear contrast here. While the British makers were enjoying relatively high growth of the domestic market through the early 1960s, managers did not make significant efforts to change the labor systems which they had chosen in the pre-War era. When they finally faced the problem, production volume had already stopped growing. A vicious cycle of productivity decrease, production shrinkage and deteriorating labor relations continued until the British auto industry started to launch major restoration programs in the 1980s. The major Japanese firms, on the other hand, had already established cooperative and flexible labor relations and work organizations before the high growth era started. Rapid increase in production volume was directly translated into rapid increase in productivity and competitiveness in this case. Such a difference in manufacturing performance became obvious after the 1970s, but it should be noted that some of the root causes of the performance gap can be traced back to managers' decisions in the 1930s to 1950s.

6.3 Models for Adaptation of Fordism

It is always difficult to apply simple models to a complex phenomenon such as the rise and fall of an industry. It may be still to develop conceptual frameworks in order to identify certain critical interactions that may partly explain why the competitive differences between the British and the Japanese motor industries.

In the present paper, we have argued that (1) both British and Japanese auto makers attempted to adopt Fordism, and that (2) they had to modify the American Fordism in order to adapt it to the home markets that were smaller and more fragmented. Despite this similarity, the competitive results, as we see now, are very different between the two. Thus, it seems to be reasonable to infer that differences in the patterns of adaptation created at least a part of this competitive gap.

Technology Push versus Demand Pull. A simple model may be the dichotomy of technology push and demand pull. The story based on this model may go as follows: a production technology called Fordism was unilaterally applied to the British market, but it collided with the

strong craft unions resisting direct shop control of managers on the one hand, and with the small and fragmented market that emphasized variety, change and design quality, on the other. Although British Ford played a key role in 'pushing' the Fordism technology to the British environment, the performance was rather poor because of the confusions, destructive conflicts and the product-market mismatch. The Japanese producer, by contrast, carefully adapted Fordism to the domestic environment by adapting the elements of Fordism selectively, modified them, and blended them with the indigenous factors in order to respond to the market demands. In this case, the Japanese makers, the recipients of the Fordism technology, were active in 'pulling' together the technological elements for the market demand.

This dichotomy of technology push in the U.K. versus demand pull in Japan would have been simple and attractive if Ford UK had been a dominant player in the British market before and after World War II, and if strong craft unions had resisted the introduction of Fordism from the beginning. This was not the case historically, though: Ford UK fell behind domestic competitors in the 1920s and 30s; and the British auto companies were generally union-free before the war. Besides, in the respective home markets, the British auto industry was far more competitive than the Japanese in the pre-War era. Thus, while the above framework may be useful to explain why Ford UK was unsuccessful in the domestic market in the pre-War era, it is not enough to explain the origin of the competitive difference between the British and Japanese motor industries.

Backward versus Forward Adaptation: In order to compare the difference between successful British makers (before the War) and the successful Japanese (after the War), we need to examine how the companies adapted its system to the labor and market environments. In the case of pre-War British makers such as Morris and Austin, production techniques of Fordism were modified and selectively adopted for the small home market that emphasized change and variety, while the work organization was adapted to the British tradition of indirect shop control even without actual presence of strong craft unions. In other words, the British production managers chose to follow the craft tradition and piece rate incentives when organizing semi-skilled workers. This choice was made partly because the managers predicted resistance from workers against direct shop control, and partly because the managers were aware of 'weaknesses in the British managerial function and the potential for getting labour to perform many of the tasks of shop floor coordination needed for efficient production', according to Lewchuk (1987, p.183). The relative success of the British mass producers against Ford UK reinforced the managers' belief that this combination of modified Fordism and modified craft system of indirect control best suited the British environment, which appeared to be the case during the inter-War period.
In the long run, however, this may have been over-adaptation of the British production managers to the past labor practice: a 'backward adaptation'. Although the British system of mass production apparently adapted itself to the tradition and effectively avoided collision between incumbent craft system and Fordism, it postponed the solution of the potential problem of indirect shop control in the mechanized mass production system, and even amplified the collision that came later. The decision not to seek direct control empowered shop stewards and facilitated the advent of militant trade unions for semi*f*skilled workers after the War. When British management finally decided to 'Americanize' their work organization in the 1960s, the unions and shop stewards had grown to become strong opponents to it. The collision between labor and management resulted in serious erosion of British competitiveness.

In the Japanese case (particularly Toyota), by contrast, craft organization was quickly dissolved and was replaced with work standardization and direct shop control after the War. However, instead of following the American mode of inflexible production system based on single-skilled work force, Toyota created a multi-skilled workforce by rearranging the standardized tasks. It

also launched worker involvement programs and delegated certain responsibility for improvements back to the workers and supervisors. Thus, Toyota revived some of the flexibility that the craft system had enjoyed without actually creating a traditional craft organization. Also, Toyota adopted certain Fordism factors selectively (i.e., moving assembly lines, transfer machines), modified them, and integrated them for the market environment where variety and change mattered. In this way, Toyota had created a production system that could exploit the opportunity of 'production growth through model proliferation' before the actual growth started in the 1960s. We may call this 'forward adaptation', in that the managers apparently had future competition and market growth in mind when blending and integrating the elements of Fordism and indigenous production systems.

The difference seems to be now clear. The British system of mass production in the pre-War era adapted itself to the imaginary pressures from the craft organizations that had not existed yet in the semi-skilled context. The Japanese system of mass production (particularly Toyota) prior to the 1960s was driven partly by the imaginary competition with the American producers. This kind of imaginary pressure from competition and conflict seems to explain partly why some of Toyota factories (according to Ohno) increased productivity by ten times between 1945 and 1955 when the market was still totally protected by the American makers.

In both cases, managerial imagination or anticipation, rather than actual conflict or competition, played an important role at an early stage of industrial development (e.g. the pre-War era), which in turn facilitated actual development of certain patterns of competition and conflict during subsequent stages (e.g. the post-War era). What Weick (1979) calls 'enactment', or the idea that organizations respond to perceived environments rather than the actual ones, seems to be at work here. Similarly, according to Penrose (1968, p.41):

"expectations' and not 'objective facts' are the immediate determinants of firms behaviour, although there may be a relationship between expectations and 'facts'... in the last analysis the 'environment' rejects or confirms the soundness of the judgements about it, but the relevant environment is not an objective fact discoverable before the event; firms cannot predict it unless they can predict the ways in which a firm's actions will themselves change the relevant environment'

In the case of the auto industry, the expectations of Japanese and British managers were very different. The imagination of Toyota's managers was linked to the future market and competition, while that of the British managers was linked to the past labor system. Although managerial imagination is but an element of the complex interaction of historical events, it seems to be an important variable that may affect actual development of the industries.[1] Although many actual factors such as high and continued growth of production and macro economic environments contributed to the success of the Japanese auto industry, certain imagination of the managers seems to have acted as catalyst that linked the favorable environments to the actual success.

Compressed versus Retarded Life Cycle: Another framework that might be applied to the present topic is the product-process life cycle model by Abernathy (1978), which argues that an industry tends to develop from the fluid stage of high flexibility and low productivity to the specific stage of high productivity and low flexibility.[2] He argues that Ford in the 1920s was an extreme example of the specific-rigid production system. Although this type of linear model

[1] See Okouchi (1979) for the concept of entrepreneurial imagination (Keiei Koso Ryoku)
[2] Abernathy, William J. (1978) *The Productivity Dilemma.* Johns Hopkins.

cannot be applied to every case of industrial evolution, it certainly gives us insights in analyzing the automobile industry. Hounshell (1984) argues that Ford's pursuit of ultimate efficiency and rigidity failed as 'flexible mass production' represented by Alfred Sloan's General Motors, took over the leading position of the industry . Womack et al (1990) also indicate an historical sequence from the craft system (fluid) to the mass production (specific) and to 'lean production system' (a Japanese version of flexible mass production).

In the three-stage life cycle model indicated above, product variety and process flexibility are high at the first fluid (craft) stage, decrease during the second specific (Fordism) stage, and then increase again at the third stage of flexible mass production. The degree of variety and flexibility is high at the first and third stage, but they are different in that the former stage lacks standardization, while the latter is based on standardization of product and process designs. In the latter case, product change and variety are absorbed by flexible linkage of standardized product-process elements; in the former case, lack of standardization itself is the source of flexibility.

This life cycle model seems to help us contrast the British and the Japanese response to the small and fragmented markets. In the inter-War period the British system of mass production attempted to absorb the variety in the market by retaining the flexible aspects of craft system and blended it with Fordism: a case of 'retarded life cycle'. This strategy functioned well initially, but faced serious resistance when the industry finally started to move to the second stage in terms of labor management. The Japanese auto makers, by contrast, pursued work standardization and creation of flexible systems at the same time and thereby skipped the second stage of ultimate Fordism: a case of 'compressed life cycle'. With the help of subsequent market growth, this mode apparently helped the Japanese makers to achieve flexibility and efficiency at the same time. The American production system also started to move from the pure form of Fordism to the GM version of flexible mass production, but the capabilities and mind sets of mass production persisted for a long time, and ultimately became obstacles when the U.S. companies tried to shift to a more flexible and efficient mode of production in response to the challenge of the Japanese auto makers in the 1980s.

Although the above story may be too simplistic for explaining the complex reality of industrial evolution, it may highlight some of the important contrasts between the British and the Japanese patterns of industrial evolution in the automobile industry.

7. CONCLUSION

This paper has compared how Fordism was adopted by British and Japanese automobile manufacturers in the pre-War and early post-War period. Although the influence of Fordism was significant both in the British and Japanese auto industries, the resultant production systems and their performance were very different. The major findings of our study are as follows:

- Direct transplantation of Fordism was in fact more successful in Japan than in the U.K. during the pre-War period. The 'technology-push' approach U.S. Ford was not effective in the British market, compared with the 'demand-pull' strategy of domestic mass producers such as Morris and Austin. In Japan, only strong protectionism by the military and government could prevent the dominance of the American mass producers;

- Ironically, the relative success of the pre-War domestic mass producers in the U.K. resulted in the delay in the introduction of key elements of Fordism, such as direct shop floor control,

machine pacing and time-based wage system. The British companies, particularly Morris, adapted their production systems to the smaller market which emphasized quality of design and model variety, and perhaps more significantly to their perceived labor environment;

- The perceptions and decisions of British automobile managers, rather than resistance by craft unions, led to the choice of indirect shop control and piece rate incentive system, both essential elements of the British system of mass production. Adaptation of the emerging production system to the past practices of craft unionism, or 'backward adaptation', created a pattern of shop floor management which was in many respects similar to actual craft production - a self-fulfilling prophesy;

- Toyota's production system, known as one of the most effective of the Japanese automobile manufacturers, introduced various elements of Fordism during the pre-War and early post-War period. It also learned from the experience of other industries, particularly textiles. Thus, it is a myth that the Toyota production system was a pure invention of Japanese managers in the automobile industry. Nevertheless, we should not underestimate the entrepreneurial imagination of Toyota's production managers, especially Kiichiro Toyoda and Taiichi Ohno, who integrated existing elements of Fordism with the requirements of the domestic market to create a system very different to American Fordism;

- Toyota continued competitive benchmarking against Ford and set ambitious goals for productivity increase even when the domestic market was completely protected from foreign manufacturers. Managers anticipated future international competition, a process of 'forward adaptation'. The memory of the dominance of Ford and GM in the late 1920s and early 1930s appears to have influenced this behaviour;

- Toyota dramatically improved productivity, if not manufacturing quality, even before the period of high growth began in the 1960s, despite the heavily protected market. Such efforts to improve during the pre-growth era, combined with the subsequent economies of scale and high growth after the 1960s, appear to have created much of the competitive advantage of the Japanese auto industry;

- The difference in evolution between Toyota and the British mass producers amy be described as 'compressed' versus 'retarded' modes of product-process life cycle. Toyota moved directly from craft production to flexible mass production by skipping the stage of pure Fordism of inflexible mass production. In contrast, the British volume manufacturers retained elements of craft production long after they had reached the level of mass production. Thus, Toyota created a 'fusion' of elements of the craft system and Fordism, which enhanced competitiveness, whereas in the U.K. there was a collision or 'fission' of elements of craft practices and Fordism, resulting in a deterioration of competitiveness;

Although we cannot simply ascribe the success of the Japanese and demise of the British motor industry vis a vis American Fordism to patterns of history alone, we believe that the current differences in performance are at least partly due to differences in historical evolution. In our future research we may explore how other historical factors, more stable socio-cultural factors, and more recent managerial decisions and strategies jointly created the current difference in competitiveness of the two countries. This may also provide clues to what might happen in the future, specifically the international patterns of adoption and adaptation of so-called 'lean production'.

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