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American Factory–Japanese Factory*

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In contrast to the prevailing view that the once-praised Japanese economic miracle stemmed from unique Japanese-style factory management, the present paper suggests that this system of management shared common roots with that of the US, which was modified to suit the social and economic environment of a latecomer to industrialization. The transplanted version was then perfected to such an extent that it was later adopted in other countries, including the US itself. The original, US-born production control skills were successfully transferred because a need for them was keenly felt and their value was highly appreciated by the Japanese workmen and engineers who adopted them.

1. An Unanswered Question

There are fashions in the academic world; and they come and go. In the 1980s, it was fashionable to talk about the 'miracle' of Japanese factory management in light of the successful achievement of its 'lean production' methods. Rather belatedly, the world realized that Japanese manufacturing of machinery, especially motor-vehicle production, demonstrated the highest levels of production efficiency, product quality and speed in new model development.

Careful field studies discovered that there were indeed differences in managerial practices between Japanese and (say) US factories, which were directly responsible for the significant divergence in economic performances. Notable characteristics peculiar to Japanese machine factories included: (1) a system of parts procurement which drastically reduced inventories of parts and components for both assemblers and parts suppliers; (2) widely adopted total quality control (TQC) operations, which, having originated in the statistical quality control advocated and introduced to Japan by William Edwards Deming, had practically eliminated product defects from Japanese factory sites; and (3) strong networks of parts suppliers, who maintained long-lasting, stable relationships, typically with a single assembler despite a heavy stress on efficiency.[1]

The timing of this intellectual fashion overlapped with the period when Japanese foreign direct investment was on the rise, accelerating awareness in the outside world of the distinct features of Japanese-style factory management. This undoubtedly was an added factor that contributed to heating up the popularity of the subject.

The fashion came to a sudden halt, however, when the Japanese economic bubble burst in the early 1990s. In a trice, Japan lost not only a substantial portion of her accumulated wealth, but also

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1. The distinctive features of Japanese factory management are discussed by, for instance, Dore (1973), Aoki (1984), Piore and Sabel (1984), Abegglen and Stalk (1985), Lincoln and Kallberg (1990), Womack *et al.* (1990), Asanuma (1992), Fruin (1992), Gerlach (1992) and Nishiguchi (1994). The adoption of mutual co-operation and competition by Japanese automobile assemblers and parts-suppliers is described in some detail in, e.g. Odaka, Ōno, and Adachi (1983).

the outside world's confidence in the sustainability of her economic performance. By then the American auto industry had absorbed the essence of Japanese-style production management, and US car makers were well on their way to innovating their work places so that they could reap the fruits of improved production performance. Japanese machine products ceased to be an economic threat to the US, and the academic interest in Japanese miracles rapidly cooled down at about the same time.[2]

But a burning question was left unanswered when the cycle of academic fashions moved on: how did Japanese-style factory management come about, and why? Answering this question is important, as it may lead to a better understanding of how initial economic conditions affect the process of technological adaptation and hence may shed new light on the long-unanswered question of how to ensure effective transfer of production technology to the present-day Third World.

The purpose of this paper is to make a small step forward in answering this question by examining the historical roots of production control as seen at relatively large machine factories in Japan. Machine production has been chosen because it has formed an essential part of the post-World War II economic growth of the country and, above all, because it was here that the miracle took place.

2. The American Century

2.1 Borrowing Technology

In the nineteenth century, Japan's chief technological borrowings were in the fields of textiles and shipbuilding, and came principally from Britain. The introduction of American technology to Japan was virtually limited to Edison's light bulbs and a few other new inventions. American farm machinery was introduced early but did not take hold outside Hokkaido.

The twentieth century, however, witnessed a significant change in Japan's introduction of industrial technology, showing a tendency to borrow extensively from the US. By reviewing some primary historical sources, this paper will look at how Japanese machine factories went about importing American manufacturing methods, and argue that the conceptual foundations of post-World War II growth, including so-called Japanese-style management, lay mostly in the way those imports from the US were made.

2.2 Hidden Benefactors behind Toyota and Nissan

At the beginning of the twentieth century, a number of Americans came to Japan and made contributions to leadership in Japanese industrial technology. Among them was Charles A. Francis, who worked on and off for Toyoda Automatic Loom Works and set about unifying equipment standards and improving technology and efficiency. The Toyoda Looms factory that he planned is said to be the first mass production system in Japan using interchangeable parts (Suzuki 1996: Chapter 11). At any rate, it is no surprise that Toyota Motor, which emerged from Toyoda Looms in 1937, inherited influence from Francis.[3]

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2. The change of the tide was well reflected in the fate of powerful academic works addressing the Japanese economic miracle, such as Dore (1973), Koike (1977) and Aoki (1984). Once so popular, they were now suddenly regarded as irrelevant.

3. Francis came to Japan in 1904 to teach in what was then called the Tokyo Engineering Higher School (now Tokyo Institute of Technology), but later worked for Ikegai Iron Works, at the company's urgent request, where he served in a leadership capacity as a regular employee from May 1906 until October 1907, and contributed to the establishment of the production management system (Odaka 1993*a*: 126–127, 167). For his association with Toyoda Loom Works, see Hoshino (1978: 92).

The fact that Ford and General Motors began to manufacture in Japan had a strong impact. Especially important was the former's Japanese subsidiary, Japan Ford,[4] which 'later adopted a system of subcontracting factories that were capable of supplying an increasing number of domestically produced automobile parts that would meet strict inspection standards' (Jidōsha Kōgyōkai 1967: 466–467). That workers in both these factories received American-style training was said to be an added benefit: 'They possessed qualities which made them suitable for working in any factory in Japan' (*ibid*. p. 467).

One person made a particularly important contribution to improving Nissan's auto-related product technology—an American by the name of William Gorham. When Kubota Steel Company of Osaka began the manufacture of utility automobiles in 1919, they invited Gorham, who was originally a designing engineer of aircraft engines, to help with the production of a three-wheel automobile. The 48,178-sq. ft factory that he designed was equipped with a turret lathe, broaching machine, automatic bolt-making machine and 'every conceivable piece of new equipment available at the time to create the first mass production automobile factory in Japan' (Katsuragi 1993: 50). Not just essential construction machinery and equipment, but also materials all the way down to nuts and bolts were imported from America (*ibid*. p. 49).

Gorham's objective of creating a lightweight, inexpensive product in keeping with Japan's economy at the time was admirable. In fact, this three-wheeler dominated the post-war scene in Japan for some time (Odaka, Ono, and Adachi 1988: 85). The vehicle was praised by some as the 'substitute rickshaw'. Ultimately, however, it did not sell as well as expected, in part because it was priced at ¥1,300, only 35% cheaper than the Ford Model T (Katsuragi 1993: 52). Probably there was too much emphasis placed on the vehicle's fittings and not enough on cost. After working at Kubota Steel for a year and eight months, Gorham eventually moved to Gisuke Aikawa's Tobata Metal Casting Company. But his influence at the Kubota factory continued for some time, as evidenced by Gotō Takayoshi, a former pupil of Gorham, who later designed the first Datsun.

At Tobata Metal Casting Company, Gorham was first in charge of the manufacture of a gasoline engine used in farm machinery. As he drafted each part, he attached a number to it, set the error margin standard, and made special tools for inspecting the parts which came in from procurement sources, resulting in 'stable and highly reliable performance' (*ibid*. p. 63) because of his thorough quality control.

Gorham also directed the making of the joints for gas and water pipes, the company's leading product. 'He preached fervently about quality and precise measurement of screws, which were basic to all machines. He raised the precision level of screw-cutting machines and carefully examined the materials from which screws were made, saying that poor quality screws made for a poor seal and shortened the life of the joint' (*ibid*. p. 64). He gave practical instruction to many engineers and specialists. Tobata joints were shipped to Southeast Asia, England and America.

After the Great Kantō Earthquake (1923), Tobata Metal Casting Company supplied auto parts to Ford Japan and GM Japan. Gorham, who was then working at Tōa Electric, a company under the umbrella of these automobile companies, introduced a new pay system replacing the older system of daily or contract wages with an hourly wage system supplemented by productivity incentives, along the lines proposed by Frederick Taylor (*ibid*. p. 75).

Presumably, Gorham had direct and indirect influence on Aikawa's establishment of Nissan Motor Company (1933). The person responsible for the new Yokohama factory, built in 1935 to make the

4. The parts procurement list at Japan Ford, 1936, appears in Odaka (1993*b*: 78–189).

Datsun, was Sōji Yamamoto (later to become CEO of Nissan), who had been a friend of Gorham from his days at Tobata. To help out his friend, Gorham took the lead in drawing up plans for the factory, bought construction machinery from America, and also hired a dozen or more American engineers, all of them first-class experts (*ibid*. pp. 98–99).

It was after Gorham's 1934 departure from Nissan that the company bought the Graham Page factory on the west coast of America in 1937 (*ibid*. p. 100). When World War II ended, however, Gorham returned to Nissan to become executive manager (1945–1946). He was also a consultant for the director of GHQ after the end of the war.

After leaving Nissan, Gorham went to the National Precision Instruments Company (later to become Hitachi Precision Instruments), where he was in charge of designing the turret lathe. The first model was completed in nine months, and Hirosuke Saitō (CEO of the company from 1938) commented, 'Among precision construction machines, this was the very first one in Japan which measured up to world standards' (*ibid*. p. 111).

2.3 Benefactors Who Came Along with Direct Investment

In connection with the opening of foreign investment in the mid-twenties, an American production engineer, Alfred K. Warren, of General Electric came to work at the Shibaura factory (later to become Toshiba). 'Knowledgeable about the organization of factory production', his major contribution was helping to establish the production system of the Tsurumi factory (completed by the fall of 1924). From June 1927 until December 1931, he served as executive director of the Shibaura factory.

Warren's talent was not limited to production technology. Judging from the fact that his opinion was sought in a number of matters connected with managerial policy, such as accounting and price setting, it is apparent that he was highly respected in the company. Reports and memos he left, though sketchy, reflect the situation in the electric company at the time. Soon after arriving in Japan in 1925, he made a minute survey of conditions in factory production. On 2 July of that year, he made the following suggestions for reform of the factory's organizational structure:[5]

> At the head of the organization there should be a superintendent or general foreman. The factory should be organized into three divisions: light machining, heavy machining, and winding and insulating coils, each with a foreman as head. Each division should be divided into five sections based on specialization, with a foreman in charge. In each division, the various kinds of machine should be grouped according to class with an assistant foreman in charge of each group with responsibility for technology and efficiency. *Assistant Foremen and Sub Foremen may be appointed by the Divisional or Departmental Foremen, with the approval of the Superintendent.*[6]
>
> For these leaders to execute their responsibilities, work assignments must be clear. Since sections work in co-operation with each other, goods should be moved from one process to the next as soon as the operation is finished. *The Superintendent (or General Foreman) must not permit the accumulation of finished products, in working departments, but must see that each foreman or assistant foreman moves finished materials promptly …*

5. 'Organization Plan for Building #7. Foremen and Assistant Foremen', by A. K. Warren, dated 2 July 1925. At the head of this document the seal of President Kanzō Iwahara is affixed. Warren's work memos quoted in this chapter all may be found on microfilm in the library of the Institute of Social Science, University of Tokyo, filed under 'Tōshiba Horikawa-chō Factory Archives 71 (Tsuru) No.1'.
6. Here and for the remainder of this section, italics indicate Warren's exact words in his typed reports on the stationery of Shibaura Engineering Works, Ltd.

> *An assistant foreman will be in charge of a section and must not occupy a desk in the foreman's office, but must be located as closely as possible in the center of the group of workmen, whose work he supervises; and must allot the work to each workman. He must know at all times what each workman is doing, and when he finishes the task allotted to him. He will be held responsible for the quality of the work done in his section, and for the industry of all operators.*
>
> *He must be competent to show his workmen how work should be done and see that they are provided with proper tools with which to work and sufficient work at all times to keep them busy … He must be selected on account of his proficiency in the work, and must be a skilled workman.*
>
> *The Superintendent (or General Foreman) should require the Divisional and Departmental Foremen to furnish reports every three months regarding each assistant foreman, sub foreman, and workman in their respective departments (especially regarding the number of 'idle hours' in each department and the accumulation of material raw, in process, and finished).*
>
> When each process is completed, the superintendent should take care that products are sent to the next process immediately. In other words, he *must see that work is properly balanced in all departments, that is to say that each foreman and assistant foreman has a sufficient number of men in his department (and no more than necessary) to produce to schedule,* and when necessary should transfer personnel *from one department to another to the best advantage* … In this connection, *no additional men may be taken on in any department without the approval of the Superintendent (or General Foreman). Also, the Superintendent (or General Foreman) must require foremen and assistant foremen to keep their respective departments in neat and orderly condition, and should keep records of each foreman and assistant foreman noting characteristics, disposition, efficiency, complaints, etc.*

The above represents nothing more than the commonplace administrative structure of a modern factory. But the fact that Warren went to the trouble of writing it down as a set of proposals can be taken to mean that in the Toshiba factory at that time, the organization, division of responsibility, work allotment and so forth was neither necessarily clear nor systematically practiced. Furthermore, his suggestions and appended comments contain technical explanations concerning the supervision of production, including production equipment, tools, inspection, testing, storage, manufacturing, price setting, piece work, and job descriptions and responsibilities of the shipping superintendent and accountant—nine categories in all.

Warren's production schedule also called for listening to the opinion of related general foremen, and, after production, reporting production results, ordering necessary materials, and noting imperfections, together with the reason for them.

In the price-setting section, Warren writes:

> *In each department or shop within the plant, there will be a competent Price setter, with a sufficient number of Time study men to establish the correct time in hours and minutes, in which every operation should be performed. The price setter will determine the proper percentage of time to be allowed for rest and delay. This allowance may vary from 5 to 20% of the actual time required to perform the operation, depending upon the nature of the work, and prevailing conditions, such as waiting for crane service, grinding of tools, etc.*
>
> *The actual time required to perform the operation, plus the Rest and delay allowance, multiplied by the group rating, shall be the piece work price. The price rate for goods produced by cooperative work would be set by the manufacturing section of each division with the approval of the general foreman of the shop, and any changes must be made by the price setting department and not altered by the foreman without permission. In the case of a new product, a 'special piece work price' should be made, taking all conditions into consideration, and this 'special price' will hold good until proper provisions are made. The introduction of new technology would of course necessitate a new calculation.*

In a section on 'Piece Work,' Warren proposes:

> *Piece work should provide for a max earning capacity of 50% above Group rating. Piece work is not successful unless the group is earning from 15–30% above group rating. Individuals of exceptional ability and speed may earn as high as 70% above group rate.* The pay rate for group work, regardless of the kind of work, would be guaranteed for all workers. *For Day workers, max & min rates should be established in accordance with prevailing rates, paid for certain classes of work. Any bonus paid to an employee, whether piece worker or day worker, should be added to his pay at the end of the pay period, as a bonus.* At the time bonuses were paid, workers *should be rated within the scale set for their class of work*, and no changes should be made to the worker's pay scale class.

At the Tsurumi factory, thanks to Warren, there were many improvements, large and small. Packing costs came down from 1.7% of product price to 1.0% in just six months, for instance, and painting costs were also slashed.

2.4 Grass-root Efforts

In order for the American system of manufacturing to develop, small and medium-scale factories, which formed the support base of the machinery industry, also needed to produce interchangeable, standardized parts and components. In this regard, let us consider a case that took place in Kōchi Prefecture, on Shikoku Island.

Around 1934, machine factories in Kōchi Prefecture were hardly more than repair shops for machine parts used in cement-producing, paper-producing, or silk-reeling machines, or for engines used in fishing boats, and motor coaches. When the economy began to recover and the prefecture began to lose its labor force through migration to the Kansai district (the Kobe-Osaka area), the prefectural department in charge of local commerce and industry took the lead and made overtures to the Kure Naval Factory in order to promote industry in Kōchi Prefecture, seeking orders from military factories (Nihon Kōgyō Kyōkai 1938: 2–6).

Historically, it had never been easy for a company to get its name on the navy's supply purchasing list: having the company's name on the list meant that the quality of that company's products was guaranteed by the navy. In fact, the companies on the list were almost all large enterprises: smaller firms and sub-contractors were the exception.

In 1934, however, Kōchi Prefecture asked the commander of the Kure Naval Factory, Hidehiko Waratani, for help in improving small machine shops in the prefecture to improve their capacity to supply parts. For example, they requested instruction for smaller private machine factories in the use of the limit gauge, resulting in an unmistakable improvement in product quality. Whereas in 1934, Kure Naval Factory contracted ¥12,000-worth of parts from Kōchi Prefecture, in 1937 they contracted for ¥45,000-worth—an increase of 400% (*ibid*. p. 104). A small effort could yield significant results during these times.

Other prefectures soon followed Kōchi's lead, and the navy co-operated with them. Upon request, naval factory engineers were sent to each prefecture to give instruction. The deputized persons included naval engineers, assistant engineers and workers (assemblers, inspectors, mechanics, draftsmen, and copper workers). In addition, the navy lent machinery. Old, inefficient machines, which were of almost no use to the navy, were judged to be of considerable value if taken to the countryside. In fact, quite a few were loaned to prefectures instead of being scrapped or sold.[7] The result was a massive increase in the supply of parts to the navy from rural prefectures (*ibid*.).

7. For Kōchi Prefecture, loaned equipment included steam hammers, punch machines, small turret lathes and vertical milling machines (Nihon Kōgyō Kyōkai 1938: 111).

However, it is important to note here that in the 1930s there was a paucity of reliable suppliers of machine components. The period of war preparation saw a great increase in the number of sub-contracting parts manufacturers (Odaka 1998*a*; Ueda 1987), primarily as a result of military expansion policy and not because of improvements in private-sector production capacity.

3. Maturation of Japanese Machine Factories

3.1 Realization of a Technological Gap

American-style mass production spread throughout the Japanese machine industry from the end of the 1950s to the 1960s. This reflected the overwhelming impression made on Japan's factory leaders by the productive power and efficiency of America demonstrated in World War II, prompting a desire to acquire American know-how.

We should not forget that the seeds of this development began to appear after World War I. Since American economic vitality was becoming apparent in every area, it gradually influenced Japanese factory management technique. A number of factories experimented with Frederick Taylor's time-and-motion studies, and studies by labor psychologists began to appear, too. As well as exposing Japan to the awesome might of US industrial technology, the war also exposed deficiencies in Japanese industrial organization, as can be seen in a round-table discussion which appeared in the periodical *Nihon Nōritsu* (Japan Efficiency), containing the opinions of engineers.

> **Saigusa Shōsuke** (machining section chief of the Kamata Factory of Niigata Tekkōjō [Niigata Iron Works]): I have a strong feeling that no matter how good the system of process control may be, we can never solve the technological problem until the human problem is taken care of …
>
> **Katō Takeo** (chief of the manufacturing department of the Kōbe Factory of Mitsubishi Electric Co.): What human problem?
>
> **Saigusa**: It boils down to the will to work. I feel it has weakened.
>
> **Katō**: You mean the workers?
>
> **Saigusa**: I mean everyone, including the office staff. I feel this is a negative side effect of Japanese family-oriented individualism, which may well be a strong point of the Japanese people in some other sense. Japanese cannot be organization men par excellence. For this reason, even a perfect organization wouldn't function as planned …
>
> **Katō**: In the old days, the design section would draw up blueprints from the plans and turn them over to the men in the plant, saying 'Could you take care of this?' and somehow they did. Things don't move that way in these days of mass production, where machine products are standardized. Right away it becomes a problem of the accuracy of the blueprints … In your factories, haven't you sometimes experienced some part going missing at a critical moment when the final product was just about to be assembled?
>
> **Itō Eiichi** (engineer at Shimamoto Iron Works): Even though we anticipate such a thing happening, we still can't come up with measures to deal with the situation …
>
> **Murai Isao** (engineer in charge of electrical planning at Aichi Watch Factory): I think it's inexcusable the way things are processed, the materials that are used, and the way things are left half-finished. Things will continue just as they are now, unless planning is made on the basis of proper communication between production site and planning section so that we can anticipate the defect rate in advance (Zadankai 1942*a*: 21, 24, 29–30).

This discussion points up the fact that there was a lack of rationalization, not only on the worker/management side, but also on the technological side. In 1942, Victor Gantnel, an engineer directing the manufacture of construction machinery at the Shōnan Industry Factory of the Dai Nippon Military Equipment Company, pointed out in the same journal that:

(1) Japanese industry is like a general store—they make anything and everything. Since wages are low, labor efficiency is inferior to that of the US.
(2) The cotton-spinning and shipbuilding industries are advanced, but construction machines are so far behind it will take five to ten years to catch up. Perhaps because of lack of experience, 'their concept of accuracy is not very keen'.
(3) There is insufficient training in processing needed for mass production, for example the need to use finishing tools (Zadankai 1942*b*: 14–16; the spelling of Gantnel's name is phonetic).

Similar comments were made after World War II. Kakuzō Morikawa, then chairman of Nihon Nōritsu Kyōkai (the Japan Management Association), reported that a Mr Andrews, a consulting engineer of 40-some years of experience who came to Japan in March 1948 as an adviser to the Occupation Army, made the following observations on the occasion of his visit to a steel plating factory in Nagoya:

> (a) Many Japanese factories have superior machine equipment, but it is used very inefficiently: they use machines designed for mass production for small lot production.
>
> (b) The factory workers do not take proper care of the machines assigned to them.
>
> (c) Engineers work as foremen and are also expected to be engineers on the production site. They cannot do both.
>
> (d) Experienced, capable engineers should be given authority with the power of execution. They should also receive firm support from company officials; otherwise even capable engineers will eventually become powerless. All the management staff, inclusive of the CEO, top executives, managers, etc., must show understanding of and interest in engineering.
>
> (e) Neither workers nor equipment work as a team. Auxiliary operations are especially weak and defective. This results in incomplete and ineffective finishing, inspection, and auxiliary equipment.
>
> (f) Almost nowhere is process control complete. This being so, no one from chief executive to engineer is informed of what is actually going on in production.
>
> (g) Inspection of products in process and handling of finished goods is exceedingly poor … This makes for very poor yield, and no one appears to feel responsible for defective products (Morikawa 1948: 16).

Many machine parts supply industries had grown out of small and medium factories, and were characterized by highly uneven quality. Assemblers 'could barely maintain themselves, let alone reach out to help with the organization of sub-contractors' factories' (Komiyama 1941: 136). Compared with the assemblers, parts manufacturers were inferior and lacking in both skill and equipment. Product standardization was poor, and ability in the manufacture of finishing tools was low (Nihon Kaigun Kōkūshi Hensan I'inkai 1969: 569–570). Nevertheless, after the beginning of World War II, the Ministry of Commerce and Industry took the lead in restricting the number and design of processed parts and components. The Ministry encouraged the specialization and, if necessary, merger of subcontracting factories, thereby gradually promoting unification among industrialists. It recognized the need to improve total productive efficiency by acquiring superior technology and equipment, with a network base of co-operating subcontractors (Fujita 1965: 159). The gradual formation of this realization on the part of the Ministry is apparent in articles appearing in the periodical *Nihon Nōritsu* (Japan Efficiency) in the later 1940s.

Two things are clear from the above. First, during the period between World Wars I and II, the American method of manufacturing was introduced into Japanese factories, centering on large-scale enterprises. The 1920s showed a remarkable improvement in real-term average labor productivity for large factories in Japan, in stark contrast to the stagnant productivity of smaller firms, which did not have the chance to study the American method of manufacturing (cf. Satō 1973). This differential in productivity between large and small factories was no doubt related to the extent to which American style rationalization was practiced. Secondly, despite these efforts, mass production did not take root in Japan before the end of World War II, even in the critical government-backed military industries.[8]

As well as lagging in production technology, Japan also had a serious problem with production control. As Wada's research (1996: 104) shows, 'Often material and order slips got separated and the person in charge of the process would have to chase through the factory looking for material, so the foreman was so busy locating and sorting material that he had no time to spend on improving production, working day after day with nothing to show for it.'

Note here that the engineers working in factories at the time were already in possession of the knowledge necessary to launch mass production using interchangeable machine parts. The knowledge was there but the physical capacity to put it to use was not.

3.2 Narrowing the Gap

The reconstruction of Japanese machine factories after the end of World War II began with recognition of the conditions described above. Consciousness of a quality difference between Japan and Europe–America no doubt was felt most strongly by those working in the airplane and airplane-related industries. Development of successful Japanese cars such as the Subaru 360, a top-selling compact model of the early 1960s, stemmed from the experience and knowledge of aeronautical engineers.

The Japanese industrial world's consciousness of the technological gap between America and Japan was intensified by the difference in production capacity between the two countries after the war—a gulf of which Japanese industrial leaders were acutely aware. Reports written by survey teams sent to the US in the early 1950s under the sponsorship of the Japan Productivity Organization[9] convey the sense of wonder the visitors experienced on observing conditions in American factories.

The following account of a 1951 study visit to a Ford factory appeared in the *Vehicle Department Report* of the Machine Bureau of the Ministry of International Trade and Industry (MITI):

> I was amazed at how advanced they were in production control. The truck assembly line at Highland Park was not operating fully … but even so it was rolling off the assembly line about 35 units per hour (with a

8. At that time the term 'large quantity production' was used instead of 'mass production'. According to Noda Nobuo (1943), 'large quantity production is the assembly of a large number of replaceable parts', and 'in order to realize the above type of production it is absolutely necessary to mechanize the work at a high level'. This mechanization included: (a) thorough use of finishing tools and gauges; (b) simple and multiple-function manufacturing machines; and (c) specialized manufacturing machines. The process Noda had in mind was essentially what might be called mass production. To my mind, it is significant that there was a Japanese specialist at this date who was well aware of the strategic importance of mass production and advocated its adoption.

9. The Japan Productivity Organization issued a total of 170 productivity reports. Study groups also went to Europe, but Europe at that time was in the process of rebuilding with the help of the Marshal Plan. Thus it was naturally US industrial activity that left the strongest impression on the researchers.

> maximum of 60 units per hour). Every vehicle was different, and the difference was great. For instance, an F8 would be followed by F4 pickups being installed with engines in four different kinds of frames and axles in many combinations—in all, about 150 varieties. They were queued up on the assembly line in random order, according to a schedule that came over the teletype. For this reason, one rarely saw two identical models come off the line in succession. The same thing applied to the assembly and the production of parts. I couldn't help admiring how skillfully all this was managed. It appeared that a lot of consideration had gone into the use of common parts, and yet the finished products were different, and not only in type and style. Even when wheelbase and colors were different the assembly went without a hitch … it is clear that, even though detailed engineering is very advanced, the secret lies in the management.
>
> In New England, quite a few of the latest machine tools are being used, but they still have many old machines that are kept in such good condition that it is hard to tell them from the new ones. It is evident that quality control is being practiced according to the book … suggestions from workers are considered seriously and rewarded generously.
>
> Factories try to improve even in the smallest details of the operations, even where they don't make much difference one way or the other … (Mizuno 1951: 48–49).

These were some of the impressions the investigating groups received. They also felt, however, that there was no insurmountable barrier to Japan emulating the US:

> Comparing Japanese gear manufacture with American, in terms of theory, ours is in no way inferior. In design and finishing, however, with the exception of Japan's big industries and a few small and medium industries, ours is not yet on a par with theirs. If we could install the superior machines of Europe and America in Japanese factories, we have the technical capability to produce gears at the level of America, but with gloomy, antiquated, out-of-date machines, it is sad but we could never reach their level of precision (Nihon Seisansei Honbu 1959: 113).

In addition, from the report of the survey group dispatched by the Japan Productivity Organization, it is clear that members were surprised at the number of small-scale foundries operating under high capital intensification, and at American factories' obsession with high efficiency to the extent that they seemed unconcerned about non-technical matters unconnected with operational goals—for example, dirty and greasy windows (Nihon Seisansei Honbu 1957: 7–12).[10] The same was true of automobile factories. The Japanese reports were filled with admiration for the scale and level of productivity, but added that the engineering principles employed, as well as most of the machines being used, such as transfer machines, were already in use in Japan. These reports are somewhat reminiscent of the impressions recorded by Yukichi Fukuzawa, who visited America at the end of the Edo period. He saw nothing surprising in terms of technology, but was dumbfounded by the socio-cultural phenomena he observed (Fukuzawa 1978 (1937): 116–117).

The survey engineering groups who visited America after World War II came away with a clear impression of US superiority in the employment of mass production methods in America compared with Japan, but also with a conviction that in principle it was possible for Japan to narrow the gap. More than industrial and technological improvements, the need was to improve economic conditions

10. A similar survey group of engineers, this time belonging to the Japan Automobile Industry Association, found in the mid-1950s that, compared with Japanese cars, US models laid less stress on outward appearance, and more on performance. Manufacturers paid little attention to features unrelated to performance, such as polishing and finishing (Jidōsha Gijutsu Kai 1955; summarized in Odaka *et al.* 1988: 74–75). The same difference between Japan and America is seen even today, for example in women's clothing, fresh vegetables, etc. The Japanese consumer is more demanding of outward appearance. This characteristic was prevalent as early as the Edo period, when much attention was paid to the lining of clothing—a part of the product that would not normally be seen except by its owner.

—capital financing for equipment and the guarantee of a market for products. Naturally, there was some uncertainty accompanying this prospect, but the uncertainty itself served as a springboard to launch Japanese engineers on a race to catch up with and overtake America.

In view of this, the effort Japanese machine factories made to reform themselves from the end of the 1950s to the early 1960s is an exceedingly important subject for study. First Japan had to create an industrial network if mass production were to be achieved. To do this, the dual structure and technological quality dispersion among industries had to be eliminated. The argument of Hiromi Arisawa (1956, 1957), centering on dual structure, focused entirely on the employment problem; that is, it only treated the labor market problem. However, from the point of view of economic development, the essential task then was to build up a sound base of machine industry by preparing what were called medium- and small-scale firms (*chūshō kigyō*) to become moderately autonomous, moderate-sized firms (*chūken kigyō*).

In this respect, the machine factory promotion law (the Provisional Act to Promote the Machinery Industry, in Japan commonly referred to as *Kishin-hō*), which was in effect for 15 years from 1957, was probably more important than is generally recognized. The Act provided an institutional framework through which production subsidies were granted by the government, on an application basis, to carefully designated sectors of the machinery industry. It signaled policy-makers' commitment to strengthening Japan's industrial power by activating equipment investment in the machine supply industry, and it provided an initial push toward establishing a market for intermediate goods. The first step in augmenting industrial power was purchasing first-class machine tools from abroad and studying the technology employed in making them (reverse engineering). The next step was to establish a corresponding industrial system, and train workers to improve the quality of goods produced. The engineers started with the most basic of machine elements and then moved on to the surrounding applied machine components (cf. Odaka 1999).

The procedure of first improving quality and then concentrating on improvement of production efficiency was important. In other words, the decisive element in the development of machine factories was not simply enlarging production scale; a change in production philosophy came first (Odaka, Ono, and Adachi 1988: 275–277).

Another important discovery in post-war Japanese machine factories was the application of science (engineering) to the work site. This must have been especially important for the improvement of production in areas where the process could not be observed by the naked eye, such as the production of pig iron. In producing pig iron, everything hinges on proper selection and mixing of the ore, but until after World War II, the making of pig iron was left entirely to the intuition of workers who had experience in the production process. After the war, Japan was stimulated by what was going on in the American manufacturing world, where the results of scientific research were being directly applied, resulting in increased profits. An engineer who formerly worked at Ishikawajima Harima Shipbuilding remarked:

> During the war we followed the same production processes (as the Americans), but we got entirely different results. Not only the materials but even the concept of manufacture was totally different. You might say, in Japan we were simply counting on our experience. To put it simply, the difference (between America and Japan) boiled down to the basic idea of production. One way was rational and the other was trial-and-error. This made a big difference, I think (Taki, Senda, and Odaka 1993: 1–3).

Connected with this was the question of the role of the engineer in the industrial workplace. Before the war, the engineer's position with respect to the work site was little more than advisory. Engineers were neither administrators nor leaders. They only worked as advisors with academic knowledge; the job operation was in the hands of the foreman. For this reason, engineers had neither authority nor responsibility with respect to production.

> Try as we might to tell the workers what we had learned in school, they wouldn't listen to us … Usually they would reject our advice, saying, 'It won't work; we've tried that before' … In the end, the technology we learn in school disappears in the workplace …
>
> Things changed a little, though, after the war … The plant superintendent and managers still listened to the opinions of experienced workmen, but their opinions were supplemented by ours (*ibid*. pp. 3–4).

In fact, after the war the situation underwent a drastic change. The formal distinctions in status and remuneration between blue- and white-collar workers were abolished, and engineers took on a new role within the factory, co-operating with management on the work site. A system for solving difficult problems came about whereby engineers and management would both contribute knowledge and share know-how. This change took place in the 1960s in connection with the effort to modernize medium- and small-scale industries and to renovate the system of organizational control.

Industry immediately saw the advantage of applying science to manufacturing, because, fortunately, there were engineers who had received European- and American-style industrial training and also had production-site work experience. In addition, post-war factories had far higher expectations of engineers with college diplomas—that they would actively assume responsibility. Engineers started to take leadership roles on the assembly line when necessary. Their advanced education at last started to be perceived as outweighing their relative lack of on-the-job experience.

These engineers also had the wisdom to utilize the know-how that had accumulated in operations on the work site. Precisely because they received the help of workers in the production process, production improved. Some engineers were stationed permanently in the workplace, where they liaised between the workplace and management and/or the R&D department. They succeeded in getting the management's vision reflected in the workplace while, conversely, their familiarity with workplace practice enabled them to suggest changes to management. This was nothing less than 'workplace-ism' in production planning. 'Workplace-ism' is more than management planning; it is a new way of allocating responsibility and authority in production organization—the introduction of an unwritten, new principle.

Hence I believe that the prototype for 'Japanese-style' co-operation between blue-collar workers and production engineers may be found in the roles played by overseas engineers who had been brought to Japan to operate plants and train indigenous personnel since the Meiji Restoration. Many were Americans—people like Francis, Gorham, and Warren.

Workplace-ism is not found everywhere. On the contrary, authoritarianism is apt to develop if engineers with a college degree but little production experience are stationed at the production site as part of the bureaucracy, exercising organizational control by virtue of their authority and protecting their own dignity. Such a system of authoritative command was often observed under colonial rule, including the Japanese version of it. In such a situation, there is very little communication between workplace and management. In a factory where there is little opportunity for engineers and workmen to interact because the workplace is clearly separate, it is hard to foster workplace-ism. In other areas of Asia, as in Southeast Asian machine factories, there is a tendency to avoid sharing new knowledge one has acquired, as knowledgeable workmen are often possessive of their expertise, and seek to monopolize it as much as possible (e.g. Odaka 1984: 115). A study on South Korea in the 1980s noted that a clear line was drawn between engineers and workmen and that little give-and-take took place between them (Shin and Hattori 1986: 245–260).

Nor is workplace-ism always necessarily the best method. It is time-consuming to gather everyone's opinions every time a decision is needed on the purchase of a piece of equipment. Moreover, in a situation where personnel have a wide variety of education and experience, it requires considerable organizational maneuvering to share the information necessary to enable all personnel to make an informed contribution to decision-making. The invisible task of 'controlling human relations' in the day-to-day running of a factory is immense.

4. The *Japanese* Method of Production Emerging?

Despite massive improvements in the 1950s and 1960s, some of them described above, it was not until the end of the 1960s that the general superiority of the Japanese machine industry came to be clearly recognized. In the case of automobiles, the totemic product demonstrating maturity in machine manufacturing, not until the early 1970s did Japanese products win recognition for quality and price competitiveness. Frequent trade friction between Japan and the US doubtless impressed citizens in both countries with the overall advance made by Japanese machine products in international competition.

When that recognition finally came, it triggered a host of attempts to explain Japan's success. Some analysts pointed to 'lean production,' symbolized by the just-in-time (*kanban*) method—inventory control that limits the quantity of intermediary products (parts) kept on hand—and a network of industries providing a large variety of machine products. The system had an enviably high level of labor productivity, and was characterized by workplace-ism: motivated workers, irrespective of position, co-operated with each other in a 'flexible' job-sharing system under the protection of long-term, so-called 'permanent' employment (Hashimoto 1995: 109), while product development and the manufacturing process were organically linked. As stated above, in workplace-ism, not only engineers but also management and foremen (including personnel directors) often appeared in the workplace and interacted with workers in the production process. Management provided workers with opportunities to acquire new skills or receive on-the-job training in the 'internal labor market'. This was considered to be a type of management 'far removed' from that found in the US (Suzuki 1995: 67).

Market environment was a key factor differentiating industrial practice in the two countries. In the 1970s, the American industrial world had fallen into a relative decline (Horiuchi 1991: 200), and was hampered by a highly concentrated market structure under oligopolistic leadership (Nanbu 1991: 43).[11] Under this structure, industry permitted relatively few reforms unless exposed to competition from abroad. In contrast, post-war Japanese machine factories made a merit of the relatively small domestic market. They made specialized products, competing for market share by improving and diversifying output. While developing new products, they tried to stay afloat by adopting a 'low profit, large turnover' policy, often entailing longer working hours. This reflected the relatively high costs of entry and quitting in Japanese industry, as compared with conditions in America (Moriguchi, 1996: Chapter 6).

After the 1960s, the American system of manufacture revealed further weaknesses. In its pursuit of production and cost efficiency, the system often ignored consumer tastes, and factory workers found themselves monotonously repeating the same procedure with no opportunity to express individuality or creativity (Kobayashi 1981: 91). In particular, as craftsmanship disappeared from the beginning of the twentieth century, engineers' attention was focused on mass production systems,

11. Nanbu (1991) writes that this structure was established in 1920.

i.e. how to combine equipment in order to reach production goals most efficiently. An atmosphere began to prevail in the workplace where skill was treated lightly. Technology lost its flexibility, and it became difficult to adapt it to the demands of the times. Kobayashi sees this as the reason America lost out to Japan and Europe in certain machine products during the 1970s (*ibid*. pp. 90–92, 152–156).

The above notwithstanding, however, we should realize that the basic framework of Japanese factory management has common roots with that of the US. The former differs from the original mostly because it grew out of a strenuous Japanese effort to adapt the latter to a different social environment.

A few historical cases may suffice to illustrate the point. The subcontracting network used in the procurement of machine components, for instance, was not unique to Japan. It was widely practiced in the nineteenth-century US machine industry, as demonstrated in a classic paper by Rosenberg (1963), before the surge of vertical mergers in the 1920s. The idea of the 'just-in-time' method could also be traced to Henry Ford I (1926: 113–116), although it was never implemented in the US labor-management councils, which became quite popular in Japan in the inter-war period, originated in the US factory committees (Okamoto 1960: 84–91). Long-term employment and seniority systems have been prominent features of some big, American manufacturing enterprises (Koike 1977: Chapter 7). One could even argue that the enterprise-based (as opposed to Scandinavian-style, centralized) labor-management negotiations practiced in the US are a halfway house between Japanese and British practice.

Even the innovative Toyota management was not an exception. Its success, as elucidated by Ōno (1978: 9–18), stemmed from mass production that permitted a variety of product models through the combination of the just-in-time method and automation. It succeeded in reducing costs by (a) eliminating inventory of (standardized) components by organizing assembly operation in such a way that operators in charge of the later stages would come to pick up the products of the previous process, and (b) realizing small-lot operations by minimizing the time required for setting up and replacing equipment in machine-tool operations. The method simultaneously required higher capital intensity *and* a highly flexible work process. In this sense it was called 'self-working (*jidō)*' instead of 'automatic (*jidō)*' (the two terms are homonyms in the Japanese language). In a sense, what Noda Nobuo (1943) considered during World War II to be the essence of large-quantity production[12] was hereby realized.

Note that Toyota developed this new production method in anticipation of the end of high economic growth: 'The American method of manufacturing was appropriate as long as high economic growth continued—through 1973. However, with the end of high growth and the current slowdown, we can no longer continue to use it' (Ōno 1978: 4). Moreover, the Toyota method originated from Henry Ford I. According to Ōno, 'The American method of mass production as it exists today is not the method Henry Ford I had in mind … His successors did not necessarily construct the assembly line in the manner that Ford planned. They had the idea that the more products coming off the line the better, but they built dams on the line that obstructed the flow of machines and presses' (*ibid*. pp. 185, 197). Ōno thinks that the transformation in American factories came as early as the 1920s. In this sense, the 'Japanese method' of manufacturing that emerged 50 years later was a reincarnation of the American method started by Henry Ford.

12. See note 8 above.

5. Concluding Remarks—Topics for Further Investigation

During the high-speed growth era, Japanese factory management developed special characteristics of its own, to which the splendid performance of the Japanese economy in the 1970s and most of the 1980s has often been ascribed. These indigenous Japanese characteristics must have contributed significantly to Japan's success in overtaking the US in machine factory production efficiency during the late 1960s and the 1970s.

This historical fact notwithstanding, Japanese and American factory systems in the twentieth century have had much in common. Examples would include: (1) the advent of massive enterprise; (2) the rise of the labor movement; (3) the development of direct contact with the workplace (i.e. elimination of internal contracting); (4) the diffusion of electricity and the use of electric motors; (5) the advent of scientific management in the twentieth century; and (6) the American method of using interchangeable parts. It is worth noting, furthermore, that personnel systems often underwent similar transformations at about the same time in the two countries [e.g. the abolition of internal subcontracting system, as reported by Littler (1982, Chapters 10–11)].

Kobayashi (1981: 16, 160–161) has some interesting observations on commonalities between America and Japan in terms of the way in which technology developed in the two countries. America was free to choose technology without hindrance from European customs and tradition, while Japan, from the end of the Edo period into the beginning of the Meiji era, in the midst of confusion over cultural values, was also surprisingly free to select technology. In addition, both countries, situated as they were on the fringe of European culture, were able to compare technologies of foreign countries and adopt those they felt most drawn to. Also, the market system was highly instrumental in both countries in the diffusion of new technologies.

In this paper, I have stressed the debt that Japanese production systems owed to American methods, and have drawn attention to parallels between industrial practice in the two countries that have not always been sufficiently acknowledged. An important remaining task for students of Japanese factory systems is to identify the factors causing the distinctive characteristics of Japanese-style factory management to develop away from their common origins with practice in other industrialized countries, and to trace the historical process through which that transformation came to pass.

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