This paper aims to examine the impact made by the Japanese-style production method on the dynamic evolutionary process of production systems in China, with a view to adding the Chinese experience to the discussion on the evolution of manufacturing systems that has become so prevalent in recent years on an international scale. Specifically, I shall go back to the first introduction of the Toyota production system (TPS) into China and the process of technology transfer, by focusing on the case of First Automotive Works (Diyi Qiche Jituan Gongsi; hereafter abbreviated to FAW), the representative Chinese automobile manufacturer.

We can trace the introduction of the Toyota production system into China to two instalments of technical guidance offered at FAW in 1977 and 1981 directly by Taiichi Ohno, a representative proponent of this system. Indirectly, also, the system was further adopted in a real sense from the late 1980s when FAW took the opportunity of building a transmission plant with technological assistance from the Hino Motor Company to begin introducing the so-called "lean production system" on a full scale. FAW's transmission plant integrated the disparate elements of the Toyota system that had been introduced separately in earlier years and established, for the first time in China on a plant level, a comparatively systematic Toyota system that had as its core the just-in-time method. This is why it occupies such an important place in Chinese manufacturing industry.

1 For more on the formation and evolution of production systems, see Takahiro Fujimoto, "Iwayuru Toyotateki jidosha kaihatsu/seisan Shisutemu no kyoso noryoku to sono shinka--Kega no komyo to jigoteki gorisei" [The competitive capability of the so-called Toyota-style automobile development and production systems, and their evolution: "Flukes" and ex post facto rationality], parts 1 & 2, Keizaigaku ronshu 61, nos. 2 & 3, 1995; and H. Shiomi and K. Wada, eds., Fordism Transformed: The development of Production Methods in the Automobile Industry (Oxford University Press, 1995).

2 "Lean production system" is a term proposed by the Massachusetts Institute of Technology / International Motor Vehicle Program (IMVP). Basically it is an idealized form of the Toyota production system. For more details, see J. Womack, D. Roos, and D. Jones, The Machine That Changed the World (New York: Rawson Associates, 1990).
As far as I know, there have as yet been no studies, either in China or overseas, that set out to investigate the introduction of the Toyota production system into China, particularly into the automobile industry. Despite the inclusion of the automobile industry among the number of studies on the international spread of the Japanese-style production system and on the overseas penetration of Japanese firms—two popular topics of discussion in recent years—most of the studies deal with the United States, NIES in Asia, or the ASEAN countries, and there still are plenty of blanks to fill when it comes to studies on China. One of the merits of this study lies in its greater three-dimensional elucidation of the process of introducing the Toyota system into China by including within its perspectives the "Japanization" presently unfolding on an international scale. At the same time, it could provide another frame of reference to which other studies on the international transfer of the Japanese-style production system can be compared.

As early as the late 1970s Chinese firm had paid more attention to the revolutionary efficiency of the Toyota production system and had begun to introduce this system earlier than American and European firms. This is a historical fact, noteworthy in itself. Nevertheless, it cannot be denied that, under the double inertial force of the old enterprise system—a management system under a planned economy and the conventional Ford mass-production system—reform of the production system and a turnaround of the enterprise system in Chinese firms (especially state-owned enterprises) are more difficult to achieve than in American and European firms.

With these issues kept in mind, in part 2 this paper will discuss the concrete technical guidance provided by Taiichi Ohno on his two visits to FAW. This was also the first introduction of the Toyota production system into China. In part 3 it will investigate the case of the FAW transmission plant, the representative Toyota-style plant within the FAW organization, to elucidate the process of technology transfer from Hino, the overcoming of the conflict between old and new systems, and the production management and quality control systems in this plant. I hope, by proceeding in this manner, that I can put China into the bigger picture of the worldwide dissemination of the Toyota production system.

INTRODUCTION OF THE TOYOTA PRODUCTION SYSTEM AT FAW

With technical assistance from the former Soviet Union, First Automotive Works was established in 1953 in Changchun City, thus becoming China's first automaker. Its production system was known for being a coherent, mature Ford production system based on a highly vertical integration incorporating casting, forging, machining, and final assembly processes. Figure 1 on the facing page shows the production logistics systems in this plant. I hope, by proceeding in this manner, that I can put China into the bigger picture of the worldwide dissemination of the Toyota production system.


2 The research for this study was based primarily on field surveys. I have visited FAW three times to conduct surveys there on 17-19 February 1992, 5-7 September 1994, and 21-24 December 1994 (including an interview with Professor Takahiro Fujimoto, the University of Tokyo). I have also conducted surveys of Toyota six times (January 1991, August 1992, November 1994 and 1996, July and November 1997) and of Hino one time (February 1996).

3 For material on FAW's acceptance of and changes to the Ford system see Chunli Lee, "Adoption of the Ford System and Evolution of the Production System in the Chinese Automobile Industry, 1953-93", in Shiomi and Wada, eds., Fordism Transformed, and Chunli Lee, "Chugoku jidosha sangyo ni okeru kigyo shisutemu no keisetsu shingekun" [Formation and evolution of the enterprise system in the Chinese automobile industry] (unpublished Ph. D. dissertation, Division of Economics, Graduate School of the University of Tokyo, 1996).
production logistics.\textsuperscript{1} This traditional mass-production system of FAW was destined in the late 1970s to encounter the Toyota system and undergo a subsequent reform.

**Ohno Raises Issues**

The earliest introduction of the Toyota production system at FAW can be traced back to the direct guidance given by its originator, Taiichi Ohno, in 1981. His advice stirred up interest in the Toyota production system among the executive officials and the middle-management stratum of the company.

Ohno's first visit to China came in September 1977, when he visited FAW and other automakers. His impressions are recorded briefly in his famous work, \textit{Toyota seisan hoshiki} [The Toyota production system]:

- Recently [15-28 September 1977] I had a look at China's manufacturing industry. They are enthusiastic in their efforts to modernize. I believe that,
- underlying everything, from the time of Henry Ford I, through our first use of the Toyota production system after the war and right up to the present,
- and now in the manufacturing industry that China is aiming at anew, here is the universal element of the true "efficiency" that Ford made mention of ....
- between fifty years ago and the present, huge changes have arisen. The situation in China is changing enormously.\textsuperscript{2}

Still, what were those changes that Ohno, who had been born in Dalian City in China, saw during his visit? They have till recently been completely shrouded in the darkness of history. No 1977 accounts remain of what he said and did at FAW. Two facts, however, shed some indirect light.

The first is the fact that the first edition of Ohno's best-known work, \textit{Toyota seisan hoshiki}, came out in May 1978, and a Chinese translation (unpublished) by the Technological Information Section of the FAW Department of Manufacturing Technology also appeared around the same time.\textsuperscript{3} It is inconceivable that a translation could have been made so rapidly without the cooperation of the author.

The second is the fact that Ohno's words and movements on his second trip to FAW (14-21 June 1981)--at FAW's invitation--are faithfully recorded in FAW accounts.\textsuperscript{4}

The general report prepared after the event by the FAW Department of Production Management, whose role it was to show Ohno and his group around the factories, records Ohno's concrete views regarding the problems existing in FAW's production system. They are trenchant criticisms delivered in Ohno's style, with no mincing of words.

He inspected all of the subfactories and summarized his impressions of the gravity of management problems in the following four comments on such things as quality, operations management, and safety.

- Quality: Seems all of the factories are producing defective items.
- Operations: They are accelerating the destruction of machines and equipment.
- In-process items: Causing huge amounts of capital to lie idle.
- Safety: if it were us [factories in Japan] we'd be too afraid to work. I have to admire the fact that there no accidents in these conditions. [What he really means is that it's unbelievable there aren't accidents!]

1. We admit that management in the factories has problems, but we hadn't raised them
2. as seriously, with as much acuity, as Ohno did. The gravity of the problems is still
3. not felt by our executive officials or the general workers. We are deeply stirred by
4. the sharpness with which this one foreigner has pointed out problems to our
5. company.\textsuperscript{5}

\textsuperscript{1} In regard to the expansion of FAW's business organization from the late 1980s on, see Lee, op. cit. in \textit{Fordism Transformed}. Figure 1 was compiled by the author from FAW publicity materials and \textit{Qiche Gongye Jiben Qingkuang 1991} [Basic state of the automobile industry, 1991], vol. 2, pp.124-25.


\textsuperscript{3} Zhiguo Li, \textit{Jingyi shengchan fangshi yu qiye jingji xiaoyi} (Lean production system and its economic performance) (Beijing: Beijing Kexue Jishu Chubanshe [Beijing Science and Technology Press], 1994), p. 239, the bibliography.

\textsuperscript{4} The work cited in the preceding note by Zhiguo Li, vice president in charge of production, contains the first publication of notes taken during Ohno's lectures at FAW over ten years earlier. Unless noted otherwise, the material that follows is based on this work by Li and on an interview with Li on 6 September 1994. I would note passing that Li was the person responsible for inviting Ohno to FAW in 1981.

\textsuperscript{5} FAW Department of Production Management, "Fengtian Qiche Gongsi daibiaotuan lai Yiqi fangwen qingkuang de..."
Let us now look at two other accounts written down at the time of Ohno's inspection of FAW subfactories and manufacturing processes.

**Quality control:** In the general assembly plant we showed him two front axles that had been rejected and taken down from the line and were in the process of being repaired. They [Ohno and his group] expressed the opinion that rejected parts should be replaced in the line, and that removing from the line items with reject parts attached to them or with parts missing was inexcusable. He [Ohno] explained as follows:

This was the American way of doing things, but we don't agree with it. It's true that it's necessary to stop the line when you carry out replacements of parts in the line, but even so it's faster than taking things down from the line to repair them. One other thing: the supplementary painting process that comes later should be eliminate. It only encourages operators not to be concerned about quality control.¹

**Process control:** Operations throughout the company are not producing items to fit in with the takt time of the final assembly line; instead, every process and every production line is operating at its own pace, without any control. There is a lot of in-process stock, but the workers keep on pushing right ahead, unconcerned about the quality of the products or about keeping the machine in good condition, because they want to work fast so they can get off work early. As a result they hasten the wear and tear of the equipment and shorten the lives of the machines. Situations like this they [Ohno and his group] found extremely incomprehensible....²

According to Ohno, assembly on the final assembly line should be synchronized with all the various chain conveyors, and at most there should be a stock of two or three items--large numbers were not to be stockpiled beside the assembly line. Nor were tires to be brought over and left piled by the side of the road. If the tempo was out of kilter, it was preferable to stop the chain conveyors....As a general rule it is better not to stop the chain conveyors, but when the need arises it was all right to stop them.

As can be seen from the above, Ohno had some trenchant criticism and scathing remarks to direct at FAW. For a company that considered itself Number One in China's machinery industry, these came as an enormous shock.

**On-The-Spot Guidance By Ohno**

Ohno also provided direct technical guidance in the FAW engine and chassis plants. One of the things he did was to take the chassis plant's machining line for the final pinion carrier (zhoucheng zuo) of the rear axle as a sample, and he gave concrete technical guidance for it, even going so far as to change the layout of the line. These were the only cases of direct guidance provided by him in China, and represented the first experiment at introducing the Toyota production system. In order to compare the situation as it stood before kaizen and then after kaizen, let me briefly summarize what Ohno's guidance comprised.³

**The situation before kaizen**

There were seven pieces of equipment or machinery in the line, six of them being four different types of cutters, the other a machine for washing. There were five operators, each working alone at their respective processes. The processes were linked by roller conveyors, the average number of in-process stock in each process was 110, and of finished stock was 360; in-process items for which there was no room on the roller conveyor were placed on the floor.

**The kind of kaizen carried out**

- First of all a takt time for the line was calculated on the basis of amount of production, and a figure of 2.6 minutes was arrived at.⁴
- A relay switch was installed in the first machine tool so that a green light would go on every 2.6 minutes. It was fixed so that, when the light went on, the machine's electric power would be connected and it would go on. In this way, the operator in the first process was

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¹ This is based on pp. 52-55 of Zhiguo Li's work cited above and an article by Kimitoshi Sato, "Xianchang shiyandian zongie baogao" [Complete report on workplace testings] , on pp. 214-18 of the same work by Li.

² Ibid., pp. 234-36.

³ The formula for calculating takt time is to divide the total amount of working time per day by the number of vehicles per day needed to fill orders.
unable to begin working earlier—or later—than every 2.6 minutes.

- The washing process was removed from the end of the first 5-man 7-process operation and replaced with a 1-man 6-process operation. The order of operations and distribution of time for this operation was shown on a standardized work chart.

- The layout of the equipment was changed, the line shortened, the number of roller conveyors reduced. The way the washing machine was lined up was changed, and the parts that had been washed were sent to the subassembly of the immediately subsequent process.

- Breakdown signal devices were attached to the processing lines, so that operators could at any time send a signal to the equipment maintenance section.

- A "Get ready! Start!" system was put in place; in accordance with this starting signal, processing parts would be sent to the line and operations begun.

**Post-kaizen results**

- One-man multimachine handling led to four fewer workers. Also, it became possible to produce at the same takt time as the rear axle subassembly line process that followed later, and synchronization was realized.

- Wasteful labor was eliminated and costs could be reduced. In-process stock fell from 110 items to the 8 items being worked on, and the number of finished stock from 360 to 160. In-process stock funds were reduced by 30%.

- The quality of parts improved, responsibilities became clear, and self-inspection was enhanced.

- The exercise was useful for bringing problems to the surface and solving them at an early stage. Since the whole line stopped when a problem arose in the process, it contributed to preventing reoccurrences.

Several basic elements of Toyota-style process management are contained in the above summary: the reduction of worker numbers through multimachine handling; the realization of synchronization between earlier and later processes; the resultant reduction in in-process stock; the building in of quality; the automatic surfacing of problems. FAW officials were impressed, so great were the differences between the production line before and after kaizen. The direct results of Ohno's technical guidance were that it brought to light problems in the mass production system at the worksites themselves and with reference to specific things, and it made the FAW top management more attentive to production methods.

Evidence of this is contained in numerous reports, mostly produced by the Production Management Department, detailing aspects of Ohno's FAW visit and his technical guidance. Some examples, all of them appearing in June 1981, are:

- "Riben Fengtian Qiche Gongsi daibiaotuan Daye Naiyi xiansheng yu chang lingdao zuotan gui (jiluzhaiyao)" [Round-table discussion between Mr. Taiichi Ohno and FAW top managers (summary)];

- "Daye Naiyi xiansheng fengwen Diyi Qiche Zhizao-Chang de baogao" [Report on Mr. Taiichi Ohno's visit to FAW];

- "Daye Naiyi xiansheng fengwen Diyi Qiche Zhizao-Chang zuotanhui de jilu zhaiyao"

- [Summary of a round-table discussion with Mr. Taiichi Ohno at FAW];

- Taiichi Ohno, "Yiqi tuixing Fengtian shengchan fangshi zhi wojian" [My views on promoting the Toyota production system at FAW];

- Kimitoshi Sato, "Xianchang shiyiandian zongje baogao (Changchun)" [Complete report on worksite testings (Changchun)].

Over a year and a half later, the most enthusiastic proponent of the introduction of the Toyota production system, Mr. Zhiguo Li, collected his explanations of the Toyota system as it would work in the FAW context in a book entitled *Shengchan guanli kexue fangfa yu yingyong* [The scientific methods and applications of production management] (FAW, 1983). This book was given the new title *Xiandai shengchan guanli jichu* [Foundations of modern production management] and published throughout the country in 1986.

The writings of Ohno, the records of his lectures, and the relevant reports were put to good use first of all for the education of personnel throughout the whole of the company, especially in regard to the area of production management. Ohno had delivered a severe shock to FAW's production
Faw's Own Introduction Of The Toyota Production System

FAW's own moves to introduce the Toyota production system began in 1979.1 Much earlier, in September 1972, the first postwar Chinese "Automobile Industry Observation Delegation" visited Japan, at the same time as the normalization of Sino-Japanese relations. Mr. Zhiguo Li, later to become an FAW vice president, was a member of the observation delegation that visited Toyota and nine other Japanese automakers and a small number of parts makers. This marked the first direct exchange between automobile industry circles in new China and their counterparts in Japan. Later,2 in 1978, FAW sent twenty of its top management team, including the president of the company, to Japan. The group, known as the Qiye Guanli Xuexi Tuan [Enterprise management study team], spent five months visiting plants at Toyota, Nissan, Mitsubishi, Hino, and other companies. They are reported to have experienced one shock after another at seeing how advanced Japan's management system was. When this delegation returned to China its members produced, on the basis of their study notes, twenty-two instructional booklets on all the specialized areas they were responsible for. These instructional booklets, called "Yellow Books", were used in seminars for all the executives and technicians in the company. These stirred up the first Toyota study boom at FAW.3

Beginning in 1979 FAW conducted early experiments with scientific management methods selected from among the advanced management systems of Japan and other countries to fit in with our company's actual conditions. These included kanban delivery, leveled production, the production of different model variations on the same line, quality control measures, control by visual inspection, target costs, value engineering, and system engineering. This was a trial that delivered the first shock to the conventional management thought and practices that FAW had introduced from the Soviet Union in the 1950s and had followed for twenty years. Control through the use of the kanban delivery that lay at the heart of the Toyota production system brought a stop to in-process inventory, and the method of supplying castings and external purchased parts directly into the process produced a golden age of production at FAW from 1979 to 1984.4

It is a historical fact, and one that should be accorded its due, that as early as the end of 1970s Chinese enterprises had adverted to the revolutionary efficiency of the Toyota production system and had begun to introduce this system even before European and American enterprises had done so. As a result, FAW, for example, was able to nearly halve the cost of in-process stock in 1983, when the kanban was introduced, from the 50 million yuan it spent the year before, to 26 million yuan.5 At this stage, however, FAW's understanding of the Toyota system is thought to have still been at conceptual level, and it could not be described as fully developed. FAW's full-scale deployment of the Toyota production system did not take place until after the completion of its transmission plant with the technological assistance of Hino Motor Company.

TECHNOLOGY TRANSFER FROM HINO-THE FAW TRANSMISSION PLANT

The new transmission plant built under technological assistance provided by Hino integrated all the constituent elements of the Toyota system that had been introduced in bits and pieces until that time.6 As an entity that established a comparatively systemic Toyota production system revolving around the just-in-time system, this factory is very significant. By the birth of a

5 Zhiguo Li, Lean Production System, p. 165.
6 The materials I present in this section are based on interviews I conducted on 6 and 7 September 1994 and on the results of an inspection tour of the transmission plant.
model factory at FAW, understanding of the Toyota system changed from a conceptual thing to something visible and concrete, and this served to instill in the employees a common value system.

The Production System at the Transmission Plant

The introduction of product technology and production management know-how from Hino was a deliberately intended technology transfer on FAW's part. FAW management saw the introduction of technology from Hino as an opportunity to learn about Japan's production management methods at the same time. Construction on the new plant was started in September 1985, and full production began in August 1990. During this period 23 technicians (57 man-months in total) were sent from Hino, and 49 people (66 man-months in total) were sent on eight separate occasions from FAW to Hino, where they visited factories, attended lectures, and received technical training.

At the time of the survey I conducted in September 1994, the new plant was employing 1,900 people and running on a continuous two-shift system. It had 79 processing lines. Of its 960 machine tools, 900 were of Chinese make, with 60 Japanese-made machines in only the key processes. It was following just-in-time principles, and it acted as FAW's model factory. The following statement appeared on a notice board found at the entrance to the plant.

In this factory we have replaced the conventional earlier-processes-push-later-processes system by a later-processes-pull-earlier-processes system. We pursue cost reduction, and we have introduced a one-at-a-time processing system, a stock supplementation between all the production lines, and the kanban delivery method for production control. On-site operators follow the wuwei yiti [5-in-1] quality control method of sanzi yikong [3 selfs and 1 control], Shenhua gongyi [deepening manufacturing technology], gongcheng luhua [process greening], wubuliu [the 5 nonflows], and product optimization activities. Operations management adopts the methods of multimachine handling and multiprocess handling; tool management involves collection and delivery at fixed locations, follow-up checks, and regular replacement; while equipment management involves both repair of breakdowns an preventative maintenance. For shopfloor management we have introduced an ongoing campaign involving the five "-nesses" [5S]: orderliness, tidiness, cleanliness, spotlessness, and professionalism.2

Every workshop has a notice board with a printed checklist of the separate elements that go into the just-in-time system. This list, shown in Table 1 on the facing page, gives the items to be inspected, the point standards, and the points gained by each line. These points gained are linked with the "management bonus" explained later. Let us look at the production management and quality control sections shown in Table 1.3

Production Management

1. One-at-a-time [iko nagashi]: This refers to the idea that the number of in-process items in the middle of every process in the production line must be one, and only one; this is the main feature distinguishing this process from the early-processes-push-later-processes system seen in the mass-production system. One-at-a-time is the key element in the just-in-time system that eliminates large in-process inventories, demands synchronizing production with line takt times, and synchronizes and parallels the flow of items from an earlier to a later process and the flow of information from a later to an earlier process. In this plant one-at-a-time was actualized on the whole production line in 1992.

2. Kanban delivery method: In this plant everything is so arranged that, unless a kanban is sighted, no casting from the warehouse will be delivered, and the production line will not begin production. At one end of every line are located kanbanboxes, divided into production instruction kanbans, finished-product inventory kanbans, and parts-withdrawal kanbans. One this last type (the parts-withdrawal kanbans) are recorded such items as the part name, part

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1 Zhiguo Li, Lean Production System, pp. 171-72.
2 This is according to notes I took when I visited the plant on 7 September 1994. The terms that appear in the description of the quality control method will shortly be explained in the text.
3 Unless I indicate otherwise, this account of production management and quality control is based on "Promoting Just-in-time Production to Achieve Optimal Management", pp. 39-42. Note that the inspection criteria and standard points for the preliminary line are not known. The Table is based on notes taken by the author during an inspection tour of the transmission plant on 7 September 1994.
3. Control by visual inspection: Andon lamps are located on the transmission assembly line; these indicate the present working state of the line, the times for line stoppage, and so on. To indicate work standards there also is the "one chart, one manual, one card". The "one chart" refers to the Toyota-style standardized work instructions chart; "one card" refers to the work instructions card; "one manual" refers to the manual containing the various work standards for all the different production personnel. Also, the parts boxes are standardized in order to ensure quantities are uniform.

4. Multimachine handling: This means that, on average, one worker handles three machines (this may at times be as much as five machines). The production line is laid out in a U-shape. Process design and plant design were the result of a joint design by Hino and FAW.

Quality Control

In the transmission plant, quality control is carried out in two ways: by building quality into the production process (through zizhu jiancha, or self-imposed inspection) and by final inspection. In the concrete this means that they use the quality control method called "5-in-1" (Table 1): "three selfs and 1 control", "deepening manufacturing technology", "process greening", "the 5 nonflows", and process optimization.

1. "Three selfs and 1 control" [sanzi yikong]: The "three selfs" refers to SELF-imposed inspection, SELF-scoring, and filling out the "quality follow-up card" by oneSELF, and the "one control" refers to self-CONTROL (ziji kongzhi) activities.

2. "Deepening manufacturing technology" [shenhua gongyi] signifies the improvement and deepening of manufacturing techniques; in the concrete, it refers to mechanisms, known as pokayoke, or "faithsafe features", set up to prevent the production of defective articles.

3. "Process greening" [gongcheng luhua]: one of the means for attaining quality control. The process inspection group carries out an inspection of a process on the basis of a checklist called "the criteria for process acceptability" and hand down a decision as to whether the process passes or fails the criteria. They make known the results by means of a round board hung onto a notice board. The front surface is green, which means Pass; the back is red, and it indicated Fail. The more green there is showing the higher the acceptability rate. This explains why this method of encouraging quality improvement is called "process greening".

4. "The 5 nonflows" [wubuliu]: During a quality inspection, items that pass inspection are given five types of marks, including a Pass mark, a production date, a shift number and an item number, etc. An item lacking any one of these five marks is not to be sent on to the next process. Hence the name, "the 5 nonflows".

5. Product optimization activities: These are consider to be the goals of the preceding four items.

Whereas the introduction of the kanban delivery method at the plant was suggested by FAW, total quality control (TQC) was suggested by Hino at technological assistance stage, but not adopted. Inspection of the products is done by an inspection of all items. In addition, from 1991 a German variation of a quantified inspection Audit System was introduced by the joint venture partner, Volkswagen. In this system, one vehicle a day undergoes a sample inspection, with a score given by a minus-points system on the basis of a checklist covering several thousand items. Inspection results are published once a week on the notice board; once a month an inspection assessment review committee meets, and the lowest scores are called upon explain the results. The FAW television channel televises the results of the review committee every month.

The other control areas are shown in Table 1 and need no further explanation. The introduction of the Toyota production system at FAW was reported in the Renmin Ribao [People's Daily] as following:

As a breakthrough in production management FAW has carried out a revolution against the conventional mass-production management system. Replacing the past system of earlier processes pushing later processes along, by a system in which later processes pull earlier processes, it has managed, by implementing the pull system of one-
at-a-time production, greatly to reduce inventories of in-process goods between processes, diminish revolving funds, achieve improvement in manufacturing quality, and greatly lower the rate of defects.

By changing from having one worker operate one machine, as in the past, to one worker operating several machines, it has reduced the number of workers, started operating on a full rotation basis, and greatly lifted its production efficiency.

By changing from the large-lot production of the past to small-lot production, it has become able to carry out multimodel production, cut back on storage space, and reduce work loads.

By changing from the parts delivery system based on a storage system, as in the past, to a parts delivery system based on kanban matched with production takt times, it has been able to realize leveled production and has improved control standards on shopfloors....

Judging from what we see here, we are able to conclude that the pull system, the production of multiple models in small volumes, multimachine handling, and the kanban system were key introductions, and the basic elements connected with the Toyota system of production management were in general outline part of FAW's production scheme. Nevertheless, the process of its attaining a solid foothold was also a process of repeated clashes between the conventional mass-production concept and a Chinese-style production management philosophy within the context of a planned economy system, on the one hand, and the concept of the Toyota system with the "just-in-time" system at its core. On the other hand, it was a process of overcoming conflicts between old and new systems at the same time. The section that follows will investigate the process by which the Toyota system was introduced and reflect on FAW's capability to learn.

Learning Capability: Overcoming Conflicts Between Old And New Systems

2 Unless otherwise indicated, the Account given in this subsection is based on "Promoting Just-in-time Production to Achieve Optimal Management", pp. 45-46.
3 Ibid., p. 45.
4 Li Song, "Chugoku Daiichi Jidosha no moderu chenji ni okeru gijutsu donyu oyobi sono kyushu shoka purosesu ni tsuite no kosatsu--Hino Jidosha to no transmission gijutsu teikei o chushin ni" [Study on the introduction of transmission technology in FAW's model changes and of the process of absorbing and digesting that technology] , Master's thesis, General Culture Division, the University of Tokyo, 1990, p. 42.
5 Ibid., p. 48
and preferred having large numbers on hand, whereas the Japanese side suggested reducing the numbers so that problems could be brought to the surface and kaizen effected, but their suggestions fell on deaf ears. ¹

In 1991 the factory’s new executive officials started work; reassessing the Toyota system as the company’s greatest strength, they decided to introduce it in earnest. From that time on the Toyota system gradually permeated the production setup, and rationalization results kept improving. Eventually it was this change in the executive officials’ awareness that, through a top-down approach, effected a turnaround in the production system.

Modifying The Chinese Approach-A Bonus-Centered Incentive System

The most hotly debated item in the process of introducing the just-in-time system was the fact that multiprocess handling and increased work intensity was not linked to wages. Instead of the one-worker-per-one-machine that was the norm in the plant, multimachine handling was introduced, and one worker operated three machines. There was opposition on the worksite. Work intensity was being increased, but wages did not keep pace. As a result, even though the machine were laid out in a U-shape, workers continued as before to operate only one machine each. In addition, though an effort was made to cut down on workers and to remove surplus personnel from the lines and transfer them to subfactories elsewhere, personnel planning was determined by the central government, which considered originality in employment procedures to be undesirable.

When a delegation from FAW visited Hino’s Nitta plant and saw how Hino employees worked, they were astounded. They are reported to have been deeply impressed, saying that "It's unlikely that in our factory people would work this way for us, no matter how much we paid them." ²

The solution to the problem was held over until after 1991. Officials came to realize "the need to use appropriate economic policies and effective incentive measures as backups" in order to promote the just-in-time system. As multimachine handling and multiprocess handling become more widespread, work loads increased and work intensified, so unless pay also increased proportionately, employees would lose the desire to go along with plans. This led to the introduction at the plant of "post wages" and "management bonuses". The "post wages" system that was introduced among on-site operators ranked the posts of operators on four levels, depending on such indices as the percentage of manual operations involved, work intensity, and technical complexity. The "post wage" of the highest post was three times that of the lowest, and the highest bonus for a direct operator was set at ten times that of an assistant operator. ³ The amount of wages and bonuses paid out was pitched to the production site and to multimachine handling.

The newly established "management bonus" was paid out to workers on the basis of the number of criteria points they had attained every month on their just-in-time production line, which had been divided into three types--preliminary line, elementary line, and standard line--each with its own target criteria (see Table 1). The six items checked were production management, quality control, tool management, equipment management, operations management, and "5 -ness" [5S] shopfloor management. The checking was done by a process inspection group that deducted points as they went down a detailed checklist.

This typically Chinese modification in the form of an incentive system revolving around wages and bonuses reflected how things are done in Chinese enterprises. Even the process of implementing the new wage and bonus system had to on a visible form in a scoring system based on inspection criteria, and objectivity was demanded. The problem of wages was a problem facing state-owned enterprises in general, and it was the most sensitive part of the old management system.

¹ Based on interviews I conducted on September 1994. So is the next paragraph.
³ It is probably appropriate to consider this "post wage" ( a term coined by China’s Department of Labor and Personnel) a form of position-linked pay peculiar to China. For more details, see Yo Nakanishi and Xin Geng, "Chugoku Daini Kisha Seizo-Sho ‘Daini Jidosha Kojo’ no ‘koshi meisai hyo’-- ‘kyuryobukuro no kokusai hikaku, sono 7” [Itemized account of salaries, Second Automotive Works of China: An international comparison of pay envelopes, part 7], Discussion Paper 91-J-14, Faculty of Economics, the University of Tokyo, 1991.
Results And Diffusion

By 1992 the just-in-time system had been introduced into the whole production line at FAW’s transmission plant. The average work load rate per operator had risen from the old 27.7% plant average to 65%, machine stoppage time had become 80% shorter, and a total of 468 production personnel had been retrenched. Labor productivity rose from 129,000 yuan per person in 1991 to 303,000 yuan per person in 1994, and the number of transmissions produced per worker rose from 27.7 units in 1991 to 68.5 units in 1994--in both cases, the increase being more than double. 1

In addition, by the introduction of one-at-a-time processing at all stages of the production line, revolving funds for in-process stock was slashed by 50% (from 7 million yuan to 3.5 million yuan), defective item rates went down by 35%, and the rate of items passing inspection the first time round rose from 70% the previous year to 92% in 1994. Commenting on these results, specialists from the Japanese side were favorable in their assessment: ”The present transmission plant was less of a worry than we expected. Its production output exceeded planned capacity, kaizen was well advanced, and it has become an outstanding factory.” 2

FAW widened the transmission plant experience and pushed for the idealized form of the Toyota production system, the lean production system (Jingyi shengchan fangshi ), for the whole of the company. Renmin Ribao informed its readers of the effects of FAW’s kaizen and how the system was being spread over the whole company.

Challenging The Conventional Mass-Production System: Faw Promotes Lean Production System Companywide

FAW began to promoting the lean production system in 1992. The company began by selecting five factories, nine workshops, and three production lines within the company that all had different technological systems, processing methods, and production takt times, to serve as a trial. In the transmission plant, within one year of introducing the lean production system, production output doubled and labor productivity almost doubled. In the Changchun gear plant, a year after the lean production system was introduced production output had increased by 44% over the previous year, labor productivity by 37%, and profits per person by 25%. 3

The same article goes on to describe the early results of FAW's kaizen and the diffusion of the lean production system

As a result of FAW's promotion of the lean production system, the company has already seen definite results, with economic results being especially notable. In 1993 sales rose by 45% over the previous year, and profits and tax payments increased by 53%; in addition, other economic and technological indices reached the highest levels ever. The lean system has also, in combination with three institutional reforms in labor and personnel, wages, and social insurance, brought about a shrinking of the management structure and minus growth in personnel. The enterprise has started to "get lean". At present both management and workers in the FAW group attach great importance to the lean system, and there is a boom in "creating a lean factory" by doing all work the lean way. It is interesting to note that every FAW manager of section-head level and above in given a copy of the Chinese translation of The Machine That Changed the World, source of the concept of "the lean production system". In addition, from 1993 to 1995 FAW has assembled all those in charge of factories to thirteen specialized seminars focused on "the lean production system" held at FAW's Academy of the Communist Party (in Hewanzhi). 4

In view of the process by which the just-in-time system was introduced into the new transmission plant, it is safe to say that, in transplanting a new system, making it take root there after the addition of modifications, and beginning to spread it throughout the company, FAW shows it has both the organizational learning capabilities and the capacities to absorb technology. The production system that Ohno once so roundly criticized was dislodged from this plant, and the system he had hoped for was able to become a reality ten years later when a new factory was constructed with the technological assistant of a member of the Toyota

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1 Shaojie Geng, “FAW Implementation of, and Lessons from, Promoting Lean Production,” p. 54
2 “Promoting Just-in-time Production to Achieve Optimal Management”, p. 31. Afterwards FAW learned cost management methods from Hino and set up a cost management department.
group, Hino Motor Company. Now, the problem really lies, if I may say so, in the technological transfer through construction of a new factory. What I mean is, in the case of building a new factory, a transplanted new production system will lead to a comparatively large impact, whereas in the case of trying to bring improvements into an old factory or kaizen into old manufacturing processes, the inertial force of the old established ways will act as a great restraint. Because no mechanism for technological transfer between factories has been built into the system, old and new systems come to coexist within one and the same enterprise and huge differences arise between factories. This is not a problem only at FAW, it is a phenomenon that can be seen often on a national level. FAW is struggling hard to overcome this problem, but how far it can introduce the ideas of the lean production system in a coherent form into the whole company will be the biggest touchstone of FAW’s evolutionary capability.

We have seen the process by which FAW introduced, in stages, the Toyota production system and made it take root—from first introduction of this system through Taiichi Ohno’s direct guidance in 1981, then via the construction of a transmission plant on the basis of technological assistant from Hino in later years. Ohno’s raising of issues and the systematic introduction of a new management system at the transmission plant are no doubt the two epoch-making events in the evolutionary process of FAW’s production system.

The introduction of Japan’s production management methods contributed to overcoming the rigidity of the old single-medel-mass-production system and increasing flexibility in the production system at FAW, and it provided a good opportunity for the production system to evolve from the Ford system to the Toyota system. In this sense, then, this study has added to the discussion about the international transfer of the Japanese-style production system a case in point from China. On the other hand, the case of FAW also has facets that put it beyond the range of the normal approach to the international transfer of the Japanese-style production system. The reason I say this is that, while FAW is a pioneer in introducing the Toyota production system into China, at the same time it is also the prototype of the Ford mass-production system in China. The introduction of the Toyota system in only one aspect within the evolutionary process of FAW’s production system.

It seems to me, therefore, that the case of FAW has a wider range of application to international comparisons of the formation and evolution of production systems. Perhaps it occupies a place as a unique pattern in the world when it comes to the replacement of the old Ford mass-production system by the new Toyota production system and the latter’s diffusion.

Furthermore, Chinese enterprises, especially the state-owned manufacturing enterprises, are facing the acute real problems of deterioration in present operating efficiencies and of breaking away from the old management system under a planned economy regime and the conventional mass-production system. With this double inertial force of the old enterprise system weighing upon everything, reforming the management system of Chinese enterprises and switching to a new production system are more difficult than in European or American enterprises. I can only hope that FAW’s challenge might provide some hints for ways in which China’s state-owned enterprises can revive their competitiveness.

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