

The Birth of **Lean**

Conversations with **Taiichi Ohno, Eiji Toyoda**, and
other figures who shaped Toyota management

Koichi Shimokawa *and* Takahiro Fujimoto, *Editors*

Translated by Brian Miller with John Shook

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Foreword

From the Chairman of the Lean Enterprise Institute

Jim Womack

Since the beginning of the Lean Enterprise Institute, we have been interested in the origins of lean. Scholars have written widely on this topic, and we have identified a number of volumes, including Takahiro Fujimoto's *The Evolution of a Manufacturing System at Toyota*, to recommend to members of the lean community. But we had not heard from the actual creators—those present at the birth of lean in the 1940s, 1950s, and 1960s—in their own words about just what they did and why they did it.

Fortunately, in *The Birth of Lean*, Fujimoto and Koichi Shimokawa have rectified this shortcoming. They have presented the insights of these Toyota pioneers through extensive interviews and annotated talks. This kind of personal commentary has never been available outside Japan. It comes to us through the editorial and translation efforts of longtime Toyota observer Brian Miller and Toyota veteran John Shook.

Although I have read practically all of the literature available in English on Toyota, I found the interviews, talks, and commentary in this volume enormously helpful in clarifying what actually happened and invaluable for those planning the path to lean transformation in their organizations. At a time when all of us are struggling to implement lean production and lean management, often with complex programs on an organization-wide basis, it is helpful to learn that the creators of lean had no grand plan and no company-wide program to install it. Instead, they were an army of line-manager experimenters trying to solve pressing business problems, in particular a lack of financial resources, to grow rapidly without accumulating large inventories.

Note: English translations of divisional names

The translators have rendered the names of most divisions, departments, and other organizational units in lower case. That is because several of the names have changed over the years and because some of the units did not originally have official English names. However, the translators have capitalized divisional names that are of historical interest in their own right: the names of Toyota's Operations Management Consulting Division, of that division's previous incarnations, and of Toyota's Auditing and Improvement Department.

Taiichi Ohno, Eiji Toyoda, Kikuo Suzumura, Masao Nemoto, and others you hear from here in their own words knew they could not solve their problems by employing the standard practices of large mass production organizations, as typified by General Motors. So they tried experiment after experiment, keeping careful notes on the results and spreading methods that worked.

Remarkably, they only came up with a name for what they discovered—the fabled Toyota Production System—in 1970 after they had invented and deployed all of the elements. And they only created a program office—now the Operations Management Consulting Division—at about the same time, after the Toyota Production System had already taken hold throughout Toyota’s operations.

I found Toyota’s approach heartening for those of us who have discovered the hard way that big, top-down lean programs rarely achieve the desired results. And I was inspired to hear the stories of line-manager experimenters who pushed steadily ahead without a grand plan but in a consistent direction, often over intense opposition.

Surely we can all make progress using Toyota’s approach if we clearly define our business problems and go to the *gemba*—the workplace—to experiment. I hope that you, too, will be enlightened and inspired by this volume as we all continue on our hard but rewarding lean journeys.

Cambridge, Massachusetts

March 2009

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Preface

Adapted from the Preface to the Japanese Edition

Koichi Shimokawa and **Takahiro Fujimoto**

Toyota established a globally influential corporate model in the latter half of the 20th century. The model is most familiar as the Toyota Production System, though Toyota-style manufacturing encompasses more than the elements narrowly associated with that system. Most notably, Toyota's prodigious success has benefited crucially from total quality control (TQC).

Companies worldwide have adopted the Toyota Production System under the name of lean manufacturing. And TQC, which Toyota and other Japanese manufacturers built from American concepts, has taken hold worldwide under the name total quality management.

Numerous commentators have described in detail the structure and functions of the Toyota Production System and of TQC. Likewise, descriptions of the development of both systems appear in official corporate histories and in works by industrial historians. Nearly all of those descriptions, however, are after-the-fact accounts that focus to a fault on the rationalization and the competitiveness that the systems engendered.

The standard histories have largely overlooked the serendipitous process of creation, the trial and error, and the multiplicity of inputs that shaped both the Toyota Production System and TQC. That has encouraged mistaken notions that the development of the systems proceeded in line with some sort of master plan. We should bear in mind, incidentally, that the management, manufacturing, and marketing methodologies based on the "scientific management" of Frederick Taylor and on the conveyor line production of Henry Ford also evolved in a less-systematic manner than historical oversimplification frequently suggests.

Toyota has unquestionably displayed a tenacious consistency over 70 years in building competitiveness and in honing the fundamental capabilities that underlie that competitiveness. That consistency, however, has masked a stunning array of happenstance, confrontation, confusion, wrong turns, and occasional crisis. The ability to nurture a capacity for perseverant organizational learning amid that chaos is arguably Toyota's most essential core competence. On the following pages, individuals who were "present at the creation" offer a wealth of insight into that competence.

Individuals who shaped Toyota manufacturing definitively from the 1940s to the 1970s appear here through talks and interviews. The remembrances presented touch on dead ends, disputes, and differing interpretations that do not appear in the official histories. Sometimes highly subjective, they furnish an invaluable contribution to the historical record. Additional commentary by the editors rounds out the first-person accounts.

Maximizing the value of these recollections is the combination of voices. Here are first-person accounts from complementary perspectives: Taiichi Ohno, the Toyota executive who was the theorist behind the Toyota Production System; Michikazu Tanaka, a manufacturing executive at the Toyota affiliate (now subsidiary) Daihatsu Motor who was close to Ohno; Kikuo Suzumura, the Toyota manager who was most influential in implementing Ohno's ideas in the workplace; Kaneyoshi Kusunoki, a Toyota executive who collaborated and occasionally sparred with Ohno from the standpoint of production engineering; Masao Nemoto, the Toyota executive who led the company's adoption of TQC; and Eiji Toyoda, the leader who oversaw the development of the Toyota Production System and the introduction of TQC while steering the company's impressive growth.

Something that emerges convincingly in these talks and interviews is the continuing relevance of the basic principles of the Toyota Production

System and TQC. That lasting pertinence is astounding in view of the forces that have reshaped manufacturing in the past half century: information technology, globalization, flexible manufacturing, and shareholder activism, just to name a few prominent examples. Those forces have spawned innumerable management fads, and the proponents of each new theory have proclaimed a de facto standard for generating corporate value. Amid the ephemera of management fashions, Toyota's system remains the singularly enduring gold standard for global manufacturing.

Tokyo

January 2001 (revised in March 2009)

Introduction

Adapted from the Introduction to the Japanese Edition

Koichi Shimokawa

Factories that use the Toyota Production System bear a deceptive resemblance to those that use Henry Ford's system of flow-based mass production. Both kinds of factories center on conveyor lines that operate in smooth synchrony. That apparent similarity, however, masks a profound difference born of an epochal paradigm shift.

The Toyota Production System defies easy characterization, but its most definitive element is unquestionably the principle of just-in-time manufacturing. That principle marked a historic departure from the Ford system's high-volume, high-speed, make-to-sell production. Just-in-time manufacturing was a rejection of the wide-ranging loss inherent in Ford's approach: vast accumulations of part and product inventories, unnecessarily long changeover times for tools and dies, inefficiencies in the deployment of human resources associated with narrow skill sets and a resultant inflexibility in accommodating changing ranges of work, and immense waste caused by product defects.

Just-in-time manufacturing reduced waste by replacing the "push" dynamic of make-to-sell production with the "pull" dynamic of make-to-order production. In traditional manufacturing, processes throughout the production sequence operated with little regard for the pace of production elsewhere in the sequence and foisted their output onto the following processes—a practice that culminated in foisting make-to-sell accumulations of products onto the marketplace. In just-in-time manufacturing, each process withdrew material from the previous process only to replace material it had actually used, and each process generated additional

output only to replace material that the following process had withdrawn. Thus did the system provide for making only what is needed, only when it is needed, and only in the amount needed.

Practitioners of traditional manufacturing had countenanced large inventories throughout the production sequence as a necessary evil—necessary to keep things moving smoothly. In just-in-time manufacturing, any inventory in excess of a minimal “standard in-process stock” became absolutely unacceptable. Production of a limited range of products in large volumes gave way, meanwhile, to producing a large range of products in generally small volumes. That meant a shift in emphasis from maximizing equipment capacity and utilization rates to maximizing flexibility in responding nimbly to trends in demand. Factories shifted to processing in increasingly smaller lots. People found ways to shorten changeover times and streamline layouts to minimize the adverse effect of frequent changeovers on capacity utilization rates.

The paradigm shift embodied in the Toyota Production System established a framework for ensuring high productivity and—by building quality assurance into each process—consistently high quality. The flexibility of the Toyota Production System proved responsive to ever-changing markets and supportive of advances in product technology and of evolving approaches to product development and design. Equally important, the system proved applicable beyond Toyota’s factories. It took hold at suppliers’ factories, in purchasing organizations, and in logistics networks, and the synergies among the growing range of participants in the system maximized the benefits for all.

Revolution, an overused term, is a perfectly apt description for the change wrought by the Toyota Production System. The system was largely responsible for the surging international competitiveness of Japan’s automobile industry in the 1980s, as documented by the Massachusetts

Institute of Technology–based International Motor Vehicle Program. Japanese manufacturers of electronic equipment and of other assembly manufacturing products also employed elements of Toyota’s system in asserting international competitiveness.

Japanese automakers and parts makers transplanted the Toyota Production System abroad when they began building large numbers of factories overseas in the late 1980s. Elements of the system soon started appearing in the factories of U.S. and European automakers: slimmed-down inventories, smaller processing lots and shortened changeover times, bar-coded kanban cards, “idiot-proof” features on equipment, lighted *andon* display panels above factory workplaces to indicate where problems were occurring, and sequenced withdrawal of parts and materials in accordance with the “pull” precepts of just-in-time manufacturing.

People at the overseas companies that emulated the Toyota Production System generally had an incomplete understanding of the philosophy behind the system. Worker participation, meanwhile, tended to be less thorough than in Japan, partly because of union rules and different labor practices. On the other hand, the growing application of information technology in factory operations, especially in the United States, favored the Toyota Production System. Database management furnished a new basis for evaluating manufacturing methods objectively and for retaining know-how of demonstrated value. It verified the effectiveness of elements of the Toyota Production System, and managements moved to adopt those elements in their operations.

Employee participation in the Toyota Production System in Japan has unfolded primarily in the context of tacit knowledge. Promoting similar participation in other nations has required companies to translate that tacit knowledge into explicit knowledge. Several business models have emerged for that purpose, and some of them cover far more than individual production processes. Companies have borrowed concepts and

methods from the Toyota Production System to foster just-in-time linkage all the way from product development through purchasing, manufacturing, and logistics to sales and service. They have used that linkage to focus activity throughout the value chain on earning and retaining customer satisfaction.

Manufacturers today face challenges of unprecedented severity. Automakers, especially, are struggling to survive. Toyota, too, was struggling to survive when Taiichi Ohno began experimenting with the methods that became the Toyota Production System. This is therefore an opportune time to examine carefully the convergence of factors that engendered the success of Ohno's experiments. Foremost among those factors was an unwavering focus on the *gemba*: the workplace.

The managers who worked under Ohno strove untiringly to explain his ideas to the workplace supervisors and to secure *gemba* participation in implementing those ideas. Toyota's continuing vitality is testimony to the vibrant workplace that the company has carefully fostered. It is also testimony to the company's continuing readiness to encourage the interplay of frequently conflicting ideas. Here, in the words of Taiichi Ohno, Eiji Toyoda, and four other remarkable individuals, is the story of how that interplay perpetrated a revolution in global manufacturing.

How It All Began

An interview with **Taiichi Ohno**

As conducted and edited by **Koichi Shimokawa** *and*
Takahiro Fujimoto

The Interview

1. Lessons from Toyoda Boshoku

When I was a student, people simply assumed that Japan was no place to make cars. That was around 1930. The United States had high efficiency and high wages. In Japan, efficiency was low, and so were wages. But the pursuit of higher efficiency ended in the United States in the early 1930s, and only wages kept rising after that, as we figured out later.

About the Interview

This chapter is the distillation of a three-hour interview with Taiichi Ohno. Koichi Shimokawa and Takahiro Fujimoto conducted the interview on July 16, 1984. The interview took place at the headquarters of Toyoda Gosei, a Toyota Group manufacturer of weatherstrip, interior and exterior trim, airbags, and other automotive components based mainly on plastic and rubber technologies. Ohno was serving as an adviser to Toyoda Gosei at the time of the interview.

Shimokawa asked most of the questions, and Fujimoto took detailed notes of Ohno's responses. The text is a reconstruction based entirely on Fujimoto's notes because the interviewers refrained from using a tape recorder. It is therefore less precise in regard to the speaker's exact phrasing than the other texts presented in this volume. All of the technical terms that appear here are faithful, however, to Ohno's word selection.

I worked as a foreman at Toyoda Boshoku (Toyoda Spinning and Weaving) up to and into World War II. The productivity there wasn't bad. But Dainippon Spinners [now Unitika] and some of our other competitors used completely different production systems, and their productivity was even higher.

A Comparison of Toyoda Boshoku and Dainippon Spinners

	Plant layout	Thread conveyance	Skills deployment	Quality control
Toyoda Boshoku	Processes in separate buildings	Large lots conveyed by trolleys, heavy labor performed by male workers	New workers load and unload spindles, veteran workers (3 to 5 years of experience) operate machines	Reliance on skilled workers to reconnect broken threads, emphasis on corrective action in following process
Dainippon Spinners	Processes in same building, integrated production	Small lots conveyed by female workers, less expensive than conveying large lots	New workers operate machines, veteran workers load and unload spindles	Emphasis on making quality threads in preceding process to eliminate need for corrective action in following process

Ohno's comments are in response to questions that focused on the following subjects:

1. What Ohno learned at the Toyota Group company Toyoda Boshoku (Toyoda Spinning and Weaving), where he worked before joining Toyota Motor and how that figured in his subsequent activities
2. Ohno's initial experiences at Toyota Motor after moving to that company in the midst of World War II
3. How Ohno and Toyota worked to raise productivity while rebuilding the company's automotive operations after the war, what lessons he and the company learned from the labor dispute of 1950, and how they applied those lessons in devising their production system
4. How Toyota established standardized work procedures in the early years and how flow-based production and leveled production took shape

We learned a lot by comparing the production systems used by different companies. Especially interesting was the concept of making sure the front-end processes delivered consistently high-quality work to the following processes. That concept is the basis of total quality control



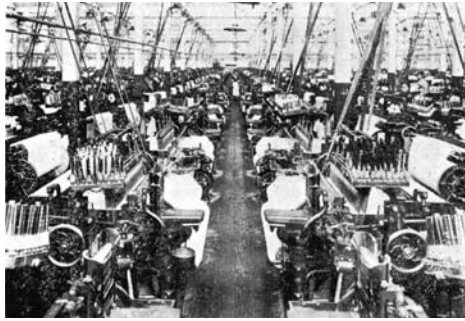
A reenactment of the work of loading spindles on an automatic loom

(TQC). The Toyota Production System is one and the same with TQC and with its principle of zero defects. They're simply different names for the same basic approach.

Another lesson we learned at Toyoda Boshoku was the importance of not relying on craftsmen. We learned to design systems that could be operated by anyone—amateurs—with a minimum of training. That's what standardized work is all about.

5. The origins of multiskilled workers and multiprocess handling and Toyota's response to the surge in demand that accompanied the Korean War
6. The history of kanban, including the reasons for adopting the kanban system, issues that Ohno encountered in deploying the system, and how he resolved those issues
7. How the kanban system was superior to the production systems employed by other Japanese automakers
8. The relationship between the kanban system and quality control
9. How and why Ohno employed the *jidoka* principle of intelligent automation

The interviewers gave Ohno every opportunity to recall and relate pertinent episodes from his trial-and-error experience in implementing Kiichiro Toyoda's just-in-time concepts. He responded in detail to the questions, offering concrete examples and touching on related contemporary issues that came to



A prewar factory scene at Toyoda Boshoku

The Toyota Production System rests on two pillars. One is Sakichi Toyoda's *jidoka*: Turning out defective work is not what we're here for. The other is Kiichiro Toyoda's just in time. This is not the Ohno Production System. It's the Toyota Production System.

2. Wartime Production

Textile work dried up in 1943, so I moved over to the automobile company, where I became a factory manager. We had reached a point in textile spinning production where further gains in productivity were hard to come by. But in vehicle production, just about anything we might try seemed likely to raise productivity three- or even five-fold. We figured that

mind. The interview ended up running an hour longer than the two hours originally scheduled. Especially poignant are Ohno's descriptions of creating a new approach to manufacturing amid the privations of the immediate postwar years. Readers can and by all means should review his account of lean production in his classic, *Toyota Production System: Beyond Large-Scale Production* (New York: Productivity Press, 1988).

we could make vehicles with the production system that we had developed for spinning work.

Japan was at war, and we converted our factories to military applications. One produced aircraft oil coolers. Another made exhaust manifolds for aircraft.

Our job in production was to increase output in support of the war effort, and we concentrated on simply producing the target volumes. I shifted to Toyota Motor's Koromo [now Honsha (Headquarters)] Plant in February 1945, and that's where I was when the war ended.



Toyota's Koromo (now Honsha [Headquarters]) Plant shortly after its completion in 1938

About the Speaker

Taiichi Ohno (February 29, 1912–May 28, 1990) is renowned as the father of the Toyota Production System. Born in Japanese-occupied Dalian, China, he joined Toyoda Boshoku (Toyoda Spinning and Weaving) on graduating from what is now the Nagoya Institute of Technology in 1932. He moved in 1943 to Toyota Motor.

At Toyota, Ohno went to work on the problem-solving innovations that became the framework of the Toyota Production System. He became the manager of a



Taiichi Ohno in the 1970s

3. Postwar Productivity Growth

After the war, I became responsible for vehicle assembly at Toyota's Koromo (Honsha) Plant. A lot of people in the company thought that we should outsource small-volume parts to low-cost contractors and make the large-volume parts on our own, like bicycle manufacturers did. They figured that we could build an export business by getting the contractors to supply parts on a just-in-time basis and by assembling vehicles from those parts and from the parts that we made in-house.

I argued for taking the opposite approach. I insisted that we should produce low-volume items in-house and buy large-volume parts—stuff that anyone could make inexpensively—from outside suppliers. Making the low-volume parts in-house would mean high unit costs, and that would pressure us to tackle kaizen improvements and cost reductions. Refining just-in-time efficiency was every bit as important in our in-house operations as it was in our dealings with suppliers.



Taiichi Ohno in his natural environment—the manufacturing workplace

machining shop in 1946, and that shop became the laboratory for the invention of the kanban and the development of flow-based production.

Ohno became a director at Toyota in 1954, a managing director in 1964, a senior managing director in 1970, and an executive vice president in 1975. He retired from Toyota in 1978 but

remained active in consulting. In addition, he served as an adviser at Toyota Gosei and as the chairman of Toyoda Boshoku after leaving Toyota.

Kiichiro Toyoda issued a call right after the war for catching up with the U.S. automakers in productivity within three years. In the spinning industry, we had reckoned in 1935 that productivity was 3 times higher in Germany than in Japan and 3 times higher still in the United States. So I figured that automakers were probably about 10 times more productive in the United States than in Japan.



Kiichiro Toyoda (1894–1952)

The productivity differential between the United States and Japan was too big to blame on differences in production equipment. I could see that different ways of managing production were a bigger factor than equipment. So I went to work on modifying our production system: leveling production, standardizing work, and optimizing factory layouts.

4. Production Restraints Precipitated by a Financial Crisis

We devoted ourselves to raising efficiency in every way possible in the first five years after the war. We raised productivity five- or six-fold and positioned ourselves to turn out 1,000 trucks a month. Unfortunately, we couldn't sell all those trucks, and we ended up with a heap of unsold vehicles. The company was on the verge of collapse.

Management announced a restructuring plan in 1950 that included job cuts, which triggered a huge labor dispute. That was an extremely tough time for Toyota. But it wasn't the first time that Toyota had gotten into serious trouble with excess inventory. The company had let unsold trucks pile up once before the war. Only a helping hand from the military had kept Toyota afloat that time.

The lesson we learned from the postwar crisis was that simply raising productivity is no cure-all. We discovered the importance of raising

productivity and reducing costs while limiting production to the kinds of products sold, in the amounts they are sold, and at the time they are sold. In other words, we learned that imitating American-style mass production would be fatal in Japan.

I lobbied aggressively for leveling production in the front-end processes while supervising final assembly at the Honsha Plant. People got so tired of hearing me rant that they gave me a machining shop to try out my ideas. It was a shop that produced transmission gears and suspension components. That was in 1946.

We were able to keep raising productivity pretty easily in the latter half of the 1940s by doing basic kaizen. For example, Toyota had assigned three or four operators to each machine in the main processes before the war. We raised labor productivity three- or four-fold by modifying the work procedures to allow for operating each machine with a single operator. Our moves ran into resistance from the old-school craftsmen among the workers, but we had a high worker turnover rate at the time, so measures for reducing manpower requirements went fairly smoothly.

5. Standardized Work

My first move as the manager of the machining shop was to introduce standardized work. The production workplace at the time was under the sway of the craftsmen responsible for the different processes. Neither the shop manager nor the production general manager above him could assert much control over a shop. All that they could do was make excuses for the production delays, and you can be sure that they got a lot of practice.

We took control of the machining shop by defining standardized work for each job, by detailing the work in a manual, and by posting the standardized work procedures in plain view at each workstation. The panels that displayed the standardized work procedures were the forerunners

of kanban. We developed kanban later as a means of making the flow of work visible. And the standardized work display panels served basically the same purpose: they let the foremen and supervisors see easily if the operators were adhering to the standardized work procedures.

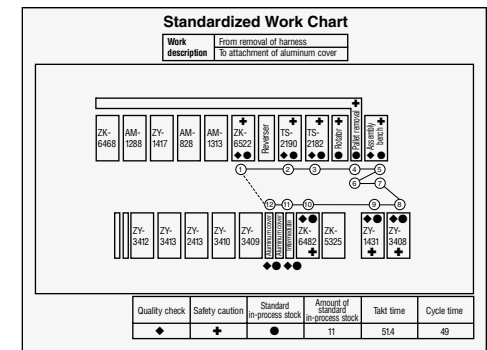
They were just like the sign [kanban] outside a retail shop. Anyone could see immediately from the sign what was likely to be—was supposed to be—going on inside.

I told everyone that they weren't earning their pay if they left the standardized work unchanged for a whole month. The idea was to let people know that they were responsible for making continual improvements in the work procedures and for incorporating those improvements in the standardized work.

Standardized work at Toyota is a framework for kaizen improvements. We start by adopting some kind—any kind—of work standards for a job. Then we tackle one improvement after another, trial and error. You could start by doing motion studies and time studies and whatever and try to come up with something perfect to start with, but that would never work. In the workplace, trying something immediately, even something imperfect, is always better than letting things sit while you refine a solution.

Continual improvements are just as important with equipment as they are with work procedures. Kaizen raises efficiency and improves quality by imparting a growing accumulation of wisdom to the equipment.

As for the pace of work, we set a pace that an average worker can maintain for a full day. That means a pace that is maintainable without undue strain, and the team leader personally verifies the feasibility of



A modern standardized work chart that details the work sequence for a process

the pace. You mustn't establish a pace based on the hand and foot speed of your most experienced personnel. Taylorism called for setting targets based on the speed of the fastest workers, but that's exploiting labor.

We make sure that everyone can see clearly what our expectations are in regard to the pace of work. Beginners need to improve steadily and gradually become as fast as their team leaders. Until people get up to speed, they receive assistance from more-experienced workers.

6. Leveling

The just-in-time practice of leveling production through the month was a pressing need at Toyota in the 1940s. We were making two truck models. But we spent the first three weeks of each month accumulating the parts we needed to assemble the trucks. When we finally had all the parts, we'd work frantically to assemble a month's worth of trucks in 10 days. So we needed three times more people than we would've needed to assemble the trucks evenly through the month.

Our suppliers produced their parts in huge batches. A supplier might make 10,000 of one part today and 10,000 of another part tomorrow and would bring the parts in when they happened to be ready. We never knew until the parts arrived exactly when we would be able to start putting our trucks together.

The people at our assembly plant did their best to find useful work to do, such as cleaning up the plant. But that didn't change the fact that we had three times as many people as we needed. We desperately needed to find a way to secure the parts we needed, when they were needed, and in the amounts needed.

I was aware of the need for leveling when I was in charge of final assembly in 1945. But we were hardly in a position at that time to tackle the changes that would have been necessary. I finally got the chance to

start experimenting with leveling when I took charge of the machining shop in 1946. And we had leveled our purchasing and production pretty much completely by 1950.

7. Flow Production and Multiskilled Workers

Machining shops at Toyota make engines, transmissions, suspension components, and other items. My shop made transmission gears and suspension components. The first change I made was in the layout.

Toyota deployed production equipment in line with the flow of work in machining shops that made big items, like engines. But it deployed the equipment by kind of machine in the machining shops that made transmission and suspension components. So we'd have groups of drills, lathes, milling machines, grinders, and whatnot. The different machine groups produced output in large batches, and they didn't begin operation until a full batch worth of work-in-process had arrived from the previous process. That resulted in huge accumulations of work-in-process between the processes.

I spent two years working out a layout that positioned the equipment in line with the flow of work. That meant increasing the number of machines. For example, we ended up with 200 drills, compared with only 50 before the change in layout. So the capacity utilization rate for individual machines declined. That was a shame, but I had decided not to worry about capacity utilization rates.

The number of operators in my shop did not increase as much as the number of machines did. I minimized the increase by training the operators to handle different kinds of machines. That allowed the operators to move freely to the processes where work needed to be done.

Multiprocess handling and multimachine handling, by the way, are completely different. Multimachine handling means assigning a single

operator to run multiple units of the same kind of machine. You stagger the work cycles of the machines, and the operator moves from machine to machine in step with the cycle time. I visited a Volkswagen plant in 1963, and the people there were using multimachine handling with gear-cutting machines.

Multiprocess handling means letting operators move from task to task in step with the flow of work. It means giving higher priority to the utilization rate for our human resources than to the utilization rate for equipment. At Toyota, we prefer multiprocess handling to multimachine handling. We are prepared to accept idle machines—to the minimum extent necessary—in exchange for using our human resources fully.

Multiskilled operators and all-around operators are completely different, too. All-around operators are employees who can step in and go to work anywhere. Multiskilled operators are employees trained to handle the tasks needed across specified stretches of the production sequence. Our emphasis at Toyota is on cultivating multiskilled operators.

8. Productivity Gains after the Korean War

The concept of limiting production to the amount of goods sold took hold after Toyota's financial crisis of 1950. Good production control ensures that processes turn out only as much work as the company is sell-



A Toyota SKB-model truck from the 1950s

ing. Inventory management only becomes an issue when production control isn't working well. So you shouldn't think of linking production to sales as a form of inventory management.

Our restructuring plan called for maintaining production

capacity for 900 trucks and 60 passenger cars a month. Then the Korean War broke out. Orders for trucks poured in from the U.S. Army Procurement Agency—the APA—and we needed to shift gears and increase our production capacity quickly. The APA was a stickler for quality and for on-time delivery, but it became a huge customer.

We didn't have the financial latitude to invest much in new production equipment. And management was not about to hire more people. Promising guaranteed jobs for Toyota's remaining workers was a decisive concession in resolving the labor dispute of 1950. Neither management nor labor wanted to bring on any more people than we could be sure of supporting over the long term. So we found ways to increase output with the equipment that had survived the war and without increasing our workforce. Incidentally, I understand that Nissan did hire more people at that time.

Our big challenge in 1953 and 1954 was to turn out 3,000 trucks a month. We increased output without increasing our workforce, so productivity rose. But the rise in productivity was less a matter of improvements in our production system than of the growth in volume.

By 1955, our productivity was 10 times higher than it had been 10 years earlier. I visited General Motors and Ford engine plants in 1956. What I saw there suggested that productivity was higher at Toyota's engine plant. That's speaking simply in terms of units produced per person per day, without taking into account the product mix or the percentage of work handled in-house.

I realized for the first time that U.S. productivity had not risen significantly since the early 1930s. Henry Ford's production system had been all about minimizing inventories while streamlining production with a conveyor-based assembly line. But somewhere along the way, attention focused entirely on the conveyor. People had perverted the spirit of the original system. At Toyota, we were carrying on in the spirit of Henry Ford

and were building on his ideas. We didn't have the kanban system yet, but we had begun splitting up batches to convey items in small lots.

Rising demand in Japan enabled us to keep increasing production after the Korean War ended, but the focus of demand shifted. It shifted especially sharply in 1957, when Japan slipped into a yearlong economic slump. Demand for large trucks plummeted, and demand for smaller trucks rose. Demand for passenger cars, like the Toyota Corona and Crown, fluctuated repeatedly before, during, and after the slump.

Toyota coped with fluctuating demand by continuing to restrain production in the spirit of making only what was selling, only when it was selling, and only in the amounts sold. People remembered how making more trucks than we could sell nearly drove us to ruin in 1950. So the principle of reining in production had become second nature.

We left the production line for large trucks as it was and expanded production capacity on the line for small trucks. That included moving some people to the small-truck line from the big-truck line.

Our challenge was more than just a matter of making things at the lowest-possible cost. We needed to make a variety of products, all of which were subject to sharp fluctuations in demand. Offering diverse products in small quantities was an unavoidable condition for doing business in Japan at that time. Things were different in the United States. The huge U.S. market supported large and more-stable demand for most kinds of vehicle models. So automakers could focus on a narrower range of models at each plant. Making a variety of products and making multiple products on the same production lines obviously raises costs. Finding ways to offset that tendency is an eternal quest.

9. Kanban

We started using kanban sometime after 1955. We began by using them in processes in our own plant. Once the system was working smoothly, we showed it to people from our suppliers and encouraged them to try it in their operations. I remember showing the system early on to people from a stamping plant and from a machining plant.

The first place in our plant where we used kanban was the body-welding line. That line received its raw material from the stamping line. Stamping is inherently a batch-processing kind of work, and the batch processing in that process exerted a powerful influence on the welding work in the following process. People on the welding line naturally tended to want to handle things in batches.

Further down the line were the assembly people. They were serving a growing range of export markets, and they needed to make all sorts of models and model variations in small lots. The specifications were especially diverse for our four-ton trucks. We had 40 sets of specifications for those big trucks, and we were only making 30 of the trucks a day! So the focus of work on the assembly line was completely different from the batch-processing mentality of the stamping line.

I told people that the kanban were like money and that anyone who withdrew parts without depositing a kanban was a thief. Some people would have liked to turn out as much work as possible "for the good of the company." And when they had built up a pile of "reserve output," they'd have walked up the line to help out with other work. I weaned people from that kind of tendency. I told them to go take a walk if they got ahead in their work. We were better off if they would just twiddle their thumbs. Another thing I did was to establish a fixed size—width and height—for the storage place for parts and to forbid people from putting any more pallets there than would fit easily.

Kanban automated production control. With kanban, people in the workplace issue production instructions automatically. They don't need to think about writing up any special directions or about finding ways to convey those directions. With kanban, you don't need a computer.

Here's an example. Let's say you need to revise your production plan. Working out all the necessary changes on a computer would take a couple of weeks, and you'd fall behind in your production control. Even if the computer could handle all the calculations in an instant, you'd still fall behind because accommodating the changes in the workplace would take time.

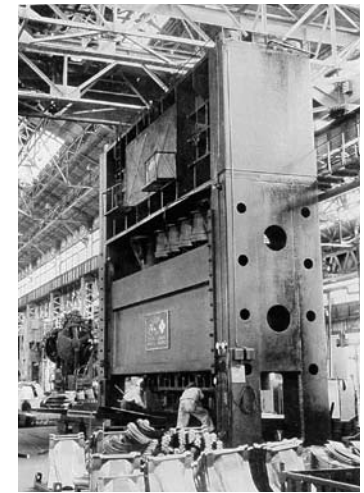
With kanban, all you need to do is adjust the number of kanban in circulation in accordance with your needs. When kanban start arriving slower than people had expected, they understand immediately that the company has reduced the production plan. As long as you keep your production leveled, changes in the production plan will take effect the next day.

The name "kanban" came after we had been using the concept for a while. We came up with the name when we were preparing to undergo the audit for the Deming Prize in 1964.

A big reason for adopting kanban was our desire to reduce the administrative burden of running a factory. We were looking for ways to reduce paperwork. The tax office told us in 1949 that we couldn't eliminate the paper trail in our purchasing and production work, and that obliged us to give up the idea of kanban for the time being. But the tax people later became more lenient about paperless processing. That was around 1953 and 1954, when companies started computerizing their operations.

We jumped at the chance to try out the kanban concept. If Toyota had introduced computers two or three years earlier, we might never have developed the kanban system. The company might have just used computers to process incoming deliveries and to prepare production instructions.

Kanban appeared in every workplace that I managed at Toyota, but the system took quite a while to really take hold throughout the company. Once we got the kanban system working on the body-welding line, we started using it in the upstream stamping processes, including work at suppliers' plants. We also started using it in our processes that made oil pans and tapet covers. Toyota adopted the kanban system at the Motomachi Plant when it opened that plant in 1959. Motomachi was the first Toyota plant built especially to produce



A stamping line at the Honsha Plant in the 1950s

passenger cars, and it contained a full range of processes, from machining and stamping to welding, painting, and assembly. I became the plant manager at the Honsha Plant in 1962, and we introduced kanban in the forging and casting work and in the heat-processing work.

Putting kanban to work in casting work was hard. Melting the metal for the castings demands batch processing. Theoretically, we could handle the actual casting work in lots as small as a single item, but people naturally tended to want to make as many items as possible before changing the casting mold. Of course, keeping fuel costs down was a high priority in running the furnace, and that encouraged people to boil up a big pot of molten metal and pour out a whole series of castings.

We had just as much trouble putting the kanban to work in the heat-processing work. The heat-treatment process for malleable iron parts took a week to complete. By the conventional wisdom, that was all the more reason to use batch processing. But that meant holding a week's worth of inventory. By my thinking, that was all the more reason to use kanban and to switch to smaller lots. And that's what we did.

As much as possible, we kept inventory only in the form of raw material. Having stocks of semifinished items on hand was convenient and reassuring, but it could result in waste if changes occurred in the production plan. We minimized inventory risk by processing raw material on a strictly just-in-time basis.

Our early kanban served mainly as production instructions and as inventory-withdrawal tags. Most of the kanban were simple cards, but we had some variations. For example, we used triangular kanban with forgings, stampings, and other batch-processing items. We would remove the triangular kanban when we had used a specified portion of a lot, and it would go back to the previous process as a production instruction. We had special “slanted” kanban to allocate work when people came in outside their ordinary shifts to help with overloads. And we had interruption kanban to allow for breaking into the ordinary flow of work to do emergency processing.

Kanban highlighted problems as soon as the problems occurred and promoted kaizen activity. But some suppliers didn’t like the discipline that kanban imposed. Some of our independent suppliers even got together once to call on Toyota to stop using kanban. That was when they were struggling with the fallout from the first oil crisis. Ironically, that very same crisis was what brought kanban to the attention of the world at large.

Nissan had its so-called Action Plate Method, which was sort of like the kanban system. And Mitsubishi Motors had something similar. But neither of those companies had worked out their systems with their suppliers. So their systems apparently struck the suppliers as arbitrary and unilateral. We at Toyota and our suppliers had gone through production downturns together in the past. We had built relationships that gave us a good basis for making the kanban system work.

10. Quality Control

The essence of quality control is to make what will sell. If the quality is lousy, the products won’t sell. In the old days, a casting that had a bird’s nest inside got all the way to a downstream process and caused problems there. We taught our people to think of the following process as the customer and to check things carefully in their own process to avoid passing on defective work.

We also taught our people the difference between quick fixes and solutions. Quick fixes that don’t address the underlying causes are simply an invitation for bigger problems later. We need to analyze problems carefully and do kaizen that will really solve the problems and keep them from happening again. Preventive maintenance is also essential, of course, in avoiding problems. And I introduced the practice of deploying maintenance personnel in two shifts a day, rather than just one.

Quality control, to be effective, needs to include measures for calling attention in the workplace to any problems that occur. You need to foster quality awareness. Your team leaders need to set an example. The quality commitment that they demonstrate in their work will spread naturally to their team members.

11. *Jidoka*

We adopted the line-stop system sometime in the late 1960s. We didn’t have very good sensors then. So our first system was more a matter of stopping the conveyor line than of having the line stop automatically. We later developed systems where the line would stop automatically when problems occurred.

The American approach to manufacturing had an unhealthy emphasis on keeping the line moving and on having it move as fast as possible. If

your production line keeps moving as a result of kaizen, that's great. But keeping the line moving should not be an end in itself. If work is exhausting and a worker gets fatigued, he should stop the line. That calls attention to the problem. Then, we can resolve the problem. Maybe by finding a better posture for the worker. Maybe by improving the job rotation.

On the other hand, some kinds of work do not allow for stopping the line or even for varying the speed of the line. Painting is a good example. Those kinds of work call for other approaches to highlighting problems and promoting kaizen.

What I Learned from Taiichi Ohno

A talk by **Michikazu Tanaka**

As recorded and edited by **Koichi Shimokawa** and **Takahiro Fujimoto** with **Kenichi Kuwashima** and **Yasuo Sugiyama**

The Talk: Under the Guidance of Taiichi Ohno

Professor [Koichi] Shimokawa has asked me to describe for you my memories of Taiichi Ohno, the father of the kanban. I, like numerous others, owe a huge debt to Ohno-san. And since he has passed on, we who learned from him have a responsibility to convey his teachings to the next

About the Text

The accompanying text is an adaptation of a talk delivered in January 1998 by Michikazu Tanaka, a former executive of Daihatsu Motor. Tanaka gave the talk to a study group convened under the auspices of the Japan Technology Transfer Association and chaired and cochaired by the compilers of this volume, Koichi Shimokawa and Takahiro Fujimoto. The study group comprises automotive production engineers and university researchers and has met regularly since 1991 to develop a vision for production systems in the automobile and automotive parts industries. The adaptation presented here reflects subsequent editing by Tanaka.