Japanese Manufacturing Techniques

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Introduction

The Japanese make do with little and avoid waste. The modern Japanese system of hand-to-mouth management of materials, with total quality control is consistent with their inclination to conserve resources. The Japanese have a "just-in-time" production objective. They use engineering to drastically cut machine setup times so that it is economical to run very small batches. The idea is to make one piece just in time for the next operation. The economic order quantity approaches one unit. The main benefit is not reduction in inventory carrying costs but improvement in quality, worker motivation, and productivity.

At one point of time, the quality of Japanese export goods had as poor an image as any in the developing world. The Japanese were determined to do something about it in the post World War II industrial rebuilding era. Becoming aware, getting organized, and implementing Western quality control techniques (chiefly statistical sampling) constituted the thrust of the first fifteen years of quality control emphasis in Japan. Today, Japanese quality control practices are widely respected. Japanese total quality control particularly emphasizes:

- A goal of continual quality improvement.
- Responsibility for quality with the line function.
- Quality control of every process, not reliance upon inspection of lots for only selected processes.
- Measures of quality that are visible, visual, simple, and understandable, even to the casual observer.
- Automatic quality measurement devices.

So successful have the Japanese become in pursuing total quality control that many Japanese manufacturers now speak of attained quality levels measured in defective parts per million, whereas Western norms have traditionally been measurable in parts per hundred, i.e., in percentages.

Just-in-Time Production

Just-in-time production is a simple concept. It is not about automation. It requires little use of computers. In some industries, JIT can provide far tighter controls on inventory than are attainable through U S computer-based approaches. Furthermore, JIT leads to significantly higher quality and productivity. JIT provides visibility for results so that worker responsibility and commitment are improved. Applications and benefits of JIT/TQC may be extended from the factory itself forward into distribution and backward into the supplier end of the business.

The JIT idea is simple. Produce and deliver finished goods just in time to be sold, subassemblies just in time to be assembled into finished goods, fabricated parts just in time to go into subassemblies, and purchased materials just in time to be transformed into fabricated parts. All materials must be in the processing stage, never at rest collecting carrying charges. This hand-to-mouth mode of operation, approaches piece-by-piece production.

The system becomes very transparent. If a worker makes only one of a given part and passes it to the next worker immediately, the first worker will hear about it if soon the part does not fit at one of the next work stations. Thus, defects are discovered quickly. The causes of defects can be nipped in the bud. Production of large lots high in defects is avoided. Due to reduced scrap and more good parts, the time and money spent on rework drops. So does the cost of wasted materials.

Under JIT, if a part doesn't fit at the new work station, the worker who made the bad part will probably not find it hard to guess what he did wrong. In short, the worker's awareness of defect causation is heightened. So, the worker is strongly motivated to improve.

Large lot sizes lead to carelessness on the part of the worker, the worker's peer group, and perhaps the labor union and management as well. They may feel, with some justification, that a certain percentage of bad parts in a large lot causes little harm; in a large lot there may be plenty of good items for every bad one. Just toss the defectives aside and keep on assembling. With small JIT lot sizes, by contrast, a few defectives parts pinch hard. The need to avoid errors is apparent, which heightens the sense of responsibility.

Western observers have marveled at how Japanese workers come to one another's aid to resolve problems. We might expect such behaviour in a JIT plant. It is natural for each affected worker to want to come to the aid of the worker whose drive belt breaks, whose machine is jammed, or who is having any of a large variety of other common problems.

The Japanese no longer accept the buffer principle. They seem to have understood the essence of the buffer inventory principle: The more irregularity, the more buffer stock. Instead of adding buffer stocks at the points of irregularity, Japanese production managers deliberately expose the work force to the consequences. The response is that workers and foreman rally to root out the causes of irregularity. They know that otherwise there may be work stoppages.

The Japanese principle of exposing the workers to the consequences of production irregularities is not applied passively. In the Toyota Kanban system, for example, each time that workers succeed in correcting the causes of recent irregularity the managers remove still more buffer stock. The workers are never allowed to settle into a comfortable pattern. The pattern becomes one of continually perfecting the production process.

A happy incidental benefit of JIT is faster market response, better forecasting, and less administration. Less idle inventory in the system cuts overall lead time from raw materials purchasing to shipping of finished goods. Marketing can thereby promise deliveries faster, can effect a change in the product mix or quantity faster, and can forecast demand better since the time horizon is shorter. In as much as JIT systems tend to be run by workers and foremen, the administrative budget for data processing, accounting, inspection, materials, production planning and control and so forth is less. With fire-fighting responsibilities clearly recognized and accepted by line workers, the executives can sit back and focus on strategy.

The Kanban System

A push system in reality is simply a schedule-based system. A multi-period schedule of future demands for the company's products is prepared. The computer breaks that schedule down into detailed schedules for making or buying the component parts. It is a push system in that the schedule pushes the production people into making the required parts and then pushing the parts out and onward. The name given to this push system is commonly referred to as material requirements planning (MRP).

A weakness of MRP is that the company needs to guess what customer demand will be in order to prepare the schedule. The company also needs to guess how long it will take the production department to make the needed parts. The system allows corrections to be made daily (called shop-floor control). Nevertheless, bad guesses result in excess inventories of some parts, though not nearly so much total inventory as in the old pull/expedite system.

Kanban is feasible in just about any plant that makes goods in whole (discrete) units (but not in the process industries). It is beneficial only in certain circumstances:

- Kanban should be an element of a JIT system. It makes little sense to use a pull system if it takes interminably long to pull the necessary parts from the producing work center, as it would if setup times took hours and lot sizes were large.
- The parts included in the kanban system should be used every day.
- Very expensive or large items should not be included in kanban. Such items are costly to store and carry. Therefore their ordering and delivery should be regulated very closely under the watchful eye of a planner or buyer.

The oldest and most widely used inventory system in the world is the reorder-point system (ROP). The simple reorder-point rule is: When stocks get low, order more. But ROP results in high inventories. More parts and raw materials are ordered for the sake of the rule rather than because of need. Manufacturers that use ROP do so because of a difficulty in associating parts requirements with the schedule of end products.

Material requirements planning (MRP) provides a better way. MRP harnesses the computer to perform thousands of simple calculations in transforming a master schedule of end products into parts requirements. But MRP shares one weakness with ROP. It is lot-oriented. The computer collects all demands for a given part number in a given time period, and recommends production or purchase of the part number in one sizeable lot. MRP companies order in lots, rather than piece-for-piece.

MRP is a very expensive undertaking. Its approach is to attack problems with complex solutions, i.e., computer systems. Where there are many stages of production, MRP or synchro-MRP may be necessary. In most cases, however, money is better spent on JIT/TQC than on computer-based planning and control. The main lesson from the Japanese, is that simplification is generally the safest path to improvement.

Kanban, is the visible record that triggers an order for more parts. If a Kanban arrives at a work center signaling the need for more of a given part, that part is needed right away. It must be possible to set up the part fast enough to economically make the very small quantity required. Other work centers will send more kanban to signal the need for other parts, and numerous new setups will be required each day as the kanban arrive.

An assembler whose production has been slowed by some problem or who is not able to keep up with the speed of the line turns on the yellow light, which is the signal for a roving master assembler to come and help. If the problem is severe enough, the line comes to a halt. Then master assemblers, supervisors, foremen, and all idled line workers help get the line going again.

The red light brings frowns, but plant management is pleased when many of the yellow lights are on. The main reason for the yellow light is too few workers on the line to handle the rate of output. If no yellow lights are on, management knows that the line is moving too slowly or there are too many workers. Usually, the response is to pull workers off the line and assign them elsewhere so that it becomes hard for the remaining workers to keep up. So yellow lights begin to come on.

Mixed-model sequencing is used to make close to the same mix of products that is sold that day. This avoids the usual cycle of a large buildup of inventory of a given model, followed by depletion to the point of potential lost sales as the next model builds up. Moreover, when mixed models are run in final assembly, the same mixed-model schedule may govern the making and delivering of component parts, ideally even from outside suppliers. Planning and control are simplified, capacity requirements are reduced, and buffer inventories are slashed – with all of the attendant quality and other just-in-time benefits.

Color-coding, is widely used in Japan. The ideal is zero time for a worker to hunt for the part needed – and also for the materials control people to hunt for the right location when restocking. Precise placement and identification of parts for assembly-line workers may save them some motions and make the work less tiring.

The Japanese were upbeat on conveyors about ten years ago; now they try to avoid them. This is because conveyors hold inventory. Quality control is not precise when inventories are on moving conveyors. Conveyors push inventory forward, whether needed or not. Conveyors are also subject to breakdown, a serious concern in a JIT factory, in which there is little or no buffer inventory. Conveyors are expensive to buy, install, maintain, and relocate.

The just-in-time system enables manufacturing to react quickly to changes in the mix of products and models sold in the market-place. This of course assumes that the company has labor flexibility so that employees may be reassigned as necessary to produce the products and models demanded. Such labor flexibility also provides limited protection against worker layoffs.

Total Quality Control

"Quality at the source" is the slogan that best epitomizes the TQC concept. What it means to the people in the plant is that errors, if any, should be caught and corrected where the work is performed.

The Western buffer stock principle, calling for inventory to protect one work center from the output variability of the preceding work center, is, irrational to the Japanese. Their solution is to do exactly the opposite: remove buffer stock to expose the variability and correct the underlying causes. That way, the process can be refined on an ongoing basis.

In U S plants, the business of production is production. If you ask about quality in a U S plant, you are referred to the quality control department. Control keeps things stable, but while the Western company is maintaining stability, the Japanese company keeps improving.

In Japanese TQC, the T stands for "total," and that means, above all, total process control: Every process is to be controlled by checking the quality during production. The only affordable way to control quality in all processes is for workers to do it themselves. Every work station becomes an inspection point.

When it comes to TQC, the Japanese follow a very transparent system. Ubiquitous display boards in Japanese plants tell the worker and the bosses, and customers, and outside visitors – what quality factors are measured, what the recent performance is, what the current quality improvement projects are, who has won awards for quality, and so forth.

The Japanese insistence on compliance, also has Western roots but has tended to be honored in the breach in the West. The Japanese make quality the first priority and output the second. Giving each worker the authority to stop the production line to correct quality problems puts teeth in the priority policy.

The worker or work group that made the bad parts performs the rework to correct the errors. This is a major departure from Western practice, in which separate rework lines with their own crews are usual. It seems efficient to perform rework in a separate area, because routing bad parts, subassemblies, or end products back through the main work areas can be a handling problem. In a Western plant, this would also disrupt the normal scheduled output rate.

Japanese plants believe in 100 percent check, i.e., inspection of every item, not just a random sample. The principle is intended to apply rigidly to finished goods, and where feasible to component parts.

The Japanese do not like lot-acceptance inspection for three reasons:

- The very notion of a lot is inconsistent with a low-inventory, just-in-time approach.
- The Japanese now talk of defects in parts per million (PPM) and reject the notion of any level of defects being acceptable.
- To those who are really serious about quality, sampling itself is considered inadequate. An effort should be made to inspect every piece.

One type of inspection that Western QC departments do a lot of and Japanese do little of is receiving inspection. By taking care of quality at the source, Japanese industry has, over the years, been able to phase out the need for receiving inspections. Supplier certification of quality is often so extensive that parts may go directly from receiving docks to production.

Small lot sizes are the key to just-in-time production. Less-than-full-capacity scheduling helps assure that the daily schedule will be met. It is also a quality control concept. For one thing, the concept makes it feasible to stop the line for quality or other problems. Less-than-full-capacity scheduling also avoids pressuring workers and over taxing equipment, tools, and support people and thereby avoids errors in quality that could arise from haste.

It is also interesting to understand how the Japanese view representative sampling. Representative," in Japanese TQC, now means the first piece and the last piece, not a random selection. The first and last pieces constitute a sample size of two, hence the name "N=2." In a stable process, the Japanese reason, the first and last pieces encompass the entire production run, but a random sample in a typical Western sample size of N=5 does not.

The quality control circle, is a small, formally organized group of workers. The agenda and procedures of a quality control circles are usually quite structured, but the details very somewhat from firm to firm, depending upon the objectives that are being emphasized. Contrary to common perception, QCs are way down on a priority-ordered list of important things to get accomplished in Japan. QC circles are very evident in Japanese plants today, but primarily as a way of wringing the last defects out of a production system that has already achieved outstanding quality.

Plant Configurations

Assembly lines are not the ultimate in efficiency. They are generally labor-intensive, and the human beings doing the assembling are subject to human inconsistencies. The lines cough and sputter. The ultimate is not assembly-line production but continuous production, which is found in process industries. Lotless production is possible in process industries, such as refining, because it is in the nature of many of the products – liquids, gases, flakes, pellets to flow continuously rather than to be apportioned into lots. Also, process industries are highly automated. This avoids human inconsistencies and the need for buffer inventories.

The Japanese just-in-time system makes unit processing as much like continuous processing as possible. In a job shop, equipment is arranged by process: for example, all the milling machines together, and so forth. Such an arrangement is not conducive to JIT production. An order for a given component part usually involves operations on several different machine tools. The distances from one machine-tool area to another are too far quick one-piece-at-at-a-time parts movements. The equipment and tooling in a job shop are usually general-purpose. But the time to set up for a particular job on a general-purpose machine tool or in a foundry can take hours or even days. When setup times and costs are high, it makes economic sense to run large lots.

From a JIT perspective, the best thing to do with a job shop is to transform it into a production line. The next best improvement is to make reductions in setup time so that lot sizes may be economically cut. Sometimes it is feasible to break up the job shop, or part of it, and rearrange the work centers into a few production lines. Each production line is dedicated to the manufacture of a different part number or a group of similar part numbers.

A fundamental JIT principle is not to make unnecessary parts simply to keep busy. A JIT plant is likely to generate slack time because of the principle of not making unneeded parts and because of the practice of deliberately pulling workers off the line when the line is running smoothly, in order to expose and correct the hidden problems. Also, the total quality control concept of less-than-full-capacity scheduling builds in slack for the sake of avoiding haste-induced quality problems.

The author explains the difference between the Japanese and western approach in a striking way. The Japanese approach is: Make a piece, check it, and hand it to the next worker; the next worker's machine is close by and there is no place to put parts except at the next worker's station. The Western approach is: Make a bunch of parts on a fast machine, set them down somewhere, and periodically call for a forklift truck to move batches between work stations – or use conveyors.

Production-Line Management

The Western emphasis is on good balance. Japanese manufacturers also want their lines to balance. But for a host of interrelated reasons, the best Japanese factories seem to look for flexibility first and line balance second.

The Japanese have a fundamental aversion to inventories which are considered wasteful. They make their lines flexible enough to absorb external and internal fluctuations. Since the Western tendency is to allow inventory buffers, line flexibility is not important. The Western line-balancing strategy, therefore, aims for stability design and balance the line with long production runs in mind so that the need to rebalance occurs infrequently. By contrast, labor flexibility is an important feature in the Japanese strategy of line flexibility. When one worker is having problems and experiencing delays, other workers move in to help, partly to avoid being idled themselves.

Another form of labor flexibility is connected with the movement of whole crews from one dedicated line to another as the model mix changes. The Japanese also believe in group technology (GT). One worker may handle a variety of tasks in a single work center. And finally, flexibility is needed to rebalance line when there is changeover from one part to another, which tends to occur often in a Japanese JIT factory.

In Japanese plants, fellow workers may help out with small irregularities involved in performing tasks; an equipment failure is a more serious matter, with the potential to shut down a production line. To avoid such failures, the Japanese are careful not to overload or otherwise tax their machines' capabilities. Workers are trained to perform a daily regimen of machine checking before starting up in the morning. When there is a breakdown during the day, the worker himself often fixes it.

The idea of workers checking and doing minor repair work on their own equipment is a core Japanese philosophy. The daily routine of the Japanese worker may begin with exercises and a chorus of the company song, and then a thorough check on the condition of his equipment. The worker may go through a checklist to be sure that the equipment will not fail during the day.

Western line-balancing analysis, is typically elaborate and generally performed by staff engineers. Mathematical and computer processing models may be employed. The analysis begins with division of the production-line work into small tasks, determination of task time standards, specification of required task sequencing, and notation of physical or other constraints. Then the analysis features a search, among many options, for the line design that minimizes worker delay. If a particularly nettlesome bottleneck task stands in the way of good balance, the methods engineers may work on the task to reduce the time it takes to perform it. Then the analysis may be repeated.

Japanese line balancing is not limited by restrictive assumptions. There is more "see and do" and less formal analysis and off-line modeling. Bottlenecks are subjected to methods study as a matter of course, not as a special case. Moreover, bottlenecks are deliberately unearthed on an ongoing basis by removing workers so that the problems may be eliminated. Thus, a Japanese line-balancing study tends to employ thought and ingenuity to change conditions, as opposed to the Western tendency to treat existing conditions mostly as givens.

Western production lines tend to be linear or L-shaped. The Japanese like U-shaped or, sometimes, parallel-configured lines. U shaped and parallel configurations allow one worker to handle tasks on both sides of the U or at adjacent stations on parallel line segments, as in an efficiency kitchen. When the scheduled output is high, more workers may be assigned to the line so that a single person would no longer work on both sides of the line.

The Japanese prefer to position manned stations close enough together that pieces may be handed from one worker to the next without walking. The Western attitude seems to be that conveyors are desirable. The Japanese gain flexibility by a preference for multiple copies of a small, inexpensive, special-purpose, self-developed machines, rather than large multipurpose commercial machines.

Key reasons why the Japanese are able to widely employ the mixed-model concept are (1) their attacks upon changeover, or setup, time and (2) their production flexibility; flexible labor; foreman-level control of balancing/rebalancing, labor assignment, and line speedup/slowdown; U-shaped and parallel lines, with stations close together; and multiple numbers of small machines.

Just-in-Time Purchasing

The Japanese by no means confine the JIT concept to in-plant production. Purchased inventories are considered as evil as in-plant inventories.

The Japanese tend to buy in small lots from the same few suppliers year after year. Suppliers develop a competency that is particularly attuned to the delivery and quality needs of the buying firm. Confidence in the supplier reduces buffer inventories which are sometimes used up in only a few hours. Delivery frequency from the supplier may be more than once a day. And over time, some suppliers achieve quality levels high enough for all receiving inspections to be bypassed and for the parts to go right to the production line rather than to a receiving dock.

Under JIT, suppliers also benefit, especially from long-term contracts and stable relationships with the buying plant. By making parts steadily rather than in batches, the supplier realizes inventory, quality, and scrap improvements. Defects are identified early, and there are fewer defectives to throw out or rework. Further inventory benefits may be gained if the supplier also initiates JIT buying from its own suppliers.

A less obvious but potentially great benefit to the supplier is less need for large, expensive equipment and steadier utilization of existing equipment since the supplier may produce in the same steady daily amounts as are called for in the JIT purchase agreement.

The benefits of JIT buying are greatest in the case of materials used every day. For materials whose usage rates are irregular, one can go only so far toward frequent deliveries in small amounts. But still the point is to try to go as far as possible.

In Japan it is common for a JIT purchase agreement to involve very little paper work. The purchase order (PO) or contract may specify an overall quantity to be delivered during a period of several months in accordance with a long-term production schedule provided by the buying plant.

Some Japanese OEM companies use kanban instead of a production schedule to trigger deliveries. The kanban are released from the using work center on the shop floor of the OEM Company. Deliveries are thus matched with the work center's rate of usage and hence are closer to being just-in-time than would be the case if they were based on a production schedule. The kanban may serve as the invoice when returned with the parts to the OEM plant. The quantity of cards is totaled. The total is payable perhaps once a month.

Another notable feature of the Japanese system of industrial buying is simplicity of the product specifications. The Japanese way, is to rely more on performance specifications and less on design specifications. The idea is to let a supplier innovate. After all, the supplier is the expert. Why not rely on the supplier's expertise?

It is common practice for U S suppliers to ship somewhat more or less than the quantity called for in the purchase agreement. The Japanese buyer expects and gets an exact quantity or very close to it. The Japanese commonly use packages or containers with a standard number of divided spaces or an exact cube. This makes it easy to count out the right number.

American buyers take shipping costs and the whole freight handling system to be a given, which tends to force large-lot buying. JIT buying, like JIT production, considers any such obstacles to cutting lot sizes as a challenge rather than as a given. The freight system may be attacked in various ways, and distances to suppliers must become an important consideration in selecting them. These issues are examined further in the next sections.

The typical U S way of dealing with inbound freight is to leave it to the supplier and the transportation industry. But the transportation system's, primary concern is with optimal utilization of drivers, storage space, and trailer or rail-car cubes. One way is to try to deal with clusters of vendors rather than widely scattered ones, so that freight may be consolidated daily in economical full trailer loads or carloads. Vendor clusters also afford increased use of contract shipping or company-owned trucks and use of trailers as portable warehouses. These measures improve control over freight scheduling and make it possible to avoid the uncertainties of dealing with break-bulk warehouses.

As deliveries become frequent, full truck loads may not be possible. Unit-load economics may be overcome by cutting the transportation distance between supplier and buyer plants. Proximity also means that there are numerous coordination benefits.

Toyota, Nissan, Honda, and many other companies that seem not to be vertically integrated actually exercise extensive control over their suppliers. Sometimes the supplier plants are partially owned by the buying firm. But even when that is not the case, control is exercised. Buyer representatives constantly visit the supplier plants and come to know the suppliers' capabilities and weaknesses, perhaps even better than a U S assembly plant typically knows its own subsidiary fabrication plants. On the other hand, Japanese companies that are highly vertically integrated in an ownership sense are often internally organized into small units, so that over control does not stifle local initiative and pride.

A rule of thumb in the U S purchasing trade is to have at least two suppliers for a given purchased part. Japanese companies, by contrast, hope to evolve to buying a given part from just one supplier but a good one, and preferably one that does little business with other buyer companies. The Japanese buying firm wants to be the dominant reason for the supplier's existence. A supplier selling, say, 60 percent of its output to a single buying company will go to great lengths to be responsive.

Building up and staying with a base of dedicated, high-quality suppliers seems resourceful, as compared with the musical-chairs pattern practised in the U S. Frequent rebidding is supposed to search out the best current price. But that opens the door to those who quote low to get the contract and then fail to perform satisfactorily. Also in awarding a contract to a new lower bidder, the previous supplier is taken off his learning curve and a supplier who may have to go through a debugging period that the first supplier already experienced. Of course, the purchasing department is supposed to thoroughly check out a potential new supplier's capabilities before awarding a contract. But such investigation is time-consuming and subject to error as compared with the administrative simplicity of sticking with the old supplier. Rebidding also fails to generate supplier loyalty, which can mean panic when a supplier is unable to fill orders fast enough and must decide which buyer to favor.

Concluding Notes

According to the author, Western industry which was lean and hungry a few decades back has now accumulated fat. The fat is nonproductive staff, which not only is expensive but actually an obstacle to fast response and the pursuit of actions done for the good of the whole organization.

The Japanese have also prospered but not gotten fat, Possibly, the Japanese environment of scarcity and overcrowding has discouraged profligate habits. The wastefulness of staff growth and overspecialization is not tolerated any more than inventory buildup and the waste of producing defective parts.

The Japanese have not discovered anything new nor amended any of the old lessons regarding line and staff people. They have simply stuck with the natural state of helping line managers and workers to improve themselves in order to do their own jobs better. Line people thus are given training and education so that they are the experts, job rotation so that they have the perspective to make major decisions, and staff support when they request it.

Manufacturing companies always start out lean and simple. They have a small number of managers with broad responsibilities and job rotation by necessity. Flexible production workers perform multiple jobs and check their own work. Simple self-developed equipment are used. There is no separation into self-contained job shops. There is hand-to-mouth, in-plant inventory control; minimal shop paper and no interference by staff specialists. As the company grows in physical size, number of employees, number of products and models, and number of markets, all this changes. Coordination becomes difficult. So they add coordinators, controls, forms, reports, and inventory buffers. If they receive a large order, they acquire a few large machines, which are so expensive that they feel compelled to run them day and night, turning out parts that will be held in inventory until buyers can be found. The machines are organized first into machines centers, then into separate job shops. Elaborate information systems are added to control flows between shops. Since there is a fear that manufacturing will be too busy producing to worry about quality, processes, methods, maintenance, provisioning, training, safety, scheduling, staff experts are hired to perform each of these functions. But the experts get in one another’s way. They also pursue self-serving objectives, and put in place heavy-handed controls.

When all of this gets out of hand and the company is generating red ink, company officials lay off people and slash budgets. The company usually survives and may go through several cycles like this before it finally fails, or is acquired.

What companies need to do is to grow and obtain economies of scale without all of the dis-economies of scale, namely, layers of costly staff and complex controls. In short, companies must strive to stay simple.

In visiting Japanese industrial companies, one is struck as much by the lack of sophisticated techniques, systems, and staff journeymen as by the productivity of the line organization. On the other hand, the effectiveness of business school education in the United States, which emphasizes sophisticated techniques and systems and the supplying of industry with staff journey men is certainly being questioned.

The Japanese success demonstrates that even as corporations grow large, the natural state-make a piece, check it, make a piece, check it – can be reserved. The collection of just-in-time and total quality control techniques presented in this book constitute the mechanism that makes such simplicity possible.