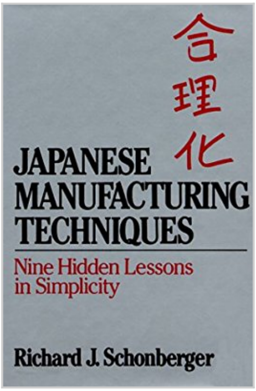

Japanese Manufacturing Techniques: Nine Hidden Lessons in Simplicity

By Richard J. Schonberger

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Japanese productivity and quality standards have fired the imagination of American managers, but until now there has been little explanation of *how to do it* -- how to apply Japanese methods at the actual operating level of U.S. manufacturing plants.

This book shows you how, exposing otherwise well-informed westernized readers to a new world of management ideas. Author Richard J. Schonberger demonstrates that the Japanese formula for success is based on a number of specific, interrelated techniques -- stunning in their simplicity -- and he shows how these techniques can be put to work in American industries today.

Here, in a clear, handbook format, are nine "lessons" for American manufacturers, introducing scores of techniques aimed at simplifying the overly-complex purchasing, inventory, assembly-fine, and quality-control processes of U.S. firms.

At the heart of Japanese manufacturing success are two overlapping strategies: "just-in-time" production and "total quality control." Some American manufacturers already know a little about these methods, but Richard Schonberger provides the most comprehensive description of these techniques available: how they developed, how they all fit together, why they are so potent, and how they "snowball" -- unleashing a powerful chain reaction of productivity and quality control improvements each time more simplification is introduced.

Japanese Manufacturing Techniques will change the way you think. Much of the received wisdom of American management -- "just-in-case" order quantities, statistical sampling for quality Control, and large inventory buffer stocks, for example -- is dismissed by the Japanese as *muri, muda, mura:* excess, waste, unevenness. In many cases, the Japanese technique is exactly the opposite of American practice ("just-in-time" ordering, quality control at the source, and elimination of buffer stocks altogether).

By emphasizing practical techniques, Schonberger shows how you can implement new methods right away -- without waiting for government policy or market conditions or worker behavior to change. The techniques themselves will improve your productivity and quality, provide strategic advantages in gaining market share, and transform worker behavior. And the author backs his nine lessons with concrete examples of how Japanese techniques are being applied in U.S. plants today.

Nearly 20 tables and figures illustrate the "lessons" given here, and a special appendix describes in full the Toyota-developed *kanban* inventory system, with the first explanation in English of single-card versus dual-card *kanban.*

This remarkable book carries you beyond theories and concepts. It's for practical managers who want *results:* better quality control and greater productivity. Implement these simple steps, and you can begin improving your division's performance *now.*

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Editorial Review

Review
C. Jackson Grayson, Jr. Chairman, American Productivity Center Schonberger's book arrives "just in time" and with "total quality" -- two characteristics that he says are the keys to Japanese success. The book truly arrives just in time to offset a rash of superficial books and articles about Japanese manufacturing that skim the surface compared to the authentic detail in this book. It is a quality product. -- *Review*

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Chapter 1

Industrial Management in Japan and the World

LESSON 1: Management technology is a highly transportable commodity.

I was sitting on a bar stool at the Hyatt Regency O' Hare, Chicago. I was to speak on Japanese manufacturing management at the National Assembly Engineering Conference the next day. A man sat down at the next stool and we struck up a conversation. He was an industrial salesman passing through town and was inquisitive about the conference and my role in it. He wanted my views on the Japanese success formula, and I said that it is inventory control. Lest I should appear ridiculous, I hastened to explain:

"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 ideal is to make one piece just in time for the next operation. In management terms, the economic order quantity has been cut down to approach one. Do you understand about EOQs?"

He did, and I continued. "The advantage may seem small -- some savings on inventory carrying costs, since you produce and carry smaller lots. But the Japanese have found that the main benefits are in quality, worker motivation, and productivity. Here's how it works.

"Say that a worker makes one piece and hands it to a second worker whose job is to join another piece to it; but the second worker can't make them fit, because the first worker made a defective part. The second worker wants to meet his quota and doesn't like being stopped, so he lets the first worker know about it right away. The first worker's reactions are predictable: He tries not to foul up again -- and tries to root out the problem that caused the defective part.

"The typical Western way, by contrast, is to make parts in large lots. A whole forklift-truck load -- two weeks' worth, maybe. The second worker might find 10 percent to be defective, but he doesn't care. He just tosses a defective part into a scrap or rework bin and grabs another. There are enough good ones to keep him busy, so why complain about defectives?

"So you see, the Japanese cut the wasted hours and wasted materials by not allowing large lots of defectives to be produced. The main force that drives Japanese quality and productivity is just-in-time inventory control."

"Is it that simple?" asked the salesman.

"It's that simple," I answered.

Of course, I overstated my case. The Japanese have a well-oiled national economic machine that runs on hard work, dedication, frugality, national resolve, and other factors. Furthermore, Japanese excellence in quality control stems not just from small lot sizes and quick discovery of defects, but, more importantly, from an industry-wide assault upon bad quality that has been going on since 1949. The Japanese have translated their quality control aspirations into a collection of procedures and techniques that may be labeled *total quality control* (TQC).

Total quality control procedures, implemented in concert with the just-in-time (JIT) system and a host of related productivity enhancing techniques, give Japan a decisive edge in industrial *management.* Catching up with the Japanese depends not so much on changing tax, trade, regulatory, and labor laws and policies as it does on changing our industrial management policies, procedures, and systems. Happily, most management concepts and approaches are readily transportable, and the basic simplicity and logic of JIT and TQC enhance their transportability from Japan to industry in America and the West generally.

The purpose of this book is to tell the heretofore untold story of Japanese just-in-time manufacturing control and total quality control and of a few early, successful attempts at implementing JIT/TQC in American plants. JIT/TQC is a multifaceted manufacturing management system, and several chapters are needed to examine each facet. A good place to begin is with the natural question "How did the Japanese develop JIT/TQC?"

The Genesis of JIT/TQC

With all of the recent journalistic attention given to Japanese industry, most of us know by now that Japan is small, crowded, and resource-poor. Nearly 125 million people inhabit the Japanese islands, whose land mass is about the same as Montana's. Montana is rich in natural resources, however, compared with Japan. The combination of masses of human resources with few natural resources may help to explain Japanese resourcefulness. The Japanese make do with little and avoid waste. The modern Japanese system of factory management -- the just-in-time approach, featuring hand-to-mouth management of materials, with total quality control -- seems in character with their historical penchant to conserve. To the Japanese factory worker, JIT/TQC objectives should seem reasonable, proper, and easy to accept, inasmuch as JIT/TQC attempts to control such costly sources of waste as:

* Idle inventories, which constitute waste of scarce material resources, and, indirectly, energy for basic material conversion and refining.
* Storage of idle inventories, which wastes limited space.
* Defective parts, subassemblies, and final products, which are a waste of materials/energy.

A Throw-away Society

In contrast to Japan, Western countries, especially those in North America, have had abundant space, energy, and material resources. High-performing manufacturing companies learned to cultivate consumer demand for change and variety and to hold goods and parts in inventory in order to be responsive to changing consumer demand. In the previous era of iow interest rates, cheap materials, and plentiful storage space, the strategy was affordable. As Western consumers became more accustomed to annual style changes and "planned obsolescence," a "throwaway society" replaced earlier generations of careful qualityconscious buyers. The industrial engine ran on the talents of designers, packagers, and advertisers. Turning out new goods quickly and keeping well-stocked shelves of finished goods and components became a path toward profitability. Waste in the form of defective parts, or shelves full of "passable" ones, was not a dominant concern.

Consumptive, profligate habits probably grew in America and Canada roughly in parallel with the growth of a middle class. The trend was interrupted during the World War II years when the countries needed -- and got -- reliable war supplies and equipment. Following the war, the growth of middle-class consumerism was rapid. The trend would surely have continued unabated had not the OPEC-induced oil shock of 1973, as well as the raw material shortages beginning about 1971, occurred.

Oil Shock

The fivefold rise in the price of crude oil between 1970 and 1974 led to worldwide economic travail. The primary effects -- skyrocketing costs for petroleum as a fuel for heating and for running automotive and other engines -- were bad enough. But the high cost and scarcities of petroleum products had numerous secondary effects, especially in high-energy-using material processing industries, like aluminum, plastics, copper, and steel -- from which much of the world's durable goods are made. Acute shortages of basic materials plagued industrial buyers, and the costs of these materials leaped upward.

The industrial world became resigned to elevated costs of materials, and many companies perceived the need to be more resourceful. The good old days were gone. Industry began to warm to the task of overhauling its materials management procedures -- and, for that matter, its plant and equipment, its product designs, its manufacturing controls, and its human resource management approaches, all of which affect the quantities of materials bought, used, stored, and sold.

Somehow the Japanese took the task more seriously than did the rest of the world. According to Dansby, Japanese ideas on tighter material control began to be implemented in earnest right after the 1973 oil shock. The reason for the quick reaction may have something to do with a lack of alternatives: Since Japan relies upon imported energy and materials for nearly all of its needs, better management of these imported resources is perhaps the only viable option for coping with runaway costs.

While Japanese industry was perfecting just-in-time materials management and factory control, the West searched for political and economic solutions to the energy/material cost dilemma. OPEC had to be pressured, the oil companies had to be watched, consumers had to conserve energy, and government had to tinker with taxes, tariffs, and quotas.

Western industry (oil companies excepted) was generally not blamed, implicated, or challenged -- until the results of the Japanese effort to streamline factory management began to pinch unmercifully. It gradually became clear that the Japanese were not grabbing world market share -- in autos, cameras, TVs, steel, shipbuilding, machine tools, and so forth -- by dumping (i.e., by selling at below cost in export markets). The success was genuine, and the reasons were excellent product quality and phenomenal rates of productivity improvement. Among nations, Japan seemed most susceptible to economic damage from the world energy crisis, but Japan dramatically gained economic ground rather than losing it.

Improvement of the Quality Image

While the oil shock may have helped trigger Japanese development of just-in-time production management, the seeds of Japanese export success had been sown much earlier. Those of us who are old enough recall when the quality of Japanese export goods had as poor an image as any in the world. The Japanese knew it and were determined to do something about it in the post-World War II industrial rebuilding era.

A milestone year for quality control in Japan was 1949. The Japanese Union of Scientists and Engineers (JUSE) established a QC Research Group, and JUSE, together with the Japanese Standards Association (JSA), sponsored quality control seminars and launched two QC journals. Invitations went out to American QC leaders, Dr. W. E. Deming in 1950 and Dr. J. M. Juran in 1954, to lecture in Japan, and their visits are widely considered to have been highly influential.

Initially, the QC training efforts were concentrated on higher managers and on engineers. In 1960 the focus shifted to foremen: *QC Text for Foremen,* a two-volume set, was published by JUSE. In 1962 a periodical, *Gemba To QC* (QC for Foremen), was initiated. The periodical, renamed *FQC* in 1973, had a monthly circulation of 93,000 in 1981.

Becoming aware, getting organized, and implementing Western quality control techniques (chiefly statistical sampling) constitute the thrust of the first fifteen years of quality control emphasis in Japan. Today, after years of intensive company-wide emphasis on quality control, Japanese quality control encompasses nearly every concept and approach known to the West -- and a good deal more. Japanese total quality control particularly emphasizes:

1. A goal of continual quality improvement, project after project (rejection of the Western notion of an "acceptable quality level").
2. Worker (not QC department;) responsibility.
3. Quality control of every process, not reliance upon inspection of lots for only selected processes (defect *prevention,* not random detection).
4. Measures of quality that are visible, visual, simple, and understandable, even to the casual observer.
5. Automatic quality measurement devices (self-developed).

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

Industrial Management Expertise

While JIT and TQC were being perfected in Japan, management was not standing still elsewhere. Indeed, U.S. industry was caught up in a major advance in production and inventory management -- known as material requirements planning (MRP), a sophisticated computer-based system. A time-line analysis of the growth of industrial management expertise may help show where the world's industries learned what they know about producing goods, and where Japanese JIT/TQC and American MRP fit in.

The Industrial Revolution

Figure 1-1 traces some of the key developments in the history of the factory system and factory management. The industrial revolution, dating back to the mid-1700s, spawned the factory system itself, along with a multitude of inventions. The hallmark of the factory system is efficiency, which is attained by division of labor, interchangeable parts, and high volume (economies of scale). Skilled craftsmanship gave way to unskilled and semiskilled factory workmanship, first in Europe and then in North America.

Eli Whitney, an American, contributed the idea of interchangeable parts -- and attendant improvements in dependability, reliability, serviceability, and productive efficiency. Standardized designs for component parts gave rise to the need to manage work-in-process (WIP) inventories of parts (in addition to inventories of finished goods and raw materials); the cost and bother of planning for and controlling WIP inventories may be offset by faster deliveries, since the product is carried in a state of partial completion before the customer orders it.

Thanks to Whitney and scores of other innovative Americans during the industrial revolution, industrial management expertise in the New World probably equaled that of Europe by the end of the nineteenth century. Then, in the first half of this century, U.S. productivity outstripped the rest of the world. As is suggested in Figure 1-1, scientific management (SM) was the major advance in industrial management during this period, and SM was developed in the United States. While historians seem generally to think of the industrial revolution as having run its course by the turn of the present century, I like to think of scientific management as a continuation. Factory efficiency had been enhanced by standardization of product design, component parts, and tools, and by the widespread use of standard engine-driven machine tools. What remained nonstandardized was the labor component. For lack of a better way, carrot-and-stick (mostly stick) foremanship continued to be the chief means of controlling the undisciplined work force.

Scientific Management

Scientific management provided a better way. Frederick W. Taylor, Frank and Lillian Gilbreth, and a host of other pioneers of scientific management perfected work-study techniques so that the worker's task could be standardized. In work study, first the work method is improved -- made simpler to do as well as more efficient; second, the improved method is timed, which provides the time standard; third, workers are trained in the standard method; and fourth, jobs are scheduled, supervised, and controlled with reference to the standard method and time. With scientific management, factory standardization was complete, and the implicit goals of the industrial revolution had finally been accomplished.

By the 1920s in the United States, the industrial engineering profession (which splintered off from mechanical engineering -- the machine-tool experts) was well established as the duly vested purveyor of scientific management. Industrial engineers could be found plying their trade in factories from coast to coast. It took at least twenty years for Europe to learn about and adopt work study, and perhaps that time lag provides a good share of the explanation for American industrial supremacy in the world in the thirties, forties, and fifties.

I'll not attempt to trace the growth of Japanese industrial management expertise through midcentury. Suffice it to say that Japan lagged behind Europe and North America, but moved ahead of the rest of the world. For the time being let us skip quickly through the World War Il and the war recovery years (more will be said in later chapter's about management advances in those years). We move up to about 1955 on the time line of Figure 1-1, a time in which the industrial emphasis was shifting from resource mobilization to rationalization, i.e., efficient resource usage. At that point the time line splits into an upper and a lower segment. The upper segment highlights job-lot-manufacturing management, and the lower segment focuses on repetitive manufacturing management.

Job-Lot and Repetitive Production Management

It is common knowledge that Japan has moved to the top of the ladder in production of autos, cameras, consumer electronics items, and a host of other high-volume *repetitively* produced goods. Repetitive manufacturing is the industrial setting in which Japanese just-in-time production and total quality control thrive.

The general public is largely unaware that U.S. industry has become highly proficient in job-lot-manufacturing management in the last twenty years. While repetitive manufacturing is high-volume production of a narrow product line, job-lot manufacturing is medium- to low-volume production of a wide variety of products and models. The job-lot manufacturer must be able to react fast to a hard-to-predict and changeable mix of orders. A small change at the end-product level has ripple effects upon work in process all the way back through parts and raw material ordering, and keeping all of the ordering up to date used to be a data processing nightmare. But the United States is the world's leader in computer processing proficiency, and it was natural for computers to be harnessed to handle these data processing chores in job-lot manufacturing. A comprehensive computer-based manufacturing management system known as material requirements planning (MRP) was developed in the United States in the 1960s and spread throughout U.S. industry in the 1970s. MRP has not proven to be as momentous a leap forward as was scientific management, but there are some similarities: Both SM and MRP are strictly American innovations; and despite vastly improved worldwide communications networks, MRP has been slow to cross the oceans -- as was the case with SM.

Thus, the state of the art in industrial management today is roughly as is shown at the right in Figure 1-1. The United States is most proficient in job-lot-manufacturing management because MRP was invented and nurtured here. Japan is most proficient in repetitive manufacturing management because the just-in-time system was developed there. European industry employs little MRP or JIT but has a diversity of other management strengths. (Placement of European industry in "second place" on both scales in Figure 1-1 is based on an admittedly small amount of hard information.)

The Just-in-Time Challenge

Those of us who have played some role in the MRP crusade of the 1970s may feel justifiably proud. One may even be tempted to rationalize that perhaps U.S. industry should attempt to build up its MRP-controlled job-lot industries and more or less abandon repetitive manufacturing industries and JIT management to the Japanese. Such rationalization would be shallow. There are several reasons why Western manufacturers, including successful job-lot MRP users, should learn all they can about Japanese JIT/ TQC:

1. The Japanese giants used to be job-lot producers, too. They got to be giants not by catering to consumer whims but by producing a few models very well, often in market segments that were being ignored by other companies. Low-cost, high-quality production leads to growth in market share (Henry Ford's credo). With more market share -- more volume -- the plant moves toward long production runs, year-round repetitive production for some product models. As we shall see in later chapters, repetitive operations make it possible to tighten JIT inventory control still more, which leads to still better quality and higher productivity. Soon the product is so good that it becomes attractive not just to shoppers who must economize but to all income levels including the wealthy. At that point Western manufacturers that have tried to compete by offering variety will have been pushed out of much of the market.

2. Growth spawns variety. The company that has gotten rich making "basic black" will then build a plant to make some other model or product. Over time, the company ends up with a full line of models, all produced and sold in volume and manufactured more or less repetitively -- the present situation at Nissan, Sony, Canon, and other top Japanese companies. The Western job-lot competitor no longer has even the advantage of more product variations.

3. Even manufacturers who are locked into a job-lot future can gain some quick benefits from JIT. Plants (or shops within plants) that produce a wide variety of parts generally try to batch several orders for the same part so that there can be one setup and one long production run. The idea is to avoid having to set up for several smaller runs spaced out over time, and there is sound economic wisdom in this -- the economic order quantity (EOQ) concept. However, the Japanese have made us aware of the important benefits (never included in EOQ calculations) of smaller lots and smaller inventories: namely, better quality, less waste and rework, more awareness of sources of delay and error, higher levels of worker motivation, and greater process yield and productivity. You don't have to achieve one-at-a-time production to gain some of these JIT benefits; any move *toward* smaller lots will help.

4. Western job-lot manufacturers that have developed advanced computer-based MRP systems (advanced "closed-loop" MRP is coming to be called "MRP II") have an Achilles heel: quality. No quality control module has been developed to dovetail with MRP. Japan has much to learn about MRP; likewise Western

MRP users have much to learn from Japan about total quality control.

5. Like all good management approaches, JIT/TQC requires hard work and discipline. But most management approaches are closed-ended; i.e., implementation (including debugging} is followed by a one-time boost in productivity. MRP is generally that way. (Or various MRP features can be implemented, one at a time, each capable of pushing up productivity a bit more.) The real power of JIT/TQC is that it has amplification properties. A round of JIT/TQC improvements tends to trigger another round, and another, and so on. In the next chapter the just-in-time chain reaction and its self-sustaining nature, coupled with total quality control, is closely examined. In later chapters we shall probe the elements of TQC and in the JIT causal chain, and consider some related issues. Three key issues are:

a. *Temperament.* The individualistic "every man for himself" temperament of workers in many Western countries, chiefly the United States, contrasts sharply with Japanese cooperation, dedication, harmony, and group-think decision processes. Can JIT systems, which forge closer bonds between workers by closing the time (inventory) gaps between them, work in a more individualistic setting?

b. *Geography.* In Japan suppliers can make deliveries in small quantities daily or more often because shipping distances are not a problem. How can just-in-time deliveries of raw materials and purchased parts be feasible given the vast shipping distances in countries like the United States?

c. *Education and training.* Japan has been immersed in quality control training for over 30 years. Is there any hope of catching up?

These and many other issues are addressed in the remaining chapters, and the answers are, for the most part, positive and optimistic. If the Japanese system can be studied as a collection of integrated techniques -- and it surely can be, as it is in this book -- then there is no reason not to be optimistic. Techniques travel well. Or, to put it in the form of a restatement of the first lesson:

The Japanese have had little trouble learning our techniques, and we will have little trouble learning theirs.

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