



1991

Bringing Japanese manufacturing systems to America: the feasibility of implementing just-in-time production in the United States

Magda Lacharite
Colby College

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Recommended Citation

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BRINGING JAPANESE MANUFACTURING SYSTEMS TO AMERICA
THE FEASIBILITY OF IMPLEMENTING JUST-IN-TIME PRODUCTION
IN THE UNITED STATES

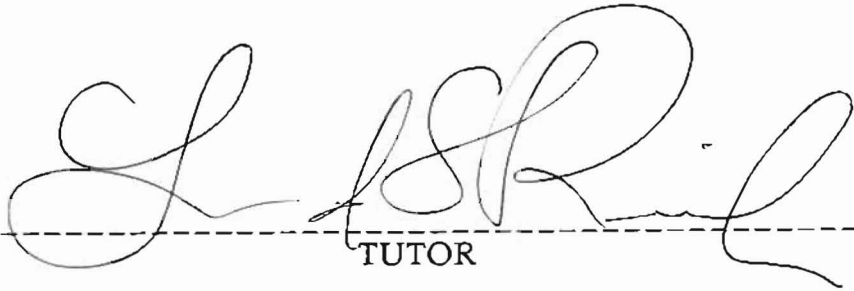
by

MAGDA LACHARITE

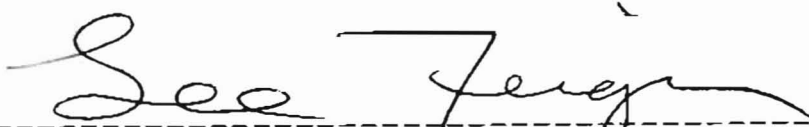
Submitted in Partial Fulfillment of the Requirements of the Senior Scholars'
Program.

COLBY COLLEGE
1991

APPROVED:



TUTOR



CHAIR, DEPARTMENT OF EAST ASIAN STUDIES



READER



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Abstract

This paper addresses the feasibility of implementing Japanese manufacturing systems in the United States. The recent success of Japanese transplant companies suggests that Just-In-Time (JIT) production is possible within America's industrial environment. Once American workers receive proper training, they have little difficulty participating in rapid setup procedures and utilizing the kanban system. Japanese transplants are gradually developing Japanese-style relationships with their American supplier companies by initiating long-term, mutually beneficial agreements. They are also finding ways to cope with America's problem of distance, which is steadily decreasing as an obstacle to JIT delivery.

American companies, however, encounter significant problems in trying to convert traditionally organized factories to the JIT system. This paper demonstrates that it is both feasible and beneficial for American manufacturers to implement JIT production techniques. Many of the difficulties manufacturers experience center around a general lack of information about JIT. Once a company realizes its potential for setup-time reduction, a prerequisite for the JIT system, workers and managers can work together to create a new process for handling equipment changeover. Significant results are possible with minimal investment. Also, supervisors often do not realize that the JIT method of ordering goods from suppliers is compatible with current systems. This "kanban system" not only enhances current systems but also reduces the amount of paperwork and scheduling involved. When arranging JIT delivery of supplier goods, American manufacturers tend to overlook important aspects of JIT supplier management. However, by making long-term commitments, initiating the open exchange of information, assisting suppliers in reaching new standards of performance, increasing the level of

communication, and relying more on suppliers' engineering capabilities, even American manufacturers can develop Japanese-style supplier relationships that enhance the effectiveness of the system.

Acknowledgements

This paper was written under the supervision and encouragement of Professor Leonard Reich, who served as my tutor. His support not only helped me in formulating my topic but also directed my progress through revisions at all stages of the project. I would also like to thank Professor Lee Feigon and Professor Tamae Prindle for providing valuable suggestions on my final draft. I would like to express my gratitude to Tamae Prindle for making arrangements for this project while I was abroad. I also thank Professor William Callahan of Kansai University of Foreign Studies for introducing me to the subject of Japanese management and presenting it in a manner that allowed me to study all aspects of Japanese industry from a non-biased viewpoint.

I would like to express my gratitude to those who helped me in directing my research and locating data. Michael Cusumano of the Massachusetts Institute of Technology's Sloan School of Management provided papers and articles that were invaluable to the early stages of my research, and discussed possible resources. Malcolm Ferguson of Komatsu Forklift, R. Lynn Mitchell of Matsushita Electronic Components Corporation of America, Bob Ledbetter of Mazak Corporation, Jenny Payne of American Matsushita Electronics Corporation, Jean Fogarty of Inland Steel Company, and Bob Markus of GM Service Parts Operations were especially helpful in giving me an understanding of what stage manufacturing facilities in America have reached in implementing JIT. I would like to thank the companies who agreed to participate in my questionnaire and provided detailed information about their relationships with Japanese and American automakers.

I am most grateful to Mr. and Mrs. Joe Lukeman and Bhaskar Sarkar for helping to defray the costs of this project. I also thank Jim MacIntyre for the use of his computer during a vital stage of the project.

Introduction

Since the beginning of the 1970s, American manufacturers have steadily lost their ability to compete internationally. Yearly trade imbalances have exceeded \$100 billion, U.S. budget deficits have grown, and unemployment has continued to rise. Meanwhile, Japanese manufacturing companies have been producing goods of higher quality and lower cost than those of their American competitors. Japan has increased its market share in industry after industry, making significant headway in semiconductors, computers, telecommunications, and specialty steels. Japanese automakers have even taken the lead in the American large car market in quality and price.¹

Factors contributing to recent Japanese success include the high skill level and commitment of workers, capital availability, corporate emphasis on long-term strategies, and government incentives and protection.² However, a major reason for higher performance levels has been Japan's new approach to manufacturing, called Just-In-Time (JIT).³ This system, developed by Toyota in the 1950s, has spread to industries throughout Japan. JIT focuses on eliminating all wasted materials, equipment, and manpower by providing parts to the assembly line in the exact quantity needed and *just in time* for processing. In this way Japanese companies keep inventories at a minimum, resulting in great savings in inventory investment and management. In 1982, the Japanese auto industry maintained \$800 million of inventory to produce 11 million cars and trucks a year, while American companies

¹ Ezra F. Vogel, *Comeback* (Tokyo: Charles E. Tuttle Co., Inc., 1985), 17-23.

² *Ibid.*, 23.

³ Many Japanese consider the term JIT to describe a highly advanced version of the system. They believe that the only true examples of JIT manufacturing are the auto factories in Toyota City, Japan. Throughout this paper I will use the American definition of JIT, which refers to any mass production alternative based on the principles Toyota has developed.

used \$8.5 billion to do the same. The average Japanese assembly plant was 600,000 square feet smaller than its American counterpart.⁴ When utilizing JIT, the factory is more efficient, the number of defects is significantly lower, and production is more responsive to changes in demand. After a five-year study of JIT, the Massachusetts Institute of Technology's International Motor Vehicle Program concluded that this new system is superior to standard mass production, and that its full implementation in North America "can eliminate the massive trade deficit in motor vehicles."⁵

Because JIT was developed abroad, it does not fit well with traditional American manufacturing practices. It is dependent on the ability to perform equipment changeovers rapidly, an aspect of production that American manufacturers have not attempted to improve. It consists of an entirely new system of organization that does not utilize American schedule-producing software programs. In order to implement JIT in the United States, manufacturers need to become highly dependent on local supplier companies, which necessitates open communication and long-term commitments. The vast distances from supplier companies to manufacturers in America also present a problem because JIT requires frequent, punctual deliveries.

Japanese companies were the first to implement JIT in the United States when they began building American-based manufacturing facilities in the early 1980s. Several automakers settled in the midwest and south, starting with Honda's motorcycle factory in Marysville, Ohio (1979). When this venture proved successful, the company built an adjacent automobile factory in 1982. The following year, Nissan's plant in Tennessee started production. Meanwhile, Toyota struck an

⁴ J. McElroy, "Making Just-In-Time Production Pay Off," *Automotive Industries* Vol. 162, No. 2 (Feb. 1982), 78.

⁵ James P. Womack, Daniel T. Jones, and Daniel Roos. *The Machine That Changed the World* (New York: Rawson Associates, 1990), 225.

agreement with General Motors to create a joint venture named the New United Motor Manufacturing, Inc. (NUMMI). This new company took over a previously shut-down GM plant in Fremont, California in 1984. GM was interested in learning the Japanese "secret" to productivity, while Toyota wanted to see if its techniques would work with American employees. When Toyota found that even union workers responded agreeably to its non-traditional approach, it quickly built a manufacturing facility in Georgetown, Kentucky (1988).

Other joint ventures in America include Mazda-Ford, Mitsubishi-Chrysler, and Subaru-Isuzu. There are also nearly 300 Japanese-owned and managed auto-parts companies in the United States, because Japanese suppliers often follow their major customers to new locations.⁶ Japanese facilities that are not related to the auto industry include construction equipment, consumer electronics, and machine tool manufacturers. Most of these Japanese companies have implemented JIT with a high level of success. Although they have not reached the level of productivity attained by their factories in Japan, Japanese manufacturers have found ways of dealing with the major problems associated with transplanting JIT to America.

In trying to improve the quality of their operations, several American companies have experimented with implementing JIT in their own factories. Ford has been the most successful of the Big Three American automakers in implementing JIT programs. The Buick Division of General Motors has also adopted a JIT system. Buick City in Flint, Michigan, rated as the best assembly line in North America, produces the most trouble-free cars in the country.⁷ Hewlett Packard, Motorola, Westinghouse Electric, General Electric, Harley-Davidson Motor Co., and Black & Decker Manufacturing are other companies with JIT systems.⁸

⁶ David Gelsanliter, *Jump Start: Japan Comes to the Heartland* (New York: Farrar, Straus & Giroux), 5-11.

⁷ Tom Ulrich, "Buick Sets Pace for General Motors," *The Christian Science Monitor* 18 Dec. 1990, 8.

⁸ C. R. Waters, "Why Everybody's Talking About Just-In-Time," *Inc* Mar. 1984, 78-80.

However, American companies have run into significant problems in converting their traditionally run factories. Most companies do not realize the benefits of implementing JIT and feel that they can not overcome the obstacles involved.

I began my research by investigating why Japanese companies have been more successful than American companies in implementing JIT in the United States. I visited several Japanese manufacturing facilities in order to determine how they are dealing with problems within the factory. I compared Toyota's Kentucky operations with one of its factories in Toyota City, Japan (which I toured last year). I also visited the other major Japanese automobile transplants in America: Nissan in Smyrna, Tennessee and Honda in Marysville, Ohio (the motorcycle factory). For comparison, I toured General Motors's Hamtramck plant, which is known for its high-tech automation and Americanized version of JIT. I also went to America Matsushita Electronics Corporation's television plant in Troy, Ohio, which has just recently started production.

In order to learn more about what is actually transpiring between supplier companies and their Japanese transplant customers, I sent out a questionnaire to a select group of American suppliers who agreed to participate in my research. This group consisted of three suppliers to Nissan and two supplying to only American companies. On a visit to Komatsu Forklift plant in Anaheim, California I learned about a unique system of controlling the delivery of supplier goods. I was able to compare this system with that at a Komatsu plant in Japan (toured last year). I also visited Matsushita Electronic Components in Knoxville, Tennessee, a Japanese supplier company of several auto manufacturers that does not use JIT. At this location I learned about a new method of changing machines over from one lot to another without halting production. Over the course of this year, I gathered information about various solutions to problems associated with JIT implementation.

In this paper I intend to show that it is possible for American manufacturers to successfully implement JIT production techniques. Moreover, I would like to demonstrate that both the manufacturers and their supplier companies will benefit greatly from adopting this system.

Part I

Small Lot Production

American automobile manufacturers made few changes in the production process between the start of Henry Ford's River Rouge factory in 1908 and the introduction of Japanese production systems in the early 1980s. These companies based their production schedules on the amount of time it took to manufacture each part or subassembly. Beginning in the 1960s, they used computers to calculate a master schedule, tying together all phases of production. Auto manufacturers found that they could keep the process running smoothly by maintaining buffer stocks of parts and subassemblies. If a problem halted one of the subprocesses, the final assembly line could continue running until the buffer stock was depleted. Even through the early 1980s, most American automakers found it wise to keep enough buffer stocks on hand to last several days.⁹

Due to the amount of time required to change machines from producing one type of part to another, it was economical to create as many of a certain part as possible before switching to a different model. Manufacturers then stored these large quantities of identical components until they were needed by the next process.¹⁰ Final assembly also built cars in large lots of identical products, then stored the cars until customers ordered them.

Maintaining large inventories required a great amount of investment and coordination. The inventory itself represented a fixed investment in materials, which was capital that could have been used more profitably in other ways.¹¹ There

⁹ Michael A. Cusumano, *The Japanese Automobile Industry* (Cambridge: Harvard University Press, 1985), 264-5.

¹⁰ *Ibid.*, 270.

¹¹ Kenneth A. Wantuck, *Just-In-Time For America* (Milwaukee: The Forum LTD., 1989), 24.

were also many costs associated with the handling of this stock: management allocated space for use as a storage area, workers transported components to and from these storage areas, materials handlers maintained the stock and filled out paperwork recording its movements, and supervisors coordinated, directed, and oversaw all of these processes.¹² This inventory sometimes got in the way of the actual production process, which resulted in wasted motions and defective products. For example workers spent time walking around piles of finished components and avoiding transport vehicles; work stations became crowded with excess finished products; and the increase in factory size complicated communications with supervisors and other workers.¹³ Knowing that there were plenty of spare parts and that mistakes would end up in the reject pile, workers produced many defective parts.¹⁴ Author Leroy D. Peterson found that a permanent reduction of inventory to minimal levels is usually followed by a 90% reduction in the number of defects, and a 75% improvement in equipment downtime.¹⁵ Furthermore, holding a large inventory of semi-finished products made the system less flexible. A manufacturer could not implement an improvement in design until all previous stocks had been used. A sudden shift in sales would make some of the materials in storage unnecessary. If one process started producing defective components, many of them would accumulate in storage before anyone noticed the problem. Workers would then have to discard the entire batch. Components would even become rusted or broken while in storage, and could not be used.¹⁶ Producing more than could be handled immediately was a significant waste in investment, manpower, organization, and system flexibility.

¹² Japan Management Association, ed., *Kanban: Just-in-Time at Toyota* (Cambridge: Productivity Press, 1985), 6.

¹³ Leroy D. Peterson, *Reinventing the Factory* (New York: The Free Press, 1990), 7.

¹⁴ Cusumano, *The Japanese Automobile Industry*, 270.

¹⁵ Peterson, *Reinventing the Factory*, 7.

¹⁶ Japan Management Association, ed., *Kanban*, 6.

American manufacturers did not attempt to reduce these inventories because they appeared necessary to make the system run smoothly. Postwar Japan, however, demanded small volumes of a wide variety of vehicles. Not only were American methods and equipment designed to produce in lots that were in far excess of Japanese needs, but Japan's high land prices increased the burden of maintaining large buffer stocks and inventory. In order to start producing smaller lots, Toyota engineer Taiichi Ono decided in 1948 to have final assembly lines "pull" materials and components through the system.¹⁷ Rather than have each process produce a predetermined number of parts, only the final assembly line followed a production schedule. As workers used up containers of parts, they sent orders back to the parts producers. Thus, each work station produced parts only as they were needed by the following process.¹⁸ If parts started to accumulate, all work stopped until those excess units were used up. The Japanese called this process a "pull" system because the demand for production originated at the final assembly line and rippled back throughout the plant, pulling the other production processes along with it.¹⁹ Moving parts throughout the factory *just in time* to be processed by each station was really an idealized situation. In actuality, workers produced in small lots, with the ultimate goal of reducing lot size to one unit. However, by 1958, Ono had eliminated all component stockpiles beside production lines.²⁰

Twenty-five years later, American manufacturers, desperately needing to improve quality and efficiency, faced major obstacles in trying to adopt JIT. This new system did not utilize traditional Western scheduling programs to conduct the

¹⁷ Cusumano, *The Japanese Automobile Industry*, 265-78.

¹⁸ James C. Abegglen and George Stalk, Jr., *Kaisha: The Japanese Corporation* (Tokyo: Charles E. Tuttle Company, 1985), 101-2.

¹⁹ *Ibid.*, 103.

²⁰ Cusumano, *The Japanese Automobile Industry*, 276, 279-80.

movement of parts through the factory. Implementing JIT required changing many of the fundamental aspects of plant organization.

1. Attaining Minimum Setup Times

One of the first barriers to producing in small lots is the amount of time it takes to change machines from producing one part to another. American manufacturers typically use a formula called the Economic Order Quantity (EOQ) to determine how many parts to produce in each lot. This formula balances the cost of holding inventory with the cost of equipment changeover. The longer it takes to set up machines, the longer it is desirable to run them before changing again. When using this formula, American manufacturers treat setup time as a constant, and their objective is to avoid changeover as much as possible.

Japanese manufacturers, however, strive to make changeovers as frequently as possible. The smaller the lot size becomes, the less inventory will build up between processes. For this to be economical, they must also minimize setup times. It would certainly be unwise to make a changeover several times a day if such a process took several hours to complete. Machine preparation, rather than actual production, would then take up a large percentage of daily work.

Japanese manufacturers are now completing in minutes setup processes that take American manufacturers several hours. Toyota employs a system called Single Minute Exchange of Die (SMED), which aims at reducing setup times to less than ten minutes. Toyota's facilities in Japan can now complete most setup procedures in less than three minutes.²¹ A small press at Tokai Rika Company exemplifies the ultimate goal of setup operations; it automatically changes dies every time the press

²¹ Shigeo Shingo, *A Study of Toyota Production System from Industrial Engineering Viewpoint*, trans. Andrew P. Dillon (Cambridge, MA: Productivity Press, 1989), 107.

is used.²² In order to produce in smaller lots, American manufacturers must significantly reduce their setup times.

Toyota's Method of Reducing Setup Times

In 1955 Toyota hired an outside consultant named Shigeo Shingo to help improve the changeover process. Shingo was a lecturer on production management for the Japan Management Association. While working with Toyota and Shin-Mitsubishi Heavy Industries, he developed a method of reducing the amount of time used to changeover equipment. Shingo called this process Single-Minute Exchange of Die (SMED), referring to setup times of less than ten minutes.²³ In 1970, working in one of Toyota's factories, within six months Shingo succeeded in reducing setup times from four to one-and-a-half hours. Several months later he had it down to three minutes. Shingo achieved these impressive results in three steps: he made the preparation process as comprehensive as possible; he cut down on all excess motions during changeover; and he made improvements in machines and dies so that adjustments and test runs were no longer necessary.²⁴

Shingo classified all processes involved in setup as either internal or external. Internal processes were those that could only be done while the line was not moving. External processes were those that could be completed while the machine was operating, yet previously had been performed during setup time. Shingo's first strategy in speeding up Toyota's changeover times was to identify external processes and have workers perform them as a part of changeover preparations.²⁵ This included arranging all materials and tools needed for the setup by the work station,

²² Robert W. Hall, *Zero Inventories* (Homewood, IL: Dow Jones-Irwin, 1983), 85.

²³ Cusumano, *The Japanese Automobile Industry*, 286.

²⁴ Shingo, *A Study of Toyota Production System*, 106-8.

²⁵ *Ibid.*, 107-8.

and postponing all cleanup and rearrangement of equipment until after the line started running again.²⁶

Shingo then studied worker motions during internal procedures in order to eliminate wasted movements. He found that workers spent a lot of time tightening and loosening nuts and bolts. Shingo replaced many of these bolts with clamps, and, in cases where bolts were absolutely necessary, he encouraged workers to find ways of turning them only once to tighten them.²⁷ Shingo fit horizontal surfaces with rollers and began storing dies on roller-topped carts. These improvements obviated the need to lift heavy dies and freed workers from dependence on cranes and forklifts. Shingo then developed setup team procedures so that workers did not hesitate once the line stopped. All workers knew exactly what to do.²⁸

Shingo also noticed that much time was spent making adjustments to dies and tools once they were in place. Workers often sent scrap pieces through the machines to test if dies had been fitted correctly. Shingo realized that this was unnecessary. He created settings on machinery so that tools fit into one of several predetermined locations and designed dies that fit in properly as they were inserted, like cassettes. When Toyota began standardizing equipment, workers did not have to finely adjust tools every time.²⁹

In this way Toyota (and later every Japanese automaker) reduced the costs of equipment changeover and started producing in small lots. By 1960 Nissan had reduced its average setup times from several hours to between 30 minutes and an hour. That time was further reduced to about ten minutes by the early 1980s.³⁰ In

²⁶ Hall, *Zero Inventories*, 91-4; Wantuck, *Just-In-Time For America*, 192.

²⁷ Wantuck, *Just-In-Time For America*, 196-7. In one case Shingo charged workers \$500 every time they turned a bolt more than once to secure it. Shingo, *A Study of Toyota Production System*, 109.

²⁸ Wantuck, *Just-In-Time For America*, 193, 196; Hall, *Zero Inventories*, 97.

²⁹ Shingo, *A Study of Toyota Production System*, 112-3; Cusumano, *The Japanese Automobile Industry*, 286.

³⁰ Cusumano, *The Japanese Automobile Industry*, 285.

1977, stamping plants in the United States, Sweden, and West Germany still required from four to six hours to change dies, while Toyota took an average of 12 minutes. Toyota was able to change dies three times per day and produce in lots of only one day's supply, in contrast to the ten to 30 days' supply common in the West.³¹

Setup Times at American Manufacturers

Machinery with rapid die-change features has been available in America for over 40 years. In fact, Taiichi Ono introduced the idea of reducing setup times to Toyota when he brought this new American technology to Japan in the mid-1950s. But American manufacturers have not implemented available technology nor have they made serious efforts to reduce setup times.³² American tool manufacturers have offered machines capable of quick setup, but their domestic customers have seldom been interested in those features.³³

Traditional Attitudes toward Setup Times

Most American manufacturers consider changeover to be a lengthy procedure and do not analyze the process to find ways of saving time. A one-hour setup is not usually considered to be a problem.³⁴ Consultant Kenneth A. Wantuck noted, "In most traditional manufacturing companies every setup is a totally new experience. I once observed the same tools being exchanged on the same machine three different times, and never once was the same procedure repeated. They were random events."³⁵ Large lot production may be responsible for this relaxed approach to setup

³¹ Ibid.

³² Cusumano, *The Japanese Automobile Industry*, 285.

³³ Hall, *Zero Inventories*, 99.

³⁴ Japan Management Association, ed., *Kanban*, 57.

³⁵ Wantuck, *Just-In-Time For America*, 195.

in American factories. When changes are infrequently made, workers become accustomed to putting aside several hours for the process.³⁶ If management encourages lot sizes of up to a month in duration, the length of setup is deemed insignificant.

Japanese Companies and Setup Times in America

Japanese manufacturers have found no significant problems implementing these systems in America because they have already had experience in reducing setup times in Japan. In several cases, their factories are exact clones of existing operations in Japan. For example, Toyota modelled the NUMMI operations on its Takoaka plant in Japan.³⁷ Toyota followed this format again in Kentucky, where it created an exact clone of its Tsutsumi plant.³⁸ In such cases, companies can implement exact setup procedures in the American plant that they have developed in Japan. If there are any problems with machinery or procedures, a quick call to Japan will connect workers with the men who created the system. Honda's setup procedure is based on reprogrammable machines moving on tracks within the plant, and workers can perform the changeover by merely slowing down the line.³⁹ Matsushita Electronic Components Corporation of America in Knoxville, Tennessee changes equipment without stopping or slowing down the line at all. The first piece of a new lot enters the assembly line directly after the last piece of the previous lot. As this first piece approaches each work station, the operator makes the necessary adjustments to his machinery to handle the new lot. This is possible only because Matsushita had developed the necessary machines and procedures

³⁶ Cusumano, *The Japanese Automobile Industry*, 285.

³⁷ Gelsanliter, *Jump Start*, 74.

³⁸ Maryann Keller, *Rude Awakening: The Rise, Fall, and Struggle for Recovery of General Motors* (New York: William Morrow and Company, Inc., 1989), 209.

³⁹ Doron P. Levin, "Honda Blurs Line Between American and Foreign," *New York Times*, 14 March 1990, D8.

before building this factory in Tennessee.⁴⁰ It is relatively easy to train a new worker to follow a set of procedures, compared with encouraging a veteran employee to improve on a process he has been performing for his entire career.

Reducing Setup Times in American Companies

American manufacturers attempting to reduce setup times are generally not building new facilities as are Japanese companies in the United States. These older factories have histories of lengthy setup times. In such cases companies must encourage the cooperation of all workers in order to develop new setup procedures. Although the majority of large American manufacturers have not even attempted to make these changes, a few companies have developed systems of reducing setup times. Not only are manufacturers of various industries utilizing these systems, but they are realizing significant savings with minimal investment. Kenneth Wantuck, author of *Just-in-Time for America*, recalled that when he first heard Toyota was achieving a single-minute setup for an 800-ton press he was amazed, because a similar process at his own company took between one and two shifts (8-16 hours) to complete. His factory ran lots over several days (many thousands of pieces), and he could not imagine a lot size of under 250. He was even more surprised when he actually saw the setup and realized that Toyota used no new technology or automation in attaining these results. Wantuck remarked, "They weren't using anything we didn't already have in our plant. That's when I realized that the setup time obstacle could be overcome without the necessity of making large capital investments. All it takes is a systematic process, rigorously applied, and some good old Yankee ingenuity."⁴¹

⁴⁰ R. Lynn Mitchell (Personnel Assistant, Matsushita Electronic Components Corporation of America), personal interview, 9 Nov. 1990.

⁴¹ Wantuck, *Just-In-Time For America*, 188-9.

After drastically reducing setup times at his own plant, Wantuck has developed a system of implementing JIT in America. He is now a consultant for manufacturers wishing to implement JIT. In his book, *Just-In-Time for America*, he bases setup reduction efforts on Shingo's three-step process described above. Wantuck has found that identifying external procedures involves almost no capital investment and cuts setup times in half. To improve time efficiency while machines are stopped, he focuses on eliminating nuts and bolts, on fastening tools together that are cumbersome to install individually, and on developing a set pattern of movements for workers. These improvements can cut setup times in half again, bringing the total reduction to 75%. Modifying equipment to avoid making adjustments is the most expensive step, but it represented a further 15% reduction.⁴²

Wantuck has also discovered that videotaping the setup procedure is the most successful technique for reducing wasted motions. For maximum results, he advises that representatives from all functions involved in performing and supporting setup procedures establish a team. It is important that this team understand Shingo's three-step process of reducing setup times. The team should then watch a videotape of workers setting up one of the machines in the plant and determine which actions are internal or external. The team should plan together how to eliminate external processes and formulate a step-by-step procedure for all members. Wantuck emphasizes that setup workers "must have a consistent process, however it may be developed, which will be precisely followed every time." In this way there is no hesitation once the machinery stops, and the process runs smoothly. However, using a set procedure is not effective without practice. Workers should practice this new schedule on overtime, such as on a Saturday morning. Wantuck remarked, "In a half day, the team can set up and tear down

⁴² Ibid., 189-90, 195, 199-200.

numerous times to optimize the timing and coordination. The long-term value of this training will far exceed the short-term cost of the overtime premiums." Workers quickly learn to think about their movements as internal and external, and strive to eliminate all wasted actions.⁴³

In starting setup reduction programs it is important for workers to see an actual SMED setup. Most workers do not believe that their own factory's setup procedures can be completed with a 90% reduction in time. Participants must believe that it is feasible and realize that it will not require new, sophisticated equipment. Shingo remarked that as soon as a worker witnesses a single-minute setup, "understanding will be instantaneous and their thinking will be revolutionized."⁴⁴

The Cost of Setup Time Reduction Programs

Many American manufacturers believe that the only way to significantly reduce setup times is to purchase robots and programmable machinery. They perceive small-lot production as not worth the investment in setup time reduction.⁴⁵ However, not only has Wantuck achieved up to 75% reduction in setup time with very little investment, but he stresses that management should focus setup reduction efforts on modifying existing equipment.⁴⁶ Manufacturers also do not need to invest in advanced engineering. JIT consultant Robert W. Hall noted that the "people who are thoroughly familiar both with the equipment and what it is supposed to do are best suited to figure out how to make setup time reductions."⁴⁷ Several American companies have used high-tech equipment to cut

⁴³ Ibid., 196, 199, 205-20.

⁴⁴ Shingo, *A Study of Toyota Production System*, 106.

⁴⁵ Hall, *Zero Inventories*, 3.

⁴⁶ Wantuck, *Just-In-Time For America*, 189.

⁴⁷ Hall, *Zero Inventories*, 84.

down setup times, but they have not achieved comparable results to those using Japanese methods of setup organization. American manufacturers not only keep costs down but achieve better results if they refrain from (at least initially) investing in new equipment and outside engineers.

Minimal Setup Times in American Factories

Unfortunately, most American plant managers today believe that their operations are running as efficiently as possible and that reducing setup time would not be worth the investment. But Toyota's single-digit setup times are possible in America. Not only have Japanese transplant manufacturers achieved them with American workers, but several American companies have produced comparable results. GM's Buick-Oldsmobile-Cadillac (BOC) division began working on improving setup times using existing equipment. A BOC plant in Lansing, Michigan succeeded in reducing setup time from 12 hours to 18 minutes. *Automotive Industries* magazine even sponsored a die-changing contest. Although only three of the five participating teams represented American manufacturers (all from BOC plants), the two teams from BOC's Lansing plant claimed second and third place, beating Nissan by a few seconds. Honda placed first, halving the Lansing plant's score of 10 minutes.⁴⁸

As more and more consultants such as Kenneth Wantuck develop programs for assisting American manufacturers in reducing setup times, the first step to JIT implementation will become more accessible. Whether or not a manufacturer is committed to learning JIT, it can significantly increase the amount of time its machines are productive without investing in new equipment.

⁴⁸ Keller, *Rude Awakening*, 212-3.

2. The Kanban System

Traditional American systems of production planning are not compatible with JIT. No matter how precisely computer-created master schedules coordinate the many phases of production, manufacturers will find it wise to maintain buffer stocks *just in case* there is a problem. These centralized planning systems also inhibit the flexibility associated with JIT, which is capable of changing the rate of production at a moment's notice.⁴⁹ Toyota's Ono was the first to try a new approach to production organization, and his kanban system is a vital component of the JIT program. The Japanese word *kanban* refers to a small card that identifies parts and materials in a plant. Under the JIT system, these cards accompany all parts in transit. When a container of components is used up, workers send its kanban to the previous station as an order for more goods. By producing only what has been ordered by kanban, a manufacturer can avoid overproduction in all of its subassemblies.⁵⁰

Toyota's Kanban System

Ono started using kanban when he became head of one of Toyota's manufacturing departments in 1953. At that time kanban were merely small strips of paper used to identify parts and record notes. As Ono developed a system of production control based on their usage, kanban started to appear as metal plates in different sizes and colors. They included complete information on an item, including its name, number, and bar code; the amount of units in each container; the model of car it would be used in; and its storage location. Kanban also displayed production information such as the preceding and succeeding processes, and the

⁴⁹ Cusumano, *The Japanese Automobile Industry*, 296-7.

⁵⁰ *Ibid.*, 287-98.

number of items permitted to accumulate as buffer stock.⁵¹ Workers could then identify any container of materials and immediately determine what should be done with it.

Toyota's method of handling kanban controlled the amount of goods produced at each step throughout the system. There was a set number of kanban in circulation between each process. Stations on the assembly line received pallets containing uniform quantities of components with a kanban attached. When an assembly line worker used up a pallet of materials, he removed the kanban and sent it back to the previous process. This kanban then acted as a job instruction tag, ordering items to be manufactured. The previous process then produced those items and shipped them along with the kanban back to the original assembly-line station. It was vital that no worker move or produce parts without kanban authorization. Kanban served as the control mechanism for avoiding overproduction, one of the Toyota Production System's major goals.⁵²

Toyota gradually extended the kanban system throughout its supplier network. Suppliers started to exchange kanban with the company in the same manner as did workers within the factory. Today, these suppliers' in-house kanban systems are compatible with Toyota's. In this way goods travel under a uniform system of organization from the moment they enter supplier facilities as raw materials until they pass through Toyota's final assembly line as parts of a finished vehicle.

Fluctuations in demand changed Toyota's rate of production without requiring any adjustments in scheduling or in the number of circulating kanban. Supervisors only gave new instructions to the final assembly line. Work stations then started to send kanban back to previous processes at a different rate, where

⁵¹ Shingo, *A Study of Toyota Production System*, 180.

⁵² *Ibid.*, 183-4.

production sped up or slowed down accordingly. Not only did this system reduce efforts in scheduling but incorrect estimations of demand did not affect final production or buffer stock levels.⁵³

Transplanting Kanban Systems to America

Manufacturers face several problems when adopting the kanban system in America. Workers who do not fully understand the system can easily “break the rules,” making the exchange of kanban useless in controlling production. Second, few American manufacturers are eager to change their existing systems of supplier management. And, unless American supplier companies start to implement their own kanban systems, inventories will merely shift from the buyer’s facility to that of the supplier.

Understanding the Kanban System

Manufacturers face the most significant problems in kanban implementation when adapting it to traditionally organized plants. Workers cannot simply “jump in” and start working under kanban organization; they must have complete understanding of the concepts behind the system. Workers must realize that simply producing as many goods as possible is no longer the company’s objective; if they do not follow the rules of the system, kanban will not prevent overproduction. The first rule dictates that workers may not move materials without kanban authorization. In other words, a preceding process may not send parts to the subsequent process unless that process has ordered them. Second, if no subsequent process has ordered parts the line should produce nothing at all, otherwise unnecessary stocks will build up between processes. The third rule prohibits

⁵³ *Ibid.*, 183.

workers from moving kanban with partially filled containers. A work station may not order parts with a kanban unless it has depleted that kanban's current load of components, nor may work stations send partially filled containers to subsequent processes. The kanban must wait until the station has produced enough components to fill one container. This rule is important in keeping the system under control.⁵⁴ If the kanban system exposes a problem in the factory, both workers and management need to address that problem rather than cover it over by fudging the exchange rules of kanban. For workers accustomed to producing as much as possible, these rules are easy to break and require a lot of discipline.

Management must also fully understand the concepts behind the kanban system. If the factory produces goods only as needed, high-speed automation may not be necessary. JIT operations have little need for investment in state-of-the-art machinery that completes its work early. Equipment that is sitting idle while the rest of the factory processes its products is not saving the company any money.⁵⁵ Companies should make investment decisions with the input of those working with the system so that money is put where it is needed, not where the latest trends in technology dictate.

Supplier Kanban Exchange in America

Kanban transfer between buyer and supplier is even more difficult to implement because it depends on two separate companies understanding and participating in the system. Many American supplier companies claim that they deliver JIT to their customers, but almost none of them utilize kanban exchange.⁵⁶

⁵⁴ Arnaldo Hernandez del Campo, *Just-In-Time Manufacturing: A Practical Approach* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1989), 58-9.

⁵⁵ Hall, *Zero Inventories*, 3.

⁵⁶ These suppliers frequently deliver small quantities of goods to their customers. However, the deliveries conform to a predetermined schedule and are not flexible to sudden shifts in parts requirements.

Currently, both manufacturers and their supplier companies rely on purchase orders to signal goods delivery, invoices to carry billing information, and receipts to record the movement of materials. Although companies in Japan can successfully perform kanban exchange without utilizing such paperwork, some American JIT suppliers request that buyers fill out certain documents for their records. Kawasaki has found that its Lincoln, Nebraska plant utilizes a lot more purchasing paperwork than in Japan. Some of this paperwork is helpful for accounting purposes.⁵⁷

However, these forms are actually unnecessary because kanban can replace this complex system of paperwork.⁵⁸ In Japan, workers send kanban to supplier companies in place of purchase orders. Those same kanban act as invoices when they return to the buyer's factory with a load of goods. The buyer totals the incoming kanban and pays the supplier periodically.⁵⁹ In this way kanban systems avoid unnecessary record keeping while tracking the amount of goods bought.

While most supplier relationships in the United States rely on purchase orders and invoices, there are several examples of paperless purchasing in America. Hoover Universal Seating Division, for example, is the sole supplier of truck seats to Nissan in Tennessee. Since every truck that comes off Nissan's line will have Hoover seats in it, Nissan knows exactly how many seats it has bought. Without the use of invoices, Nissan sends a check to Hoover every ten days.⁶⁰

Kanban and MRP

American manufacturers have also been reluctant to implement kanban exchange because they have already made large investments in supplier

⁵⁷ Richard J. Schonberger and James P. Gilbert, "Just-In-Time Purchasing: A Challenge for U.S. Industry," *California Management Review* (Fall 1983), 61.

⁵⁸ A. Ansari, "Survey Identifies Critical Factors in Successful Implementation of Just-In-Time Purchasing Techniques," *Industrial Engineering* Vol. 18, No. 10 (1986), 50.

⁵⁹ Schonberger and Gilbert, "Just-In-Time Purchasing," 60-1.

⁶⁰ Wantuck, *Just-In-Time For America*, 302.

management systems. In order to be able to provide suppliers with long-range schedules of parts requirements, manufacturers during the 1960s and 1970s began utilizing programs called Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP II). Still in use today, these programs create master schedules as well as materials requirements for each stage of production. MRP II links the manufacturing, finance and sales departments so that joint decisions can be made.⁶¹ Manufacturers using MRP can give vendors forecasts from six months to a year before delivery. Purchasing departments process purchase orders directly through the MRP system.⁶²

MRP software and computer systems require large investments in capital, staff, and implementation. Therefore manufacturers utilizing MRP are not enthusiastic about switching to the kanban system. They believe that not only would they have to invest in reorganizing their operations, but their MRP systems would go to waste. However, the kanban system is not incompatible with MRP. The kanban themselves do not carry any long-range information; they are merely tools in controlling production and purchasing. Manufacturers can forecast future requirements with MRP while using kanban as the actual system of ordering.

In fact, Japanese JIT manufacturers also provide periodic estimations of future production levels. For example Yanmar Diesel, which converted to Toyota's production system in 1975, prepares master schedules for its suppliers one year prior to actual production. Six months later, schedules are further refined. Three months after that a "middle schedule" is prepared, and at this point Yanmar guarantees that the volume estimation will not change more than 30%. Two months before production another estimation is distributed, which will not change more than 15%.

⁶¹ Hernandez del Campo, *Just-In-Time Manufacturing*, 67.

⁶² O. W. Wight, *MRP II: Unlocking America's Productivity Potential* (Boston: CBI Publishing Company, Inc., 1981), 227-8.

One month prior to delivery the schedule is “frozen,” and suppliers are assured that a determined amount of components will be ordered within a certain time frame.⁶³

Unlike American MRP programs, however, the actual ordering of parts only takes place with the manual exchange of kanban at the time of delivery.⁶⁴ While MRP manufacturers are bound to their long-term estimations, most Japanese companies freeze their schedule for only a month. Some Japanese manufacturers freeze their schedule for as little as two weeks. Toyota’s goal is to keep it frozen for less than a week.⁶⁵ Freezing the schedule in this way prepares suppliers for long-term changes in production, while still leaving the delivery schedule open to fluctuations in daily kanban orders.

Not only are MRP manufacturers bound to their long-term forecasts, but they run MRP purchase orders on a weekly basis. Kanban are exchanged at least once a day. MRP rarely has the precision to dictate exactly when parts are needed and frequently schedules delivery dates earlier than necessary, creating a need for larger inventories.⁶⁶ Third, MRP is dependent upon the information humans input; if forecasts of demand are the least bit incorrect, there will be shortages and/or surpluses of supplier goods. However, if American suppliers agree to partake in kanban exchange, MRP forecasts are no longer inflexible to sudden changes in demand. While companies in Japan are utilizing their own programs for materials forecasting, American JIT manufacturers can continue to use MRP to complement their new kanban systems. Author Leroy D. Peterson remarked, “Material requirements planning systems will always be needed.... There will always be a need to see future demand trends for the purpose of planning future capacity.”⁶⁷

⁶³ Abegglen and Stalk, *Kaisha*, 103-4.

⁶⁴ Wantuck, *Just-In-Time For America*, 303.

⁶⁵ Abegglen and Stalk, *Kaisha*, 110-1.

⁶⁶ Peterson, *Reinventing the Factory*, 212.

⁶⁷ *Ibid.*, 213.

Avoiding Shifts in Inventory

Critics of the JIT system suggest that inventory and cost reduction is only at the expense of suppliers. When a buyer forces suppliers to make small, frequent deliveries, the suppliers will have to start maintaining large inventories of goods. The buffer stocks involved in this transaction have merely moved from the buyer's location to the supplier's. The cost does not leave the system but reappears as a price rise of supplier goods.

This is not a problem in Japan, where suppliers not only conform to kanban ordering but also utilize JIT manufacturing techniques within their own factories. But many American suppliers of JIT facilities have experienced inventory buildup. When suppliers are producing in large lots, the only way for them to deliver goods on a JIT basis is to start holding larger inventories. While Japanese transplant manufacturers have started to work with their American suppliers in eliminating the need for these inventories, many American manufacturers believe that the JIT system consists solely of forcing suppliers to deliver more frequently. These companies do not even concentrate on reducing work-in-process within their own plants. For example, a senior purchasing executive for the Ford Motor Company said, "If we need two hundred more roof panels today, rather than keep it in inventory, we call Budd [a supplier]. Budd's got two choices: they have it in their own inventories, or they reset their dies and make them for us then and there. The supplier typically has a week's [supply], and we have a week. We're cutting back our week's worth. What we'd like to see happen is for Budd to get down to a day. It puts a lot more pressure on the suppliers. We're doing it to Budd, and we're doing it to all of them."⁶⁸

⁶⁸ Abegglen and Stalk, *Kaisha*, 115.

In response Budd's president commented, "That's not what they do in Japan at all. If we're going to move inventory out of the car plant and into the supplier plant, the cost is still there. They [Ford] are pushing the costs onto someone else. There are times when [auto manufacturers] have forced suppliers to eat costs that, with a cooperative effort, could be eliminated."⁶⁹ To ensure that inventories do not build up at supplier locations, Charles O'Neal, Professor of Marketing at the University of Evansville in Illinois, suggests that there should be a "cooperative effort among buyers and suppliers to help suppliers develop a mode of operation that is responsive to buyer needs—and at the same time one that permits a reduction of their own inventories."⁷⁰ While several Japanese companies in the United States have worked with their American suppliers in reducing inventory, very few American JIT manufacturers have initiated similar programs.

Kanban Systems in America

Although the kanban system has recently become a popular concept in America and is compatible with traditional systems, kanban exchange between companies is not yet feasible because so few manufacturers, especially supplier companies, have fully operating in-house kanban systems. Although many suppliers have been delivering frequently and reliably, the daily schedule is less flexible without kanban. Robert Frinier, Nissan's Purchasing Director, described the difference between purchasing in Japan and America: "At the Japanese plants, when the basket is empty, the plant goes back to the supplier and says I now need another shipment of such and such part. In our case, we anticipate when the basket will be empty and tell the vendor to make a delivery then."⁷¹ Kawasaki's Lincoln,

⁶⁹ Ibid., 116.

⁷⁰ Charles R. O'Neal, "The Buyer-Seller Linkage in a Just-In-Time Environment," *Journal of Purchasing and Materials Management* Vol. 23, No. 1 (1987), 11.

⁷¹ Ed Gregory, "Part in Time Saves Nissan Money," *The Tennessean* 16 Oct. 1983, 1-G.

Nebraska plant has to send out a schedule of specific delivery dates at the beginning of each production season. But some suppliers have agreed to allow Kawasaki a daily variation in delivery quantity. For example, if Kawasaki produces fewer motorcycles than scheduled, the next day a Kawasaki buyer will call suppliers and request a decrease in the amount of products to be delivered.⁷² In this case schedule changes are only delayed one day.

There are several examples of Japanese manufacturers in the United States utilizing kanban exchange with American-based suppliers, both Japanese and American. Many of Nissan's suppliers utilize kanban exchange in making deliveries. Some JIT manufacturers in America have developed systems of achieving kanban results without actually using kanban. For example Plasti-Line, Inc., a custom sign builder in Knoxville, Tennessee, decided to have a single supplier deliver all of its hardware every day as needed. Management placed several floor stock racks in strategic locations in the factory. Every day a supplier representative restocked each rack with the items that had been used the previous day. He made a list of all the things he replaced, and submitted that list to the material control office every day. This process eliminated ordering, receiving, stockroom maintenance, and material handling. Not only did Plasti-Line receive frequent shipments of exactly what it was consuming, but the factory never ran out of stock due to forgetting to place an order.⁷³

Manufacturers can even adapt the kanban system to run through existing computer networks. Instead of sending a physical card to supplier locations, workers send an "electronic kanban" signal through computers as a purchase order. This not only saves time in transport, but allows the company to utilize its own equipment. Changes occur only within the computer program and in supplier

⁷² Schonberger and Gilbert, "Just-In-Time Purchasing," 61.

⁷³ Wantuck, *Just-In-Time for America*, 305.

agreements. For example a supplier of seat covers to GM's Inland Division seat assembly plant orders fabric by an electric kanban system. When a line worker takes a roll of fabric from storage, he reads a bar code label on the roll with a computer wand. The seat-cover factory submits this information to the fabric manufacturer daily, who then sends out the same number of new rolls. A worker at the fabric company reads the outbound rolls by barcode and returns this information to the buyer for processing.⁷⁴

The kanban system, although drastically different from traditional production controls, can be implemented in America. With sufficient worker training and company-wide understanding, kanban can replace master scheduling and the maintenance of buffer stocks. Because kanban exchange between suppliers is compatible with existing methods of ordering, there are no technical difficulties in installing the program. However, the concept is relatively new in this country. Although many suppliers have been delivering on a JIT basis, few have been ready to participate in kanban exchange. Once the JIT system is better established in America, buyer-supplier kanban arrangements will be much easier to agree upon.

3. Small Lot Production in the United States

Not only is it possible for American companies to implement Japanese JIT systems, but it is profitable to do so. Setup time reduction under Shingo's three-step procedure not only requires minimal investment, but it produces better results than investment in new machinery. The kanban system also does not replace current systems, and it reduces the amount of necessary paperwork and scheduling. Although some suggest that there is no net loss in inventory when utilizing supplier kanban exchange, manufacturers who work together with suppliers in

⁷⁴ Peterson, *Reinventing the Factory*, 262-3.

eliminating inventories from the entire system benefit from great reductions in buffer stocks of supplier goods.

Japanese JIT systems make small-lot production possible in America. Solutions are currently available for the two major obstacles to successful implementation: American traditions of lengthy setup times and schedule-based organization. Once a company realizes that it is possible to reduce its setup times, workers and managers can work together to create a better procedure for changing over machines. The kanban system can also be successful in American factories with the help of effective employee training programs. Kanban can replace paperwork ordering systems and work alongside existing MRP systems.

Part II

Supplier Relationships

Operating under JIT systems demands a new type of relationship between a manufacturer and its suppliers. Whether or not a buyer uses a kanban system to order shipments, suppliers must deliver components *just in time* to be processed. If a supplier does not ship small loads of components to its customer several times a day, manufacturers will need to maintain inventories of supplier goods. These are just as wasteful as inventories within the plant. In other words, suppliers act as geographically distant subprocesses of the factory.

There are several problems in transplanting the total JIT system to the United States. Buyers must develop long-term, open relationships with suppliers and provide them with incentives to participate in the JIT system. America's vast distances increase shipping costs per delivery and threaten punctuality. JIT manufacturers in the United States are trying to overcome these problems by utilizing Japanese methods of maintaining close relationships.

1: Long-term Relationships

A JIT system requires that supplier companies take on much more responsibility than is the case in traditional American relationships. Since the manufacturer holds barely any inventory, one late delivery or defect shuts down the entire plant. An ideal supplier is reliable in providing defect-free goods in exact quantities and at specified times. Supplier representatives respond immediately to problems, and the entire company strives for continuous improvement. Suppliers honestly report all events that may interfere with performance, because delays in

supply will directly affect the customer's production. And, most importantly, the supplier is flexible in responding to customer demand.⁷⁵

In return, JIT manufacturers make long-term commitments to suppliers rather than negotiate contracts on a yearly basis; encourage a mutual exchange of information and assistance; and allow suppliers to perform a larger percentage of product engineering. In doing so, the customer develops longer-term, closer relationships with its suppliers. This is one of the fundamental differences in supplier relationships between Japan and America.⁷⁶ Charles R. O'Neal explains that because an outside organization supplies the JIT system, "The buyer-seller linkage must be extremely tight, both behaviorally and logistically, for the system to function properly."⁷⁷ By encouraging mutual trust and exhibiting concern for the supplier company, Japanese manufacturers rely on suppliers for increased service and dependability.

Traditional Supplier Relationships in Japan

Historically, Japanese companies have relied more on supplier goods than have American companies. In the mid 1950s, when Toyota was developing the first JIT system, the Japanese automobile industry faced rapidly increasing demand. Initiating new supplier relationships did not require the investment and risk involved in producing more in-house components or founding subsidiaries. Major automakers believed that through their specialization and lower wage scales, small firms would be able to produce high-quality components at costs comparable to or lower than their own.⁷⁸

⁷⁵ Wantuck, *Just-In-Time For America*, 301-6.

⁷⁶ Michael A. Cusumano and Akira Takeishi, *Supplier Management and Performance at Japanese, Japanese-Transplant, and U.S. Auto Plants*, working paper, M.I.T. Sloan School of Management, 1990, 4.

⁷⁷ Charles R. O'Neal, "The Buyer-Seller Linkage in a Just-In-Time Environment," *Journal of Purchasing and Materials Management*, Vol. 23, No. 1 (1987), 8.

⁷⁸ Cusumano, *The Japanese Automobile Industry*, 241-2.

Japanese automakers have continued to manufacture less parts involved in creating an automobile than have their American competitors. For example, during the spring of 1990 General Motors maintained 13 internal component divisions that produced a wide variety of parts. Ford had seven such divisions. Meanwhile Japanese automakers purchased nearly everything from outside sources, with the exception of a few critical components such as engines, transmissions, axles, and large stamped parts. Likewise, in-house production ratios were higher for American auto manufacturers than for those in Japan. Between January and March 1990, Michael A. Cusumano and Akira Takeishi of the MIT Sloan School of Management conducted a survey of auto manufacturers in Japan and the United States. They found that in-house production ratios were significantly higher for GM (43% to 70%) and Ford (36% to 50%) than for those of Japanese companies (26% to 30%).⁷⁹

Although Japanese companies depended more on supplier goods, they typically had fewer parts suppliers than American manufacturers. Traditionally, American suppliers bid against one another for each contract, and manufacturers often split purchases between two or three suppliers. This practice of "dual sourcing" provided the buyer with leverage in cost, delivery performance, and quality.⁸⁰ Japanese manufacturers not only used a single supplier for each part, but often for whole families of parts.⁸¹ Ansari and Modarress claimed that without a drastic reduction in the number of suppliers, "JIT purchasing becomes unmanageable and strong long-term relationships with suppliers cannot exist." With fewer suppliers, Japanese manufacturers could work closely with each supplier to improve quality; there were fewer communication problems; organization required less paperwork; and the suppliers could concentrate on cost-

⁷⁹ Cusumano and Takeishi, *Supplier Management and Performance*, 4.

⁸⁰ Dean Bartholomew, "The Vendor-Customer Relationship Today," *Production and Inventory Management* (Second Quarter 1984), 108.

⁸¹ Wantuck, *Just-In-Time For America*, 300.

cutting ideas.⁸² Because Nissan relied on a single company for 98% of its horns, that vendor was free to engage in long-term research and to invest in equipment. In return, Nissan benefited from productivity gains and cost savings.⁸³ The Cusumano/Takeishi survey demonstrated the extent of this difference in supplier base size. In Japan, 170 to 320 companies supplied semi-finished materials to Toyota, Nissan, and Mazda, while GM alone held contracts with more than 5,500 supply firms (as of 1988).⁸⁴

Because Japanese manufacturers relied heavily on a small number of supplier firms, relationships were more stable than in America, with contracts extending over several years. Japanese automakers maintained contracts with a select group of suppliers for particular components until they altered those parts through a full model change (every four years) or a minor model change (every two years).⁸⁵ By contrast, American manufacturers treated each procurement as a separate transaction. Many American companies considered a year-long contract to be long-term. Multi-year buys were only common in the aerospace and defense industries.⁸⁶ According to the Cusumano/Takeishi survey, while 82% of contracts with American auto manufacturers lasted for one year, contracts in Japan ranged from six months to eight years, with 62% of those for four years (the typical model life cycle).⁸⁷

⁸² A. Ansari and B. Modarress, *Just in Time Purchasing* (New York: The Free Press, 1990), 53.

⁸³ Bartholomew, "The Vendor-Customer Relationship Today," 109.

⁸⁴ Cusumano and Takeishi, *Supplier Management and Performance*, 4.

⁸⁵ *Ibid.*, 5.

⁸⁶ Wantuck, *Just-In-Time For America*, 300.

⁸⁷ Cusumano and Takeishi, *Supplier Management and Performance*, 21-2.

How Japanese Companies Encourage Supplier Reliability

The Japanese are known for maintaining long-term relationships with their suppliers. But in actuality, the length of buyer-supplier relationships is no longer than those by American companies. The Cusumano/Takeishi survey reported that while all Japanese companies in Japan continue purchasing parts from their major suppliers for more than ten years, 82% of U.S. automakers do the same. The remaining 18% of American companies maintain relations with suppliers for five to ten years. None reported relationships ending after the one-year contract expires.⁸⁸

Although most American supplier companies are involved in relationships with manufacturers for more than ten years, they must participate in an annual competitive bidding process in order to sustain those relationships. Japanese manufacturers treat their suppliers in a different fashion. Although there is no formal guarantee of contract extension between buyer and supplier, the Japanese companies usually have an implicit agreement to continue the relationship.⁸⁹ This understanding contributes to the foundation of a more stable, trusting relationship between factory and supplier. Aware that the buyer will provide continuing business and support, the supplier is more willing to invest in the improvement of its services.⁹⁰

A second stabilizer in factory-supplier relationships in Japan is a mutual exchange of information, ideas, suggestions, and technology. Japanese companies tend to offer suggestions to supplier companies concerning ways to improve designs, materials, and manufacturing methods. Japanese companies also assist suppliers by participating in product development, grading suppliers on

⁸⁸ *Ibid.*, 23.

⁸⁹ *Ibid.*, 5.

⁹⁰ O'Neal, "The Buyer-Seller Linkage," 13.

performance, and sending resident engineers to supplier locations.⁹¹ Open relationships enable Japanese manufacturers to negotiate semi-annual reductions in the price of components. American contracts agree on a constant price and in some cases American automakers allow suppliers to pass on cost increases. Japanese automakers set a target price for each part based on the sales price of the car, then encourage suppliers to reach their targets. Buyers and suppliers work together to find ways of reducing costs. These agreements are based on the assumption that through experience and continual effort, suppliers should be able to reduce their costs.⁹² In this way manufacturers are helping suppliers to improve their cost efficiency.

By aiding and encouraging the development of suppliers, a manufacturer not only guarantees high quality in the design and manufacture of parts, but also ensures a continuing relationship with a company actively seeking improvement and technological advance in its field. In return, the supplier is ready to adjust to the buyer's schedule and standards, especially if the supplier is receiving help in meeting these demands.

The Japanese approach to product development also contributes to the level of trust and intimacy in supplier relationships. Japanese manufacturers utilize "black-box" parts, which are designed and engineered by the supplier according to the buyer's functional specifications. American suppliers traditionally produce standard parts for all their customers, or manufacture parts to the buyer's exact specifications.⁹³ Not only does the Japanese method lessen the total engineering hours required to develop a product, but dependence on the supplier's engineering staff aids in the technological development of supplier companies. A Harvard

⁹¹ Cusumano and Takeishi, *Supplier Management and Performance*, 10.

⁹² *Ibid.*, 7-8.

⁹³ *Ibid.*, 6-7.

Business School research project found that black-box parts (for which suppliers performed approximately half of the product engineering) accounted for 62% of all components among a sample of projects at Japanese automakers. By contrast, American automakers engineered 81% of the components they use.⁹⁴

Japanese manufacturing companies depend heavily on a small number of supplier firms to deliver quality goods on a strict schedule. In gaining the trust and cooperation of these suppliers, manufacturers offer long-term contracts and imply an indefinite continuation of the business relationship. Japanese companies offer technical aid, assist in product development, and encourage factory improvement in strengthening the relationship and helping the supplier to become a better manufacturer. The resulting mutual trust and openness of Japanese supplier relationships are necessary for the JIT system.

Adopting Traits of Japanese Supplier Relationships

Requirements for the successful implementation of JIT purchasing and delivery are no different in America. One way of ensuring prompt delivery of parts and supplier dedication to quality and technological improvement is to conduct honest and open communications. Traditional American supplier relationships are characterized by short-term agreements, transfer of neither information nor technology, minimal communication, and a lack of mutual trust. Under such circumstances, manufacturers cannot depend on suppliers to deliver precisely coordinated shipments or to make mutually beneficial investments. A closer relationship is also necessary for undergoing the changeover from traditional to JIT delivery, which requires a significant increase in supplier responsibility.

⁹⁴ Ibid., 6.

Some believe that JIT can never be fully implemented in the United States because of these "arm's-length" supplier relationships. However, both Japanese and American manufacturers in the United States are changing the basis of supplier relationships by contracting fewer companies, initiating long-term relationships, increasing the level of communication, and relying more on supplier companies' engineering capabilities.

Reliance on Select Supplier Companies

Reducing the number of contracted supplier companies is the first prerequisite to developing long-term, closer relationships. Transition to JIT delivery requires a high degree of buyer-supplier communication and assistance, as discussed later. It is impossible for a manufacturer to expend this effort on individual relationships when contracting more than one supplier per part.

American companies have recently found it profitable to purchase a greater amount of parts from outside sources. Because supplier companies specialize in their own area of expertise, they tend to have the most current technology and in many cases produce superior products. Furthermore, supplier labor costs are lower than those of larger manufacturers, who are locked into high-wage structures.⁹⁵ By outsourcing more, manufacturers have obtained high-quality components at low prices. In 1985, 45% of U.S. automobile parts were produced by outside suppliers. According to the University of Michigan's Office for the Study of Automobile Transportation, that number will reach 58% in the 1990s.⁹⁶ More than half of the respondents to a 1987 poll taken by *Purchasing* magazine replied that compared to five years previous they were more apt to buy a production item rather than make

⁹⁵ Thomas F. Lyons, A. Richard Krachenberg, and John W. Henke, Jr., "Mixed Motive Marriages: What's Next for Buyer-Supplier Relations?" *Sloan Management Review*, Vol. 31, No. 3 (1990), 31.

⁹⁶ *Ibid.*, 30.

it. Fifty-eight percent of these purchasing managers cited high labor and material costs as the reason for this increase in outsourcing.⁹⁷ Although American companies are not making these changes in order to facilitate new JIT programs, the fact remains that manufacturers are becoming more dependent on outside sources. This increased dependence on supplier performance is paving the way for the implementation of JIT purchasing.

There are also cases in which American manufacturers have realized the benefits of Japanese purchasing practices and are acting to implement them. The first step they have taken towards JIT supplier management involves an aggressive reduction in the total number of suppliers. The American Big Three have cut their supplier base in half, and many firms are planning to reduce their total number of suppliers by at least two-thirds within the next three years.⁹⁸ Between 1980 and 1985, Xerox reduced its number of production suppliers from 5,000 to 300.⁹⁹ Some American manufacturers have started using single-sourcing policies. All American manufacturers implementing JIT have been drastically reducing their number of suppliers per part, at least to the level of three or less.¹⁰⁰ Respondents to the University of Evansville study claimed to have traditionally selected two or more suppliers for major purchases. After the implementation of a JIT system, these automakers started using fewer sources, and more than half of the respondents reported having a single-source policy. Three-quarters of the respondents expected to have a single-source policy within the following five years.¹⁰¹

⁹⁷ "The Numbers Tell the Story: PMs Are Outsourcing More," *Purchasing*, 21 May 1987, 16.

⁹⁸ Lyons, Krachenberg, and Henke, "Mixed Motive Marriages," 30.

⁹⁹ Brian H. Maskell, *Just In Time: Implementing the New Strategy* (Carol Stream, IL: Hitchcock Publishing Co., 1989), 104.

¹⁰⁰ Ansari and Modarress, *Just In Time Purchasing*, 52-3.

¹⁰¹ O'Neal, "The Buyer-Seller Linkage," 9. GM, for example, was in the process of increasing its dependency on suppliers for single-source production. David Barkholz, "Suppliers Fear GM Scrutiny," *Crain's Detroit Business*, 28 Sept. - 4 Oct. 1987, 33.

When starting up operations in America, Japanese manufacturers have initiated negotiations with only a small number of supplier companies. Not only is single sourcing a vital aspect of JIT, but Japanese companies also find it important when dealing with American suppliers for the first time. Because JIT delivery is practically unknown in America, purchasing agents spend a lot of time working with each supplier in JIT negotiations and education. Because these manufacturers keep the number of supplier companies to a minimum, both parties have time to work on improving quality and cutting costs.¹⁰² Single sourcing also provides Japanese companies with goods at a consistent level of quality and eases coordination efforts.¹⁰³ Therefore, Japanese companies have continued to implement single sourcing policies when manufacturing in America. Japanese transplant companies such as Nissan use single vendors for each product they purchase. Hoover Universal Seating Division, for example, is Nissan's sole supplier of truck seats.¹⁰⁴ Honda deals with only three steel manufacturers, differing significantly from the practices of American automakers. In order to control the quality of steel throughout its automobiles, Honda does not allow suppliers to buy steel from companies other than those three. After receiving bulk orders, the steel manufacturers make deliveries to supplier facilities according to Honda's specifications. Toyota has a similar policy for steel.¹⁰⁵

Not only does reducing the number of companies supplying each part allow manufacturers to devote more time to developing positive relationships, but it cuts down on the communication, organization, and storage costs of parts delivery. Buyers are also better able to control quality and reliability of delivery.¹⁰⁶

¹⁰² Ansari and Modarress, *Just In Time Purchasing*, 52-3.

¹⁰³ Lyons, Krachenberg, and Henke, "Mixed Motive Marriages," 31.

¹⁰⁴ Gregory, "Part in Time Saves Nissan Money," 1-G; Wantuck, *Just-In-Time For America*, 302.

¹⁰⁵ Jean Fogarty (Inland Steel Company), telephone interview, 25 Feb. 1991.

¹⁰⁶ Gelsanliter, *Jump Start*, 222.

Furthermore, giving a supplier the status of "sole supplier" communicates the level of confidence the manufacturer holds for the supplier's performance and contributes to the level of mutual trust.

Initiating Long-Term Relationships

Supplying a JIT manufacturer requires a great deal of capital investment, factory reorganization, and effort. In order to gain the cooperation of American supplier companies, JIT manufacturers must commit themselves to continuing business relations into the foreseeable future. When there is no such guarantee, suppliers have little incentive to invest in changing their operations. For example, in an effort to develop closer supplier relationships and improve the quality of goods, General Motors implemented the "Targets for Excellence" program in September 1987. Supplier assessment teams consisting of three GM experts spent two days at each supplier company inspecting every aspect of the company's management, quality, cost, delivery, and technology. GM then worked with the supplier in implementing the team's recommendations and followed up the assessment with additional assistance. However, supplier companies were forced into making costly investments for fear of losing GM's business without any guarantee of future GM contracts. David Barkholz, in a 1987 *Crain's Detroit Business* article, reported that because of this program many GM suppliers would "decide to sell or close their businesses rather than try to borrow from banks in such an uncertain automotive environment."¹⁰⁷ While understanding the need for a more open relationship between buyer and supplier, GM at the same time neglected an important aspect of effective supplier relationships: the buyer must provide

¹⁰⁷ Barkholz, "Suppliers Fear GM Scrutiny," 1, 33.

stability and a guarantee of future business in return for long-term supplier investment.

Although Japanese manufacturers in the United States frequently offer yearly contracts, they continue to promote long-term relationships with their American suppliers. The Cusumano/Takeishi survey reported that half of the transplant companies utilize year-long contracts, indicating that the buyer is following traditional American contract terms. The other 50% offer contracts lasting for four years, the typical Japanese model cycle.¹⁰⁸ However, in most circumstances Japanese manufacturers make it clear to suppliers that they intend to maintain the relationship for an indefinite period. As Nissan director Robert Frinier said, "When Nissan selects a vendor, that company can plan on being in business as long as Nissan is making trucks. What we have is total, open communication with our vendors. Once a vendor is selected, he has a decided advantage over any outsider, and we like it that way. We want to develop long-term relationships with our vendors."¹⁰⁹ Japanese transplants also assure their suppliers that they will continue buying even in bad circumstances. Bill Taylor, President of Capitol Plastics, is confident that if Honda's business begins to drop, less-important suppliers would lose contracts first. He noted, "It's a matter of Honda looking out for the vendors that depend on Honda's business versus another that does only a small amount of business with [Honda]. Honda is interested in building long-term relationships with those vendors that are committed, dedicated, and loyal. Like a partner, Honda's purchasing people work closely with us in developing our long-term projections. Consequently, we have a fairly good idea of what is expected of us at least two years in advance."¹¹⁰ Japanese transplants are also careful to negotiate

¹⁰⁸ Cusumano and Takeishi, *Supplier Management and Performance*, 22

¹⁰⁹ Gregory, "Part in Time Saves Nissan Money," 1-G.

¹¹⁰ Robert L. Shook, *Honda: An American Success Story* (New York: Prentice Hall Press, 1988), 179-80.

contracts that will allow their JIT suppliers to maintain substantial profits in the long run. One Honda purchasing manager said, "We don't want to enter a relationship with people by squeezing them so tight that they're forced out of business. We recognize that suppliers have a substantial investment in their capital equipment, and it's necessary for them to get a good return or they'll go belly up. We're interested in establishing long-term relationships with our vendors."¹¹¹ Japanese transplant companies have successfully communicated their long-term intentions to their valued suppliers.

Recently American companies have started encouraging longer-term supplier commitments in an effort to develop Japanese-style JIT relationships. Buyers are now offering multiyear contracts that last throughout the life of a particular model.¹¹² Buick, for example, offers its JIT suppliers 18- to 36-month flexible contracts, with an option to renegotiate every six to 12 months.¹¹³

Contract negotiation processes are also changing from adversarial bargaining to mutual-benefit bargaining.¹¹⁴ Donald Pais, vice president of GM's materials management staff in Detroit, stated in 1987 that GM was changing its relationship with suppliers and starting to build on common goals and objectives.¹¹⁵ This is important in ensuring the survival of both partners. Suppliers can look at long-term needs of their factories and make investments once they have a guarantee of stable business. The resulting improvement in quality is beneficial to both parties.

¹¹¹ *Ibid.*, 174.

¹¹² Lyons, Krachenberg, and Henke, "Mixed Motive Marriages," 30.

¹¹³ Ansari and Modarress, *Just In Time Purchasing*, 53-4.

¹¹⁴ Lyons, Krachenberg, and Henke, "Mixed Motive Marriages," 30.

¹¹⁵ Barkholz, "Suppliers Fear GM Scrutiny," 33.

Information Exchange

JIT production depends on the open exchange of information between manufacturer and supplier. In America, however, supplier relationships are characterized by secrecy and distrust. This can interfere with the efforts of JIT manufacturers. For example, suppliers were reluctant to disclose information to supplier assessment teams for GM's "Targets for Excellence" program. Previously, GM had taken advantage of suppliers who voluntarily shared cost-saving innovations. Purchasing representatives immediately demanded significant price cuts, and sometimes shared the new information with competing suppliers. Consultant Calvin Shannon noted, "There's a lingering distrust [among suppliers] of engineers and purchasing agents."¹¹⁶

However, American manufacturers are beginning to encourage open relationships and the exchange of information.¹¹⁷ Results of the University of Evansville study indicate that this is happening in automotive-industry firms implementing JIT. Respondents reported that the frequency of supplier interaction had increased since the implementation of JIT. The divisions involved include purchasing, materials management, quality assurance, production, and design engineering.¹¹⁸ This study also found that 35% of the respondents were working more "closely" with their suppliers than before, and the remaining 65% were working "much more closely" in the areas of product design, technical assistance, quality of product provided, product standardization, value analysis, and supply agreement length.¹¹⁹

Japanese transplants have offered both technology and assistance to their American supplier companies. A high percentage of transplant respondents to the

¹¹⁶ Ibid.

¹¹⁷ Lyons, Krachenberg, and Henke, "Mixed Motive Marriages," 30.

¹¹⁸ O'Neal, "The Buyer-Seller Linkage," 10.

¹¹⁹ Ibid.

Cusumano/Takeishi survey reported having made suggestions in quality control, production processes, cost reduction, design, materials, equipment, and inventory control.¹²⁰ Japanese companies in America have initiated information exchange at the bidding stage. Traditional American corporate purchasing agents simply choose the lowest of at least three quotes. But Japanese transplants such as Honda require bidders to submit detailed breakdowns of each quotation, including prices of raw materials, fabrication, packaging, and transportation. From this information, Honda identifies problems and suggests improvements. Companies resistant to making changes do not get the bid.¹²¹

Because quality is extremely important to the JIT system, Japanese transplants frequently inspect supplier facilities and assist them in improving quality. Nissan engineers inspect local suppliers' plants regularly and work closely with them in identifying and solving problems through improvement of design and process engineering.¹²² Japanese companies understand that by improving technologically, supplier companies can deliver superior products of higher quality. Therefore, Japanese transplants have often worked with American suppliers in upgrading their equipment and processes. For example, Honda has shown the Inland Steel Company a method of removing imperfections in its steel. At first Inland Steel was unable to meet Honda's technical and quality requirements, but Honda made the commitment to work with that company as a partner to solve these problems.¹²³ Inland Steel can now use Honda technology in products it sells to other companies as well. Inland's Jean Fogarty emphasized the importance of Honda's increasingly high standards. In keeping up with Honda's quality requirements, Inland Steel stays

¹²⁰ Cusumano and Takeishi, *Supplier Management and Performance*, 34

¹²¹ Shook, *Honda*, 174.

¹²² Ansari and Modarress, *Just In Time Purchasing*, 67.

¹²³ Shook, *Honda*, 176.

ahead of its competitors. When American companies start demanding higher standards, Inland Steel will already possess the capability to meet them.¹²⁴

Japanese manufacturers are concerned with the well-being and long-term survival of their new American supplier companies. They have encouraged partnerships between their suppliers in Japan and new American supplier companies. These partnerships have often resulted in the mutual exchange of technology. Inland Steel recently formed a partnership with Nippon Steel, which supplies 90% of Honda's steel in Japan. Inland Steel has since traded with and bought technology from this new partner.¹²⁵ Japanese transplant manufacturers often make limited purchases from local, small-scale American companies. As these suppliers prove their loyalty and determination, orders increase. Sometimes Japanese companies rely on them to the point of doubling the supplier's level of output. Japanese manufacturers have helped these suppliers cope with organizational problems associated with plant expansions. Capitol Plastics, for example, underwent rapid growth when Honda started increasing its orders. Honda teams worked side by side with Capitol employees to implement changes and help in the expansion of production capabilities.¹²⁶

In order to develop open relationships with American suppliers, JIT manufacturers must initiate the exchange by offering both information and assistance. They cannot simply demand the disclosure of private information. However, once information starts to flow freely in both directions, the two companies can begin to collaborate on cost-saving ideas.

¹²⁴ Jean Fogarty, telephone interview, 25 Feb. 1991.

¹²⁵ Ibid.

¹²⁶ Shook, *Honda*, 179.

Level of Communication

Although an American company may follow the "rules" of conducting JIT supplier management, developing a genuinely close relationship depends on more than just making demands and offering aid. Increasing the level of communication is one method of involving suppliers to a higher degree: frequent delivery requires frequent contact. William Taylor, owner of Capitol Plastics, a supplier to both Chrysler and Honda, says that he rarely hears from Chrysler more than once a year to sign the contract. But there are few days in which no contact is made with Honda. One of his employees will go to Honda, the manufacturer's employee will show up at Capitol's plant, or Bill will receive a phone call himself.¹²⁷ It is also important for the buyer to provide feedback on supplier performance. Many Japanese manufacturers have grading systems and send monthly "report cards" to suppliers. Honda, for example, sends quality grade cards to its American vendors. Low scores can result in reduction or elimination of future orders.¹²⁸ Nissan has a similar system of grading suppliers based on percent defect rates. In response to a survey question regarding Nissan's method of supplier feedback, Schrader Automotive Inc. enthusiastically reported that it had received a 100% defect-free score from Nissan for the past five years, along with 100% service-level awards. Providing performance scores and awards acts as a reward to reliable suppliers.

Meetings and conventions help to develop a sense of being part of the manufacturer's family, along with other new American suppliers. NUMMI holds conventions where suppliers meet to discuss common problems.¹²⁹ The Toyota Supplier Association holds conferences on industrial engineering and quality control, as well as executive conferences to discuss new models.¹³⁰ Every spring

¹²⁷ Gelsanliter, *Jump Start*, 219.

¹²⁸ Shook, *Honda*, 175

¹²⁹ Japan Management Association, *Kanban*, 183.

¹³⁰ Hall, *Zero Inventories*, 206-7.

Honda holds a Vendors Appreciation Day at its Marysville, Ohio plant. More than 200 suppliers and guests attend, and the company presents awards to companies excelling in quality, delivery, and cost improvement.¹³¹ Regular communications and annual events both serve to make buyers and suppliers working partners rather than separate organizations held together by contract.

Outsourced Engineering

Because American manufacturers often perform the engineering of supplier parts, many supplier companies have not developed engineering capabilities. Therefore, some manufacturers are reluctant to implement the Japanese practice of black-box purchasing in the United States. American companies are also questioning whether or not this practice is necessary. Black-box sourcing may be merely a cultural tradition that has no unique impact on the JIT system.

While some Japanese transplant companies are following American traditions in product development, others have started to rely more on the engineering capabilities of their suppliers. Although Honda has a strong engineering department of its own, Nissan employs only a few staff engineers. Nissan prefers to build upon its suppliers' expertise.¹³² Nissan director Robert Frinier indicated, "With us, the vendor is very much involved in the detailed design of parts. In order for both Nissan and the vendor to remain in business, we both need to make a profit."¹³³ While Nissan is avoiding investment in an engineering department, its suppliers have the opportunity to develop their own expert staff and make a profit from their engineering work.

¹³¹ Shook, *Honda*, 177.

¹³² Gelsanliter, *Jump Start*, 217.

¹³³ Gregory, "Part in Time Saves Nissan Money," 1-G.

American manufacturers are also allowing supplier companies to do more of their own parts engineering. Lyons, Krachenberg and Henke claim that in many cases suppliers assume greater responsibility for their products than in the past. Some of the services involved are design, prototype development, and engineering. Although American manufacturers have started to buy goods on a black-box basis, "gray-box" sourcing is an alternative for suppliers who have not yet developed extensive engineering capabilities. In this case, the buyer has an idea of what the appearance and internal functions of the item will be. This differs from black-box sourcing, in which the buyer only specifies the part's overall function.

Lyons, Krachenberg and Henke claim that this increase in outsourcing of professional services results in a shift of labor, administration, scheduling, and coordination costs to suppliers.¹³⁴ It is also beneficial to suppliers because it contributes to their overall development. Moreover, black-box purchasing lessens the costs of the entire system. Bob Drake, Nissan of America's purchasing vice-president, has indicated that once Nissan finds a supplier with compatible goals and sufficient capability, purchasing agents trust that supplier in designing parts to fit Nissan's specifications. He explains:

If I give you the design and say 'Build me this motor,' my design might not be suited to your process. To meet my design requirements, you might have to retool, which increases my costs immediately.

But if I say to you, I want you to design a windshield wiper motor that will fit into this space, and by the way, I want the wiper blade to be hidden when it's off and I want it to execute four million cycles--and one other thing, it needs to have holes in these exact locations so it will attach to the fire wall properly--when I do that, I've given you the black box with some pretty strict parameters. But I've left the design up to you--to be adapted to your process. You're the expert when it comes to making your process run efficiently.¹³⁵

¹³⁴ Lyons, Krachenberg, and Henke, "Mixed Motive Marriages," 30.

¹³⁵ Gelsanliter, *Jump Start*, 217.

In this way manufacturers allow their suppliers to develop products that will be most compatible with their existing equipment. Forcing a supplier to manufacture a product that may be incompatible with their systems will only waste money in factory investment in the long run.

The Importance of Supplier Cooperation

When implementing JIT, manufacturers in the United States have found it beneficial to adopt some of the aspects of Japanese supplier relationships. Reducing the amount of suppliers contracted to provide each part, initiating relationships on a long-term basis, increasing the level of communication, and relying on suppliers for the development of their own products helps to create more stable, open relationships.

There are a few cases in which closer supplier relationships allow JIT manufacturers to receive frequent, punctual deliveries. Hoover Universal Seating Division delivers truck seats daily to Nissan's facility, which maintains no safety stock of seats at any time. Kawasaki's Lincoln, Nebraska plant receives 20% of its parts from American companies, either daily or twice weekly. Kawasaki keeps an inventory of only two to four days. Approximately 85 of General Motor's Buick Division's 600 suppliers deliver parts on a daily basis under JIT arrangements.¹³⁶

However, in many cases JIT manufacturers cannot locate American suppliers who are willing to supply in this manner. Their factories must therefore maintain large inventories of supplier goods. So that supplier inflexibility does not disrupt the factory's JIT system, several Japanese manufacturers in America have created warehousing facilities to receive, store, prepare, and deliver goods to the factory as needed. Midwest Express, Inc., a subsidiary of Honda Express, is a warehousing

¹³⁶ Ansari and Modarress, *Just In Time Purchasing*, 79.

facility near Honda's plant in Ohio. American suppliers ship parts to Midwest Express, which then stores, repackages, and arranges them for delivery according to Honda's JIT schedule. The size of this investment, however, clarifies the potential for cost savings under JIT-style relationships; if American supplier companies would perform to JIT standards, the entire warehousing facility would be unnecessary. Midwest Express is a \$30 million investment consisting of five 200,000-square-foot warehouses. It employs between 100 and 400 workers.¹³⁷

¹³⁷ "Zane Township's Midwest Express," *Bellefontaine Examiner* 13 Sept. 1988, 16.

2. The Problem of Distance

Whether or not a manufacturer maintains open, long-term relationships with its supplier, high freight costs of frequent delivery will outweigh the benefits of JIT shipments if the manufacturing facilities are geographically distant from one another. Furthermore, the honesty of the two companies will have no effect on delivery delays due to transportation difficulties. Because supplier companies are located all across the country, some critics believe that JIT delivery is impossible in the United States.

Industrial Communities in Japan

Many manufacturing operations in Japan are surrounded geographically by their major supplier companies. In Toyota City, several of Toyota's manufacturing facilities, as well as those of its suppliers, are located within walking distance of each other. On the whole, 90% of Toyota's suppliers are within a four- to five-hour driving distance. Ninety percent of Hino Motors's suppliers are located within a 100 kilometer radius, and 90% of Hitachi's Sawa Works's suppliers are within 50 kilometers.¹³⁸ The cost for these firms of delivering frequently is small when compared to the expense involved in transporting goods cross-country in America. When suppliers' production facilities are located nearby, there are few delays in delivery due to transportation problems, and communication is less difficult.

The Origin of Supplies

Both Japanese and American companies in the United States receive goods from suppliers located all across the country. Although the bulk of supplier goods is domestic, manufacturers still import a substantial percentage of parts from abroad.

¹³⁸ Hall, *Zero Inventories*, 210-1.

Japanese automakers in the United States import approximately 12% of their parts from Japan.¹³⁹ American-made Toyota Camries, Honda Accords, and Honda Civics consist of more than 25% foreign parts.¹⁴⁰ For these imported parts, JIT delivery is almost impossible, and factories must store large amounts of components between shipments.

Increasing Local Content

Since the start of their operations in America, Japanese manufacturers have been trying to increase the local content of their products. Not only can local suppliers deliver more frequently, but Japanese automakers are interested in gaining the support and good will of local communities. Toyota, for example, holds contracts with 51 suppliers based in Kentucky.¹⁴¹ For marketing purposes, an "American-made" car is especially popular. Honda has significantly reduced the percentage of imported parts since its arrival in Ohio. The number of American-based parts suppliers has risen from 27 to 194, including American companies, Japanese companies based in America, and joint ventures.¹⁴² Several of Honda's advertisements emphasize the Marysville plant's use of both American components and heavy equipment.¹⁴³ Honda is now the only automaker in the United States that buys all of its steel from American companies.¹⁴⁴ Nissan's Robert Frinier stated that Nissan Motor Manufacturing Corporation U.S.A. has a general agreement with its parent company to increase the number of American-made parts as soon as

¹³⁹ Cusumano and Takeishi, *Supplier Management and Performance*, 19.

¹⁴⁰ Toyota Motor Manufacturing, U.S.A., Inc., *Fact Sheet: Toyota Motor Manufacturing, U.S.A., Inc.* (Georgetown, KY: Toyota Motor Manufacturing, U.S.A., Inc., 1990); Gelsanliter, *Jump Start*, 216.

¹⁴¹ Toyota Motor Manufacturing, U.S.A., Inc., *Growth of Kentucky's Auto Manufacturing Supply Industry Since December 1985* (Georgetown, KY: Toyota Motor Manufacturing, U.S.A., Inc., 1989).

¹⁴² Levin, "Honda Blurs Line Between American and Foreign," D8.

¹⁴³ For example, see "Quality for the World, Made in Ohio," *Wall Street Journal*, 21 Mar. 1988, 20.

¹⁴⁴ Shook, *Honda*, 176.

possible.¹⁴⁵ Nissan's plant manager, Marvin Runyon, commented, "We didn't want to become an assembler of foreign parts if we could help it."¹⁴⁶

As time goes by, the distance between manufacturers and suppliers is decreasing. Japanese transplant manufacturers are starting relationships with suppliers not only within the United States, but also within the boundaries of the states in which they are located.

The Migration of Supplier Companies

The distance problem is also dissolving because supplier companies have recently been building manufacturing operations in the vicinity of JIT manufacturing plants. A large percentage of these companies are suppliers of Japanese transplant companies' factories in Japan. As David Gelsanliter remarked, "Each time a Japanese manufacturer locates a plant in the United States, its major suppliers usually are not far behind."¹⁴⁷ American-based Japanese suppliers provide a significant percentage of components to Japanese manufacturers in America.¹⁴⁸ Some American supplier companies with previous relationships are also following Japanese manufacturers to their new locations. Johnson Controls has a close supplier relationship with NUMMI in California. When Toyota announced its plans to start manufacturing in Georgetown, Kentucky, Johnson Controls immediately invested in a manufacturing facility on the south side of town. Incidentally, there had been no previous contract or agreement that Toyota would continue to buy from Johnson Controls in Georgetown.¹⁴⁹

¹⁴⁵ Gregory, "Part in Time Saves Nissan Money," 1-G.

¹⁴⁶ Gelsanliter, *Jump Start*, 56.

¹⁴⁷ *Ibid.*, 213.

¹⁴⁸ Cusumano and Takeishi, *Supplier Management and Performance*, 19.

¹⁴⁹ Gelsanliter, *Jump Start*, 219.

New American suppliers of Japanese transplants are also starting production facilities near the Japanese operations. Two-thirds of Honda's 160 Ohio-based suppliers are American-owned companies.¹⁵⁰ American companies implementing JIT systems have started to pressure their suppliers to build manufacturing operations near their facilities. General Motors, for example, is demanding that suppliers relocate their operations next to GM's main facilities because of recent experimentation with JIT principles.¹⁵¹

These developments are resulting in a general movement of supplier companies to the location of their major customers. Since Toyota announced in December 1985 that its American manufacturing facility would be located in Kentucky, 51 auto supply manufacturing facilities have opened in that state (as of December 1989). These companies made a total investment of \$1.2 billion, employing 9,700 workers.¹⁵² As time goes by and more suppliers relocate, the local content of JIT manufacturers' final products increases dramatically.¹⁵³ The localization of supplier companies allows for an increase in flexibility and reliability of delivery, as distance is no longer a problem and communications are improved. If supplier companies continue relocating to manufacturers' neighborhoods, JIT operations in America may eventually be characterized by a surrounding community of suppliers, as in Japan.

How Companies in America are Coping with the Problem of Distance

JIT manufacturers are also finding new methods of ensuring the prompt delivery of goods. By phasing out rail transportation, utilizing private carriers to a higher degree, and developing long-term relationships with carrier companies,

¹⁵⁰ *Ibid.*, 216.

¹⁵¹ Abegglen and Stalk, *Kaisha*, 92.

¹⁵² Toyota Motor Manufacturing, U.S.A., Inc., *Fact Sheet*.

¹⁵³ Cusumano and Takeishi, *Supplier Management and Performance*, 19.

manufacturers in the United States are working to make JIT delivery feasible for their geographically distant suppliers.

The Switch to Motor Carrier

Rail transportation is slower and less flexible than motor carrier and is being phased out as a way of shipping supplier parts to JIT systems. Although all respondents to the University of Evansville study reported their major traditional mode of transportation to be motor freight common carrier (truck), all respondents that had used some rail transportation expect to be "less dependent" on it under their new JIT program.¹⁵⁴ According to the results of the Lieb/Miller study, the "biggest loser" in transportation selections under the JIT system is rail transportation. Contract carriage trucking gained the most business from JIT operations, and air cargo showed an "appreciable increase."¹⁵⁵ With the increased flexibility of motor carriers, supplier deliveries can be more frequent, dependable, and responsive.

Gaining More Control Over Carriers

JIT manufacturing organizations also need to gain more control over the carriers delivering their supplies. In order to do this, JIT manufacturing operations in America are utilizing private carriers to a larger degree and developing long-term relationships with carrier companies. American manufacturers implementing JIT have shifted from common carrier to private carrier in transporting supplier goods. The University of Evansville study found that about two-thirds of American JIT

¹⁵⁴ O'Neal, "The Buyer-Seller Linkage," 12.

¹⁵⁵ Lieb and Miller, "JIT and Corporate Transportation Requirements," 6.

manufacturers receive components by supplier-owned vehicles. Over 60% of these manufacturers expect an increase in supplier-owned carriage.¹⁵⁶

Not only are supplier firms using more of their own carriers, but JIT manufacturers are also investing in motor carriers. The University of Evansville study revealed that currently 27% of the respondent firms occasionally use their own carriers to pick up products from suppliers. That percent is expected to increase to 47% over the next five years.¹⁵⁷ Komatsu Forklift, for example, sends one of its own trucks to pick up the components if a shipment is late or if the factory needs an extra shipment.¹⁵⁸ By owning their own fleet of carriers, JIT operations have more control over the transportation segment of the manufacturing process.

As with supplier companies, JIT manufacturers in America have found that they can control more of the quality and dependability of carrier service by developing close, long-term relationships with a small number of companies. Robert Lieb and Robert Miller found in their study that by decreasing the number of supplier companies involved in a JIT system, the number of carriers can also be decreased. Seventy-eight percent of the JIT manufacturers responding to the survey used fewer carriers after implementing JIT.¹⁵⁹ O'Neal claims that in order to minimize the transportation costs of smaller, more frequent shipments, manufacturers must negotiate long-term agreements with carrier companies. This provides incentive for carriers to make capital investments required to achieve greater cost efficiency.¹⁶⁰ Although American companies usually pay for carrier services on a day-to-day basis, JIT manufacturers have started to offer contracts to

¹⁵⁶ O'Neal, "The Buyer-Seller Linkage," 12.

¹⁵⁷ *Ibid.*

¹⁵⁸ Malcolm Ferguson (Deputy General Manager, Komatsu Forklift Manufacturing Company of U.S.A.), personal interview, 6 Nov. 1990.

¹⁵⁹ Lieb and Miller, "JIT and Corporate Transportation Requirements," 7.

¹⁶⁰ O'Neal, "The Buyer-Seller Linkage," 13.

carrier companies. Seventy-three percent of JIT respondents to the Lieb/Miller study indicated using specific contracts with carriers.¹⁶¹

A recent increase in communications between manufacturer and carrier indicates a growing closeness in relationship. Eighty-five percent of JIT respondents to the Lieb/Miller study reported that the extent of communications with carriers was higher than before implementation of JIT. Eighty-four percent stated that the quality of these communications had also improved. In an effort to ensure on-time deliveries and reduce paperwork, manufacturers have developed new software and communications networks, revised data bases, and acquired additional hardware.¹⁶²

Because of the changes JIT manufacturers are making in their relationships with carriers, transportation service has improved. Most JIT manufacturers responding to the Lieb/Miller study indicated that the quality of carrier service "improved and became more consistent" since implementation of JIT systems.¹⁶³

Overcoming the Problem of Distance

Although the distance between buyer and supplier continues to be a disadvantage in utilizing JIT in the United States, it no longer prevents JIT delivery. As JIT becomes more established in this country, manufacturers are starting relationships with conveniently located suppliers. Suppliers are also moving their facilities in order to secure contracts. Further, JIT manufacturers are utilizing methods of ensuring prompt delivery of goods.

¹⁶¹ Lieb and Miller, "JIT and Corporate Transportation Requirements," 7-9.

¹⁶² *Ibid.*, 8.

¹⁶³ *Ibid.*, 9.

3. JIT Delivery in the United States

The nature of supplier relationships and the vast distances between manufacturers and their suppliers have posed problems for companies attempting to implement JIT in America. However, by initiating a higher level of trust and by offering support, Japanese manufacturers have succeeded in making JIT agreements with several American supplier companies. Some of these suppliers perform at a level comparable to suppliers in Japan: they deliver frequent, small shipments from geographically close manufacturing facilities. Johnson Controls, located across town from Toyota, delivers seats in lots of sixty, approximately once every hour, and they are in exact order for insertion onto the assembly line. Just about the only inventory either Johnson Controls or Toyota maintains is in a truck or on a conveyer.¹⁶⁴ According to questionnaire results, Clarion Corporation and Tridon Inc., both located within 30 miles of the plant, send daily shipments to Nissan. Nissan carries one day's inventory of Clarion's radios and eight hours' of Tridon's wiper blades.

Although there are fewer examples of JIT arrangements with American manufacturers, there has been a trend towards receiving shipments at a higher frequency. The University of Evansville study found that there has been a significant increase in the rate of parts deliveries from supplier companies. Originally there was a mix between monthly and weekly shipments, with an average frequency of 2.8 deliveries per month. Currently there are daily deliveries as well as weekly deliveries, with an average of 6.9 deliveries per month. Future plans call for a mixture of weekly, daily, and some twice-daily deliveries, a frequency of more than ten shipments per month.¹⁶⁵ Although deliveries to American JIT factories have not yet come close to the Japanese standard (between once every 15

¹⁶⁴ Gelsanliter, *Jump Start*, 219-20.

¹⁶⁵ O'Neal, "The Buyer-Seller Linkage," 11.

minutes to once a day),¹⁶⁶ the frequency of deliveries has increased significantly. As this trend continues, it will be easier for manufacturers to start JIT programs and for all American companies to make even higher demands.

¹⁶⁶ Hall, *Zero Inventories*, 207-13.

Conclusion

The recent success of Japanese transplant companies suggests that JIT is possible within America's industrial environment. Once American workers receive proper training, they have little difficulty participating in rapid setup procedures and utilizing the kanban system. Japanese transplants are gradually developing Japanese-style relationships with their American supplier companies by initiating long-term, mutually beneficial agreements. In return, these suppliers are providing higher levels of service than is normal in this country. In a few cases suppliers are delivering components according to the exchange of kanban, in a truly JIT fashion. Japanese transplants are also finding ways to cope with America's problem of distance, which is steadily decreasing as an obstacle to JIT delivery.

American companies, however, run into significant problems in trying to convert traditionally organized factories to the JIT system. This paper demonstrates that it is both feasible and beneficial for American manufacturers to implement JIT production techniques. Many of the difficulties manufacturers experience center around a general lack of information about JIT. Once a company realizes its potential for setup-time reduction, workers and managers can work together to create a new process for changing over equipment. Significant results are possible with minimal investment. Also, supervisors often do not realize that kanban exchange with suppliers is compatible with current systems. The kanban system not only enhances current systems but also reduces the amount of paperwork and scheduling involved. By working together with suppliers, manufacturers can effectively reduce the level of inventories throughout the entire system. When arranging JIT delivery of supplier goods, American manufacturers tend to overlook important aspects of JIT supplier management. However, by making long-term

commitments, initiating the open exchange of information, and assisting suppliers in reaching new standards of performance, increasing the level of communication, and relying more on suppliers' engineering capabilities, even American manufacturers can develop Japanese-style supplier relationships.

At a time when Japanese companies are rapidly gaining market share in industry after industry, it is important for American manufacturers to utilize the most effective techniques for enhancing productivity available. Although there are many reasons for Japanese industrial success, JIT has made a significant contribution to factory productivity. Hence, American manufacturers should study this Japanese system and the methods being used to adapt it to operations in the United States.

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