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Study of Zero Inventory based on Just In Time (JIT) in the automotive industry

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ABSTRACT

Managing optimal inventory in the supply chain is critical for an enterprise. The ability to increase inventory turns and the use of best inventory practices will reduce inventory costs across the supply chain. Moving towards zero inventory will result in effective inventory management in the business process.

The meaning of Zero Inventory. The "zero" in the zero inventory can be understand from two angles, from the physical level understanding, that's the widespread sense of zero inventory, which is the absolute number of inventory as little as possible and infinite close to zero; from the legal level to understand Zero Inventory, namely the ownership of the inventory does not belong to you, that is, as long as the ownership does not belong to you it also can be called a zero inventory even if stock piled high with inventory.

The scope of this paper is to study and understand in depth the concept of Zero inventories based on JIT system of supply hub and how inventory holding costs can be diminished.

This paperwill suggest changes if any, required to meet the needs of an organization in terms of inventory management and will give in depth knowledge of how it is implemented in various automotive organizations.
Keywords: Zero Inventory, Automotive, Supply Chain, Ownership

INTRODUCTION

*JIT (JUST IN TIME) : Just-In-Time is defined as "the production of the minimum number of different units, in the smallest possible quantities, at the latest possible time, thereby eliminating the need for inventory***.**

The project work is basically a complete study of zero inventory based on Just In Time (JIT) in an automotive industry.

JIT is developed by Toyota which increased there quality manifolds and reduced the inventory holding cost hence putting the company at a reference point for the other companies in the market. JIT works as the concept of zero inventory which makes an organization an inventory free company .

Objective of the Paper

To study the concept of zero inventory based on Just In Time (JIT) in the automotive industry, its benefits and its analysis and implementation process.

Scope of the Paper:

The scope of this paper is to analyze and understand in depth the concept of JIT implemented in an automotive company.
This paper also suggests changes and gives suggestions, required to meet customer needs in a better way in association with JIT in the automotive industry.

Outline of the Paper :

This work is a successful study of JIT, in depth knowledge of its implementation process.

THEORETICAL FRAMEWORK

With reference to the research papers **Ahmed, N., Tunc, E. & Montagno, R.** (1991) refer Bibliography research paper 1 and **Srinidhi, B. & Tayi, G.** (2004) refer bibliography research paper 3. AIDT-just in time manufacturing September 11, 2006 reference bibliography books no 1. Just in Time Manufacturing: Introduction and Major Components by Alejandro A. Loreficei New York – April 1998 refer bibliography, book no 2

Introduction to JIT:

JIT was firstly developed within Toyota manufacturing plants by Taiichi Ohno, during the beginning of the 70s. The oil embargo probably triggered his theory, the program was intended to avoid wastes, reduce inventories and increase production efficiency in order to maintain Toyota's competitive edge. Besides he believed that customers should be satisfied with maximum quality in the shortest time.

Toyota realized that JIT would only be successful if every individual within the company was committed to the new project. At the beginning JIT was used as a method to reduce inventories in Toyota's shipyards, but afterwards it evolved to a management philosophy containing a set of techniques

Cultural aspects

It is necessary to consider several factors that influence the Japanese culture, and that surely accelerated the evolution of JIT. Heiko (1989) suggested different Japanese characteristics, from which I will take those that I consider the most relevant:

- Lack of space: in Japan in general there is not room enough for mostly any activity, not surprisingly the reduction of inventories was welcome by the management.

Publicaciones

- Commitment to consumers: consumers' satisfaction has always been a priority. JIT is a pull production system that minimizes the waiting time of each buyer. This time starts when the buyer places the request for new products.
- Overcrowded living conditions: lead time shortages and maximum efficiency are a consequence of Japanese's requirements to improve their living conditions, either inside the company or within the society.
- Environment cleanliness: in addition to the former, small places force Japanese people to reduce wastes, another basic constituent of JIT.

Four Basic Conditions

There are different points of view about the elements that led the approach to productivity. E. Hay (1988) understands that there are six internal factors and one externally focused element, the purchasing activity. On the other hand Harrison (1992) explains the "core techniques" of waste elimination, total quality and people preparation; however I will follow Cheng and Podolsky's (1993) structure to present the necessary conditions for the JIT implementation, to which I am adding the external factor of purchasing.

• People involvement

Whoever is related to the company that intends the implementation, shall be committed to the project. Starting with the machine operators and ending on the high level management, everybody has not only to be aware of the implications but to support the implementation as well.

Implementation is a critic phase of JIT, and is advisable to avoid problems, to reduce the amount of time and efforts throughout this stage.

• Plants

Numerous changes take place in the layout of the "new" plant. Some changes are easy to achieve as the so called productions cells, in which the machinery is located in a way that helps reducing the time it takes to move materials from one process to another.

Nevertheless the introduction of Kanban (Japanese name of the cards that confirm material requirements), self-inspection, Material Requirement Planning ("MRP") and MRP II (in case they were not already in use) and job enrichment within plant workers, involve structural change; thus they are far from being simple to implement.

MRP I involves a computer system for building inventory, scheduling the production and to administrate inputs; on the other side MRP II, that stands for Manufacturing Resource Planning, includes the MRP I's activities plus marketing and purchasing operations and the financing function.

• Systems

Existent systems may remain within the company, however the MRP and MRP II systems should be implemented. Further investments can take place, as the use of luminous Kanbans or the implementation of the Electronic Data Interchange ("EDI") to link inventory existence with suppliers

• Purchasing

Relationships with suppliers become a key factor not only in a JIT environment but in other production systems that intend to reach efficiency and to shorten production time. This issue is reviewed in depth on the 3rd part of this paper.

What To Expect

While the prevailing view of JIT is that of an inventory control system, it is much more. JIT is an operational philosophy which incorporates an improved inventory control system in conjunction with other systems, such as:

• A set-up time improvement system.
• A maintenance improvement system.
• A quality improvement system.
• A productivity improvement system.

A properly implemented JIT system should:

•Produce products customers want.
•Produce products only at the rate that customers want them.
•Produce with perfect quality.
•Produce instantly with zero unnecessary lead time.
•Produce with no waste of labor, material, or equipment.

Every move has a purpose and there is no idle inventory.

Adding Value, the forgotten fundamental

Western companies suffer from bureaucratization. Along the production line activities like transporting, storing, registering and inspecting in some cases outnumber those that add value to the process.

Only an activity that physically changes the product adds value. By no means it has to be a complex process. On the contrary, a simple metal cut adds value in a metallurgic workshop, as well as to ensemble a wheel does in the automobile industry.

Moving goods from one container to the other, inspecting and counting materials, instead of adding value they represent a cost to the process, reducing thereafter, efficiency and profitability. Not surprisingly value added activities are JIT's main objective because, as mentioned before, the system pursues the elimination of wastes and functions that impede productivity or that, otherwise, add unnecessary expense to customers at the end of the production line.

Kanban (The Pull System):

Legend has it that Ohno got the idea for his manufacturing system from America's supermarket system. Ohno learned the kanban (pull) system from our supermarket system in which customers pulled items from the shelves to fill their shopping carts, thereby creating an empty space on the shelf. The empty space is a signal for the stocker to replace that item. If an item was not bought that day, there was no need to replace it. When item quantities become low, that is the signal for the stockers to order more goods from their suppliers. Customers are content to take just what they need, because they know that the goods will be there the next time they need them.

Importance of Pull Systems

Within a pull system the production of a certain product starts on the demand or request made by the buyer. The consumer of the product is the one that pulls from the last link of the production chain, this last link pulls its preceding and so on.

In western companies, for many years, the so called push systems have been promoted as the most cost-effective. Furthermore, when cheap highspeed computers became available, they seemed to be a solution also to small and midsize factories.

Push systems are schedule-base projections of what the demand is expected to be. Based on historical information (updated on a week or monthly basis) a program "explodes" the information giving a detailed sub-schedule for buying materials and producing goods. It is this schedule what pushes the production in order to comply with the "expected" demand.

The already mentioned MRP is one of these sort of programs. Its disadvantage is that predictions not always are coincident with facts, therefore excess of inventories appear, or in the worst scenario the company cannot supply the required products.

Despite the innovative appearance of JIT among the pull systems, is necessary to mention that by no means Toyota was the creator of the latter. Even western companies used to put them into action before the Japanese did. The difference is that only small factories or workshops used them to satisfy uncertain demands; for example, when our car needs repairing we send it to the mechanic, and our demand starts the "production" process.

Nevertheless Toyota's creative efforts should not be diminished because is very difficult to satisfy "just in time" the demand when the company is producing massive and complex products as engines, gear levels (from one department to the other) or even finished automobiles (for end buyers).

To avoid guesswork Toyota implemented the Kanban (cards). The Kanban advises a section that a unit (or more, but not many) has to be produced or transported in order to satisfy the request of another section. There are two types of Kanban, the "C" (Conveyance Kanban) and the "P" (Production Kanban). The process is further analyzed on the 2nd part of this paper.

Despite the process seems to be simple, it will only work in a high flexibility and zero defect context. Thus the set-up time has to be minimum (to respond quickly to customer demand) and high quality standards must prevail to avoid machine-stops and defective goods.

Inside the Company

Flexibility

In a perfect JIT environment changes in customers' needs do not affect the production schedule. Let us suppose that instead of demanding X amount of red cars and Y amount of blue cars, a certain buyer requires X amount of both blue and red cars. This scenario under push systems might become hazardous; on the contrary producing JIT avoids the problem of changing shop orders and, furthermore priorities do not affect the system at all.

Because this is a pull system, each feeder operation is waiting to find out what are the customers needs hour by hour.

Wastes elimination

When we talk about wastes in JIT, we are not referring to loses or diminishes in materials (despite is necessary to minimize them), but to those activities that do not add value to the production process.

Some authors consider that quality is the key word; to operate under high quality standards, to have close relationships with suppliers, to avoid defective goods, and others.

The Toyota criteria about wastes, besides it is close related with quality.

Toyota identifies seven types of wastes, all of them may apply either to productive or to service operations, and are as follows:

i) Overproduction, producing more than needed. This is an important issue in those countries were the cost of money is high e.g.: Argentina.
ii) Waiting time, it affects productivity and efficiency, at the same time may distract operators.
iii) Transport, typically a non value added activity, double and triple handling from different storage points is a common practice.
iv) Process, to reduce them as much as possible in order to save time, it is necessary to rethink the way processes are being made.
v) Inventory, increasing stocks show a bad performance of the JIT system.
vi) Motion, avoid movements to look for materials or distant machines.
vii) Defective goods, this is a double effect waste, not only the cost of defective goods are not easy to calculate but, to make matters worse may provoke stops and delays.

KANBAN SIGNAL

Poor inventory timing causes waste in operation management, increases lead-times and consequently derives in a poor customer service.Toyota understood the Kanban as "invisible conveyor lines" that connected all external to internal processes.Despite Kanban stands for "card" in Japanese, it shall be considered as any signal through which a customer (succeeding operation) instructs a supplier (preceding operation) to send more parts. Different types of Kanban are used, starting from the dual or simple card system,blinking lights, small balls in a tube or even the verbal request of an operator asking for more units or material.

JIT is close related to the use of Kanban because is the most common way to pull the production system, however JIT can exist without the Kanban, on the contrary the Kanban is meaningless in a non JIT environment.A small number of Japanese companies use a single-card Kanban instead of using Toyota's "C" and "P" cards. Parts are produced and bought according to a daily schedule, and deliveries are controlled with "C"

(conveyance) Kanban.This dual system is easier to implement and is called a combined push and pull production program.

JIT AND QUALITY

The single most substantial ingredient of JIT is quality. It is impossible for JIT to be successful until the company has drastically improved its attitude toward quality. In the language of the Malcolm Baldrige National Quality Award, quality is a "race with no finish line." The ultimate aspiration is to satisfy all customers (internal and external) all the time. The Wallace Company, a past winner of the Baldrige Award, installed a buzzer on the shop floor that sounded anytime a customer called their customer service hot line. Instantly all workers knew they had a dissatisfied customer. Can you imagine installing such a device in a traditional manufacturing company?

The Chicken or The Egg

Analogous to the familiar chicken or the egg question, it is often asked, "Which comes first, quality or JIT?" Quality is a two way street; JIT is impossible without quality, but quality is directly enhanced by JIT. Although quality is possible without JIT, it requires the use of wasteful procedures such as inspection and rework. JIT proposes the idea of "do it right the first time" rather than inspecting in quality. In a JIT environment, each internal customer (the next operator down the line) must be completely satisfied by the previous operation. Any problems in quality are resolved immediately, rather than allowing them to contaminate the system further.

To produce quality you must install quality. Quality must evolve from both sides at the same time. To allow operators to satisfy their internal customers, quality procedures, materials, machines, and mindset must be present. JIT is not possible without quality, but JIT is a means by which quality is achieved.

A mathematics riddle known as the Xeno's paradox asks if a person walks toward a wall, each step being one half as large as the previous one, when will that person reach the wall? The answer is "never", but that person is continuously getting closer and closer to his or her goal. Continuous improvement in quality must be viewed in the same way. If you set a standard at 95 percent, people figure that they are doing fine as long as they are at or near that objective.

What is Quality?

One of the great gurus of quality, Phil Crosby, says that companies often have a misconception of quality. He says that the true definition of quality is meeting requirements—not an intuition for aesthetics, roundness, or perfection—but something that can be truly measured. If a Yugo (economy car of the the early 1970s) meets its customer's requirements as well as a Rolls Royce meets its customer's requirements, then it can be argued that the Yugo is as much a quality car as a Rolls Royce.

Now that we understand what quality is and what it can do for us, how do we get quality? The key is to obtain quality at the source. The sources for quality are the manufacturer's and vendor's processes, machines, and operators. Contrary to traditional beliefs, the source of quality is not the inspection bench.

Preventing Quality Problems

To dismantle the inspection bench mentality, we must take positive steps in prevention of quality problems. Specific guidelines and rigorous procedures must be established. The steps toward attaining a quality product are to first define the requirements, get the process under control, and then keep the process under control.

Defining the Requirements

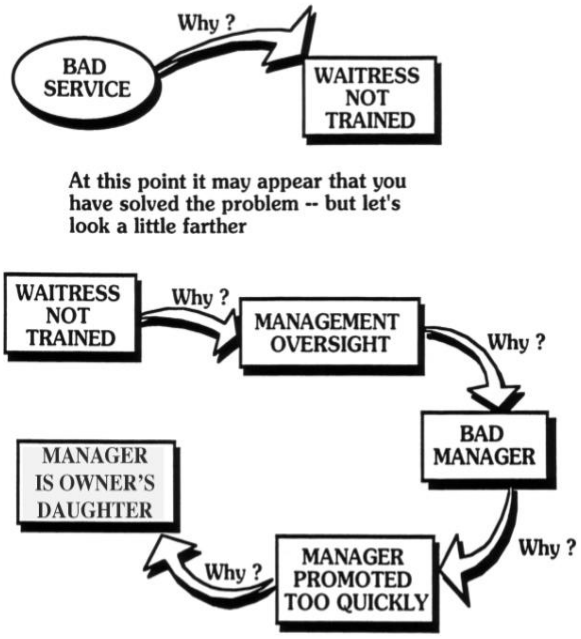
Many manufacturing companies do an inadequate job of defining quality requirements. If you are looking at a part or a process, and say "that's good enough" then you have not sufficiently defined your requirements. The real definition of quality is meeting both internal and external customer requirements. Employees and vendors should have strict guidelines that distinguish good parts (quality) from rework or rejected parts so 100 percent customer satisfaction can be reached.

The Root Cause of the Problem

To get the process under control, you must first find the root cause of the problem. This can be accomplished by running the gamut from simple methods such as pareto and matrix analysis to complicated design experiments. A common problem is to attack the symptom and not

the problem. For example, if a breaker tripped at your house, you could reset the breaker and hope for the best, replace the breaker box, or you could check for an overloaded plug (too many appliances plugged into one outlet). In your manufacturing process, don't make the mistake of rewiring the whole house before the actual problem is diagnosed.

FIGURE 1-4
Getting To The Root Cause



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Keeping Control of the Process

Once you have found the solution, keeping the process under control is an easier task. Statistical Process Control (SPC) is a method of managing a process by gathering information about it and using that information to adjust the process to prevent problems from occurring. Using SPC is one way to keep your process under control. Poka-yoke, a Japanese word for fail-safing, should also be applied. In the Pokayoke theory, parts and processes are designed so that doing the job right is easier than doing it wrong. An example of this is to design a part that is asymmetrical so that it fits only one way, thus eliminating misinstallation. Machines can be fitted with limit switches that will not allow it to cycle if all processes are not completed in the correct order. These methods should not only be used by your company but by your vendors as well.

IMPLEMENTING JIT

JIT implementation must start by creating a suitable environment for JIT to flourish. A structure must be established whereby responsibility for problem solving is appropriated to all levels of the organization. Shop floor personnel will be asked to find solutions for shop floor problems and so on throughout the organization. This reversal from traditional management style to a Total Quality Management (TQM) style can only be accomplished through Total Employee Involvement (TEI) and employee teams. TQM is a prerequisite to JIT.

Forming Teams

The first team that should be established is the quality team sometimes called the Executive Council or Quality Steering Committee. No matter what you call it, the objectives of the top team will be the same. The Steering Committee will address the issues with TQM implementation (you are not ready for JIT yet) while attending to everyday organizational issues as well. If possible, Steering Committee members should be removed from the interruptions of everyday organizational decisions. It is a proven fact that companies that allow their Steering Committees to dedicate all their time to solving TQM/JIT implementation problems have higher success rates and shorter implementation times.

The Steering Committee will be made up of high ranking officials within the organization. They will assign teams from the workforce to solve various implementation problems. The employees that constitute these teams now have the power to make decisions that directly affect productivity at their level. Team logistics will not be discussed in this manual.

Developing A JIT Strategy

Now that you understand the basics of JIT, a specific implementation strategy must be developed. There are no cookbook solutions for JIT implementation. Each Steering Committee has a different vision and each company goes about implementation differently. Below are examples of how JIT has been successfully applied in various types of organizations.

• Company 1 concentrated on finding the bottleneck in its manufacturing process and worked to eliminate it through reducing setup times, forming machine cells,

removing nonvalue-added steps, or whatever means required. After each bottleneck had been eliminated, the company found the next largest bottleneck and eliminated it, and so on, throughout the entire organization. Employees are still finding bottlenecks (albeit much smaller ones), and will continue to do so through the process of continuous improvement.

• Company 2 implemented JIT at its final operation and progressed in reverse order throughout the plant until reaching incoming raw materials. The idea behind this strategy is that as you implement JIT, you eliminate the need for excess inventory for the succeeding process or processes down the line. Suppose a plant has nine operations to perform before a part is shipped. If you optimize step nine first, parts can be pulled from step eight to step nine after eight has been optimized. When you reach step five, parts will flow from five to nine in a true JIT fashion.

• Company 3 started by removing as many nonvalue-adding steps from the manufacturing process as possible without moving any machines. Employee teams solved as many problems as they could while leaving machines in the traditional configuration. Machines were then relocated into cells and the teams went back to work to eliminate waste in the new configuration. The teams will now continually move machines and optimize the process.

• Opposite to company 3, company 4's Steering Committee moved machines into cells to improve product flow. Employee teams were then tasked with removing as much waste from the process in the current configuration. When teams recommended, machines were moved again. Company 4 moved machines frequently while company 3 rarely moved machines.

• Company 5 used what we will call the shotgun approach. Teams were tasked with implementing JIT as fast as possible with no visible structured approach. Machines were moved and inventory reduced and then it was up to the teams to implement JIT. Problems were solved on a priority basis as determined by the Steering Committee. A word of warning: this approach cannot happen if quality will not allow smaller inventories. On the positive side, employees were assured of management's commitment because the conversion to JIT happened fast.

• Similar to company 2, company 6 initiated JIT one cell at a time, but not at the last operation. Pilot projects were selected by the Steering Committee on the basis of success probability. Since the pilot project set the tone for the entire JIT effort, a project was chosen that would get the best results. Company 6 continued to add projects until the entire organization was converted to JIT.

PRACTICAL APPLICATION

Now, so as to understand and analyze the practical application of JIT , this paper considers JIT implementation in toyota.

Toyota's JIT Revolution: A Legendary Production System

In the mid-1990s, more than fifty executives an engineers from major automobile companies worldwide visited Toyota Motor Company's (Toyota)[1] manufacturing complex at Georgetown, US, to study the Toyota Production System (TPS). The visit also included an intensive question and answer session. Even though the visitors were from competing automakers, including Ford and Chrysler, Toyota did not deny them access to the plant.

The TPS aimed to produce world-class, quality automobiles at competitive prices. It was built on two main principles, Just-in-Time (JIT) production and Jidoka.[2] JIT was used not only in manufacturing but also in product development, supplier relations and distribution. Analysts remarked that despite imitating Toyota's JIT for many years, no other automaker in the world had been able to make their production systems and processes as efficient as Toyota had done. Analysts felt that though other leading automakers like Mercedes-Benz, Honda and DaimlerChrysler excelled in advanced engineering techniques, engine technology and styling, they did not match Toyota in efficiency, productivity and quality.

Executives of rival companies also appreciated Toyota's manufacturing and product development systems. Officials at GM commented, "Toyota is the benchmark in manufacturing and product development." A top executive at Ford said, "Toyota is far ahead in developing markets that the real race is for the second place." Some executives at BMW also considered Toyota the best car company in the world.

The early adoption of JIT principles by Toyota seemed to have helped the company achieve significant success. It helped the company respond quickly to changing customer needs and offer high quality products at low costs, thus increasing customer satisfaction.

Toyota's history goes back to 1897, when Sakichi Toyoda (Sakichi) diversified into the handloom machinery business from his family traditional business of carpentry. He founded Toyoda Automatic Loom Works (TALW) in 1926 for manufacturing automatic looms. Sakichi invented a loom that stopped automatically when any of the threads snapped. This concept of designing equipment to stop so that defects could be fixed immediately formed the basis of the Toyota Production System (TPS) that went on to become a major factor in the company's success.

In 1933, Sakichi established an automobile department within TALW and the first passenger car prototype was developed in 1935. Sakichi's son Kiichiro Toyoda (Kiichiro) convinced him to enter the automobile business. After this the production of Model AA began and Toyota Motor Corporation was established in 1937. Kiichiro visited the Ford Motor Company in Detroit to study the US automotive industry. He saw that an average US worker's production was nine times that of a Japanese worker. He realized that the productivity of the Japanese automobile industry had to be increased if it were to compete globally.

Back in Japan, he customized the Ford production system to suit Japanese market. He also devised a system wherein each process in the assembly line of production would produce only the number of parts needed at the next step on the production line, which made logistics management easier as material was procured according to consumption. This system was referred to as Just-in-Time (JIT) within the Toyota Group.

The JIT production was defined as 'producing only necessary units in a necessary quantity at a necessary time resulting in decreased excess inventories and excess workforce, thereby increasing productivity.' Kiichiro realized that by relying solely on the central planning approach, it would be very difficult to implement JIT in all the processes for an automobile. Hence, TPS followed the production flow conversely. People working in one process went to the preceding one to withdraw the necessary units in the necessary quantities at the necessary time. This resulted in the preceding process producing only quantities of units to replace those that had been with drawn.

Toyota flourished during the Second World War by selling trucks and buses to the army and the company launched its first small car (SA Model) in 1947. After the war, the company faced a series of financial problems. A financial support package from a consortium of banks (after the intervention of the Bank of Japan) helped Toyota tide over its problems. The package consisted of a series of steps that included downsizing and restructuring the company into separate manufacturing and sales divisions. As per the revival package, The Toyota Motor Sales Company Ltd. was formed in 1950. In the same year, Kiichiro resigned.

By 1952, Toyota made a turnaround and in 1953, the company appointed distributors in El Salvador and Saudi Arabia and started exports. Meanwhile, Taiichi Ohno (Ohno) took charge of the company. In 1957, Toyota entered the US market through its subsidiary, Toyota Motor Sales, USA. In 1959, the company began its first overseas production in Brazil and over the next few years, developed a vast network of overseas plants. Besides manufacturing, Toyota started a global network of design and Research and Development facilities covering the three major car markets of Japan, North America and Europe. By the early 1970s, Toyota's sales exceeded that of Chrysler and Volkswagen and its production was behind that of only General Motors (GM) and Ford. Toyota continued its efforts to make its production system more efficient and also developed flexible manufacturing systems. It also began to tap the markets in the Middle East and by 1974 the Toyota Corolla, (launched in 1965) became the largest selling car in the world. In 1984, Toyota entered into a joint venture with GM and established the New United Motor Manufacturing Inc. (NUMMI).

By the early 1990s, as Toyota expanded its overseas operations, the excessive capital spending affected its profit margins. Tatsuro Toyoda (Tatsuro), who took over as the company President in 1992, began to control costs by eliminating all unnecessary expenditure. In 1995, after Tatsuro resigned due to health reasons, Hiroshi Okuda (Okuda) became Toyota president. In 1996, Toyota consolidated its production in North American production units into the Cincinnati based Toyota Motor Manufacturing.

In 1999, Okuda replaced chairman Shoichiro Toyoda and Fujio Cho (Cho) became the president. In the same year, Toyota listed its shares on both the New York and London stock exchanges. By the end of 2001, the company's net income had reached $5,447 million and net revenue reached $106,030 million. According to analysts, Toyota's success in both the local and global markets was mainly because of its state-of-the-art and well-planned operational strategies. The company had continuously focused on gaining a competitive advantage through implementation of innovative and path-breaking ideas on its production floors. TPS worked on the basic idea of maintaining a continuous flow of products in factories in order to flexibly adapt to demand changes. The most important feature of TPS was the way it linked all production activities to real dealer demand through implementation of Kanban, JIT and other quality measures that enabled Toyota to manufacture in low quantities.

Table 1 : Just-In-Time Production System

What it is • Management philosophy • 'Pull' System through the plant	**What it does** • Attacks waste (time, inventory, scrap) • Exposes problems and bottlenecks • Achieves streamlined production
What it requires • Employee participation • Industrial engineering/basics • Continuing improvement • Total quality control • Small lot sizes	**What it assumes** • Stable environment

Kanban was an essential component of Toyota's JIT concept. The Japanese referred to Kanban as a simple parts-movement system that depended on cards and boxes/containers to take parts from one workstation to another on a production line. Ohno had developed the idea in 1956 from the super markets in the US, which had devised an effective system for replenishment of store shelves based on the quantities picked by the customers. Initially, Ohno used pieces of paper contained in rectangular vinyl envelopes to convey information (called Kanban). In a period spanning three decades, Kanban developed into a sophisticated information system that ensured production in required quantities at the right time in all manufacturing processes within the factory.

The essence of the Kanban concept was that a supplier delivered components to the production line only when required, thus eliminating storage in the production area. Suppliers delivered desired components when they received a card and an empty container, indicating that more parts were needed for production. In case of line interruption, each supplier produced only enough components to fill the container and then stopped. Since Kanban was a chain process in which orders flowed from one process to another, the production or delivery of components was 'pulled' to the production line.

In a pull system, the production of a certain product starts only when a demand or request is made by the buyer. The consumer of the product 'pulls' from the last link of the production chain. This last link pulls its preceding link and so on. In western companies, the push system was considered to be more cost-effective. Push systems were schedule-based projections of what demand was expected to be. Based on historical information (updated on a weekly or monthly basis), a computer program processed the information giving a detailed sub-schedule for buying materials and producing goods. This schedule pushed the production in order to comply with the expected demand. The disadvantage of the push system was that predictions did not always coincide with facts. This resulted in either excess or inadequate inventories.

In the traditional forecast oriented method, parts were 'pushed' to the line (Refer Exhibit III for a comparison of the Kanban philosophy with the western philosophy). At Toyota, two types of Kanban cards were used: one, to move parts from one place to another, known as the Conveyance Kanban card, and the other, to authorize the production of parts, known as the Production Kanban card. (Refer Figure I). A standard size container was used to store parts and each card was treated like a coupon. (Refer Box).

Suppose a container of item X is required in work centre A. As a first step, a production Kanban card is issued to work centre A. The work centre withdraws a container of raw materials from its inventory. The container of raw materials also included a conveyance Kanban card. Work centre A removes the conveyance

Kanban card from the container and sends it to the proceeding work centre where it serves as an authorization to pick up a container of raw materials.

Three types of information were exchanged using Kanban. Pick up information guided the earlier stages regarding parts to be produced for the succeeding stages. Transfer information indicated when the parts had to be produced for the succeeding stages. Production information was transmitted from the earlier stages to the later stages to inform the workers about the product mix and other operational matters.

To make the Kanban system effective and reap maximum benefits (Refer Table II) from it, Ohno framed six rules:

• Later process went to the earlier process to pick up products.
• The earlier process produced only the amount withdrawn by the later process.
• Should not pick or produce goods without a Kanban.
• A Kanban should be attached to the goods.
• 100% defect free parts were required.
• Reduce the number of Kanbans.

Advantages of Kanban

1. A simple and understandable process
2. Provides quick and precise information
3. Low costs associated with the transfer of information.
4. Provides quick response to changes
5. Limit of over-capacity in process
6. Avoids overproduction
7. Minimizes waste
8. Control can be maintained
9. Delegates' responsibility to workers

The Kanban cards were re-circulated and the number of cards controlled work-in-progress (WIP) in the system. In this way, the activities of final assembly were linked to previous operations by a chain system of card ordering that 'pulled' production through the factory.

Another important component of JIT was Heijunka (production smoothing). JIT's principle of building only the required number of items helped keep the production costs low. Heijunka helped in the accomplishment of this principle by creating a consistent production volume. Heijunka averaged the highest and lowest variations of the orders. The variations were then removed from the production schedule. This ensured that the right quantity of parts was produced with minimum workforce. Heijunka took care not only of the total volume of items but also the type of items produced and the other options.

Although many automobile companies around the world adopted JIT, the system was far from perfect and difficult to implement. It was based on the key assumption that sources and channels of supply were reliable and dependable at all times. Analysts felt that it did not take into account the possibility of labor strikes at automotive plants. Moreover, JIT involved high set up costs and Special training and reorganization of policies and procedures in the company were necessary to implement JIT. The supplier relations of the company also needed to be improved to ensure timely delivery. In the absence of good supplier relations, JIT increased the risk of inventory shortage. Organizational culture also seemed to play a crucial role in the implementation of JIT. Many companies outside Japan reported difficulties in the implementation of the concept.

Another problem seemed to be the difficulty of removing the 'human element' from the systems that generate requirements.
An analyst commented, "Computer algorithms, they say, go only so far. Good people, with lengthy experience at reading the ups and downs of the industry are still a must." Most companies felt that people should be actively involved in the system.

Moreover, there could be many barriers to the successful implementation of JIT. For JIT to be successful, companies had to ensure that they did not make frequent changes in production planning and that their forecasting procedures were reliable and did not result in under or over forecasting of demand. Other barriers could be equipment failure and employee absenteeism.

Analysts felt that Toyota's JIT was a complicated process and that its success inside a plant depended mainly on highly experienced, highly motivated managers. Outside the plant, JIT's success depended on a network of capable suppliers that operated in sync with Toyota's production processes. In fact, according to some analysts, Toyota was not able to replicate the JIT

production system in an efficient way in any of its operations outside Japan. John Paul MacDuffie[5] said, "Toyota hasn't developed a single facility that is as efficient as the ones it has inJapan." Although Toyota's JIT had some drawbacks, it offered several advantages over other manufacturing processes. Because of the early adoption of JIT, Toyota benefited more from the system than other automobile companies. By 2000, JIT was adopted by many Japanese companies, as well as some US car companies. Analysts felt that JIT was not only a process that could be applied to manufacturing, but also a philosophy that governed the attitude of a successful business. According to one analyst,[6] "Using JIT, Taiichi Ohno had revolutionized production. The market clearly reflects the success of JIT. The concept has made Japanese products affordable and reliable in quality. Quality is no longer a privilege - it is a standard accompanied by low cost."

THE HARLEY DAVIDSON MOTORCYCLES

THE THREE M'S OF HARLEY'S SUCCESS

- MANAGEMENT
- MARKETING
- MANUFACTURING

MANAGEMENT

Although Harley was very profitable during World War I and World War II, this status quickly changed during the 1970's. After the leveraged buy-out, Harley's new owners realized that in order to make the necessary improvements, they had to determine what went wrong. After careful analysis, the management team developed the following list of practices which were main contributors to the problems previously experienced: Corporate management focused mostly on short term returns. Management did not listen to its employees or give them responsibility for the quality of what they made. High inventories of parts gobbled up cash and reduced productivity. Belief in quick fixes for problems, such as throwing in computers and state-of-the-art machinery to improve productivity. High break-even point that left the company vulnerable to unpredictable market fluctuations. Management that woke up too late to the threat of foreign competition because of the "it can't happen here" syndrome. As with anything in life, recognizing the problems to any given situation is only half the battle. The development of methods for improvements and gaining company wide support for implementation was the key. The first accomplishment was for management to learn the importance of relationships. Strong relationships with workers can aid in the advancement of new company practices. A good example can be seen in the following conversation between a machinist and the Vice President of the power train plant at Harley. "You are new here, aren't you?" asked the machinist. "Let me buy you a cup of coffee!" (Filipczak 38). It was a simple gesture which quickly taught the new VP how important "relationships" were in the workplace; one of the major components of Harley-Davidson's corporate culture. Harley's new management realized to survive they needed to become a perpetual learning and improving organization. Open communication between all levels of employees was essential. Everyone needed to understand their roles and the consequences their roles contributed to the company. But to develop employees to a greater degree, management had to get them to understand the business environment of the corporation. Harley-Davidson wanted the ability to develop processes and people which would ensure employees would have the capability for rapid, effective change based on an understanding of the whole business environment in which they operated. In order for that to happen, Harley-Davidson realized that individuals needed to have a shared vision of the company values: tell the truth, be fair, keep your promises, respect the individual, and encourage intellectual curiosity. Management needed to earn the respect and trust of their employees. Incorporating all of these high moral values into the entire company structure and expecting nothing less from employees, at all levels, helped emphasize Harley's commitment to its team of workers. Since Harley's workers were unionized, this could have been a major problem. But, because the unions stuck to Harley-Davidson when times were tough, Harley today sticks to them. The unions even censure their workers for shoddy performance. This commitment allowed for Harley to switch to "self-managed" teams. The plan was to create semi-autonomous workgroups, who were cross-trained and could set their own work schedules. Therefore, Harley-Davidson created the Harley-Davidson Learning Center. This is a facility dedicated to life-long learning. Its primary role is to serve employees who want to keep their skills current. In some cases, this means remedial training in basic skills, but mostly the Learning Center is a place to come with requests for specific job-training courses. Continuous Improvement Harley-Davidson is driven by a constant vision of what an excellent company should be: one that is never satisfied with the status quo but is always searching for ways to do things better. This is best exemplified by a manager's

comment, "The day we think we've arrived is the day we should all be replaced by managers of greater vision". All companies can and should learn from this position and adopt the idea of continuous improvement. Continuous improvement demands involvement from employees. Management's dilemma was how to align employee motivation with company goals. In Harley-Davidson's case, all employees take part in a gain-sharing program and are paid cash incentives for attaining and maintaining quality, profitability, and product delivery goals. In 1995, more than 2,000 of Harley's 4,694 employees took training and education programs from the Harley-Davidson Learning Center. These courses helped the company to be more competitive and to foster employees' personal growth and development. Extensive team-building has taken place at all levels of the company, including team-building for union leaders, negotiation committees, and stewards. Open communication, at all levels, is used as a major key to achieving teamwork and employee participation. For example, engineers are located right in the plant, within walking distance of machine operators. The practice of open communication is also represented in the relationship between top management and the union.

MARKETING

Harley-Davidson enjoyed a monopoly in the motorcycle industry for many decades. In the 1970's, Japanese manufacturers flooded the market with high quality, low priced bikes. From 1973 - 1983, Harley's market share went from 77.5% to 23.3% with Honda having 44% of the market by 1983. HarleyDavidson could not compete on price against the Japanese motorcycle producers, so it had to establish other market values and improve quality. Simultaneously, the United States consumer base was undergoing a revolution which mandated consumer driven products. Harley had to change from a company which dictated what its customers could have to strategies based on direct input from customers. A marketing philosophy was developed based on the customers desires, gathered through surveys, interviews and focus groups.

Customer Relations

When a person buys a Harley-Davidson motorcycle, they receive a free 1-year membership to the Harley Owners Group (HOG), which was developed in 1983 as a program to keep people active with their Harley. Simultaneously, it keeps the company close to its customer. HOG has 295,000 worldwide members, 900 local chapters and is the largest company-sponsored motorcycle enthusiast group. They conduct four US national rallies, two touring rallies and 44 state rallies. These rallies encourage people to use their motorcycles and to share in the excitement of riding. The people are given demonstration rides, have the opportunity to ask questions, register their bikes and buy merchandise. According to Michael D. Keefe, director of HOG, these rallies are considered "more like customer bonding. If people use the motorcycle, they'll stay involved" (Berry, 104). " What the Harley management crew, who are masters of marketing, do well is listen to their customers. The result is that Harley cannot keep up with demand at current production levels" (Croghan 31). Company executives learn from their customers by maintaining a database to track consumer desires. Company officers spend almost every weekend from April through October at motorcycle events and dealerships accumulating this information.

Product

Harley found its strength was in the heavyweight division. They also identified and exploited mini niches, such as customized, touring, sport/touring and sport/street motorcycles, in the heavyweight end of the market. When Harley-Davidson was formed, it only offered one color of motorcycle - gray and three basic styles. The company learned it needed to give the customers a choice and now offers a variety of models, including Sportsters, Super Glides, Low Riders, Softails, Sport Glides, Tour Glides and Electra Glides, in numerous vivid colors. Many of these models and changes were developed when Harley realized their customers were customizing the bikes and none of the revenue from the work was going to the company. When a style is changed or developed, Harley always develops it around their signature image to make sure that the product is not only a high quality piece of equipment but is also charismatic.

Price

Harley-Davidson quickly learned it could not compete with the foreign manufacturers on cost. Not only did Honda have a low priced product, it was able to defeat Harley in advertising 40-1. Therefore, Harley developed a strategy of value over price. This was created through the development of mini-niches and the heavy construction of the parts. Japanese manufacturers used plastic while Harley used steel, which is able to be rebuilt and rebore. Harley was careful not to exceed demand in production of their motorcycles. Currently,

people must wait six to eighteen months for a new motorcycle and the price for a year-old Harley is 25% to 30% higher than a new one. By not being able to meet demands, an attitude of musthave has developed. Therefore, Harley has plans to double capacity to 200,000 motorcycles annually by 2003.

MANUFACTURING

Original Process

Initially, Harley's manufacturing plants were designed to use a batch process in the flow of material on its plant floor and the frequency of products made. "The batch format has neither inflow or outflow of materials while the process is running, and has the disadvantage of high labor costs per unit production and is difficult with large-scale production" (Folger 8,15). Harley's batch operation was illustrated by its grouping of machinery. "Harley's production system was a huge, maze-like operation in which parts were tooled in large batches and moved from one machine to another all over the plant" (Reid 156). As illustrated in figure 1 in appendix (Reid 156), operators had to use forklifts to move the materials around the facility. There was no straight flow process; therefore, setup times were very high and output rates were very low causing financial concerns for AMF. With Harley's transition from a privately financed company into a public company, they were forced to seek an alternative method of production to achieve quality and productivity. The first step was to determine the specific areas which needed improvements. It was important for Harley to understand all aspects of the business would need to be examined for flaws in order to develop an effective flow process. An improved process was determined and implemented, successfully, only after the synergy of what is known as the productivity triad was conceived.

Just-In-Time

Although all three methods are not new concepts in the business world, just-in-time inventory (JIT), employee involvement (EI), and statistical operator control (SOC) are the attributes of the productivity triad. Just-in-time inventory "was the driving force of Harley's quality-improvement program. Very simply, as you operate with lower and lower inventories, it becomes essential that all your inventory is usable. If you're only going to get a few parts, they all have to be good ones" (Reid 150). Suppliers of Harley had to implement JIT into their production process in order to compliment Harley's system. Previously, Harley utilized a complex, computerized inventory system, Material Requirements Planning, which was based on maintaining high levels of stock, to offset any manufacturing problems, so the assembly line would not be halted. This system was inefficient because it did not address the manufacturing process problems, instead "it was a little like sweeping dirt under the rug" (Reid 151). But with JIT, "as each problem is exposed, you are forced to identify its cause, fix it, and move on to the next problem that is revealed" . After being renamed MAN (materials as needed-to differentiate from ineffective JIT's processes implemented by other companies.) and concentrating on "setup reduction, focus flow processing, containerization, parts control and operator preventive maintenance" .

Harley recorded impressive improvements:

1. Inventory turns up from 5 to 20.
2. Inventory levels down 75 %.
3. Percentage of motorcycles coming off the line completed up from 76 % to 99 %.
4. Scrap and rework reduced by 68 %.
5. Productivity up by 50 %.
6. Space requirements down by 25 %.

Employee Involvement

Successful implementation of any company program occurs when there is a commitment at all levels of the organization. Top management must not only direct but take direction from the lower level employees. In order to feel comfortable with this, top management must encourage education for employees of company objectives and develop a trust that employees will execute the right decisions. Simultaneously, employees must learn that their job stability is dependent on the overall health of the company. Their dedication must be expressed in learning techniques to continuously improve the quality of Harley's manufacturing processes. Harley has set the following nine guidelines to follow for successful employee involvement (Reid 163). Management, through its words and actions, must demonstrate that continuous improvement of quality and efficiency is a way of life, not just another "program." Management must be firmly committed to the people-building philosophy-that is, the belief that employees are thinking, rational human beings and therefore should be encouraged to develop and grow. All management must be totally committed to the EI program and by demonstrating that commitment foster a mutual trust between employees and management. Employees must be thoroughly trained in specific problem-solving and quality-control techniques. Managers must encourage participation from everyone. Employees must be given

responsibility and authority for production, quality, preventive maintenance, and other aspects of their jobs. Individual employees must help each other develop and grow. Employees must attack problems, not each other- that is, there must be no finger-pointing when things go wrong. Creativity must continuously be encouraged through a free, non-threatening atmosphere.

Improved Process

Harley's continuous flow process proved wrong the belief that "continuous improvement in quality and productivity was an attractive concept but likely to be uneconomical" (Mefford 137). Moving from a batch process to a continuous flow process can be difficult. However, Just-in-time inventory, Employee Involvement, and Statistical Operator control combined to make it possible. For Harley's continuous flow process, U-form lines were used as illustrated in figure 2 in appendix (Reid 157). These lines consisted of 1-4 people working together to produce a finished part. The group had containers at the starting end which held the raw materials/ products and were taken through the "U-line", eliminating a need for a stock room. In the example shown, you can see how the different stages of machinery are all arranged in a "U" shape making access easier and taking up less floor space. Each manufacturing department has a number of these "U-lines" arranged on its manufacturing floor as illustrated in figure 3 in appendix (Reid 157). Therefore, many different types of products can be made at one time. The original "batch" took six weeks to four months to produce a product, now it can be accomplished in just minutes with the continuous flow methods. A reduction in lead time, inventory, and defects greatly improves the quality of the merchandise. The new system also allowed engineers to improve methods more rapidly and effectively. These new methods have lead to a source of renowned excellence. Harley-Davidson's techniques were proven to work when their productivity levels rose to record levels. Other companies realizing "The Story of Harley's Success" wanted to learn these new tactics. Therefore, Harley holds training seminars to teach other company management personnel their improved manufacturing techniques which enabled them to overcome stiff Japanese competition and lead themselves to excellence.

ANALYSIS

JIT achieved the following in Harley Davidson motorcycles company **:**

(i) Zero inventory
(ii) Zero breakdowns
(iii) 100% on time delivery service
(iv) Elimination of non-value added activities
(v) Zero defects.

In Harley Davidson motorcycles earlier JIT was not implemented, Honda , when entered in American market of motorcycles in the heavy segment i.e 600 cc engines segment it ate up the whole market like anything. The reason of there success at that time was the concept of zero inventory. Harley guys studied the system of Japanese two wheeler manufacturer and tried to diagnose there production system because Honda motorcycles were both cheap and of higher quality. The main reason they foud out was the improper inventory management and less involvement of the workers at the time of decision making. Decisions were made by the higher management of the company but Harley had started a unique program of decision making with the involvement of shop floor workers. One of the example is that top management of Harley Davidson motorcycles had decided to leave painting scheme of the company on the floor workers.

The closer you get to operating in a true JIT situation, the more responsive you are to your customers – and the less capital you have tied up in raw materials and finished goods inventory. The less you spend to store and carry inventory, the less obsolescence you have to write off, and the better you can optimize your transportation and logistics operations. Ultimately, this all translates into saving your company real money.
The downside of JIT is that it is a continuum; the closer you get to it, the more beneficial it is to your business. But go too far and reduce inventories too far, the less beneficial it is for your business. Too much or too little inventory leaves you at a competitive (or cost) disadvantage to your competitors. But if you can do it right, JIT can be a strategic source of competitive advantage.

In the JIT-based operation, day-to-day activities are driven by continuously replenishing the customer-demand-driven finished goods inventory targets. These targets “pull” or drive the production plan, the use of production assets, labor and even the reordering of raw materials from suppliers or warehousing/distribution operations. In essence, JIT requires production to be tied more directly to short term customer demand patterns.

JIT Production Planning

Production planning in a lean JIT environment means doing things differently. Since there is less margin for error, the planner needs to be very familiar with the process capability in terms of changeover times, changeover patterns (the relative difficulty of switching from one specific product to another) and the true lead times of each product. Having a good handle on the actual demand patterns for products is essential.

These are just some of the key inputs to developing the production plan in a JIT environment. By using empirical methods to better understand and define acceptable parameters, a consulting expert can develop effective production plans that support a JIT environment.

Advantages of JIT

By minimizing inventory, JIT frees up resources to employ elsewhere in the company. A retail store using JIT can remodel the warehouse space into more retail sales floor space without expanding the physical store. A manufacturer gets more space to produce goods. Both companies free the workforce to focus on primary tasks, from making goods to interacting with customers rather than stocking merchandise. Manufacturers can train employees to work at different stages of the assembly line or at different workstations, to meet shifts in demand. A better-trained, more flexible workforce focusing on quality production can mean faster set-up or customization of workstations and lower defect rates, which lower costs and increase customer satisfaction.

Disadvantages of JIT

The primary disadvantage to JIT is its relative complexity. Management must rethink the entire work flow of the company, from initial intake of raw materials to final output of finished product. Supply-chain relationships require retooling that involves multiple suppliers, closer locations, or companies that can supply materials with little advance notice. Companies ordering smaller amounts of goods may encounter difficulty meeting minimum orders, requiring a different contract or a way to break up a large order over time or among several smaller manufacturers. All goods must meet quality requirements to avoid shutdown due to defects. Staff must understand more of the entire process and shift to where they are needed as work flow ebbs and surges to meet customer demand swings. This overhaul requires a sizable commitment of time and money initially, plus a change in mindset and a commitment to stay the course in implementing JIT, at the risk of the system's never gaining traction within the corporate culture.

CONCLUSION

Verdict

Japan's auto industry meant JIT to operate within a culture of continuous improvement, as one way to eliminate waste. JIT may be a good way to introduce continuous improvement or quality management, but it is very difficult to implement as a stand-alone process. This may even require coordinating with other companies operating within the area, as in an industrial park. Personnel managers need to communicate with staff, stressing the importance of JIT to providing quality products and services and reducing costs, as well as convincing staff of the benefits in rounding out skill sets by taking on different tasks.

Despite JIT process itself is not complicated, the implementation stage is not easy to face at all. However the system can bring high levels of competitiveness to big companies that in general suffer from excessive stocks at different stages of the production chain.

If someone intends to embark on JIT, he should go through different aspects either indoors and outside the company. In some countries the power of unions prevents management to instruct flexible practices to the lower levels as floor-shop workers and supervisors. In spite of the recessive environment, in some places is common belief that the worker must have only one task and that he can not be asked to do different things at the same time. This is a drawback that should be considered

Evolving from a non-JIT to a JIT production process requires tremendous commitments from many different company departments, as well as a number of employees.

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LIMITATION

The limitations of this study are be as follows:

- The study is based on the data that existed so far in journals and does not include any self implementation of this concept in any organization.

- The study is a theoretical analysis of JIT and its concepts that have been successfully used so far in automotive industry.

- Recommendations are based on study.

- Access to any organizational data where it is used was limited.