Publicaciones

Just in Time Manufacturing: Introduction and Major Components

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Abstract

The paper is divided in four parts. On the first one I explain how Just in Time ("JIT") was implemented in the Japanese industry and the way cultural factors promoted its creation. I intend to summarize the main contents of JIT, such as flexibility, small lot size, elimination of wastes and high management decisions on how to reduce the base of providers or to improve quality throughout the production chain.

Some techniques are explained on the 2nd part of the paper, the analysis is extended to the resources supply and the particular relationship that managers have to establish with suppliers.

Finally, I make the conclusion and some personal comments (4th part) aiming to ease a comparison between JIT and the existent traditional production systems.

1. JIT, What is it about?

1.1 History and Development

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.

1.2 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.

- 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.

1.3 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.

1.4 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.

1.5 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 high-speed 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 can not 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.

2. Inside the Company

2.1 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.

2.2 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.

I believe is necessary to add 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 and finally (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.

2.3 The 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.

Further study should be made about the Kanban process, however it exceeds the purpose of this paper.

2.4 Reducing the Setup Time

Now we know that the system must respond quickly to frequently changing demands (discarded if it works with a stable and predictable demand), and to machine changeovers when production is mixed.

To do this the lot size must be reduced, and to reduce the lot is necessary to reduce the setup time. Short setup times pursue efficiency and rapid response to change, but they must not be used to increase production levels, is necessary to avoid this pitfall that might increase inventories.

As in other stages of JIT, success depends on commitment of both the shop floor workers and their supervisor. The latter can act as a team leader to help them improve tasks and identify delays.

There are various techniques to achieve minimum setup times, some of them are the application of PERT (Program Evaluation and Review Technique) that identifies operations that can be done simultaneously, in parallel, and which operations must "wait" for another one to finish. The use of chronometers and also videorecording can help the shop floor personnel identify unnecessary or duplicated operations.

2.5 Small Lot size

The lot size and the setup time are not independent variables under the JIT philosophy. If the lot size is reduced to a half, and working in a mini-

mum setup time scenario, then machine changeovers can be doubled with no additional cost.

Suppose that during a certain week factory N produces 100 units of product "A", and on the succeeding week it produces 100 units of product "B". In case the lot size is reduced to a half the factory would be able to produce 50 units of "A" and 50 of "B" within the first week, and so on.

At the end of the fortnight the production stays the same (100 u. of "A" + 100 u. of "B") however production shifted from one product to the other the double of times. The goal of JIT is to produce smaller and smaller lots, and therefore respond to demand almost instantly. Despite the practice seems not to be cost-effective, Japanese companies have been using it successfully for the last two decades.

Those companies that use a combination of push and pull systems (single-card Kanban) must be aware of the stockout risks, minimizing them by keeping updated records and, at the same time using safety stocks.

3. Purchasing

3.1 A different point of view

The traditional relationship between the supplier and the customer is changed completely in JIT. Is common to see an adversary attitude among them in most western companies, or otherwise, under complex contracts and clauses that slow down the purchasing process.

A sort of partnership has to be established among supplier and customer in order to involve the latter into the efficient process of JIT.

Price is not the critic element of the selection criteria, as defective goods have to be eliminated from the production cycle, an improved quality turns out to be the relevant factor.

The objective of wastes stays the same, thus inspections are reduced, freight costs minimized (with geographic proximity), and both paperwork and supplier selection costs are avoided through the small base criteria. The goal of the small base is to have only one supplier for each type of material.

3.2 Supplier quality assurance

Despite the importance of frequent small lot deliveries from nearby suppliers, the quality assurance became the most important prerequisite to establish a relationship with a company that works JIT.

Anyhow the selection process is still slow, probably because of the adversary days' remembrances. Big companies certificate their best suppliers in order to reduce the base to those that worth the relation.

As has been said before, safety or protective stocks are, in most cases, eliminated, therefore a stoppage because of defective materials may provoke a delay on the delivery to customers.

While using the word "quality" is necessary to avoid misconceptions; a quality material, finished good and even a service, is the one that complies

with the specifications and not the one that outperforms what is expected. When the supplier provides on the right dose (quantity), at the correct time the required materials, he is bringing quality to the production process. That is why certifications are not easy to be obtained, because many aspects have to be covered by the solicitor.

3.3 The supplier base

Every company working JIT should pursue the "one supplier per product" objective. To assure a close relationship with the upstream partner, the company has to be able to open its doors to the new link of the production chain.

Moreover, the supplier might need financial aid from the customer, as the case of the US Toyota plant, in which Toyota almost build up the facilities of one supplier.

Not that far, the customer can facilitate some technology systems to exchange information as material requests, changes in specifications, date of delivery or any other. The EDI is an example of the technology that can be facilitated or financed to the supplier.

Long term contracts have a dual purpose: to avoid paperwork searching for new bids and to make the parties more confident on the relationship. Nevertheless, Cheng and Podolsky (1993) recommend the suppliers not to enter a relationship in which the customer would control in excess of 20% of the business.

The selection of the supplier and the relationship is an important determinant of success, in addition it establishes advantages for both parties; to the customer an increased control over purchasing activities, the elimination of inspections and reduced paperwork; on the other side the supplier increases the volume of its business, achieves schedule stability and finds increasing success due to his relation with a successful company.

3.4 What JIT brings to quality

In his book, Hay (1998) states that JIT brings a number of unique elements to a total quality environment.

From an interesting point of view he presents the counterpart of Just in Time benefits. These are "Immediate Feedback", "Slower Run Speeds" and "Stopping the Process".

The under demand pull system gives immediate information about the situation, now defects can be detected within two hours, or two minutes or even while they are still happening rather than ten days or two weeks later.

The production schedule, under JIT is not pressing any more to work as fast as possible, instead frequency is set by the demand, the machinery is not forced and the process becomes predictable.

Finally, he advises not to fear from stopping the process (as the traditional theory teaches) but to take advantage of it detecting a defective part and not letting another problem to happen again.

4. Conclusion

Despite JIT process itself is not complicated, the implementation stage is not easy to face at all. However I believe 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.

Not surprisingly JIT was invented by a Japanese company, the conditions were favorable there, and still are, in comparison with the western arena.

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 prevent 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.

I disagree with some authors' extreme point of view that states JIT has to be fully implemented because, otherwise, it does not worth even to start with.

I believe that some things can be learnt from this system whether it is carried out or not. To mention, as an example, the inventory reduction and the minimization of setup times. In most developing and less developed countries, like Argentina, the cost of money is very high, furthermore credit is expensive for small and midsize companies, therefore high fixed costs can be saved through these practices.

Finally, on what concerns the relationship with suppliers, I think the agreement must not reach the level of cooperation in the whole production process; the company should never share its core competence with third parties.

Sources

- "The Just In Time Breakthrough: implementing the new manufacturing basics". Edward J. Hay; Wiley, 1998.
- "Just In Time Manufacture". C.A. Voss; IFS 1987.
- "Just In Time Manufacturing: an aggressive manufacturing strategy". Richard T. Lubben; Mc Graw Hill, 1988.
- "Just In Time Manufacturing: an introduction". T. C. E. Cheng and S. Podolsky (2nd edition); Chapman & Hall, 1996.
- "Just In Time Manufacturing in Perspective". Alan Harrison; Prentice Hall, 1992.
- "Fundamentals of Logistics Management". D. M. Lambert, J. R. Stock and L. M. Ellram; Irwin - Mc Graw Hill, 1998.

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