

## Just-In-Time Inventory Management: Implementation of A Successful Program

RUTH W. EPPS

In the early 1980's a new concept, known as "zero inventories" was introduced to the American manufacturing industry. The "zero inventories" concept called for the transportation of materials from the outside vendors directly to the work-in-process area, where the required value added\* through the manufacturing operations occurred, followed by the shipping of the finished products out of the door, all at a reasonable rate of time. This "zero inventories" concept would save companies the costs of inspection, stocking, material handling, inventory tracking, carrying the inventory, and the risks of damage and obsolescence. The concept now formally termed just-in-time (JIT) inventory has evolved into a corporate philosophy that seeks to do the process right the first time and to eliminate any non-value added activities.<sup>1</sup> The time a part is delayed, moved, or inspected is referred to as non-value added time. It is *waste time* because no value is created for the customer when the product is not being processed. Under the JIT concept activities such as moving parts, waiting for parts, machine setup, and inspection are referred to as non-valued added activities. Inefficiencies in production cause non-value added activities.

There are three basic stages of what JIT is and how JIT works. These stages are termed: (1) Kanban, (2) Production planning, and (3) Global management philosophy. Organizations claim that they are using JIT when they are at any of these stages. In reality, these are not three separate stages but rather a migration path from using JIT simply as a shop-floor-control tool (Kanban) to the installation of a factory wide global management philosophy.

In stage one which is the simplest form, JIT is a shop-

floor-control tool that allows the scheduling of inventory movement through the shop floor with the use of a Kanban, a materials movement tracking device. The Kanban can take the form of a card, a box, or a marked off area on the floor. These Kanbans are used as an authorization to move materials or to produce new product. This initial stage of JIT should generate impressive reductions in work-in-process inventory because of the direct uninterrupted movement of materials between work stations.

The second stage of JIT, production planning, focuses on the basic principle of receiving production parts as needed, rather than building up inventories of these components. Using the JIT production planning approach, managers reduce inventory to a minimum level, keeping on hand only the amount needed in production until the next order arrives. This approach eliminates the double handling of products which occurs when storage is relocated to the work area or shipping area. The JIT production stage is driven by having continuous delivery of items. The use of production planning eliminates the need for material requirements planning (MRP) as a production planning tool. In contrast to the JIT system, a MRP system is a "push-through" system driven by forecasted demand. It examines the finished goods requirements before determining the demand for raw materials, components, and subassemblies. The purpose of MRP is to maintain the lowest possible level of inventory while making certain materials and parts are available. In production planning, detailed bill-of-materials for the manufacturing process which authorize the movement of materials or parts from storage to work areas, are no longer needed. The

Ruth W. Epps is Associate Professor of Accounting in the School of Business, Virginia Commonwealth University, Richmond, VA. The author wishes to thank the reviewers for their helpful comments.

\*A value added activity (e.g., assembling) is an activity that customers perceive as adding usefulness (utility) to the product or service they purchase. A nonvalue added activity is one that customers perceive as not adding value to the product or service (e.g., movement of materials).

lead time in JIT is dramatically different. In a large production type environment, lead time may be reduced from months to hours. With such a short time horizon, it is easy to determine what parts will be needed each day. Another important part of the planning environment in JIT involves the long-term contractual relationships which are established with vendors. These relationships will eliminate the need for purchase requisitions and purchase orders. A last critical part of the production planning process in JIT is that quality evaluations are performed differently. Quality is part of the manufacturing process. Every employee is a quality inspector. Inspection is done before the work is started and after it is finished. This process is referred to as in-line quality control or total quality control.

The third basic stage of JIT, global management philosophy, is something that affects every aspect of a manufacturing environment. Costing through the use of standards has been eliminated; only actual costs are used. Inventory tracking has been eliminated; inventory should be kept to a minimum. In management styles, the concepts of management circles, bottom-up management, statistical management, and long-run planning become important. In facilities planning strategies, JIT offers suggestions about factory planning, technology specialization, and resource sharing.<sup>2</sup>

### Pointers for Success

There are a series of actions and conditions that can spell success for any JIT program. These actions will not guarantee success, but will greatly improve the chances of JIT gaining acceptance in the work place. The first thing a company has to realize is that JIT is a two-way opportunity. A company has to involve the supplier in the process. A company cannot expect to decrease inventories and expect the supplier to hold the excess for them. Benefits should be attained mutually, among all parties involved, otherwise the enthusiasm to continue the project diminishes and is soon forgotten. The company, i.e., customer, must initiate a supplier certification program to enable the supplier's products to bypass inspection. The relationship between the supplier and the customer must be one of respect, trust, and open and honest communication.

Additionally, operational policies and procedures must be understood and practiced on a daily basis by all employees. The data in the procedures must be constantly monitored to ensure that there is no obsolescence. Adequate training must be done to ensure that the concepts and procedures become a way of life for all employees. Production employees play an important role in the JIT process. Each employee becomes an operator/inspector who is fully responsible for the preventative maintenance on the machine. The production employees must not be operators with the mindset of production only. They need to be in a position to improve the process and the function of the machinery. This concept requires management to exhibit a *tone from*

*the top* of encouraging initiative and risk taking with employee. Employees should be encouraged to become more educated with regard to the total production cycle. They also need to participate in discussions concerning quality improvement techniques, in order to promote ownership, accountability, and the inner feeling of being part of the team.

Narrowing the supplier base is another essential activity in JIT. For example, a division of Xerox in its move toward JIT purchasing, reduced its number of suppliers from 5,000 to 300. Additionally, long-term contracts with suppliers will create mutual benefits. Benefits will accrue not only through pricing but by sharing technical data. A complete understanding of the process by the supplier and the customer will enable the process to be adjusted to maximize profits and foster the development of cross-functional teams to reduce costs while continually enhancing quality. In the initial negotiations, suppliers are made aware of the premium placed on the on-time delivery of high-quality goods in the exact quantity ordered. Companies that implement JIT purchasing choose their suppliers carefully. Price is not the only component in evaluating suppliers, the relevant costs of quality and also the costs of failure of delivery or late delivery are considered. For example, Wal-Mart 'fines' suppliers for late deliveries and incomplete orders. If the suppliers know that they are the sole supplier for a particular product to the customer, this will motivate them to go to great lengths to ensure that quality requirements are met if they want to keep the customer.

It is wise for a company using JIT to involve the freight carrier in the process. Inventories are costly and, when delayed, can have a negative impact on production schedules and customer service. Freight cost can be lowered through partnerships and expedited deliveries in smaller lots. This will support the JIT process through inventory reduction. Smaller lot sizes mean there will be greater movement from one work center to another. Products can no longer be partially assembled. Products must arrive on a *pull system*. This type of system produces only quantities necessary to fulfill the demands of the next operation. The quantity is pulled when it is needed, where it is needed, and in the exact quantity which is needed. The company will also need to ensure that the process has adequate response time to maintain an uninterrupted schedule. Companies can make great strides in JIT by reducing setup and changeover times for machinery. Just-in-Time philosophy recognizes that any motion which does not add value to a product increases the nonvalue added cost of the product. Reduction of setup and changeover time reduces the nonvalue added costs attached to a product.

One of the most important aspects of the JIT process is cooperation. Just-in-Time thrives on open, honest communication and trust among all people involved in the process. Employees must work together to improve the product and the process and they must be given incentives to do so.

Management must be open minded and willing to help in the change. Just-in-Time is a philosophy that stresses training, cooperation and preparedness to eliminate waste. When undertaking this philosophy, companies need to look internally to improve themselves. Once their internal work is executed to an acceptable level, they can look to their suppliers for support.

Quality is the most important part of any product. If a product is of poor quality, it will have a short life cycle. There is a cost involved. The cost of poor quality can be defined as the sum of all costs that would disappear if there were no quality problems. Examples of poor quality costs include scrap and rework, supplier corrective action, downgraded end product, warranty costs, loss of future sales, recall costs, and returned costs. JIT often is wrongly thought of as a way to decrease inventories alone. While the reduction of inventories is a major benefit of the JIT process, the increased product quality is the major benefit. This occurs as the result of the philosophy of JIT.

### Do it Right the First Time

Two main areas of quality affected by JIT are process and product quality. The first requirement of a successful JIT program is a stable process, that is a continuous production process with a level and constant output throughout a production period. Without a stable process, a large amount of work-in-process must be used to offset the lack of predictable daily output. In situations where there is an unstable output due to a poor process, there is often a large amount of costly rework. The way many companies solve this problem is through the use of statistical process control. Using trial and error experimentation, upper and lower limits are set for the process. Trial runs are made to determine the capability of the process to remain within these critical values. A control chart (X Bar & R) is then established for the operator to monitor the production process. These controls should yield immediate improvement in any production process. The process should be continually studied to identify further improvements or alternatives that will increase the yield in the production process.

The second requirement of a successful JIT program is to reduce work-in-process. This often requires downtime for certain operating units because most JIT programs will cut work-in-process down to a minimum number of units. This will result in some structural changes being made in the process. Operators will be cross trained to perform other jobs. This has various benefits. Absenteeism can be coped with easier because of a greater number of cross trained employees. The process can be improved easier because there will be a larger number of employees who are familiar with the overall process.

A third requirement of process improvement is to reconfigure the assembly area layout. The usual configuration

picked for the JIT process is a U-shaped assembly line. This is done for several reasons. Material flow is enhanced because the product goes from start to finish with no transportation required between operations. Hence, the configuration reduces the nonvalue added costs. The U-cell also has improved visibility. All operators can now see most of, if not all of, the entire assembly process. This allows operators to easily communicate with one another and react quickly to help each other if a problem develops. A final benefit to the U-cell is improved line balancing. The U-cell allows any operator to move easily between two or more workstations to assure work output is kept in sync at all workstations.

Measurable goals need to be established for the process. Often this is one area that is overlooked in many companies. Upper management must establish the objectives and set the tone of the JIT process. Management has to set the tone by establishing achievable and measurable goals that the workers can look upon as a way to measure their success in the JIT process. If these goals are not in place, the JIT process will often flounder after initial success.<sup>3</sup>

Another area of process improvement that must be examined is the critical role played by the buyer-supplier relationship. What companies would like to have is a vendor that will produce all the parts, defect-free and deliver them just-in-time. Once companies have their production process under control, they can turn their attention to the suppliers to improve their process. Some type of vehicle is needed to determine which supplying firms are capable of meeting the needs of the JIT process and thus, should be retained. One vehicle for making such a determination is the certification of vendors. The certification process for suppliers should include the following: the supplier should be part of the manufacturer's formal education program where the concept of JIT is introduced and the responsibilities of all parties involved are explained; the supplier should be utilizing statistical process control (SPC); the supplier should make a delivery commitment; and the supplier should have a quality assurance plan.

The manufacturer's education program is very important in the certification process. Customers must explain to suppliers why changes are needed and show by example how lot sizes, lead times, and setup times can be reduced. Companies are taking the initiative to train suppliers since this effort will be mutually beneficial for both parties involved.

Many reputable sources claim that up to 30% of all errors in the manufacturing process can be blamed on supplier delivery of defective parts.<sup>4</sup> To correct this problem, vendors need to utilize statistical process control (SPC). SPC provides measurements to monitor the process in order to get and maintain the process under control. If a supplier knows that its process is out of control, it must take corrective steps to ensure that it is supplying quality products. In this way quality can be maximized, and a zero defect level can be an approachable reality. This procedure which is



based on the philosophy of 'quality at the source,' allows many JIT users to eventually curtail the receiving inspection function and reduce costs. A number of large corporations such as Alcoa, Boeing, Hewlett Packard, Philip Morris USA, Harley Davidson, and General Electric have already benefited from this process.

A written quality assurance plan is advisable in the JIT process. This will assure that the customer and the supplier are in agreement on matters of SPC, delivery commitments, and performance. The quality assurance plan also provides a means of informing the supplier's employees of exactly what is expected of them and the commitment that their company has made in the area of customer service.<sup>5</sup>

Additionally, the delivery of the product is critical in the JIT process. However, it is not just delivering the product, but delivering the agreed upon quantity of acceptable product on time, neither before nor after the agreed-upon date.<sup>6</sup> This part of the process is not to be compromised. Delivery becomes even more important as the JIT effect ripples from the customer to the supplier and to the supplier's supplier.

With JIT management, a company can dramatically improve its product quality. The key is to ensure that all employees are properly trained. All employees need to be cross-trained in various jobs. Product quality can be increased by well trained employees. Often times management will accuse the hourly workforce of not caring and being lackadaisical. The real problem in many cases is that management has not trained the hourly workforce well and as a result, has created a workforce that is unsure of itself and the process. Companies operating in this manner are not making use of the full benefit of the talents of the worker.

Additionally, lowering inventory levels often results in the implicit benefit of improved quality. Using JIT, a company only holds enough inventory for current production, zero defects must be maintained. Once parts are put into production, attention to quality must continue since no finished goods inventory will be held.

### JIT Inventory Management

It is generally recognized that the implementation of JIT will result in significant reduction in inventory. Inventory levels are a key measurement of the JIT process. The JIT philosophy on inventory management is simple. It includes: strive for a level of zero inventories, produce items at a rate required by the customer, eliminate all unnecessary lead times, reduce setup costs to achieve the smallest economical lot size, optimize material flow from suppliers through the production process to the point of sale of the finished product, so that inventories are minimized, ensure high quality just-in-time delivery from suppliers, minimize safety stocks, implement a total quality control program which will minimize scrap, rework, and resultant delays in production.<sup>7</sup>

In JIT the raw materials and other purchased items should be delivered by the supplier when they are needed. A blanket purchase order or other form of a basic agreement should cover the terms and conditions for procurement. Communications between the customer and supplier should be clear to ensure that supplies are delivered on time. Several techniques exist for controlling the flow of material from supplier to customer. Automatic inventory replenishment by a vendor is a technique by which the supplier determines the need for required materials based on frequent deliveries to the plant. Also, the methods of written order for vendor delivery and verbal order for vendor delivery can be utilized.

Inventory records can be posted by backflushing. This is a method for automatic calculation of component usage by bill-of-material explosion of the end item for the quantity completed. It can be applied to a flow process as well as a batch process manufacturing operation. For low-unit-cost items the inventory records posting requirement can be eliminated altogether. Such items can be expensed when delivered and invoiced by the vendor. Visual controls usually suffice for reordering.

Each item should also be identified by an inventory policy code. This code is used to designate the specific method of inventory management to be applied to the item, such as automatic inventory replenishment by the vendor, vendor delivery based or verbal delivery based or written order. The inventory policy code identifies the methods that are used for each technique. The code must also define the requirement for transaction reporting and the degree of inventory record keeping. These may include one or more of the following options: transaction reporting of receipts, transaction reporting of issues, transaction reporting of serial number items, transaction reporting of scrap and rework, transaction reporting of returns to vendor, receipt and issue calculation based on backflushing, no transaction reporting nor perpetual balance in the inventory record.<sup>8</sup>

In the JIT manufacturing environment, inventory is "demand" pulled into and through the process on a part-by-part basis in small quantities. The movement of inventories is no longer from the storeroom to a work center, to a storeroom, to another work center and so on. JIT accounting systems are similar to process costing; the vehicle for collecting costs is the time in the system, not a work order. Direct labor does not have to be discretely tracked, and is often simply applied in total to overhead. This is referred to as "charging labor" to the process. This can be done because the labor portion of the product in a JIT manufacturing operation is small relative to the total manufacturing cost.<sup>9</sup>

Manufacturing inventory flows in JIT are compared to pipelines, but they are often referred to as "four wall systems." Once raw materials enter the four walls, they are not recorded again until they leave as finished goods. There are three reasons for this. First, the product does not spend enough

time in the plant to make several inventory recordings necessary. Second, the higher quality in JIT systems reduces rework and minimizes abnormal flow paths and times, lessening recordings needs. Third, in a JIT system product flows are disciplined and flow distances are short, lending a visual aspect to work-in-process inventory control.

### JIT Accounting

Obstacles to JIT accounting success can arise. Suppliers whose quality and delivery are inconsistent are incompatible with JIT systems. In addition, if long processes within the four walls exist, intermediate stock points for discrete measurement of items coming in and leaving may be set. The key is flexibility.<sup>10</sup>

With the modified process costing being used in JIT, the cost accountants have much less information to track. Accountants can be redeployed to aid in financial analysis for production and materials management in decisions such as, make-or-buy, cost reduction, and process improvements.

One barrier to cost-accounting implementation for JIT is the required financial reporting to external entities such as the government and stockholder. Financial and cost-accounting standards are not always compatible with JIT costing systems, and some companies may have to maintain parallel accounting systems and records for several years until JIT accounting methods are accepted. A company may find that their outside auditors may be the biggest barrier to JIT accounting implementation.<sup>11</sup>

### Conclusion

There is a definite downside to JIT. In the JIT system often a sole supplier is used for products for the manufacturing process. A company becomes vulnerable if that sole supplier shuts down for some reason. The General Motors Corporation recently faced such a problem. When the Lordstown body stamping and fabrication plant went on strike, the GM Saturn division was forced to shutdown. Lordstown is the sole supplier for about 300 Saturn parts. Eight more GM plants followed suit within days, at a daily cost to GM of between \$8 and \$10 million in pretax profits. It is easy to see that a JIT inventory management system intensifies the impact of a strike. General Motors plight painfully illustrates the risk of a JIT strategy: It puts a company at the mercy of its key suppliers.

In contrast to GM, farm machinery maker Deere & Company was able to maintain production when employees of a key supplier walked off the job. A real-time system drawing data from Deere's batch-oriented manufacturing system quickly identified the work adversely affected by the strike and helped Deere locate substitute suppliers.

Most manufacturers are moving towards long-term, sole-source relationships for custom parts in order to im-

prove the quality of the end product. Yet with real-time systems, manufacturers embracing sole sources become more highly susceptible to facing GM's fate someday: a production process stilled by a lack of alternative suppliers.<sup>12</sup>

Presently, there is a fair amount of resistance in moving to JIT as a global management philosophy, due primarily to a number of the inherent structural requirements that are inimical to change. One U.S. plant halted its implementation of JIT when the corporate directors became upset because the resulting reduction in inventory (considered an asset) caused the plant's asset-to-debt and asset-to-equity ratios to get smaller and produced financial statements which were looked upon unfavorably by the banks.

JIT also involves a difference in the way managers think; employees' suggestions become the backbone of the organization. Additionally, the elimination of costing and financial analysis may make managers feel they have lost control of the plant, because they now receive less data. The tendency of the stockholders to be short-term-profit oriented causes managers to plan for short-term results rather than long-term successes. This short-term thinking has damaged many American companies and must be curtailed if we are to compete in the global economy of the future. The JIT system has the makings of providing the competitive edge needed in the 21st century.

### Endnotes

1. Selim Noujaim, "A Blue for Successful JIT Implementation," *APICS*, p. 20, August 1992.
2. Gerald Plenert, "Three Differing Concepts of JIT," *Production and Inventory Management Journal*, p. 2, Second Quarter 1990.
3. Scott Ellis and Bill Conlon, "JIT Points the Way to Gains in Quality, Cost, and Lead-time," *APICS*, p. 18, August 1992.
4. R. Anthony Inman, "Quality Certification of Suppliers by JIT Manufacturing Firms," *Production and Inventory Management Journal*, p. 58, Second Quarter 1992.
5. *Ibid*, p. 59.
6. *Ibid*, p. 59.
7. Henry Jordan, "Inventory Management in the JIT Age," *Production and Inventory Management Journal*, p. 57, Third Quarter 1988.
8. *Ibid*, p. 58.
9. Moharn Tatikonda, "Just-in-Time and Modern Manufacturing Environments: Implications for Cost Accounting," *Production and Inventory Management Journal*, p. 3, First Quarter 1988.
10. *Ibid*, p. 4.
11. *Ibid*, p. 4.
12. Linda Wilson, "Saturn Thrown Out of Orbit," *Informationweek*, p. 21, September 14, 1992.