Just-In-Time (JIT) Manufacturing

Overview

- The Just-in-Time (JIT) Manufacturing Philosophy
- Prerequisites for JIT Manufacturing
- Elements of JIT Manufacturing
- Benefits of JIT Manufacturing
- Success and JIT Manufacturing
- Wrap-Up: What World-Class Producers Do

APICS Definition of JIT

"A philosophy of manufacturing based on planned elimination of waste and continuous improvement of productivity." …...

APICS Definition of JIT

"The primary elements of Just-in-Time are to:
- have only the required inventory when needed,
- improve quality to zero defects,
- reduce lead times by reducing setup times, queue lengths, and lot sizes,
- incrementally revise the operations themselves, and
- accomplish these things at minimum cost".

JIT Synonyms

- IBM - Continuous Flow Manufacturing
- HP - Stockless Production
        Repetitive Manufacturing System
- GE - Management by Sight
- Boeing - Lean Manufacturing
- Motorola - Short Cycle Manufacturing
- Japanese - The Toyota System

Time-Based Competition

- It is not enough for firms to be high-quality and low-cost producers.
- Today, they must also be first in getting products and services to the customer fast.
- To compete in this new environment, the order-to-delivery cycle must be drastically reduced.
- JIT is the weapon of choice today to reduce the elapsed time of this cycle.

Traditional View of Manufacturing

- Key objective was to fully utilize capacity so that more products were produced by fewer workers and machines.
- How? With large queues of in-process inventory waiting at work centers.
- Workers and machines never had to wait for product to work on, so capacity utilization was high and production costs were low.
- Result: Products spent most of their time in manufacturing just waiting, an arrangement that is unacceptable in today's time-based competition.

JIT Manufacturing Philosophy

- The main objective of JIT manufacturing is to reduce manufacturing lead times.
- This is primarily achieved by drastic reductions in work-in-process (WIP).
- The result is a smooth, uninterrupted flow of small lots of products throughout production.

Successful JIT Applications

- Most successful JIT applications have been in <u>repetitive manufacturing</u>, where batches of standard products are produced at high speeds and in high volumes.
- Successful use of JIT is rare in large, highly complex job shops where production planning and control is extremely complicated.
- Smaller, less complex job shops have used JIT, but operations have been changed so that they behave somewhat like repetitive manufacturing.

Changes Required for JIT

- JIT requires certain changes to the factory and the way it is managed:
  - Stabilize production schedules
  - Make the factories more focused
  - Increase work center capacities
  - Improve product quality
  - Cross-train workers
  - Reduce equipment breakdowns
  - Develop long-term supplier relations

Elements of JIT Manufacturing

- Eliminating waste
- Enforced problem solving and continuous improvement
- People make JIT work
- Total Quality Management (TQM)
- Parallel processing
- Kanban production control
- JIT purchasing
- Reducing inventories
- Working toward repetitive manufacturing

Eliminating Waste in Manufacturing

- Make only what is needed now.
- Reduce waiting by coordinating flows and balancing loads.
- Reduce or eliminate material handling and shipping.
- Eliminate all unneeded production steps.
- Reduce setup times and increase production rates.
- Eliminate unnecessary human motions.
- Eliminate defects and inspection.

Problem Solving and Continuous Improvement

- JIT is a system of enforced problem solving.
- One approach is to lower inventory gradually to expose problems and force their solution.
- With no buffer inventories to offset production interruptions, problems are highly visible and cannot be ignored.
- The job of eliminating production problems is never finished.
- Continuous improvement -- or <u>kaizen</u> -- is central to the philosophy of JIT.

Uncovering Production Problems

- We must lower the water level!
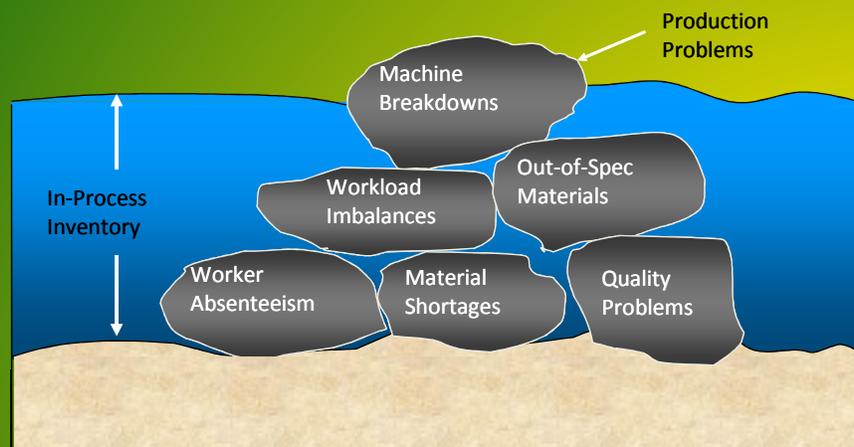
People Make JIT Work

- JIT has a strong element of training and involvement of workers.
- A culture of mutual trust and teamwork must be developed.
- An attitude of loyalty to the team and self-discipline must be developed.
- Another crucial element of JIT is empowerment of workers, giving them the authority to solve production problems.

TQM and JIT

- Long-term relationships with suppliers
    - Certified suppliers eliminate incoming inspection
    - Share design process for new products
- Simplify design/processes
    - Poka-yoke
    - Process capable of meeting tolerances
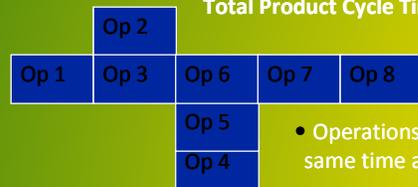   - Operators responsible for quality of own work

Parallel Processing

- **Operations performed in series:**

  Cycle Time for Each Operation = 1 Hour
  Total Product Cycle Time = 1 x 8 = 8 Hours

Op 1	Op 2	Op 3	Op 4	Op 5	Op 6	Op 7	Op 8

- **Operations performed in parallel:**

  Cycle Time for Each Operation = 1 Hour
  Total Product Cycle Time = 1 x 5 = 5 Hours

  Op 2

Op 1	Op 3	Op 6	Op 7	Op 8

  Op 5

  Op 4

  - Operations 2 and 4 start the same time as Operation 1

JIT: A Pull System

- In a <u>push system</u>, such as an MRP system, we look at the schedule to determine what to produce next.

- In a <u>pull system</u>, such as JIT, we look only at the next stage of production and determine what is needed there, and then we produce only that.

- As Robert Hall states, "You don't never make nothin' and send it no place. Somebody has got to come and get it".

Kanban Production Control

- At the core of JIT manufacturing at Toyota is Kanban, an amazingly simple system of planning and controlling production.
- Kanban, in Japanese, means card or marquee.
- Kanban is the means of signaling to the upstream workstation that the downstream workstation is ready for the upstream workstation to produce another batch of parts.

Kanbans and Other Signals

- There are two types of Kanban cards:
  - a conveyance card (C-Kanban)
  - a production card (P-Kanban)
- Signals come in many forms other than cards, including:
  - an empty crate
  - an empty designated location on the floor

Conveyance Kanban

Conveyance Kanban Card

Part number to produce: **M471-36**   Part description: **Valve Housing**

Lot size needed: **40**   Container type: **RED Crate**

Card number: **2 of 5**   Retrieval storage location: **NW53D**

From work center: **22**   To work center: **35**

Production Kanban

Production Kanban Card

Part number to produce: **M471-36**   Part description: **Valve Housing**

Lot size needed: **40**   Container type: **RED crate**

Card number: **4 of 5**   Completed storage location: **NW53D**

From work center: **22**   To work center: **35**

Materials required:
    Material no. **744B**   Storage location: **NW48C**
    Part no. **B238-5**   Storage location: **NW47B**

How Kanban Operates

When a worker at downstream Work Center #2 needs a container of parts, she does the following:

- She takes the C-Kanban from the container she just emptied.
- She finds a full container of the needed part in storage.
- She places the C-Kanban in the full container and removes the P-Kanban from the full container and places it on a post at Work Center #1.
- She takes the full container of parts with its C-Kanban back to Work Center #2.

Containers in a Kanban System

- Kanban is based on the simple idea of replacement of containers of parts, one at a time.
- Containers are reserved for specific parts, are purposely kept small, and always contain the same standard number of parts for each part number.
- At Toyota the containers must not hold more than about 10% of a day's requirements.
- There is a minimum of two containers for each part number, one at the upstream "producing" work center and one at the downstream "using" work center.

Calculating the Number of Containers between Work Centers

$$N = \frac{UT(1+P)}{C}$$

N = Total number of containers between 2 stations

U = Usage rate of downstream operation

T = Average elapsed time for container to make entire cycle

P = Policy variable indicating efficiency... 0 - 1

C = Capacity (number of parts) of standard container

Example: Number of Containers

There are two adjacent work centers, one of which is fed parts from the other. The production rate of the using work center is 165 parts per hour. Each standard Kanban container holds 24 parts.

It takes an average of 0.6 hour for a container to make the entire cycle from the time it leaves the upstream center until it is returned, filled with parts, and leaves again. The efficiency of the system is observed to be 0.2.

How many containers are needed?

Example: Number of Containers

- **Number of Containers, N**

$$N = UT(1 + P) / C$$
$$= 165(0.6)(1 + 0.2) / 24$$
$$= 99(1.2) / 24$$
$$= 118.8 / 24$$
$$= 4.95 \ \text{ or } \ 5 \text{ containers}$$

Essential Elements of JIT Purchasing

- Cooperative and long-term relationship between customer and supplier.
- Supplier selection based not only on price, but also delivery schedules, product quality, and mutual trust.
- Suppliers are usually located near the buyer's factory.
- Shipments are delivered directly to the customer's production line.
- Parts are delivered in small, standard-size containers with a minimum of paperwork and in exact quantities.
- Delivered material is of near-perfect quality.

Working Toward Repetitive Manufacturing

- Reduce setup times and lot sizes to reduce inventories
- Change factory layout to allow streamlined flows
- Convert process-focused layout to cellular manufacturing (CM) centers
- Install flexible manufacturing systems (FMS)
- …..more

Working Toward Repetitive Manufacturing

- Standardize parts designs
- Train workers for several jobs
- Implement preventive maintenance (PM) programs
- Install effective quality control programs
- Develop an effective subcontractor network

Benefits of JIT

- Inventory levels are drastically reduced:
  - frees up working capital for other projects
    - less space is needed
    - customer responsiveness increases
- Total product cycle time drops
- Product quality is improved
- Scrap and rework costs go down
- Forces managers to fix problems and eliminate waste .... or it won't work!