Lecture 9

Just-In-Time (JIT) Production

What is the meaning of Just-in-time (JIT)

- JIT is a materials management technique which ensures having the right part, at the right place, in the right amount, at the right time.
- It is a core principle of lean manufacturing philosophy.
- It is an approach to production and operations management that seeks to streamline the flow of material and information.
- JIT approach leads to less variability, shorter cycle time and less inventory.

What is Just-in-Time process?

- JIT is a Management philosophy of continuous and forced problem solving (forced by driving inventory out of the production system)
- In JIT process, supplies and components are 'pulled' through system to arrive where they are needed and when they are needed.

Goal: Achieve the minimal level of resources required to add the necessary value in the production system.

Objective of JIT

- Produce only the products the customer wants
- Produce products only at the rate that the customer wants them
- Produce with perfect quality
- Produce with minimum lead time
- Produce products with only those features the customer wants

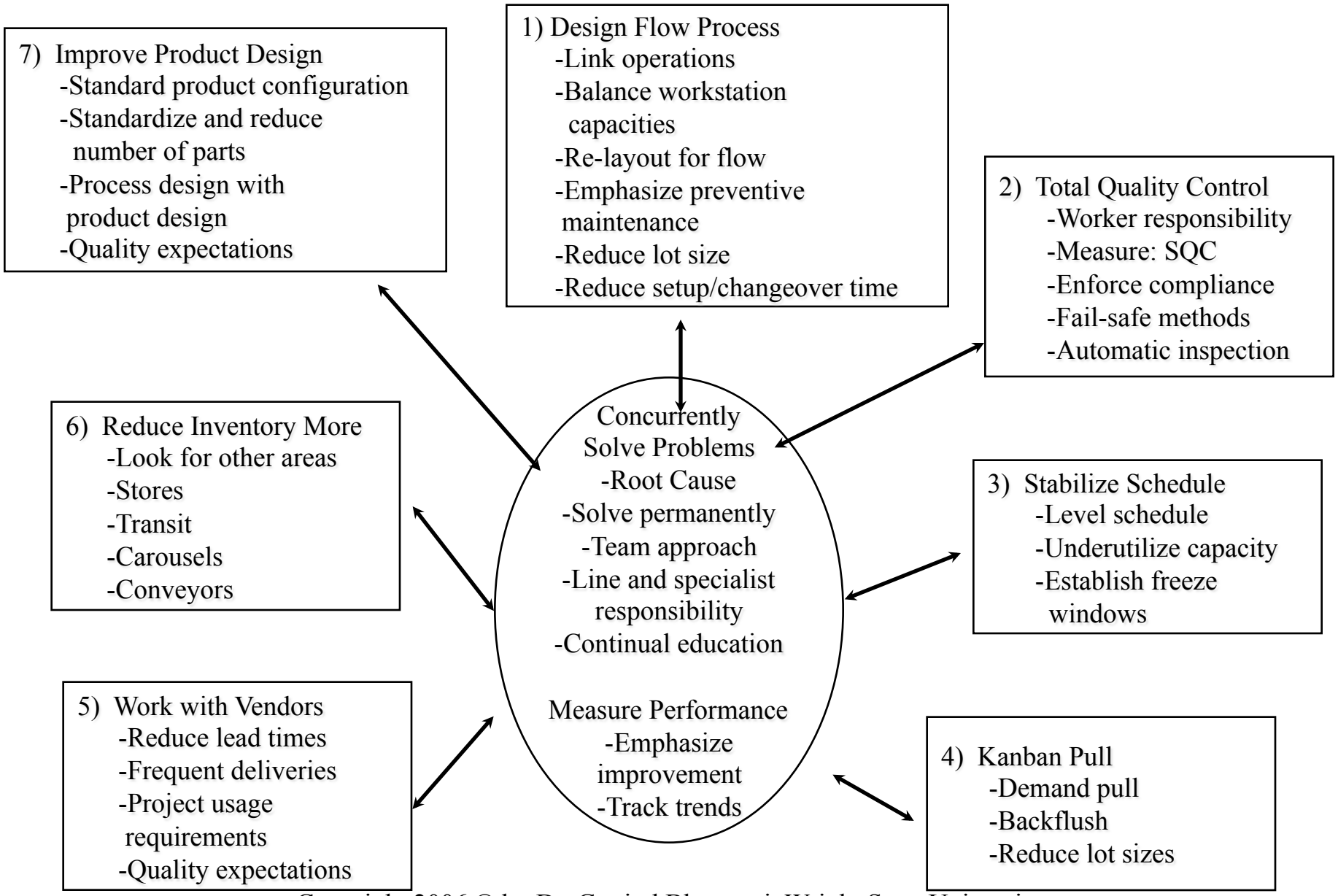
JIT Principles

- Create flow production
  - one piece flow
  - machines in order of processes
  - small and inexpensive equipment
  - U cell layout, counter clockwise
  - multi-process handling workers
  - easy moving/standing operations
  - standard operations defined

Quality enables JIT

- Processes are easy to understand and visible
- Quality issues are apparent immediately
- Scope of problems are limited because of lower inventory levels
- It can help management incorporate TQM

How to accomplish JIT production



JIT and Inventory reduction

- When an organization adopts JIT, the inventory level drops by a factor of 10.
- Reduction in inventory is not an explicit goal of JIT, but it the consequences of reducing the variability in the system.
- By reducing the variability & cycle time, the inventory level is reduced.
- JIT also provides the flexibility which reduces WIP and improves market responsiveness in the face of uncertain market demand.

Benefits of implementing JIT

- Quick response to customer demands.
- Shorter cycle time & customer lead time.
- More efficient utilization of resources.
- Greater reduction in inventory.
- Improved material flow due to less WIP.
- Less congestion & more flexibility.
- Lower production cost & higher profits.

Key elements of Just-in-time (JIT)

1) Schedule Level, mixed production
2) Maintain Production Tempo
3) Establish Single-Piece Flow
4) Develop Cellular Manufacturing layout
5) Use Lean Approach to Line Balancing
6) Involve suppliers into JIT delivery.

Element #1: Schedule Level, mixed production

- Level, mixed production is a tool for scheduling production quantity & product mix based on customer demand.
- The factory produces at the rate of customer demand, making what the customer wants & when the customer wants it.
- In this procedure, for a given period (daily or weekly), all the orders of one product are combined and spread evenly through the production schedule.
- The demands on the suppliers and on the production operation are evenly distributed.
- This minimizes the variability in demand for material, equipment & effort.

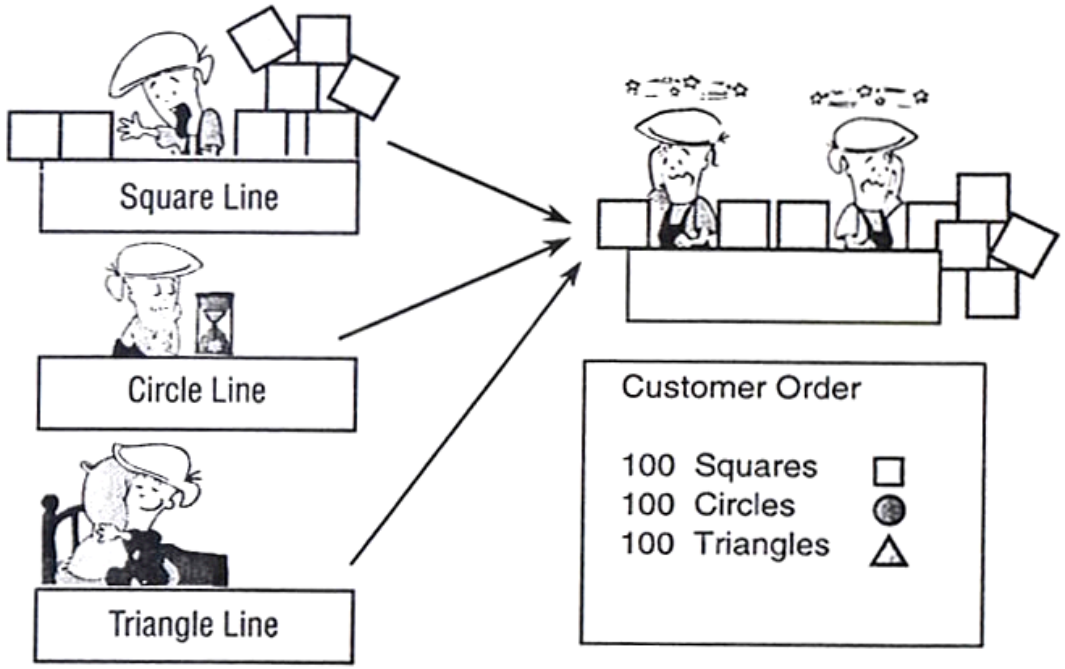
What interferes with the scheduling concept of level, mixed production?

- "Economies of scale" mindset
- Production runs based on Economic Order Quantity (EOQ) model
- Running large-lot sizes to reduce cost variances by the supervisor.
- Resistance for frequent changeovers.

What is bullwhip effect ?

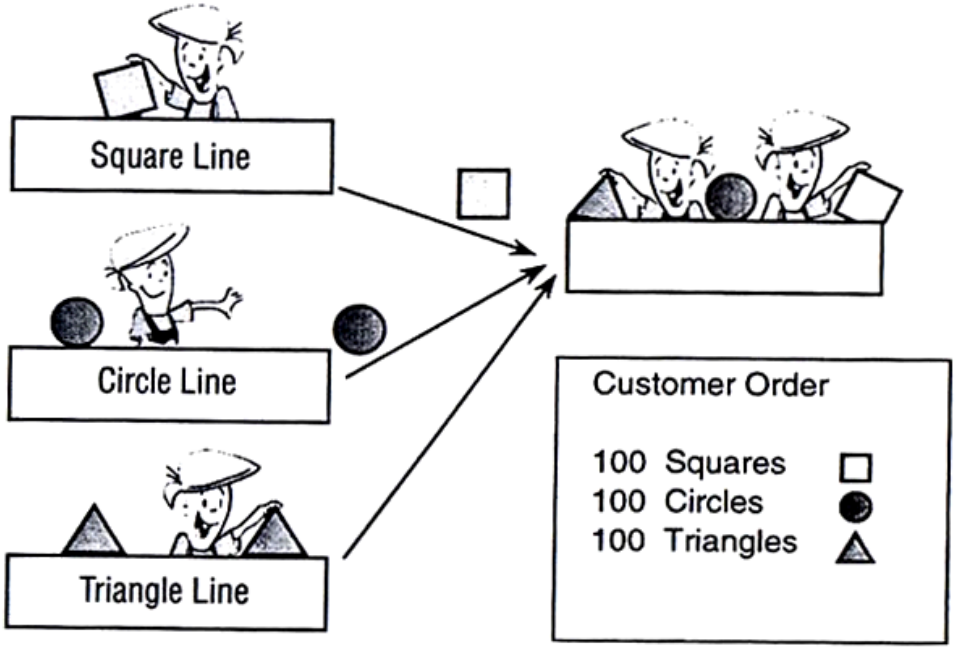
- It refers to disruptive variability brought about by uneven or erratic customer demand.
- The average demand may stay the same, but order peaks & valleys are large.
- This places a sudden increase in demand on the production floor.
- The supervisors often overreact & overproduce to satisfy the increased demand building WIP inventory.
- The purchasing department also increases orders from suppliers sometimes increasing order sizes.
- *Just like a bullwhip, any slight movement of handle causes a wave of motion that travels in increasing amplitude throughout the whip. This bullwhip effect causes havoc in production system.*

Traditional "Batch & Push" production



- All the production quantity is produced in large batches at the same time.
- This will result in long production lead time long customer waiting time based on the batch size.
- If the customer wants a smaller quantity of one item, he has to wait for the whole batch to be produced.
- By producing large quantity, the department may look efficient (labor efficiency) but the whole plant will suffer with large inventory & carrying cost.

JIT level smooth production



- Each cell produces enough quantity to fill the buffer (Kanban) based on the rate of customer usage.
- Production is matched to the rate of customer (internal or external) demand.
- Little or no finished goods inventory is required.
- The factory resources are properly used (never idle or overused).
- The bullwhip effect does not transmit variability in the operation or suppliers.
- It leads to shorter lead time to the customers

Element # 2: Maintain Production Tempo

$$\textit{Takt}\ \text{Time} = \frac{\text{Available Work Time}}{\text{Customer Demand}}$$

- Maintain the production rate to customer demand rate.
- This involves establishing production schedules, line rates, staffing levels & delivery arrangements with the suppliers.
- Use Takt time to schedule production rate.

How to use Takt time to maintain production tempo

Takt time = Available work time / customer demand

Production demand

(Square) Part 1 = 840 pieces per day

(Circle) Part 2 = 420 pieces per day

(Triangle) Part 3 = 1260 pieces per day

Available work time

480 minutes per shift - 30 min. (lunch) - 30 min. (2 breaks) = 420 min. per shift

Available work time for 2 shifts = 420 x 2 = 840 minutes = **50,400** seconds / shift

Takt time

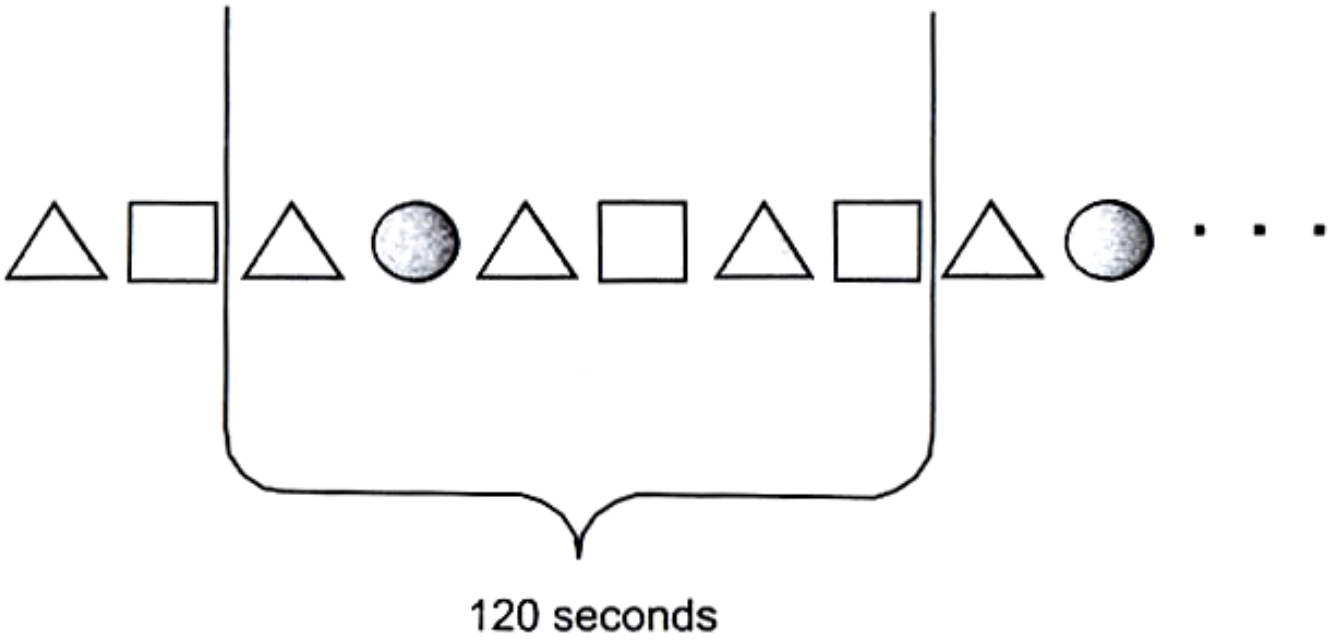
Takt time for part 1 = 50,400 / 840 = 60 seconds

Takt time for part 2 = 50,400 / 420 = 120 seconds

Takt time for part 3 = 50,400 / 1260 = 40 seconds

Overall Takt time = 50,400 / 2520 = 20 seconds / piece

Production sequence using Takt time

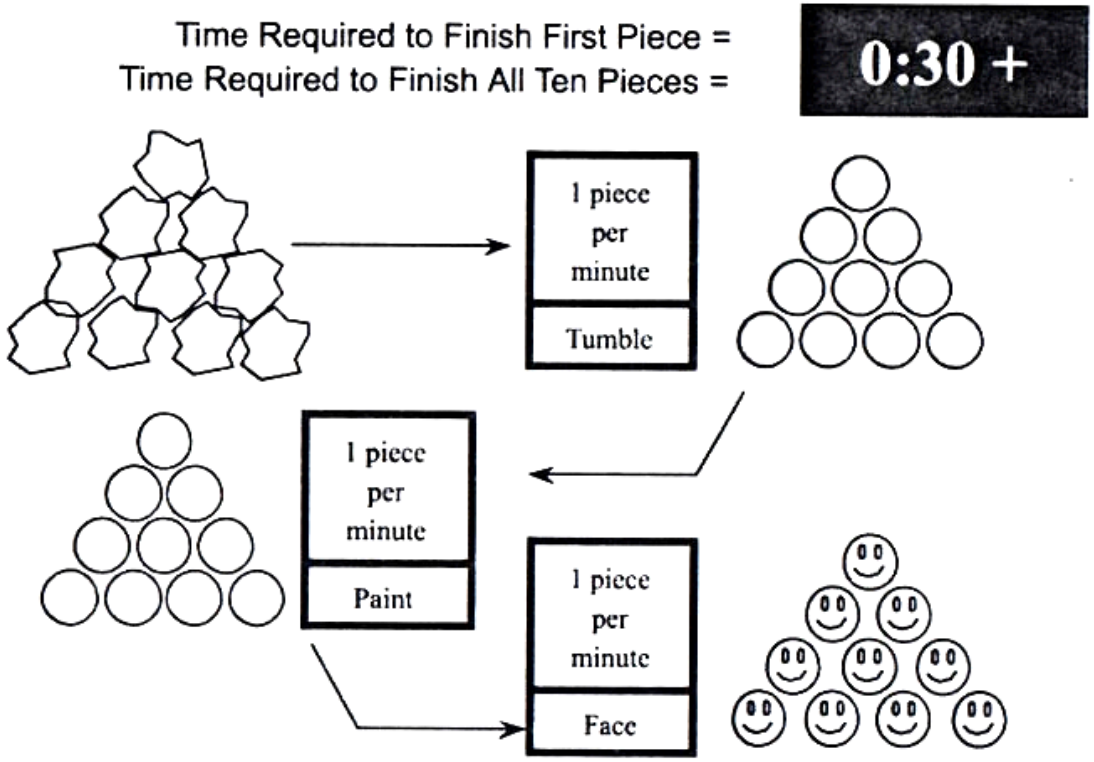


- On average, 1 piece is produced every 20 seconds.
- 1 square (part 1) is produced every 60 seconds
- 1 circle (part 2) is produced every 120 seconds
- 1 triangle (part 3) is produced every 40 seconds

Element # 3: Establish Single-Piece Flow

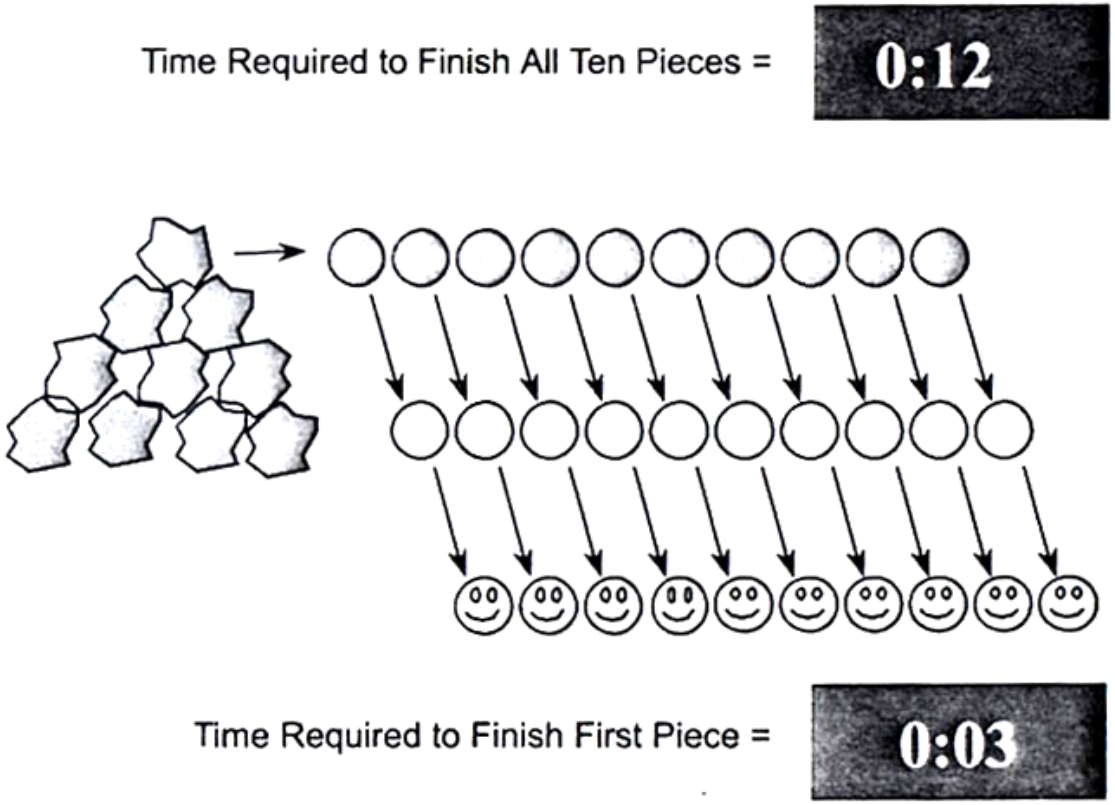
- Single piece flow is one of the most important element of JIT production.
- It is also sometimes referred to as “one-piece flow” or “continuous-flow production”.
- Single-piece flow is the uninterrupted movement of material through the factory(a single piece at a time).
- It is most efficient way to process material through a factory.
- Single-piece flow is best suited for assembly rather than machining processes such as molding, forming, grinding, casting, plating etc.

Batch & Push Production



- It takes 30 minutes to complete the order plus any additional time needed to count, inspect, stage and move the part from one process to the next.
- Minimum of 30 minutes elapses before even one piece is ready for the customer.
- Not one piece can be sold to the customer until the entire batch is completed.

Single - Piece Flow Production



- In this process, the part is moved immediately to the next station as soon as it is ready.
- The entire order is completed in 12 minutes & it takes 3 minutes for the first part to be ready for the customer.
- The production is very flexible to changes in customer demands.

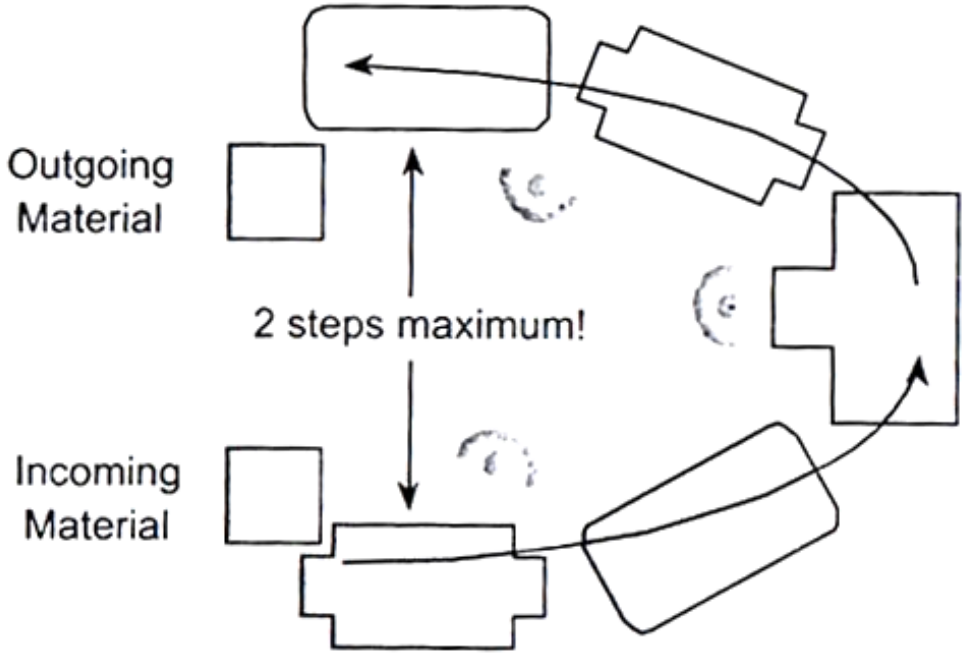
Element # 4:
Develop Cellular Manufacturing layout

- One way to achieve the single-piece flow is to develop manufacturing cells.
- The equipment is located & arranged in sequence.
- The part is moved one by one from one machine to the next.
- The production rate in the manufacturing cell is determined by the customer demand & Takt time.
- Each operation in the cell must have a processing time that is strictly less than the Takt time.
- The layout of manufacturing cell is determined by the sequence of operation.

Guidelines for cell design

- No overproduction allowed
- Consider ergonomics & material presentation
- Workers should be able to stand and move among the workstations
- Use fixtures and clamps instead of manual adjustment
- Do manual work in parallel with machine work
- Never pass on a defective part for future rework

A typical U-shaped cell

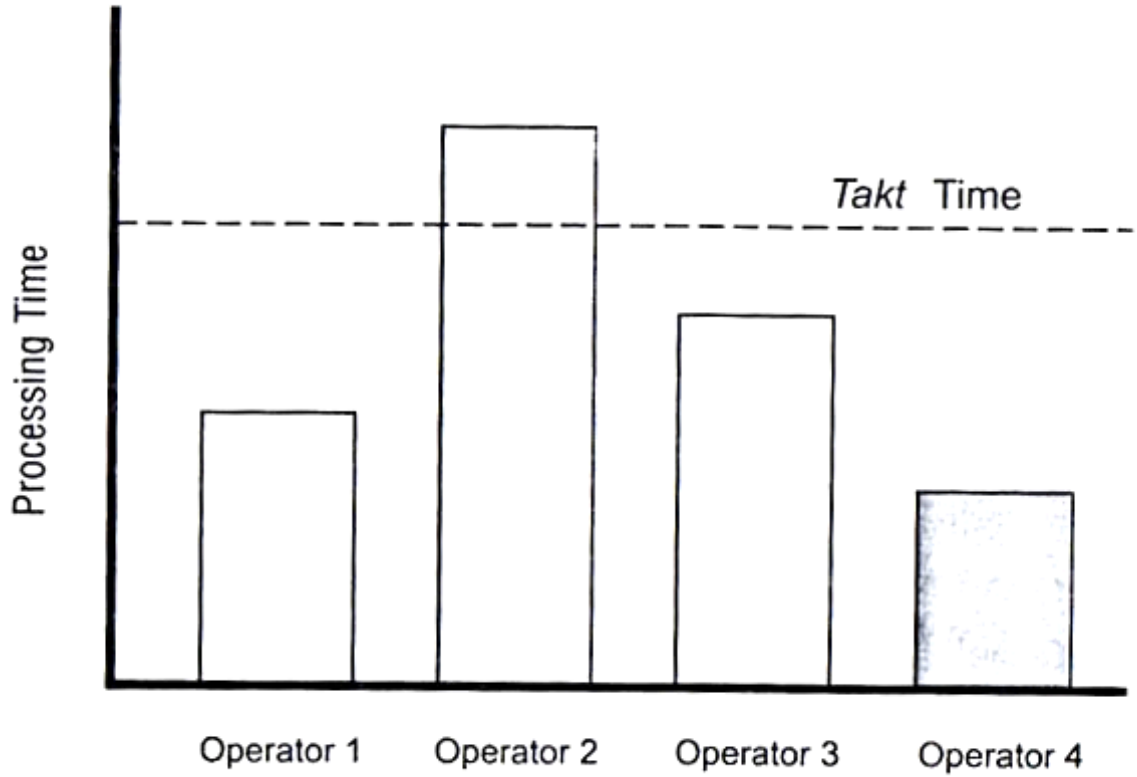


- The workers are inside the "U" & can perform multiple tasks.
- Workers on the inside reduces the distance traveled by the part on its way through the cell.
- Proximity promotes teamwork & it is easier to see the next worker as a customer.
- Production output of the cell can be easily adjusted by changing the staffing level.

Element # 5: Lean Approach to Line Balancing

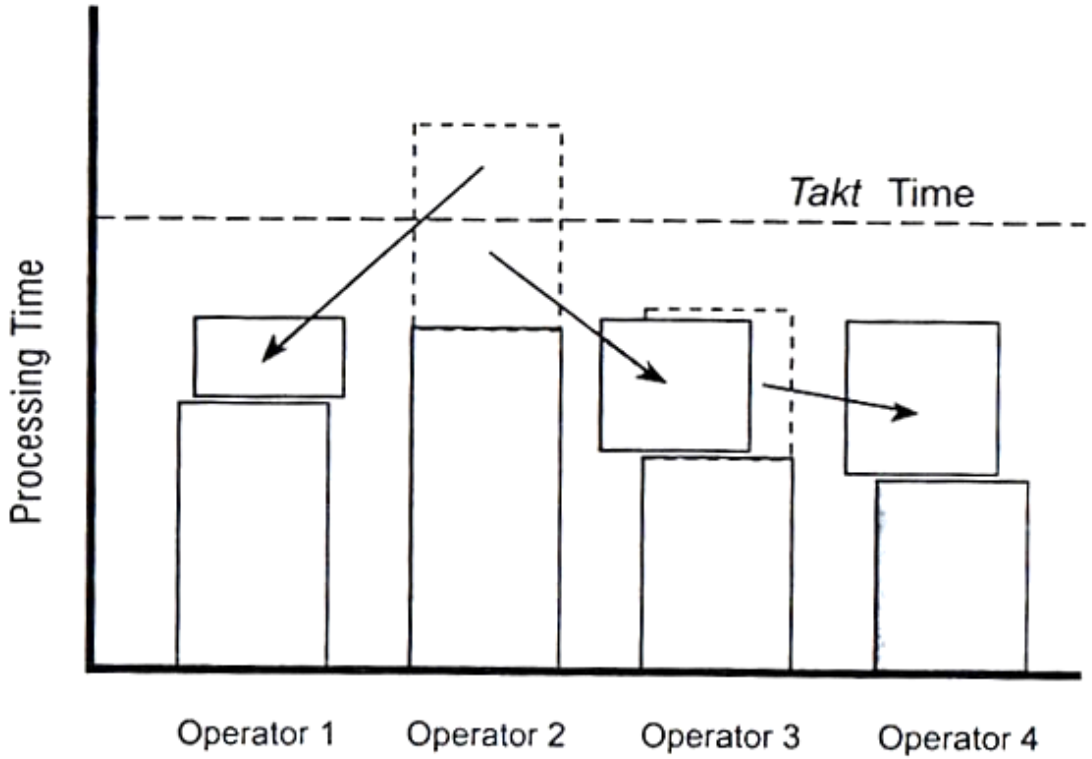
- Line balancing is a technique of equalizing each operator's workload when number of workers perform many production tasks on a production line.
- It is a well-known technique used in industrial engineering.
- The line can be "balanced" in a traditional sense by transferring work elements until all operators have approximately the same workload.
- The goal is to make adjustments, such that the work can be completed within the Takt time.

Current operation which is unbalanced



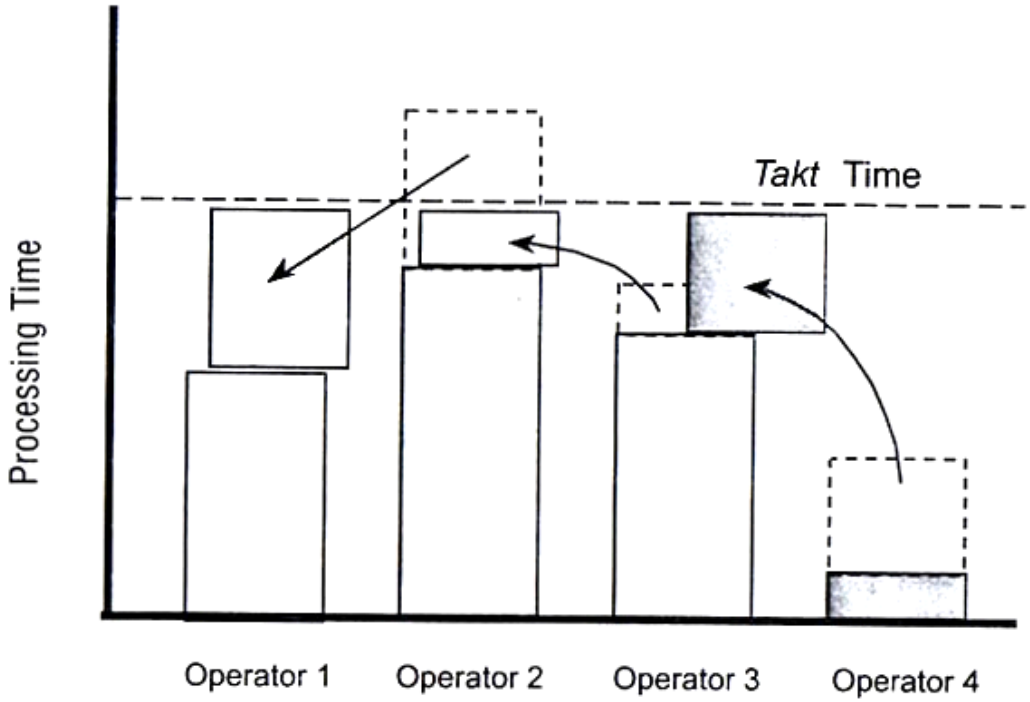
- Notice that the time required for operator # 2 to complete his task is longer than Takt time.
- This cell therefore cannot satisfy customer demand.

Line balancing using traditional approach



- The traditional approach balances the workload by transferring work elements until all operators have approximately same workload.
- In this case the work can be completed within the Takt time & customer demand can be met.
- Unfortunately the cell production rate is much faster than the tempo established by Takt time (production time is much lower than Takt time).
- This can lead to overproduction and all the "waste" associated with it.

Line balancing using Lean Manufacturing approach



- In this approach, work elements are distributed so that the amount of time required for each worker to complete his task is slightly less than the Takt time.
- This will result in one of the workers (operator 4) being underutilized.
- This creates an opportunity to improve operation 4 using kaizen and eliminate that operator or add other value-added work on operator 4.

Element # 6: Just-In-Time (JIT) Delivery

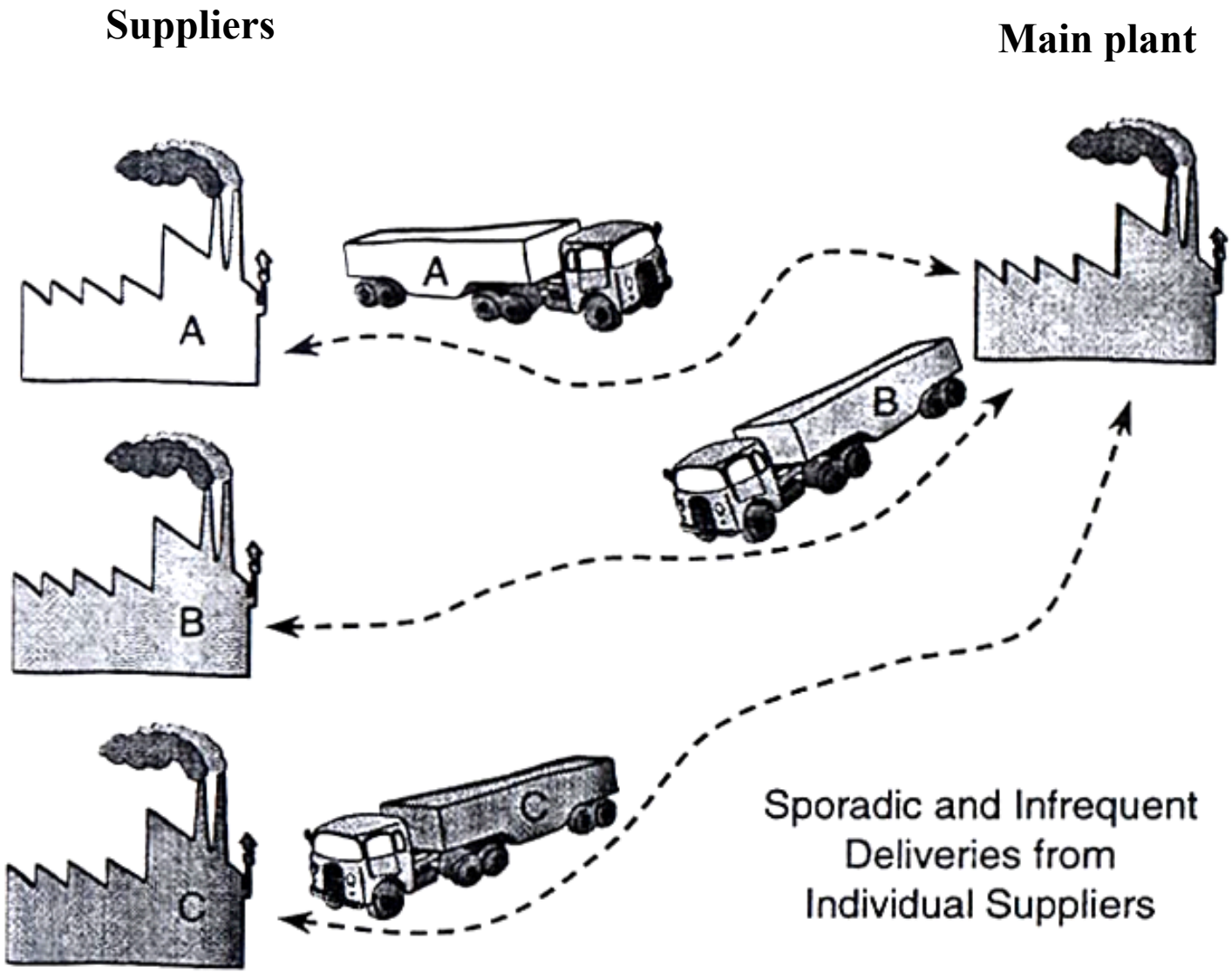
Traditional delivery approach

- In a traditional approach, the parts are delivered to the factory by suppliers in large quantities (weeks or months).
- This is based on Economic Order Quantity (EOQ) from the company's MRP system.
- Material Handling & QC.. departments prefers large quantities to increase their individual efficiencies.
- The overall plant suffers due to longer lead time & reduced flexibility.

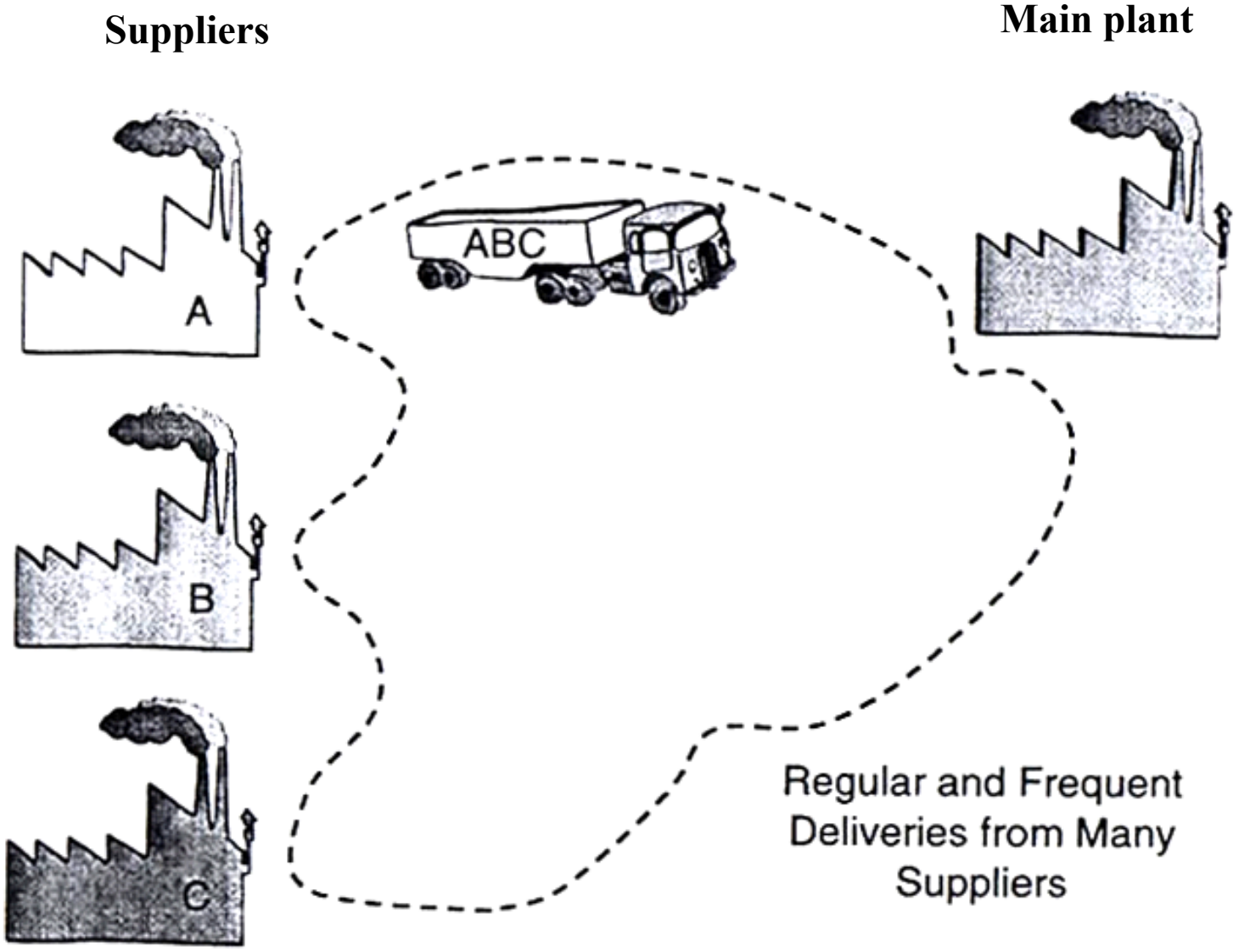
Just-in-time (JIT) delivery approach

- In JIT approach, factory gets regular frequent deliveries of production material in much smaller quantities from suppliers.
- Additional shipping costs are offset by lower inventory carrying cost.
- Mixed load delivery is becoming very important for JIT. In this process, an individual truck makes stop at several suppliers to pick up parts. It is also known as "milk run"..
- JIT production and JIT delivery. are two different processes. JIT delivery without JIT production can be counter productive.

Example of traditional delivery approach



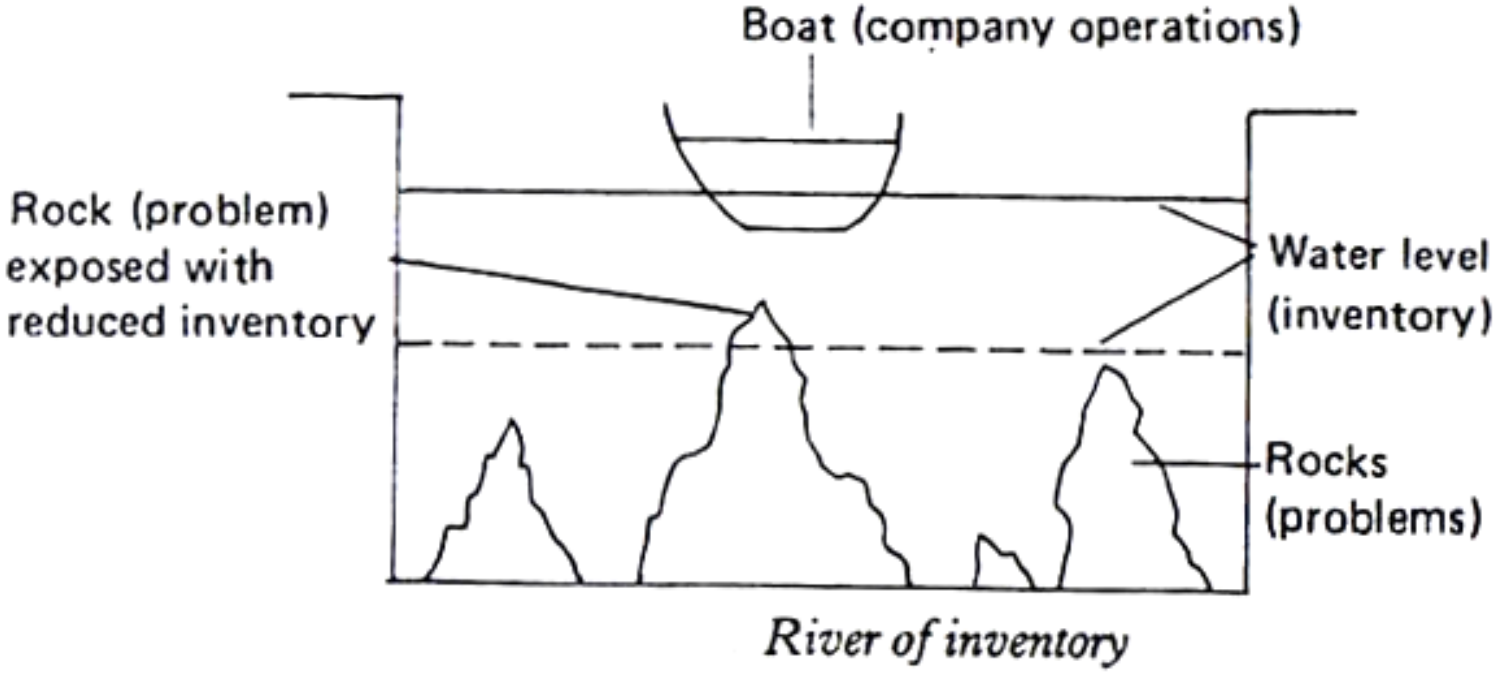
Example of JIT mixed load delivery (milk run)



Strategies for implementing JIT

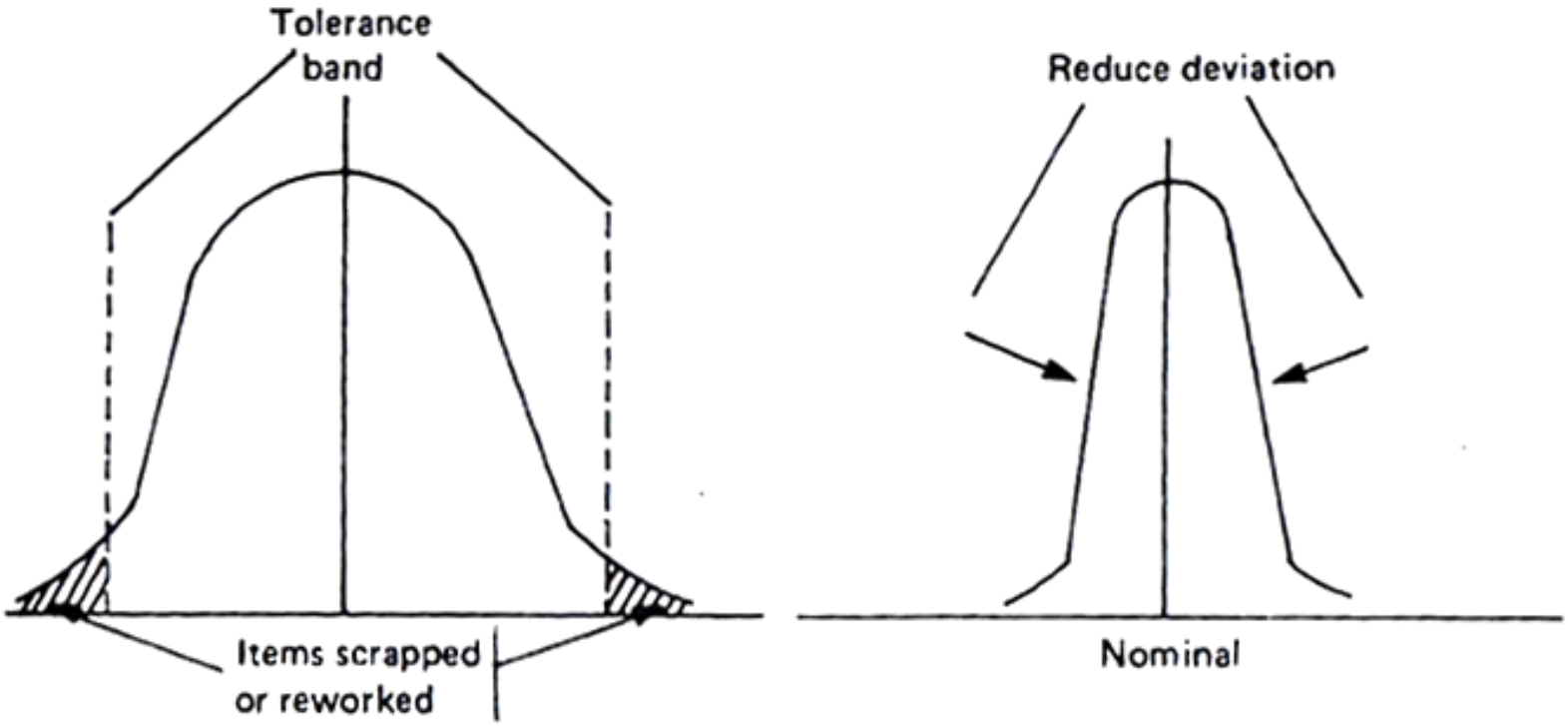
1) Attack fundamental problems(waste)
2) Improve process reliability
3) Strive for simplicity
4) Device systems to identify problem

Strategy #1: Attack fundamental problems

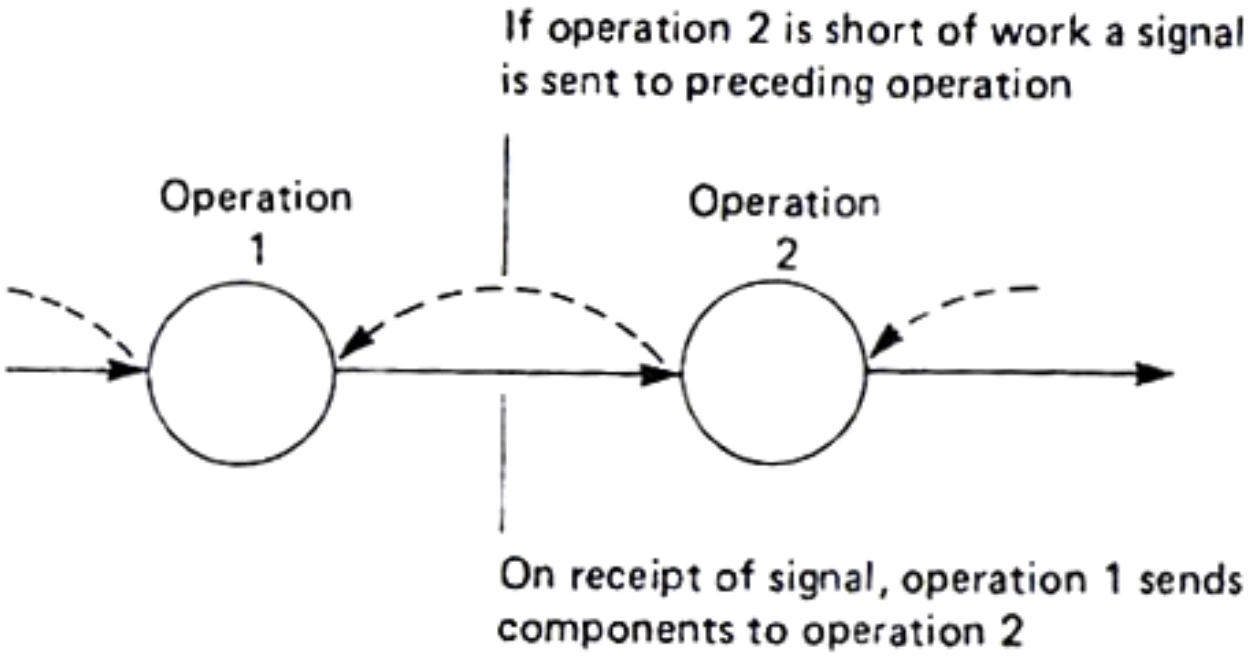


Problems (Rocks)	JIT solutions
• Unreliable machine	Improve reliability
• Bottleneck areas	Increase capacity
• Large lot size	Reduce set up time
• Long lead time	Use pull system
• High rejects	Check processes and/or suppliers

Strategy #2: Improve process reliability



Strategy #3: Strive for simplicity

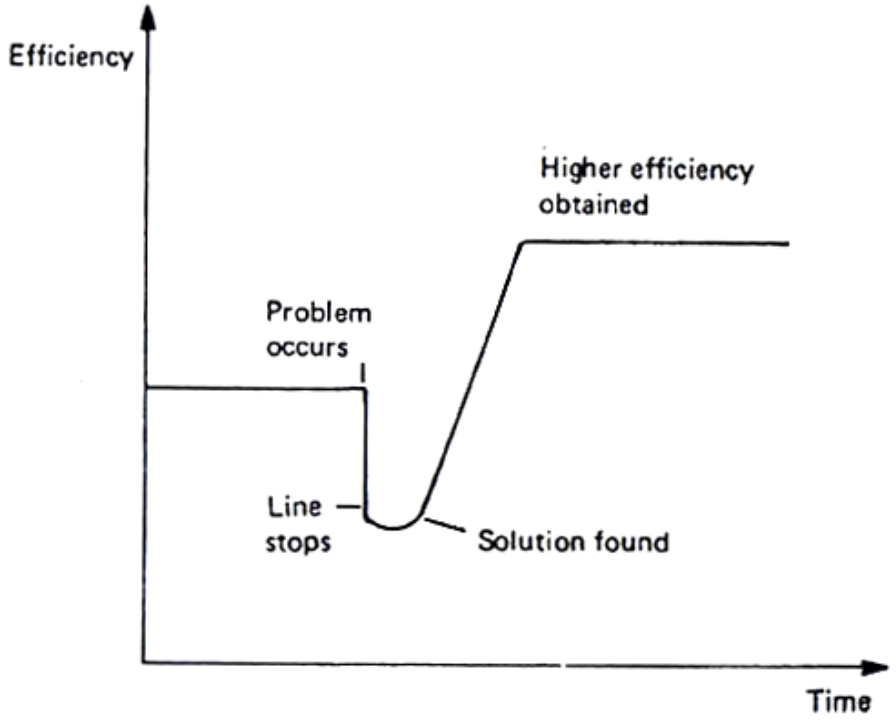


Two areas to strive for simplicity

1) Material flow: Simplify material handling & material flow

2) Control: Simplify control system by using Kanban

Strategy #4: Device systems to identify problem



- Set up mechanisms & procedures so that problems are identified without fear of reprimand.
- Be prepared for short term drop in efficiency for long term gain. (example: shut down the assembly line)