Process Design & Analysis

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251

Process & Capacity Analysis
Context

- Decisions taken with respect to
  - The amount of capacity that an operating unit has
  - The manner in which the existing capacity is put to use

  will lead to loss of productivity & overall reduction in the profitability of the operating system
- Examples
  - Excessive delay and waiting in service systems such as a teller counter in a bank
  - Some factories working with near 100 percent utilization of their resources

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Issues in Process Analysis

- Do I have adequate number of resources to meet the demand?
  - *If I need to add some extra resources where should I add?*
- What is the utilization of my resources?
- If I need to increase the capacity of my system how should I modify the process?
  - *Should I add some more resources?*
  - *What will the cost of my operation?*
- One can find answers to the above questions by *process analysis*

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Process Analysis
Definition & Scope

- Process analysis utilizes some analytical mechanism to understand the impact of
  - process design on output, cost or any other performance metric
  - alternative process configurations on the chosen performance metric

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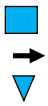
Process Flow Charting

- Design & Analysis of process begins with identification of
  - activities that constitute the process
  - time taken for each of the activity
  - nature of flow of materials/information in the process.
- A pictorial representation of all these information could be developed using *process flow charting*.
- Process flow charting employs a set of standard symbols and graphical tools to represent all the information pertaining to the process
- The symbols used are
  - A step in the Process
  - Transportation (Move)
  - Storage or Inventory



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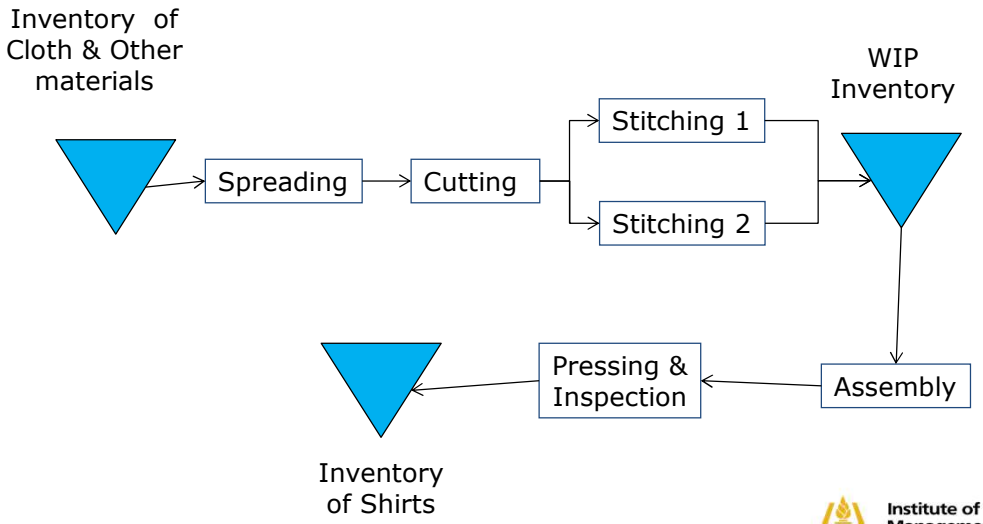
255

A Simplified Process Flow Chart

Case of Shirt Manufacturing



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Process Analysis

Performance Metrics

- *Throughput time*: Throughput time (TPUT) is the elapsed time from the first stage of the process to the last stage of the process. It is also known as lead time.
- *Cycle Time*: Cycle time is the elapsed time between two successive output from a process that is continuously operating in a given period of time.
- *Bottleneck*: That stage of the process that dictates the output of a process is the bottleneck.
- TPUT is a relevant measure for MTO systems.
- Measures such as Cycle Time and Bottleneck are relevant in the case of MTS systems.

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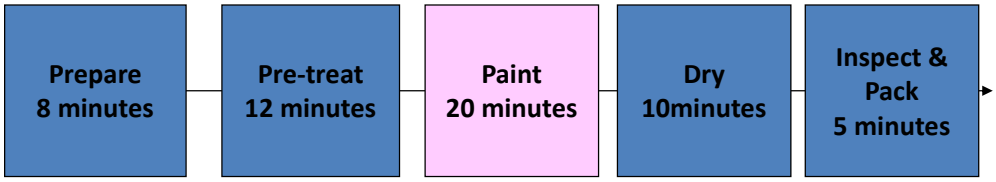
Process Analysis

Toy Manufacturing (Example)



- *The throughput time for the process is 55 minutes*
- *The spray painting is the bottleneck in the process*
- *Cycle time is 20 minutes. The implication of this is that when the process operates in a continuous manner, a pallet of finished toys come out every 20 minutes.*

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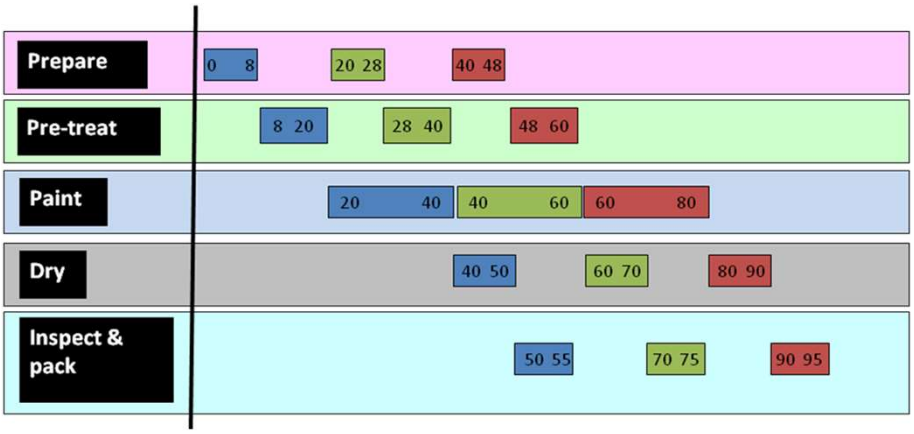
Process Analysis (Example)

A graphical representation with start and end times



Every batch of four toys come out exactly in an interval of 20 minutes which is the cycle time for the process

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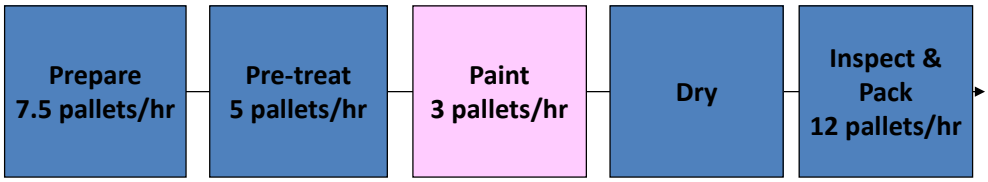
Process Analysis (Example)

Production Capacity of the system



- *The system can produce at the rate of 3 pallets per hour (12 toys)*
- *For a 8 hour operation the daily production is 24 pallets (72 toys)*
- *Capacity is unbalanced across different stages of the process*

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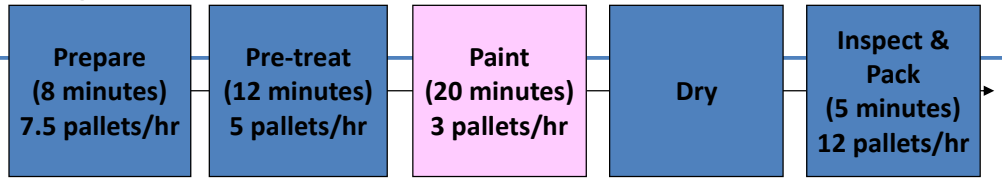
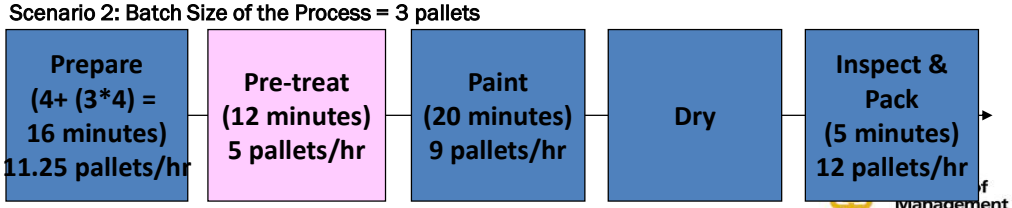
Production Capacity under varying batch sizes (Example)

Existing Scenario: Batch Size of the Process = 1 pallet



Scenario 1: Batch Size of the Process = 2 pallets

Scenario 2: Batch Size of the Process = 3 pallets



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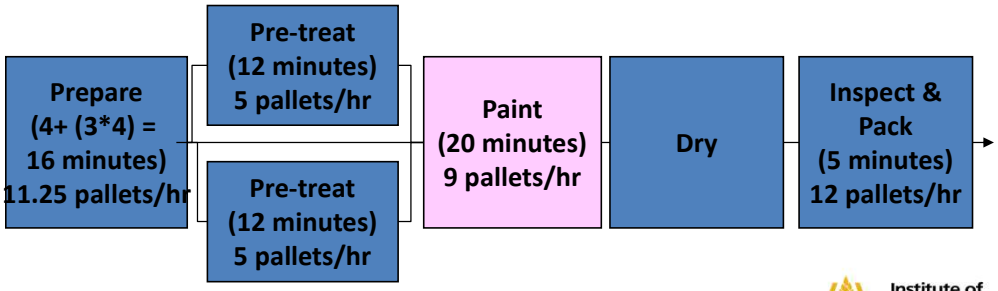
Production Capacity under varying resource availability (Example)

Existing Scenario: Batch Size of the Process = 1 pallet, 1 painting booth

Scenario 1: Batch Size of the Process = 3 pallets, 2 pre-treatment units



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Process Analysis (Example)

Some important observations

- Batch sizes play a crucial role in determining the bottleneck of a process
- As several choices are made with respect to the resources and batch size bottleneck shifts from one stage of the process to another. This is referred to as *wandering bottleneck*.
- A process analysis exercise often leads to the issue of improving the process

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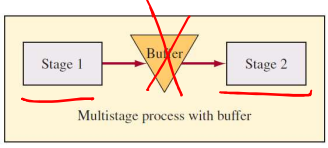
Buffering, Blocking, and Starving

- **Buffer:** a storage area between stages where the output of a stage is placed prior to being used in a downstream stage
- **Blocking:** occurs when the activities in a stage must stop because there is no place to deposit the item
- **Starving:** occurs when the activities in a stage must stop because there is no work
- **Bottleneck:** stage that limits the capacity of the process



Multistage process with buffer

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Production Process Mapping and Little's Law

Total average value of inventory

- Sum of the value of raw materials, work-in-process, and finished goods inventory

Inventory turns

- Cost of goods sold divided by the average inventory value

Days-of-supply

- Inverse of inventory turns scaled to days

Little's law

- There is a long-term relationship among inventory, throughput, and flow time
- Inventory = Throughput rate x Flow time