

# **BE 102- Design and Engineering**

## **Module 3**

## **Module 3 - 15 % Marks**

### **2 Hours Lecture**

Design Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis

### **3 Hours Lecture**

Engineering the design – From prototype to product. Planning; Scheduling; Supply chains; inventory; handling, manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design.

### **4 Hours Project**

List out the standards organizations. Prepare a list of standard items used in any engineering. Develop any design with over 50% standard items as parts.

# PROTOTYPING

*Prototype is the first fully functional product made as per design.*

- ❑ It is also done for some part alone to study certain requirements.
- ❑ Prototyping is done using the materials specified so that their performance is also taken into account.
- ❑ This some times is a costly and time consuming procedure.
- ❑ Models are used in certain designs to understand the specific performance of that part or product. (Aircraft, buildings, ships, rockets etc.)
- ❑ RP is replacing the conventional prototyping method.

## RAPID PROTOTYPING

- **Rapid Prototyping** is a general term encompassing techniques used to create 3D physical models directly from electronic data.
- Primarily uses method of layer by layer or additive means of construction – “*Additive layer Manufacturing*”
- Also known as *3D printing*

*CAD File > .stl File > split to layers > 3D printing > Post processing*

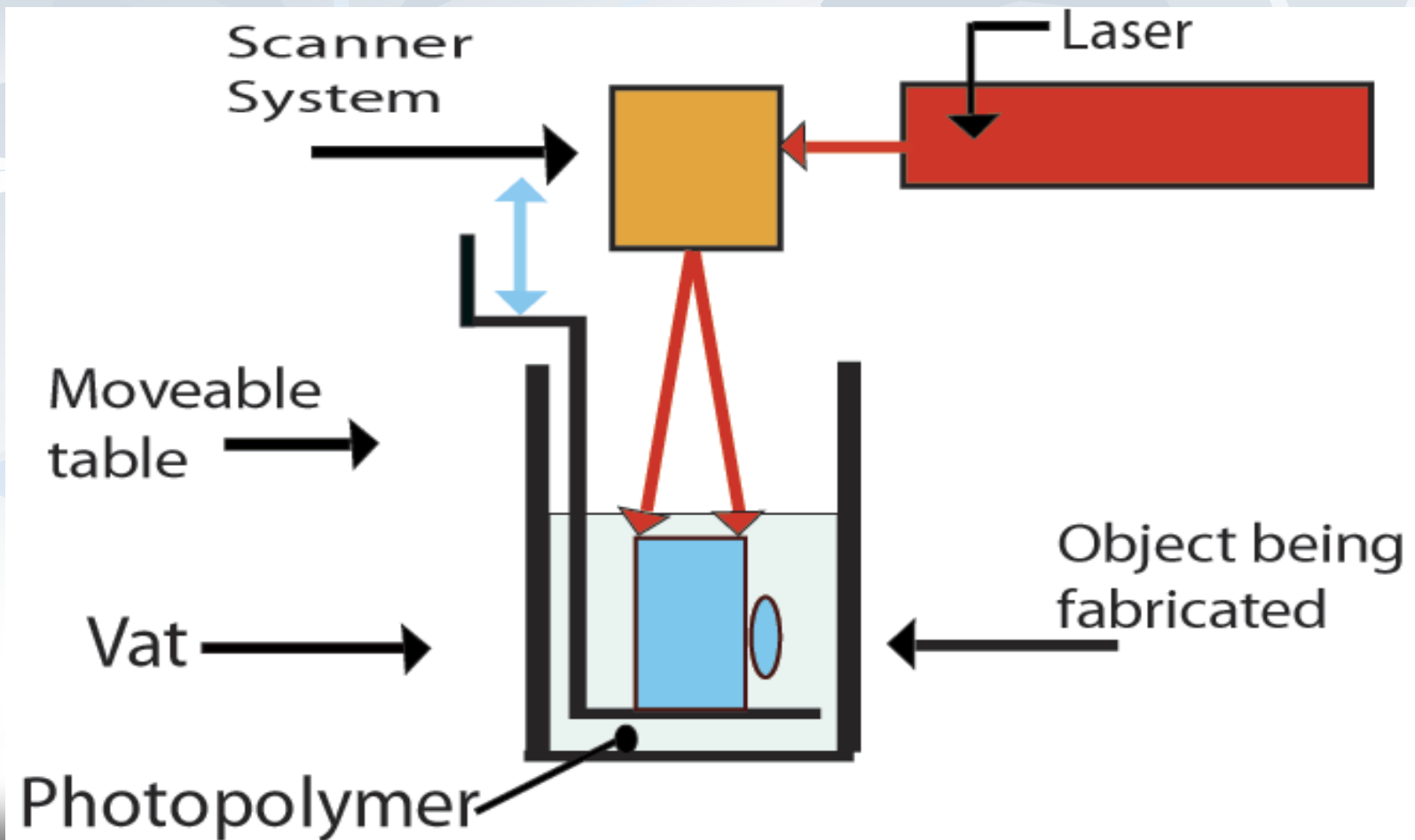
- *Mainly has three techniques:*
  - *Stereolithography.*
  - *Fused Deposition Modeling.*
  - *Selective Laser Sintering.*

# STEREOLITHOGRAPHY

- Concept models, form & fit study, Master patterns for molding techniques.
- The Equipment consist of a vat containing photopolymer.
- **Each layer is formed by solidifying the photopolymer using UV laser.**
- UV Rays are positioned using x – y scanner system.
- Once a layer is done then platform moves one layer down.
- A blade sweeps over , evenly spreading the polymer.
- After completion the object is post processed : chemical wash to remove excess resin, cured in UV oven, Remove supports.

# STEREOLITHOGRAPHY

- [../Innovative designs/Video 13 Stereolithography.mp4](#)

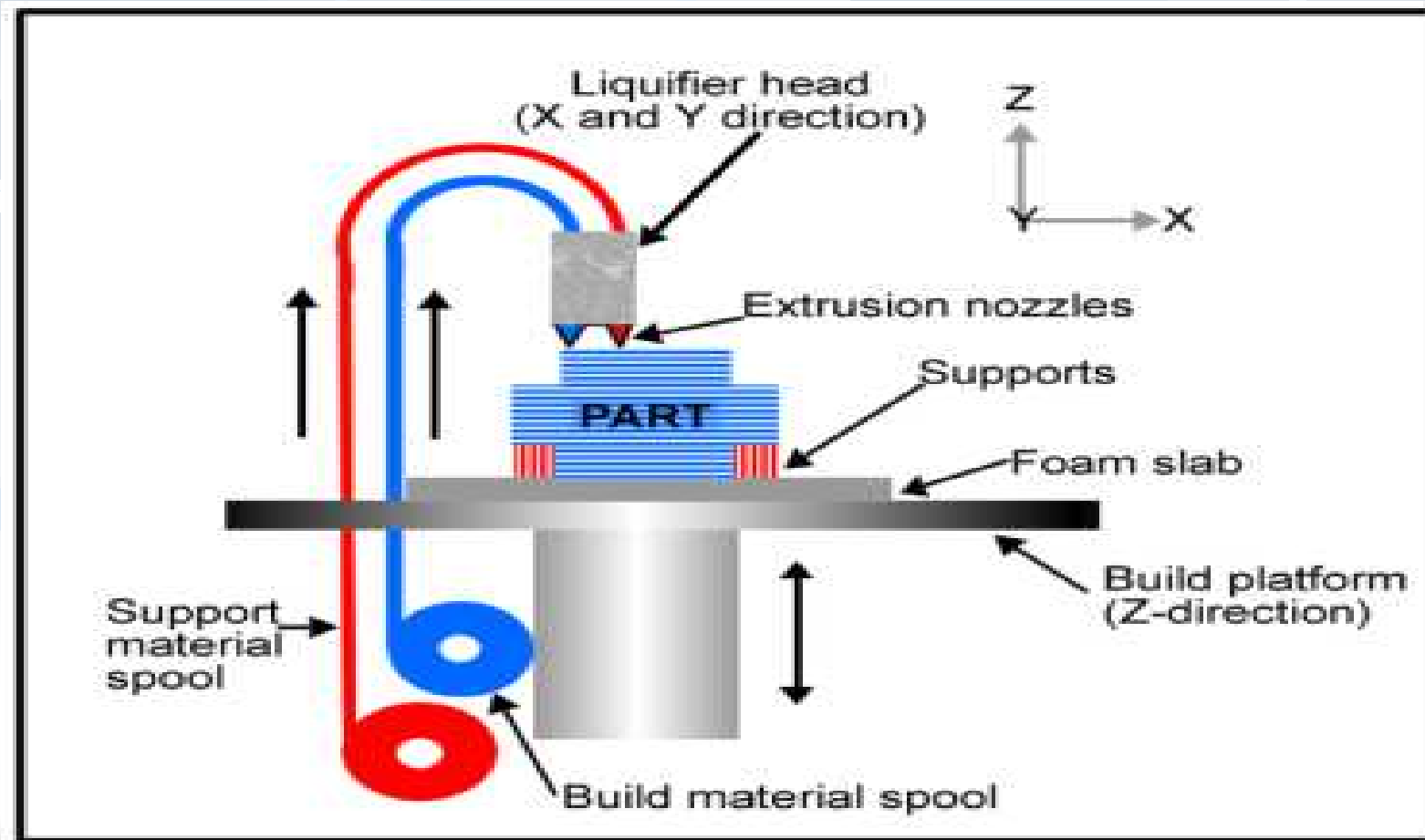


## **FUSED DEPOSITION MODELING**

- ❑ **Production grade Thermoplastics for making prototypes or parts.**
- ❑ **Concept models, Functional prototypes, manufacturing aides.**
- ❑ **Thermoplastic and support material are in thin thread like form stored in spool.**
- ❑ **They are taken from spool arrangement, heated and passes through extrusion nozzles.**
- ❑ **The nozzles carefully places the build material and support material.**
- ❑ **Nozzle moves in x-y plane while the platform lowers.**
- ❑ **After completion goes for post processing.**

# FUSED DEPOSITION MODELING

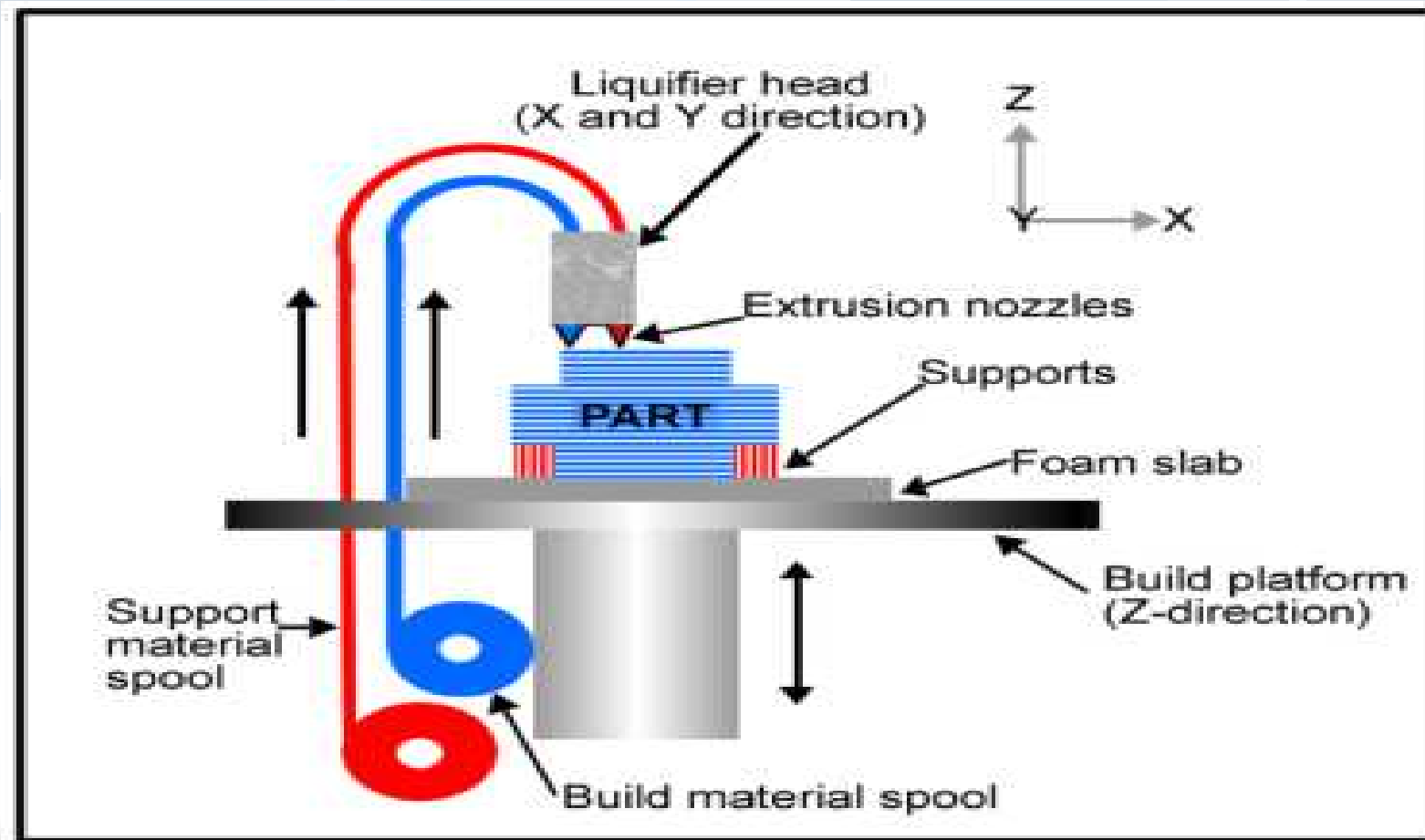
- [..|Innovative designs|Video 14 Fused Deposition Modeling](#)



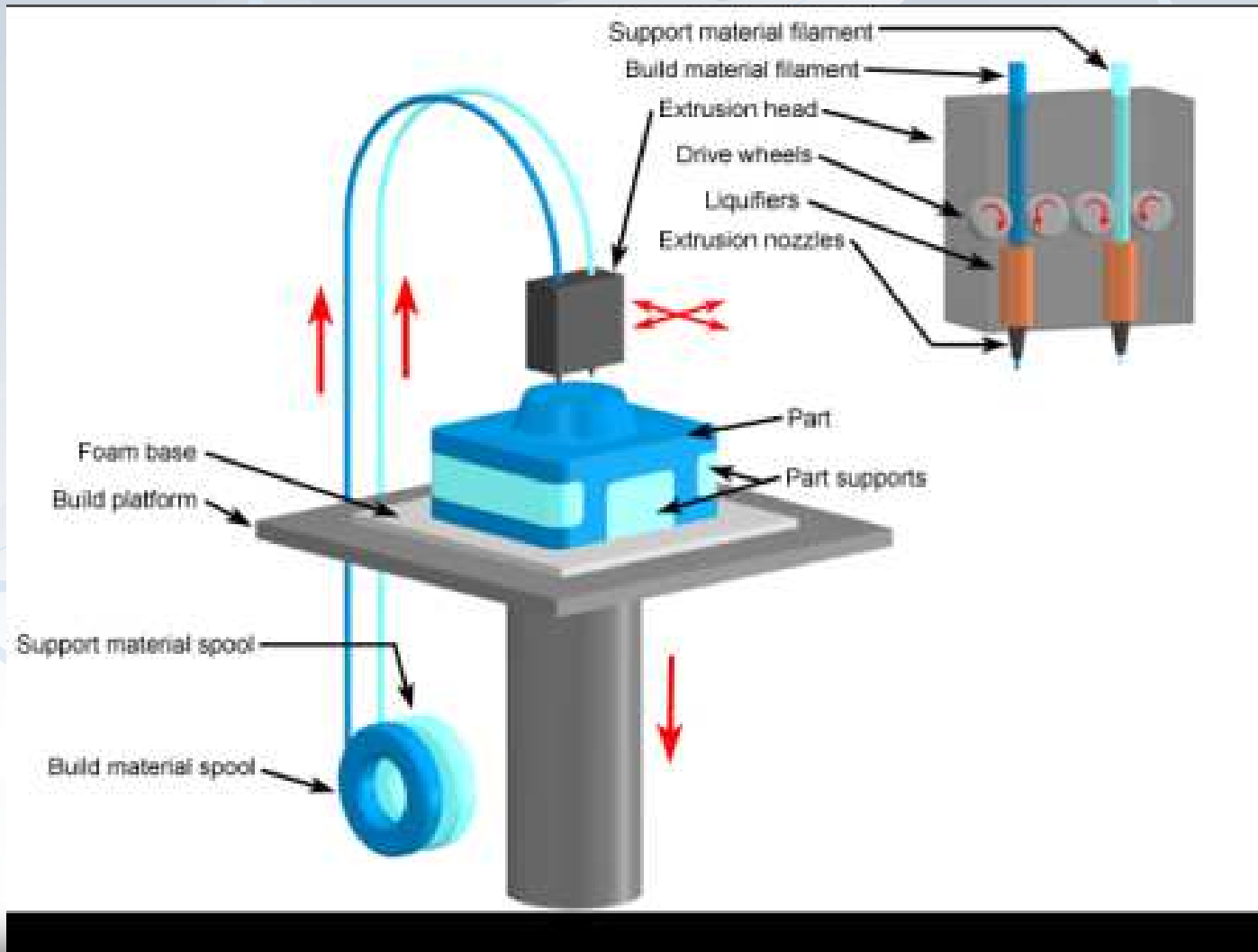


# FUSED DEPOSITION MODELING

- [..|Innovative designs|Video 14 Fused Deposition Modeling](#)



# 3D PRINTING



## 3D PRINTING

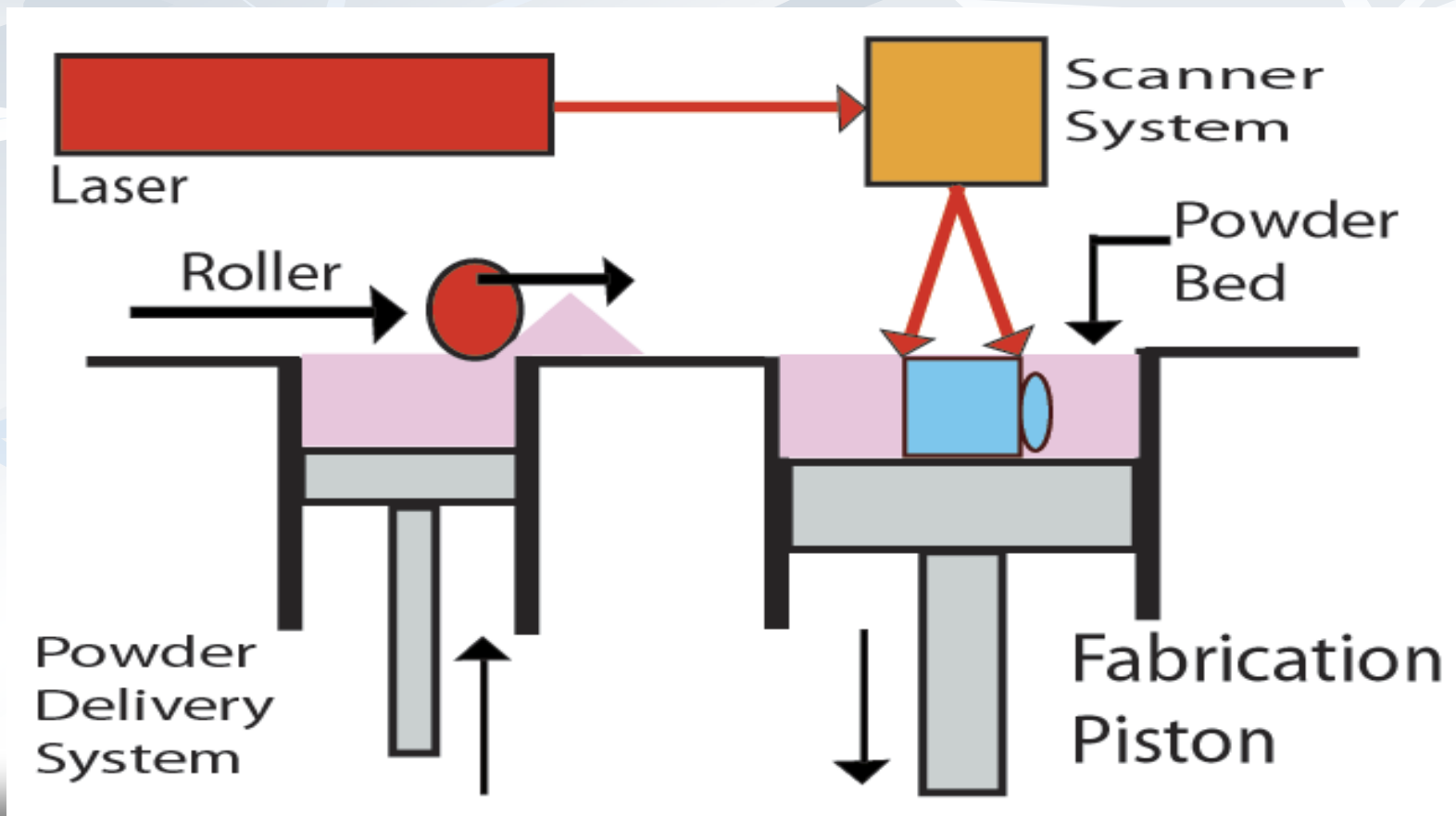
- ❑ [..\Innovative designs\Video 17 Incredible 3D Printed Objects \(FDM\).mp4](#)..*Video 18 Newest in 3D printing*
- ❑ **3D printing** refers to processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together **3D printing** is used in both rapid prototyping and additive manufacturing (AM).
- ❑ The action or process of making a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession

## **SELECTIVE LASER SINTERING**

- ❑ **Uses CO<sub>2</sub> laser for sintering process.**
- ❑ **Material is in the form of powder ( can be metal).**
- ❑ **The laser is positioned using the scanner system and fuses the powder at required points.**
- ❑ **After one layer, the platform moves one layer down.**
- ❑ **A roller rolls over with fresh layer of powder and continues.**
- ❑ **Support is achieved by unsintered powder**
- ❑ **Final product is taken for post processing : Cleaning with water to remove the powder ( Powder is reused).**

# FUSED DEPOSITION MODELING

[..\Innovative designs\Video 15 Selective Laser Sintering.mp4](#)



## **TESTING, EVALUATION & MODIFICATION**

- ❑ **Before the product is introduced it is to be tested fully for all the designed function.**
- ❑ **Other requirements that are taken into account in the design are to be evaluated (safety, environmental issues, etc)**
- ❑ **In novel design the Proof of concept tests are to be done to ascertain the workability of the design.**
- ❑ **Such studies are done using Department of Energy (DoE) procedures.**
- ❑ **If testing reveals any “bug” the design undergoes “modification”.**
- ❑ **Modified design is again tested till favourable results are obtained.**







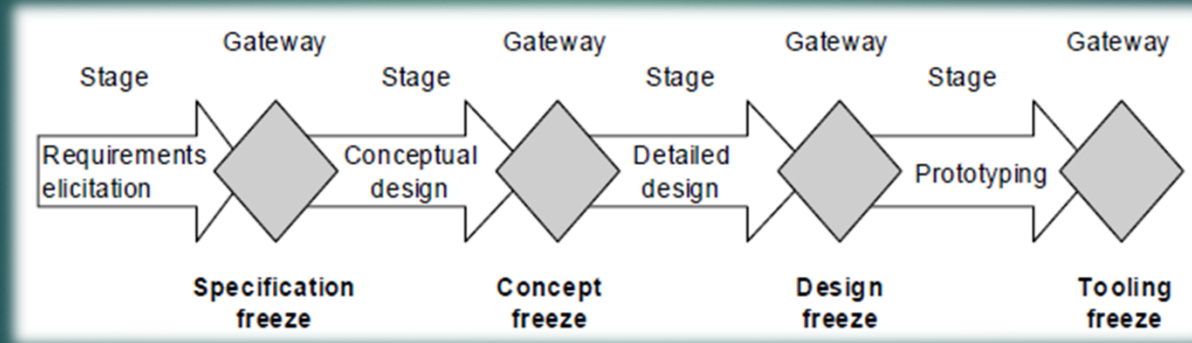
## **FREEZING THE DESIGN**

- ❑ **Any set backs seen in the design is used to improve the design. These modified designs are again tested till satisfactory results are seen.**
- ❑ **Then the design is frozen for and it is handed over for production.**
- ❑ **Frozen design are improved further, based on customer feed back.**
- ❑ **So design are never frozen ( only done temporarily), but are always evolving.**

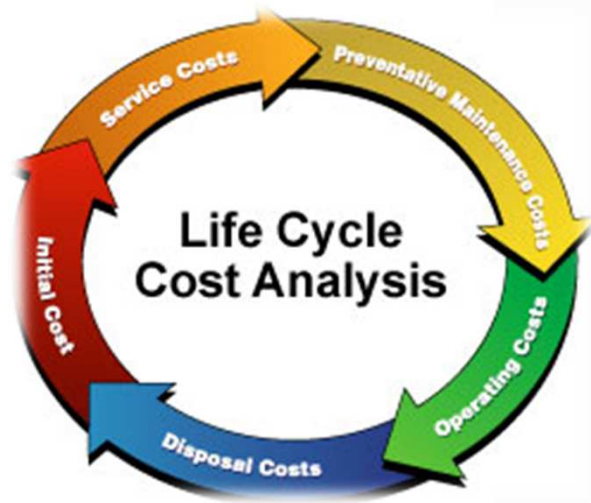
# Freezing the Design

'Design Freeze' describes the end point of the design phase at which a technical product description is handed over to production

Although Design Freeze refers to an unchanging design, in reality a complete freeze is not possible.



# Cost Analysis

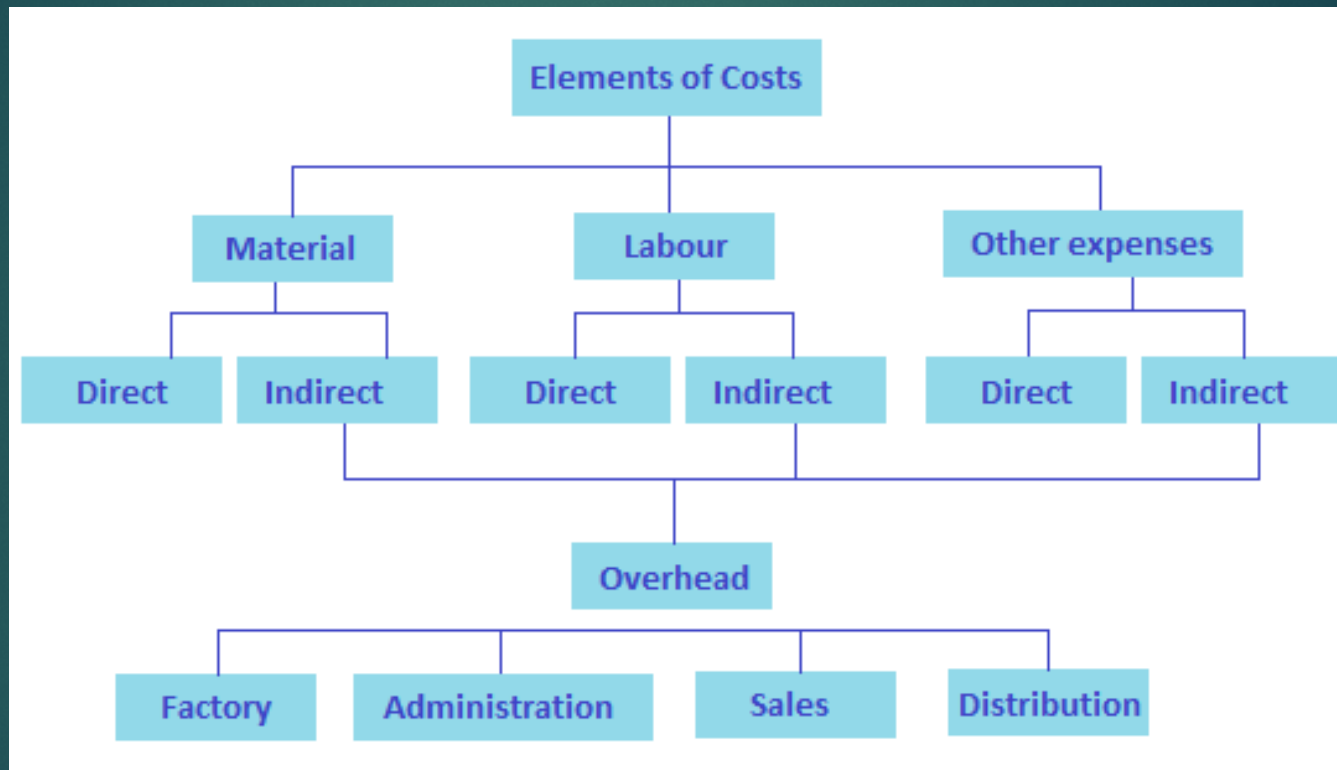


# **COST ANALYSIS**

## **Importance of cost analysis:**

- 1. To provide information to establish the selling price of a product or a quotation for a good or service.**
- 2. To determine the most economical method, process, or material for manufacturing a product.**
- 3. To become a basis for a cost-reduction program.**
- 4. To determine standards of production performance that may be used to control costs.**
- 5. To provide input concerning the profitability of a new product.**

# Classification of Cost



# COST ANALYSIS

Elements of Cost: *Labour, Material & Expenses.*

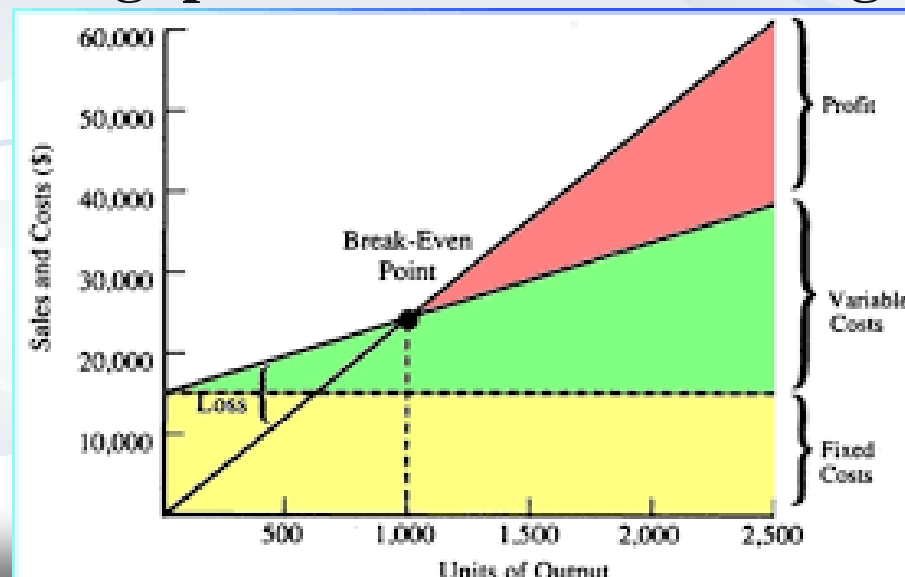
Element	Direct	Indirect
Labour cost	Salary + fringe benefits to employees who build designed device	Wages of workforce supporting direct labour like cleaning staff, clerical, maintenance etc.
Material cost	expenses of all materials that are purchased for a product, including scrap and spoilage. ( wood, metal)	Expense of materials that are used during production. Grease, Coolant, Cotton waste
Expenses	Cost of special support tools, patterns/moulds for a particular job	Power, Plant maintenance, security, building rent, phone bill.

# SELLING PRICE OF A PRODUCT

					<b>Selling price</b>
				<b>Cost of sale</b>	<b>Profit</b>
				<b>Selling &amp; distribution overhead</b>	<b>Cost of sales</b>
				Sales, advertising, sale service, warehouse charge, transporting, loading/unloading, delivery vehicles	
		<b>Cost of production</b>			
		<b>Office over head</b> Office rent, Clerical charges, Salary to director, manager.			
	<b>Factory Cost</b>				
	<b>Factory overhead</b> Building expense, Insurance, Repairs, Maintenance, indirect material & labour cost				
<b>Primary Cost</b>		<b>Factory Cost</b>		<b>Cost of production</b>	
<b>Direct Expenses</b>					
<b>Direct Labour Cost</b>	<b>Prime cost</b>				
<b>Direct Material Cost</b>					

# BREAK EVEN ANALYSIS

- ❑ **Fixed Cost:** Cost unaffected with volume of products  
Eg: Management salary, office expense, rent.
- ❑ **Variable cost:** Cost varying directly with volume of products. Eg: direct material, direct labour, insurance.
- ❑ **Break Even Chart** shows graphically the profit and loss on the selling price and manufacturing costs of the product.





# Engineering the design

Design  Product

## ENGINEERING THE DESIGN

- ❑ For the design to be realized it has to be engineered.
- ❑ Prototype gets changed to manufacturing designs.
- ❑ Here comes the significance of value engineering, group technology, standard parts, modularity, interchangeability.
- ❑ Decision on manufacturing approaches, assembly techniques are finalized at this stage.
- ❑ Apart from materials, tooling, manpower, energy requirements and overheads are to be taken into account.
- ❑ Accounting for the M s in Manufacturing a product:  
**Men, Material, Method, Machine, Measurement & mother nature**

# PRODUCTION PLANNING

□ Foreseeing every step in production for smooth and efficient operation.

□ *Decision on*

*What to produce* > *Product planning & its design*

*How to produce* > *Process planning, material planning*

*Where to produce* > *Facilities planning, subcontracting*

*When to produce* > *Production scheduling, machine loading*

*Who will produce* > *Man power planning*

*How much to produce* > *quantity, Economic batch size*

# Planning

- ▶ It is the road map for development
- ▶ It defines the present situation in detail
- ▶ It helps in deciding objectives both in quantitative and qualitative terms
- ▶ Planning fills the gap between input (need) and output(product)
- ▶ Plan should be a realistic view of expectations
- ▶ Planning are flexible
- ▶ Planning is important when way to achieve, goals of objective are many.

" A GOAL  
WITHOUT  
A PLAN  
IS JUST  
A WISH "



## Benefits

- ▶ Planning reduces uncertainty, risk and confusion in operation
- ▶ Planning guides decision making by managers
- ▶ Planning helps in achieving coordination and control
- ▶ Planning is an element of flexibility makes an organisation capable of coping with changing environment challenges
- ▶ Planning leads to economy and efficiency in operations

“Failing to plan,  
is planning to fail.”

## **Limitations**

- ▶ Planning can minimise risk but cannot eliminate risk
- ▶ Planning is a big process so its time and money consuming
- ▶ Planning cannot foresee every thing thus may be obstacles
- ▶ Planning once planned reduces creativity
- ▶ Planning doesn't guarantee success

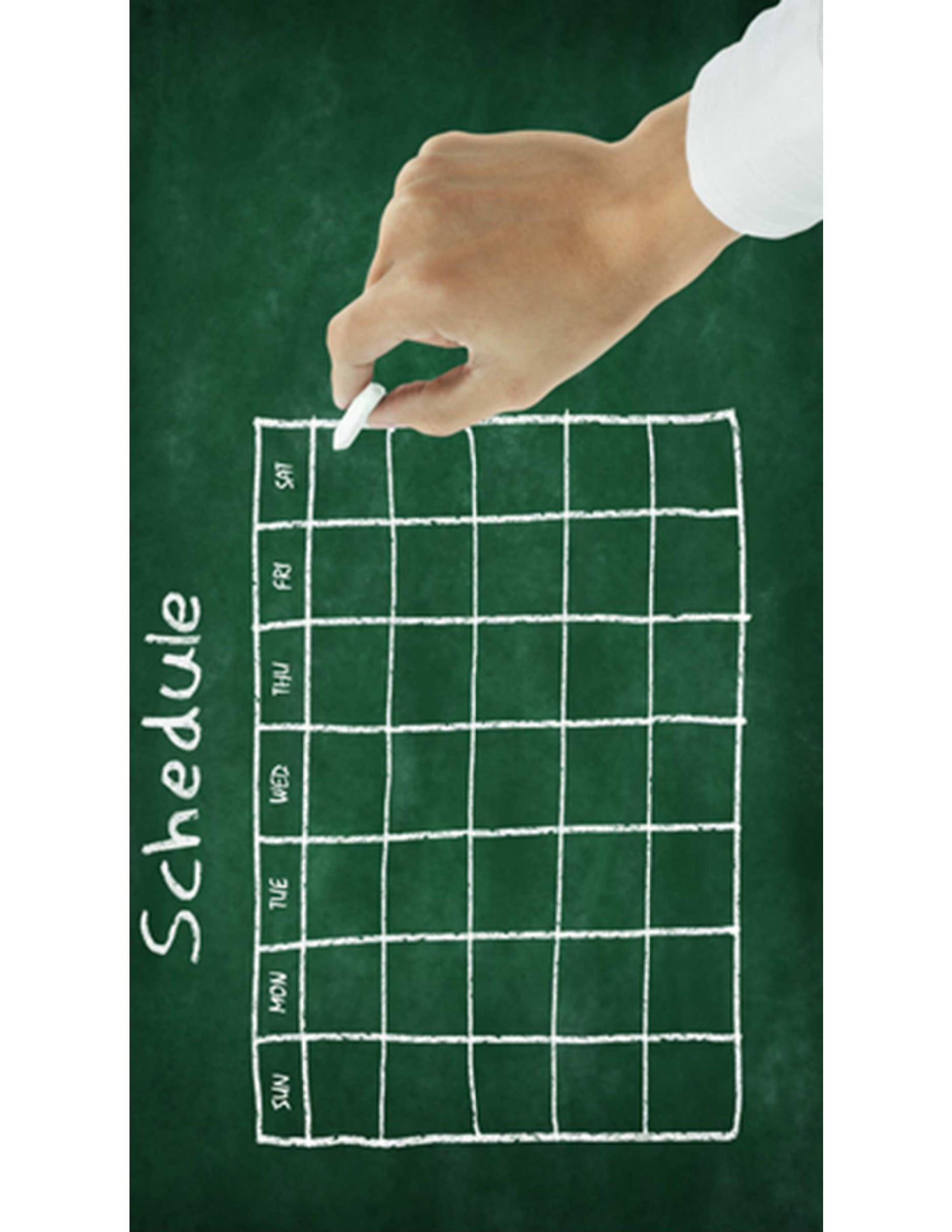
## **Essentials of good plan**

- ▶ The planning process must be continuous, creative and communicated to the lowest level
- ▶ Planning should be time bound
- ▶ Planning should not be rigid
- ▶ Planning should essentially achieve satisfaction of user

## ELEMENTS OF PRODUCTION PLANNING

- ❑ **Planning:** Deciding in advance about work to be done. Various charts, manuals & production budgets are made.
- ❑ **Routing:** Selection of stages through which each unit has to pass to for finished product.
- ❑ **Scheduling:** Allocation of machinery, labour & time for completion of activity.
- ❑ **Despatching:** Order to commence work. Start work as scheduled.
- ❑ **Follow up & Expediting:** Regulating material and part through production process.
- ❑ **Inspection:** Ensure products made are of required quality.

# Schedule



SUN	MON	TUE	WED	THU	FRI	SAT



# Scheduling

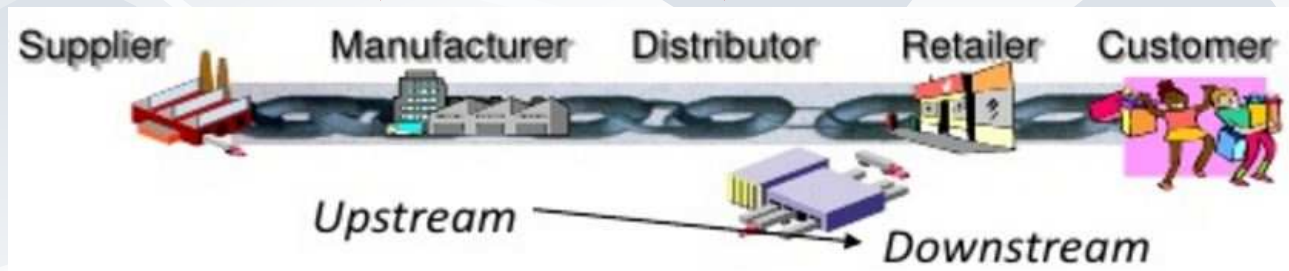
- ▶ The schedule must portray the activities required to support the project plan.
- ▶ Provides time-scaled network schedules that define when work tasks are to be performed.
- ▶ Produces reports that provide the Project Manager, the information necessary to monitor schedule status and to initiate corrective action if required.
- ▶ Provides assistance in implementation of corrective action when required

# SUPPLY CHAIN MANAGEMENT

*Management of flow of goods and services from point of origin to point of consumption.*

A set of approaches used to efficiently integrate :

**Supplier , Manufacturer, Warehouse, Distribution Centre  
Customer**



So that product is produced and distributed

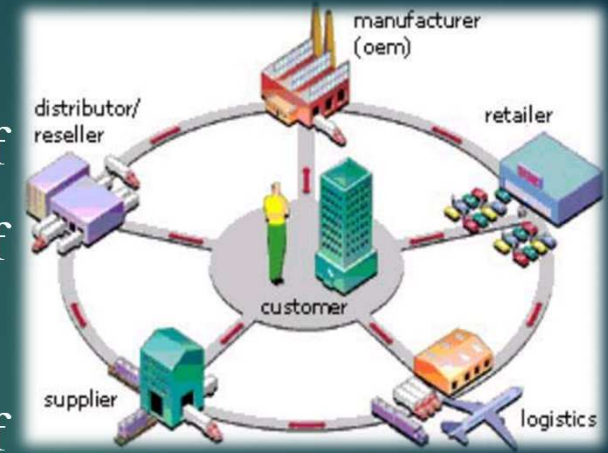
**In right quantities, In right time, To right location**



# Supply chains

Also referred to as the logistics network

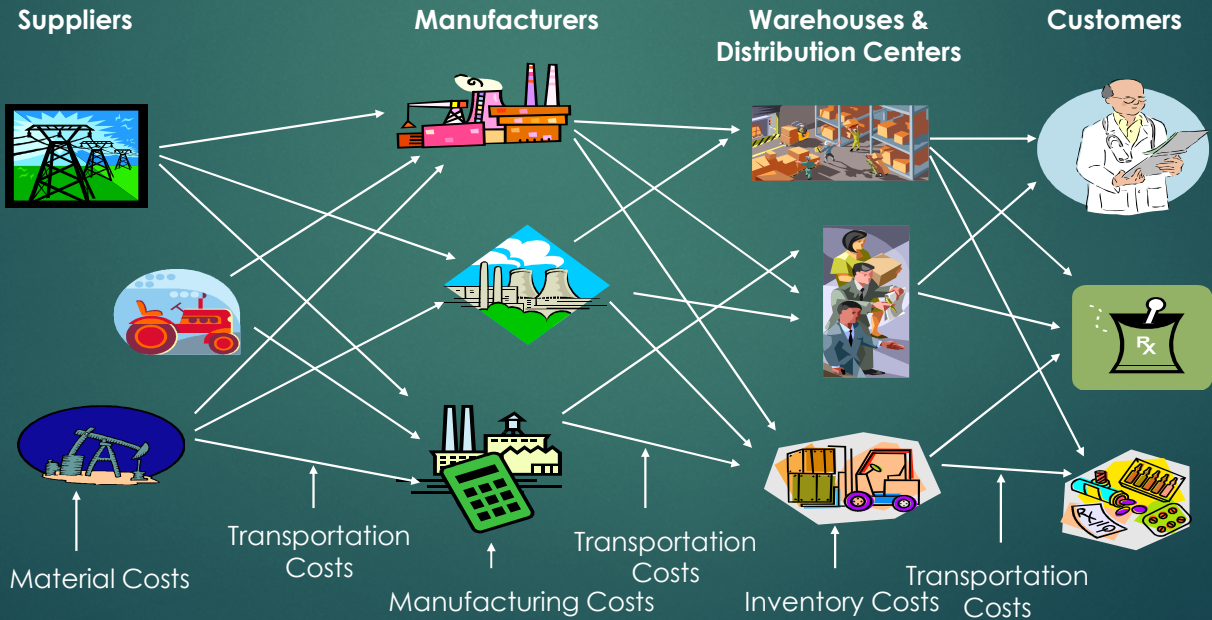
- Supply chain management is the management of network of interconnected businesses involved in the ultimate provision of goods and services required by the end customer.
- Supply chain management spans all movement and storage of raw materials, work-in-process inventory and finished goods from point-of-origin to point-of-consumption.



## Critical aspect:

- **Everyone is involved**
- **Systems approach to reducing costs**
- **Integration being the key**

# The Supply Chain – Another View



# Supply Chain Management – In a nutshell is

*SCM is all about effective integration of...*

✓ Right Product



✓ At Right Place



✓ Right Quantity



✓ At Right Time



✓ Right Quality



✓ At Right Value





**Inventory**



## What is inventory?

A physical resource that a firm holds in stock with the intent of selling it or transforming it into a more valuable state.



## Purpose of inventory management

- How many units to order?
- when to order? discount



# Types of Inventories

Raw materials

Purchased parts and supplies

Finished Goods

Work-in-process (partially completed products )

Items being transported

Tools and equipment





# Inventory Costs

## Carrying cost

- cost of holding an item in inventory

## Ordering cost

- cost of replenishing inventory

## Shortage cost

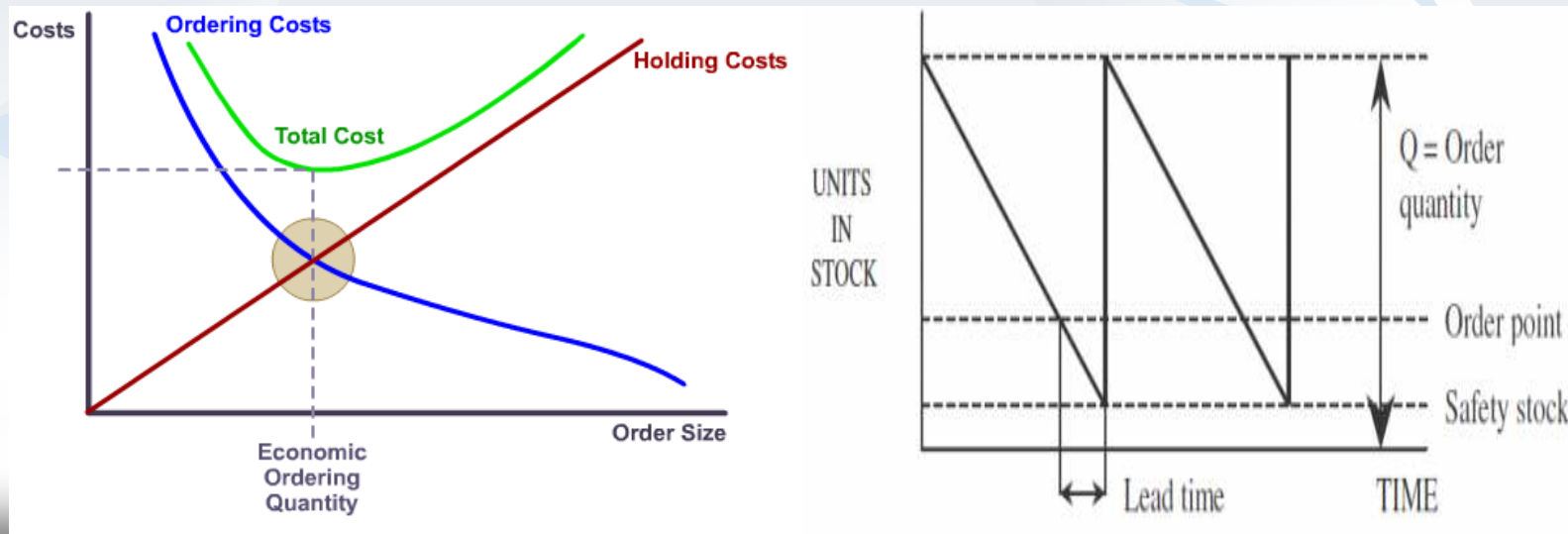
- temporary or permanent loss of sales when demand cannot be met

# INVENTORY CONTROL

*To keep track of inventory*

- *To Ensure: good quality inventories , High quality inventory*
- *Decision on: how much to order, Decision on when to order*

*Economic Order Quantity (EOQ) and Time*



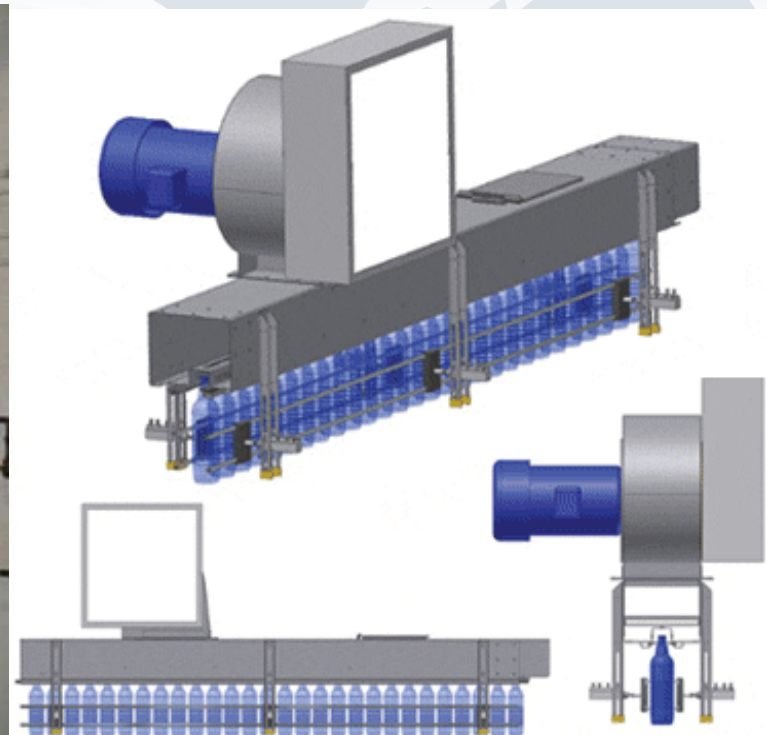
# Inventory Management















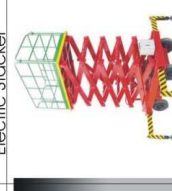
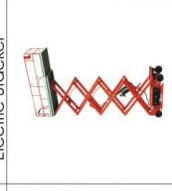







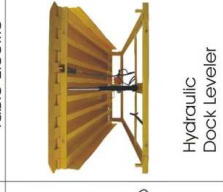











- ▶ Inventory Management tries to optimize the ordering of stocks and safety stocks along the supply chain, aiming to minimize holding and backorder costs while fulfilling the typically uncertain demand of customers.
- ▶ It develop methods for the measurement and control of inventory system performance under uncertainty.
- ▶ Applications are the distribution of safety stocks in supply networks in the process industries, spare parts distribution, and reorder policies in retailing.

# HANDLING

*Art and science of moving packing and storing of substaces in any form*



 <p>Hand Pallet Truck, PHL-25</p>	 <p>Manual Stacker</p>	 <p>Semi Electric Stacker</p>	 <p>Electric Stacker</p>	 <p>Wider Leg Electric Stacker</p>	 <p>High Lifting Hand Pallet Truck</p>	 <p>Counter Balanced Electric Stacker</p>	 <p>Pit Mounted Lift Table-Multi Scissor</p>	 <p>Semi Electric Pallet Truck</p>	 <p>Drum Handling Stacker</p>	 <p>Special Purpose Pallet Truck</p>
 <p>Paper Roll Pallet Truck</p>	 <p>Pallet Truck with weighing Scale</p>	 <p>SS Pallet Truck</p>	 <p>High Raised Lift Table</p>	 <p>High Raised Lift Table-Self Propelled</p>	 <p>Pit Mounted Lift Table</p>	 <p>Aerial Work Platform</p>	 <p>Electric Pallet Truck</p>	 <p>Pit Mounted Lift Table-Multi Scissor</p>	 <p>Hydraulic Goods Lift</p>	 <p>Storage System</p>
 <p>Lift Table-Platform Rotate Type</p>	 <p>Hydraulic Dock Leveler</p>	 <p>Movable Dock Ramp</p>	 <p>Electric Platform Truck</p>	 <p>Narrow Aisle Forklift</p>	 <p>Electric Tow Truck</p>	 <p>Aluminium Scaffolding</p>	 <p>Electric Reach Truck</p>	 <p>Aluminium Scaffolding</p>	 <p>Storage System</p>	 <p>Storage System</p>

**AFZA MATERIAL HANDLING AND STORAGE SYSTEMS**

No. 156/5, Gangalair, Village  
Rayavattal Road, Krishnagiri-635 122,  
Tamil Nadu, India.

Website: [www.afzaindia.in](http://www.afzaindia.in)



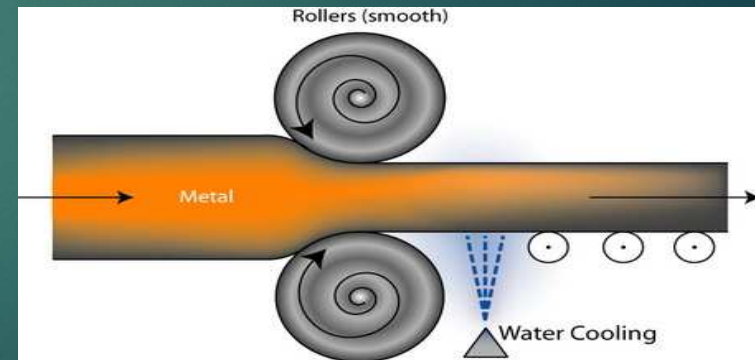
# Manufacturing process



- ▶ Process are classified into:
  - ▶ Primary shaping process
  - ▶ Machining process
  - ▶ Joining process
  - ▶ Surface finishing process
  - ▶ Process affecting change in properties.

# Primary shaping process

- ▶ Two types:
  - ▶ One which produce finished product (deforming process) i.e. requires no metal removal Examples: casting , forging, rolling etc...
  - ▶ One which requires machining operations (material removal process)





# Machining process

- ▶ Other wise called as secondary process.
- ▶ Additional process for the products undergone in primary to get dimensional accuracy or to proper design.
- ▶ Examples: turning, threading, grinding ,drilling etc...



# Joining & Surface finishing process

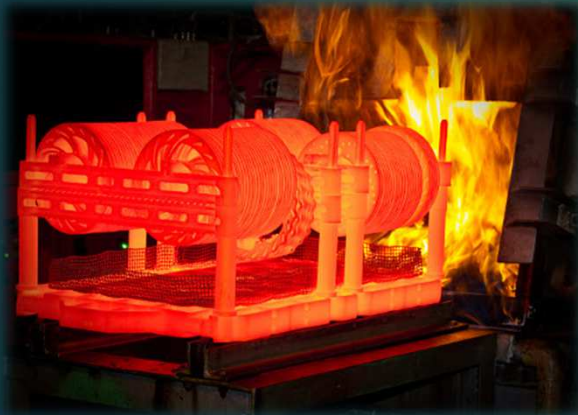
- Joining parts in general fabrication work.
  - Examples : welding , soldering , brazing , riveting etc...
- ▶ Process to get good surface finish
  - Examples: buffing , lapping etc...



# Process effecting change in properties

- ▶ Process for imparting certain properties to the metal parts to make them possible for particular operations.

Examples: heat treatment , cold working , hot working etc.



# Classification of manufacturing process

- ▶ Job production
  - ▶ Small number of pieces produced only once - **Prototype**
  - ▶ Small number of pieces when need arises- **Parts of stopped models**
  - ▶ Small number of pieces periodically after time interval – **Raincoats**
- ▶ Batch production
  - ▶ Batch produced only once
  - ▶ Batch produced repeatedly at irregular intervals
  - ▶ Batch produced periodically at non intervals to satisfy continuous demands

**So job production involves less quantity and more varieties while batch production involves large quantity of identical parts**

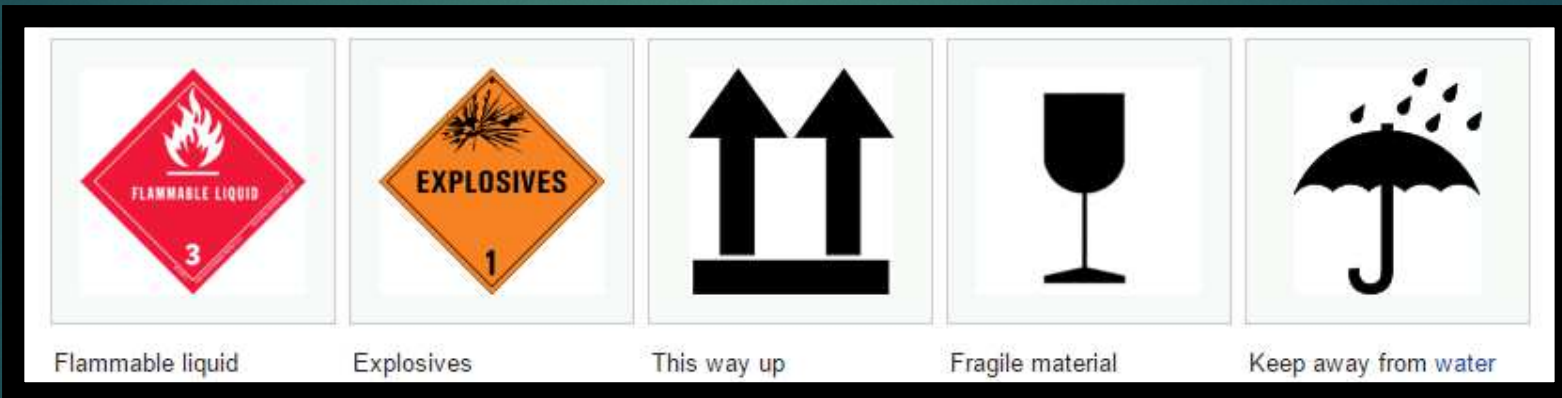
# Storage



- ▶ Inventory control is concerned with achieving an optimum balance between two competing objectives. The objectives are:
  - To minimize investment in inventory
  - To maximize the service levels
- ▶ Inventory is a stock of physical goods held at a specific location and at a specific time. Each distinct item in the inventory at a location is termed stock. Each location is a stock point.

# Packaging

- ▶ To store, distribute, protect the product
- ▶ It is a marketing strategy by applying certain graphics to attract costumers
- ▶ Helps a lot during transportation by means of certain symbols



# Packing Process



Primary



Secondary



Tertiary

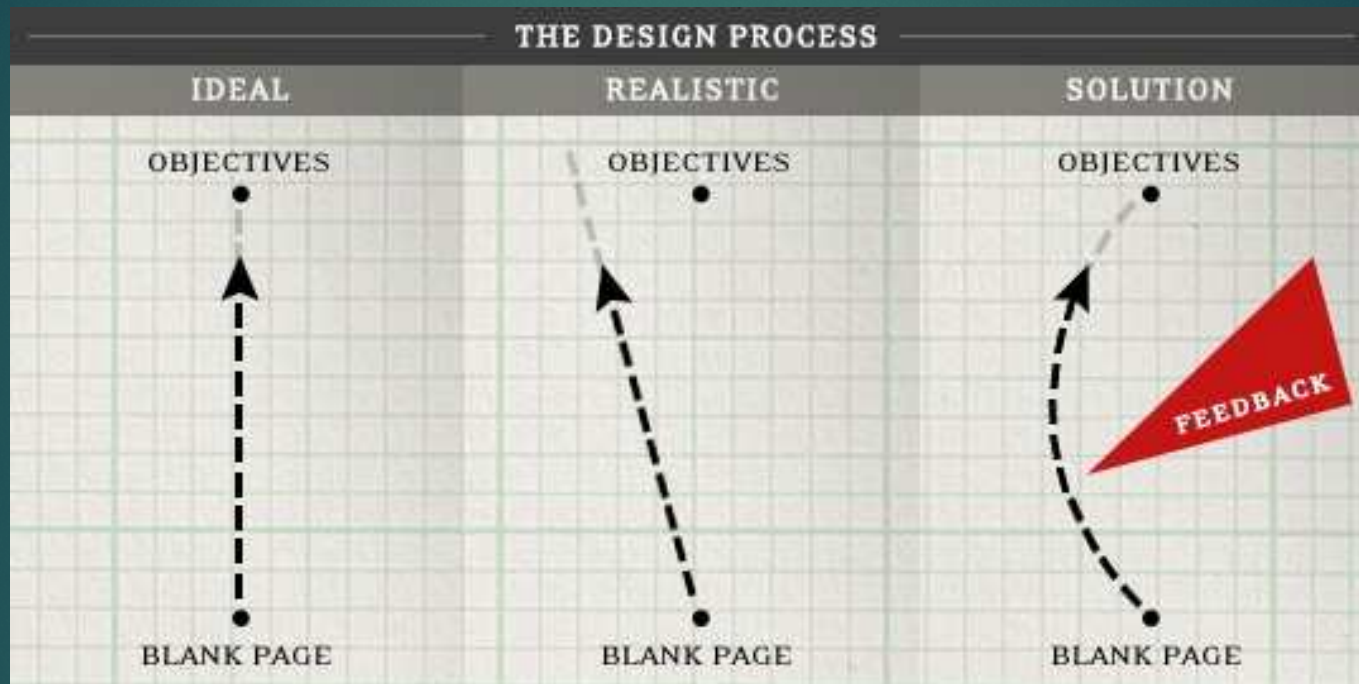
# Package Design



**What are the advantages of this package design ?**



# Feed-back On Design



## Importance of Feed-Back in Design Process

- ▶ Prevent a meandering design from veering too far from timeline, budget, scope, or other project constraints,
- ▶ Allow others to help, teach, and guide when there are weaknesses or confusion,
- ▶ Familiarize colleagues, managers, and clients with the design process,
- ▶ Invest everyone in the project early on,
- ▶ Distribute responsibility for developing creative output,
- ▶ Help build team trust, and eliminate destructive ego

## **FEEDBACK ON DESIGN**

- **To improve product or service**
- **To measure customer satisfaction**
- **Provide information on failure in the entire process**

## **STANDARDIZATION**

- **Reduces Cost**
- **Increase quality**
- **Interchangeability**
- **Reduce complexity, lead time**