CAD/CAM

Topic: INTRODUCTION TO CAD/CAM

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Unit 1

INTRODUCTION

CAD is used in many applications

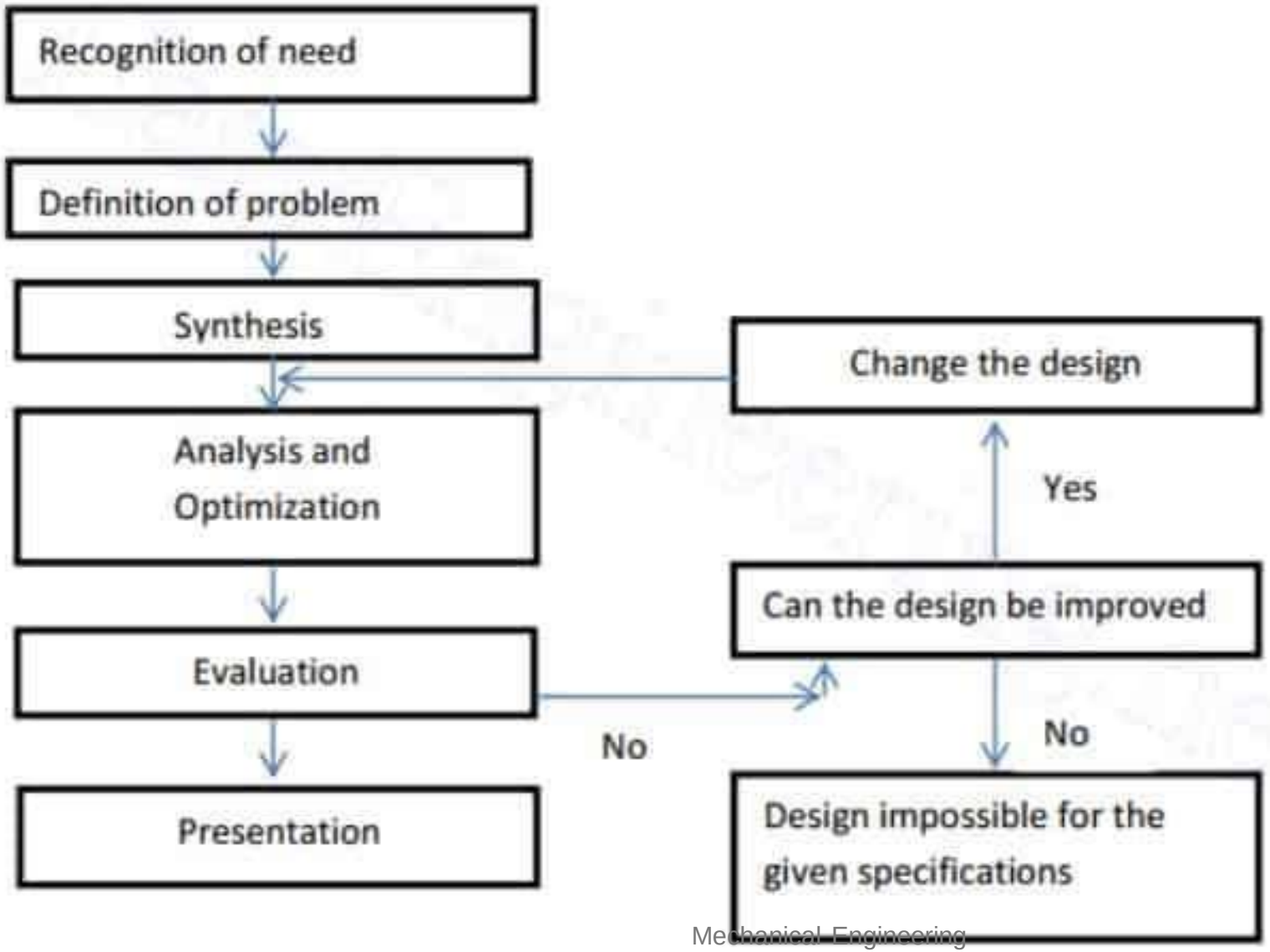
✓including automotive,
✓ shipbuilding,
✓aerospace industries,
✓industrial
✓ architectural design

✓2D CAD programs usually include a library of geometric images; the ability to create Bezier curves, splines and polylines;
✓Among the most popular 2D CAD programs are AutoCAD, CADkey, CADDS 5, CATIA v4 and Medusa.

Need of CAD

- The purpose of CAD is to optimize and streamline the designer's workflow, increase productivity, improve the quality and level of detail in the design, improve documentation communications and often contribute toward a manufacturing design database
- CAD helps users create designs in either 2D or 3D to visualize construction, and enables the development, modification, and optimization of the design process.

PROCESS OF CAD/CAM



using that portion to be

CAD allows :

- **to create more accurate design**
- **CAD replaced manual design drafting,**
- **allowing design development,**
- **alteration and optimization.**
- **CAD enables engineers to craft more precise**
- **designs and manipulate them virtually.**

Advantages of CAD

- ✓ **Saves Time. The ongoing era of product development entails a lot of competition.**
- ✓ **Increases Productivity. Time saved translates directly into augmented productivity.**
- ✓ **Improves Accuracy.**

The five types are:

2D CAD (flat drawings of product)

2.5D CAD (Prismatic models)

3D CAD (3D objects)

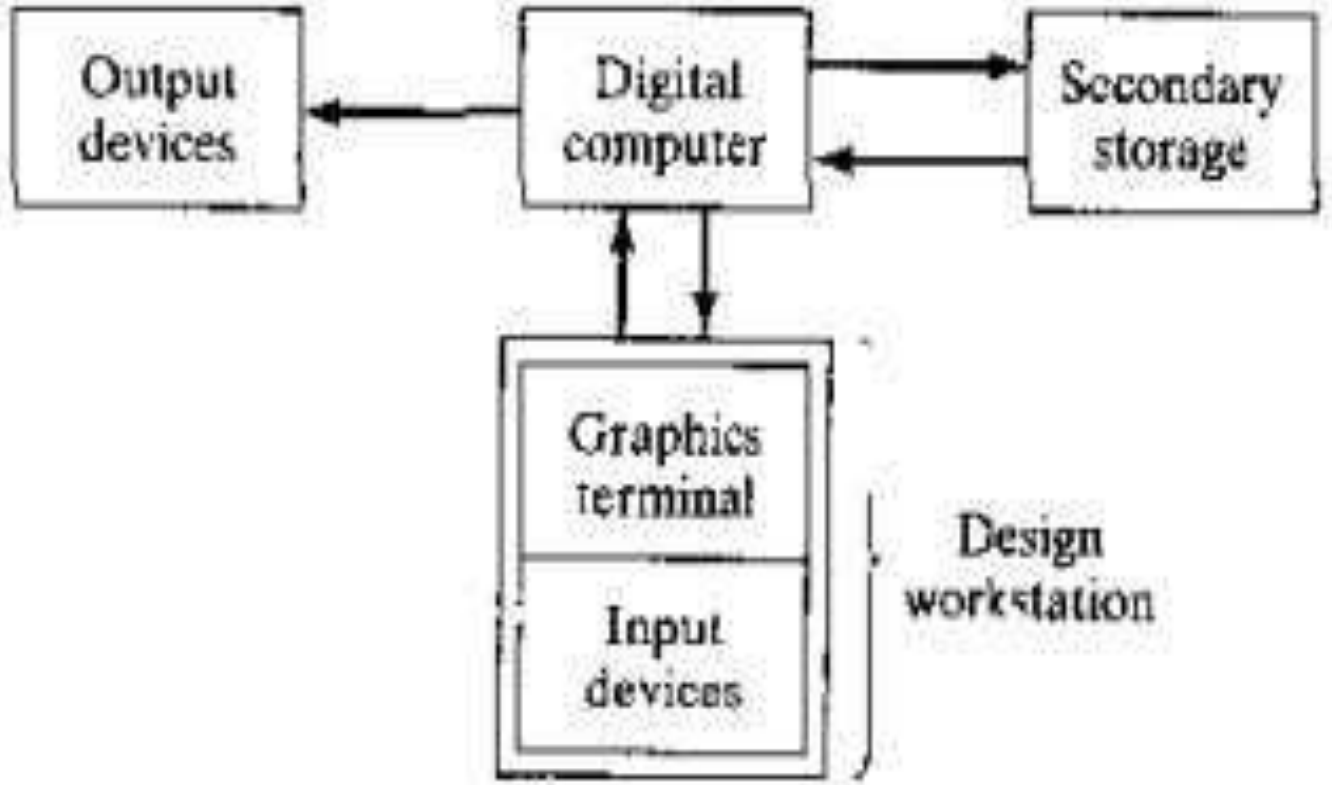
3D wireframe

surface modelling (skeleton like inner structure)

solid modelling (solid geometry)

peripheral devices include:

- **printers,**
- **external floppy disk drives and**
- **other data storage devices,**
- **monitors,**
- **keyboards**,


Output devices
Digital computer
Secondary storage
Graphics terminal
Input devices
Design workstation

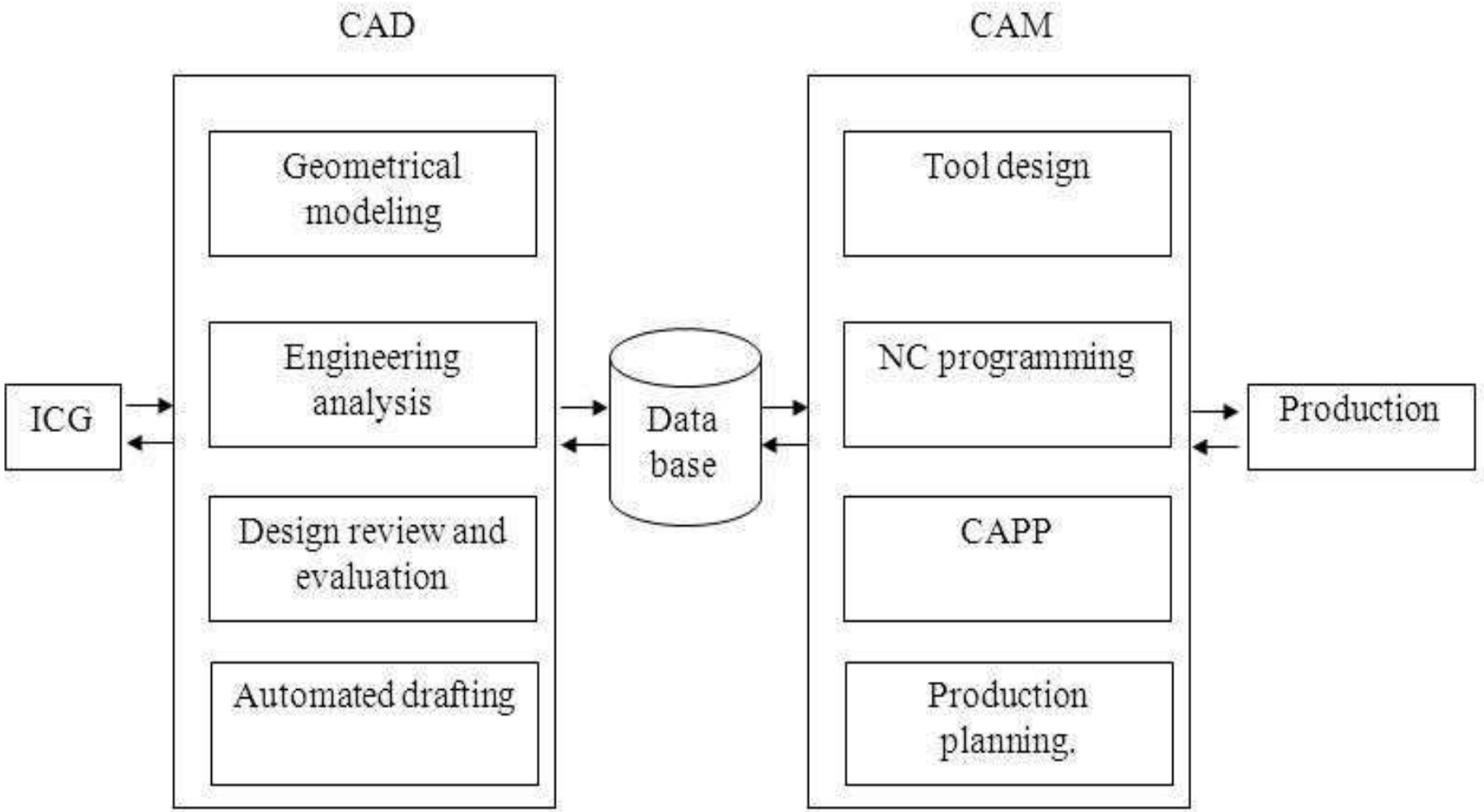


Fig. 1.4 The CAD/CAMrelations

GEOMETRIC MODELLING

- A prototype is needed for testing and optimizing design.
    - Costly
    - Time consuming

- CAD eliminates the need of developing prototype.
    - Assists to evaluate the design.

- "Computer compatible mathematical description" of the geometry of the object is called as geometric modelling.

- CAD software allows the mathematical description of the object to be displayed as the image on the screen of computer

3D MODELING

There are three basic types of three-dimensional computer geometric modeling methods:

- Wireframe modeling
  - modeling the curves of the part.
- Surface modeling
  - Model the surfaces of the part, but without knowledge of material.
- Solid modeling
  - full solid representation

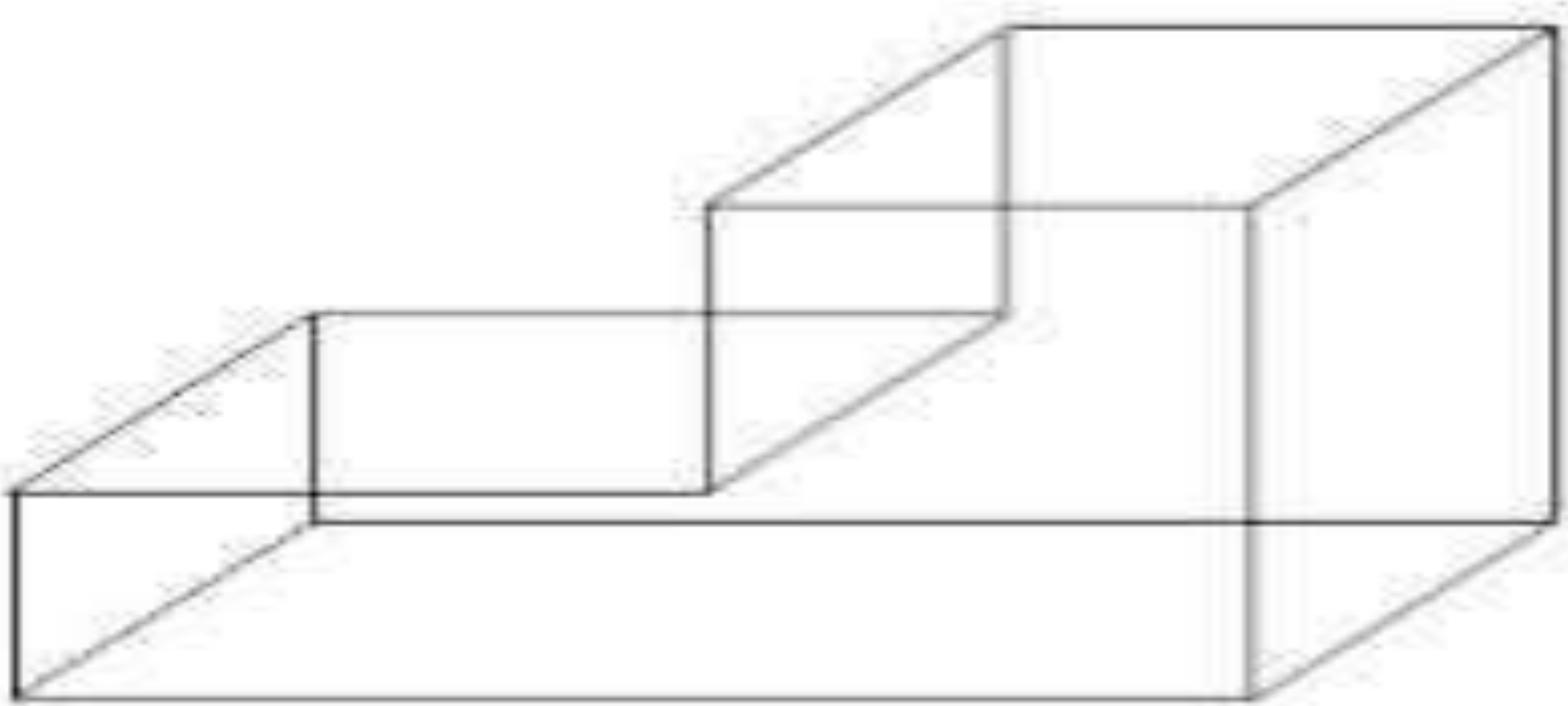


Fig 2.1 Wire frame model

Wireframe modeling - Advantages

- Can quickly and efficiently convey information than multi view drawings.
- Can be used for finite element analysis.
- Can be used as input for CNC machines to generate simple parts.
- Contain most of the information needed to create surface, solid and higher order models

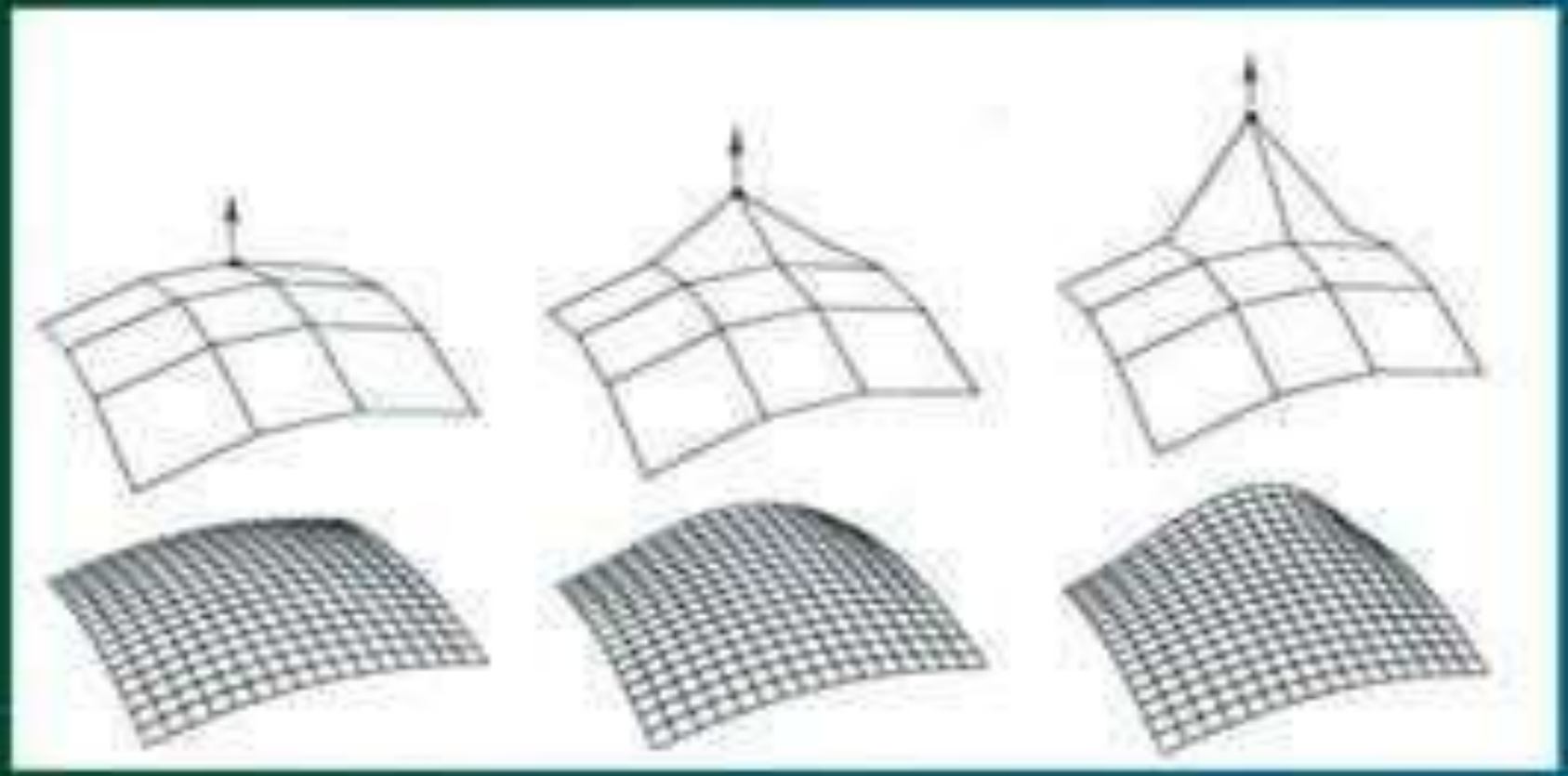
Unit- 2
SURFACE MODELING

A wire frame model consists only of edges of surfaces or lines of intersection of surfaces but does not contain information about the areas between the lines.

For a 3D surface model, you must define the surfaces mathematically.
Several other surfaces, such as cylinders and spheres, have mathematical expressions that can be written to describe them.

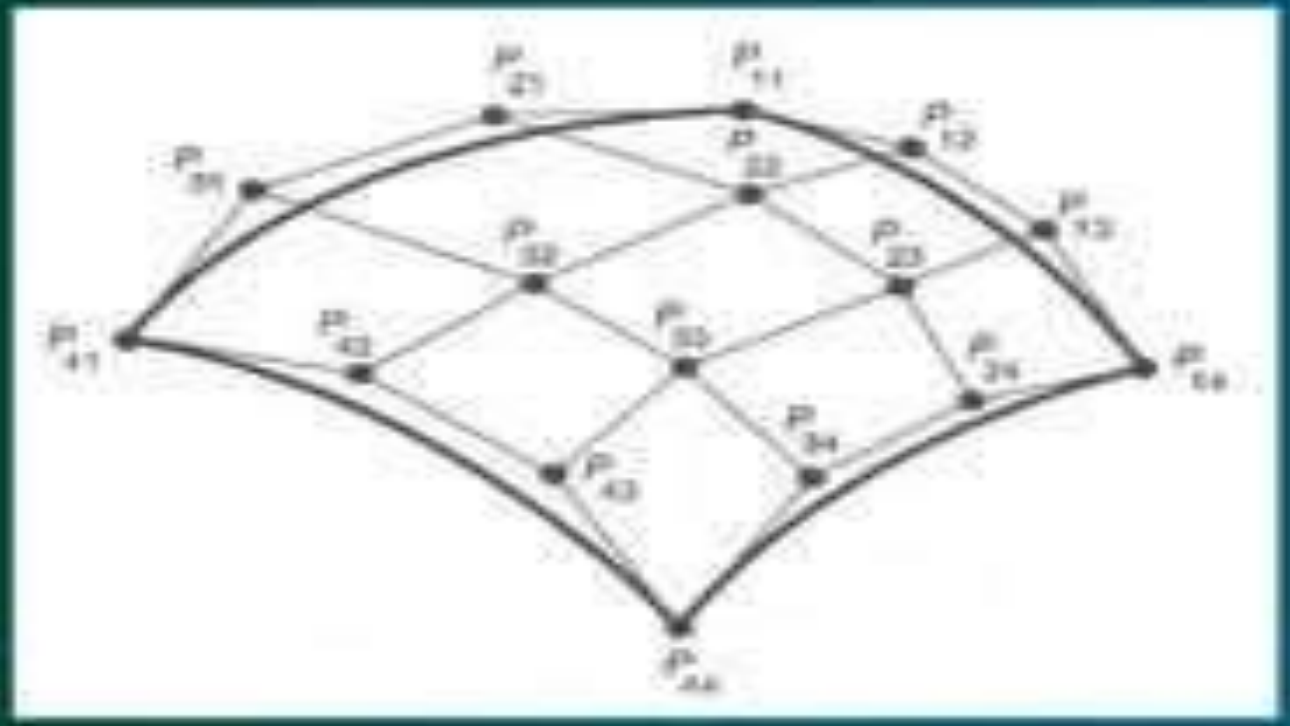
Surface Patch

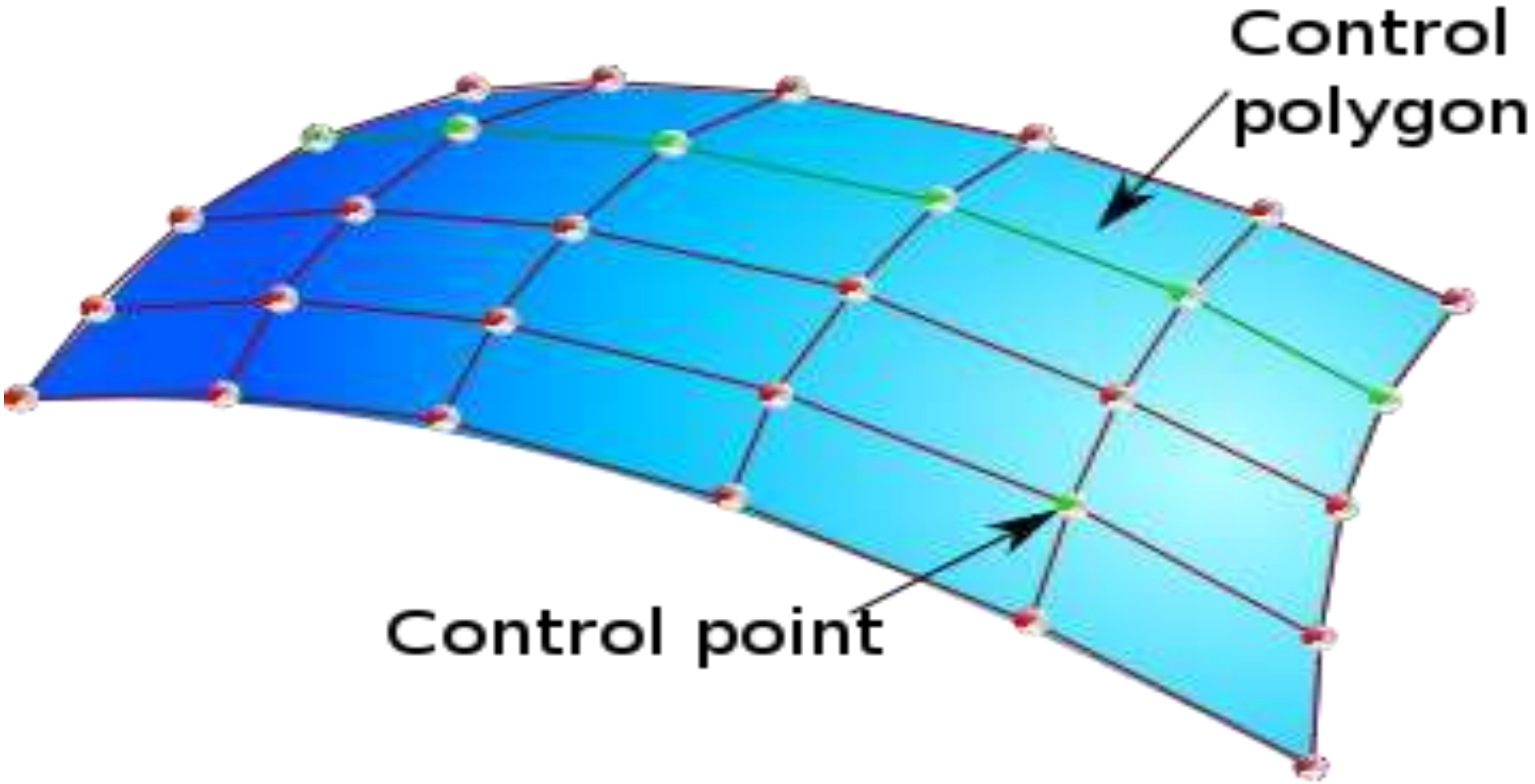
- The effect of "lifting" one of he control points of a patch.



Parametric Surface Patch

- Each patch is defined by control points net (Control Polyhedron).




Control
polygon
Control point

Advantages:

- Eliminates much ambiguity and non-uniqueness present in wireframe models by hiding lines not seen
- Renders the model for better visualization and presentation, objects appear more realistic
- This can be used to design and analysis complex free-formed surfaces of ship hulls, aeroplane fuselages and bodies
- Surface properties such as roughness, color and reflectivity can be assigned and demonstrated

Disadvantages:

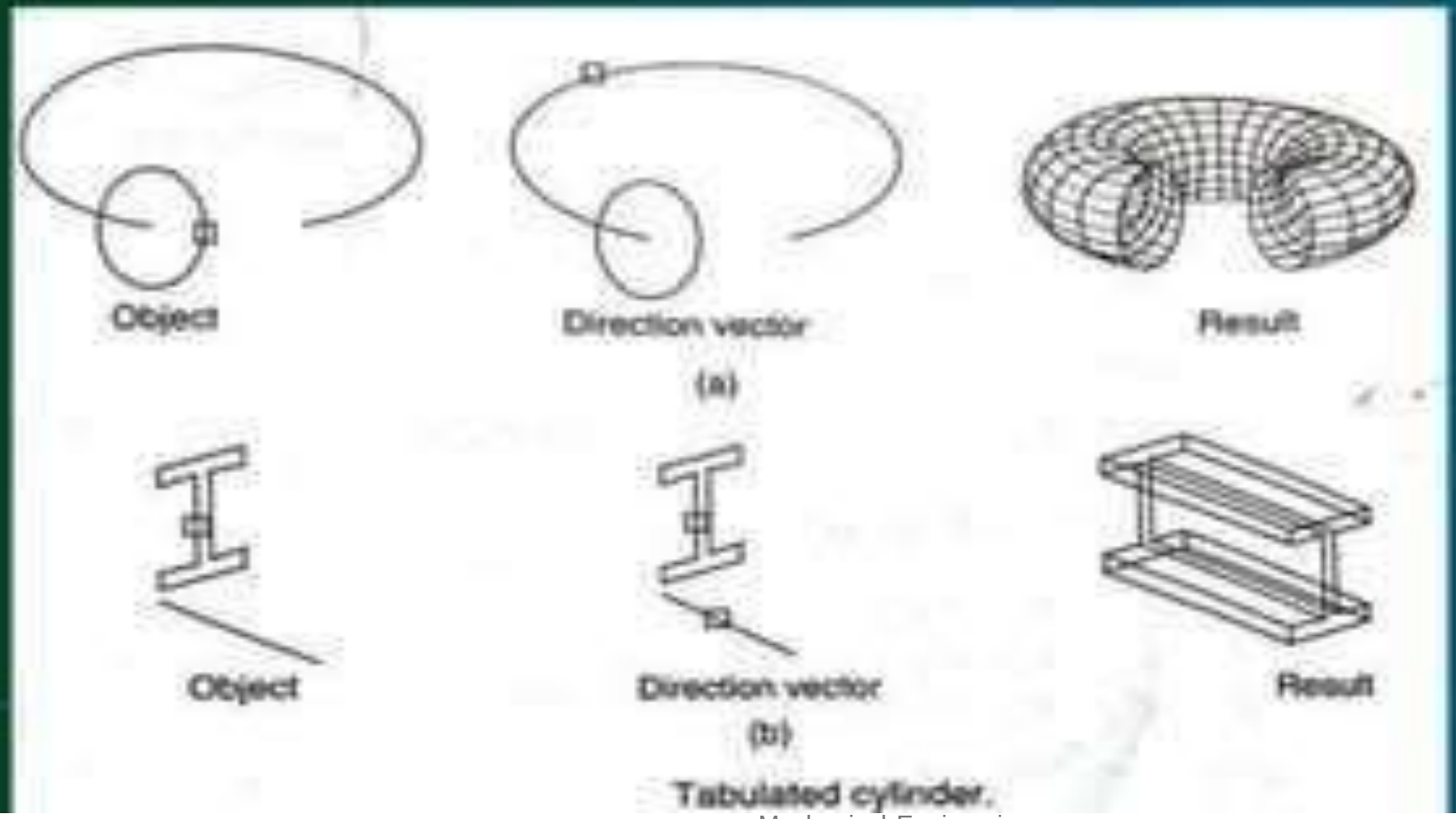
- Provides no information about the inside of an object
- Curved surfaces need a fine mesh to be accurate
- Provides wrong results if mesh is too coarse

Complicated computation, depending on the number of surfaces

4.Tabulated cylinder:

1.This is surface by translating a plane curve at a given distance along a specified direction.

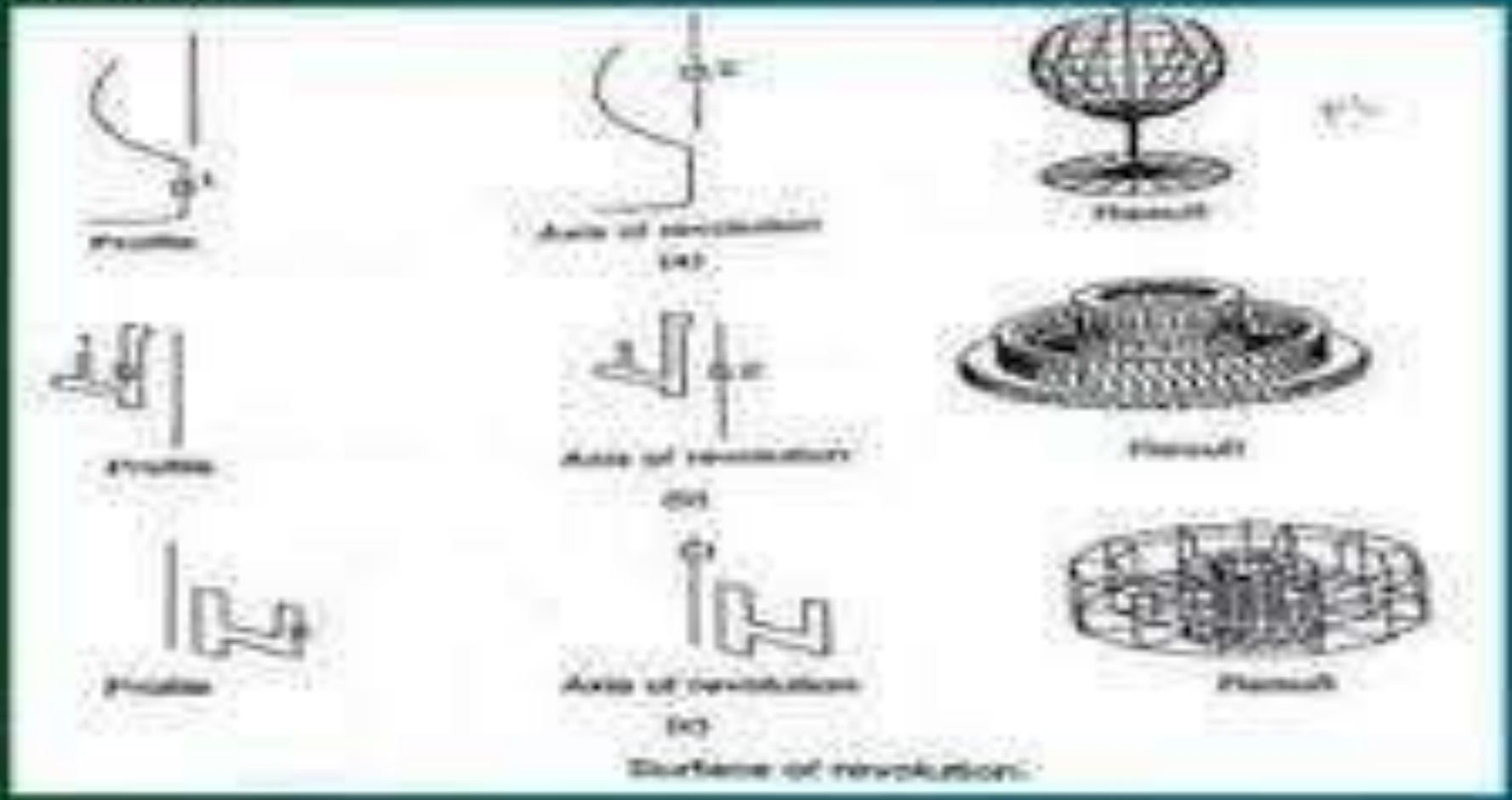
2.Plane of the curve is perpendicular to the axis of generated cylinder



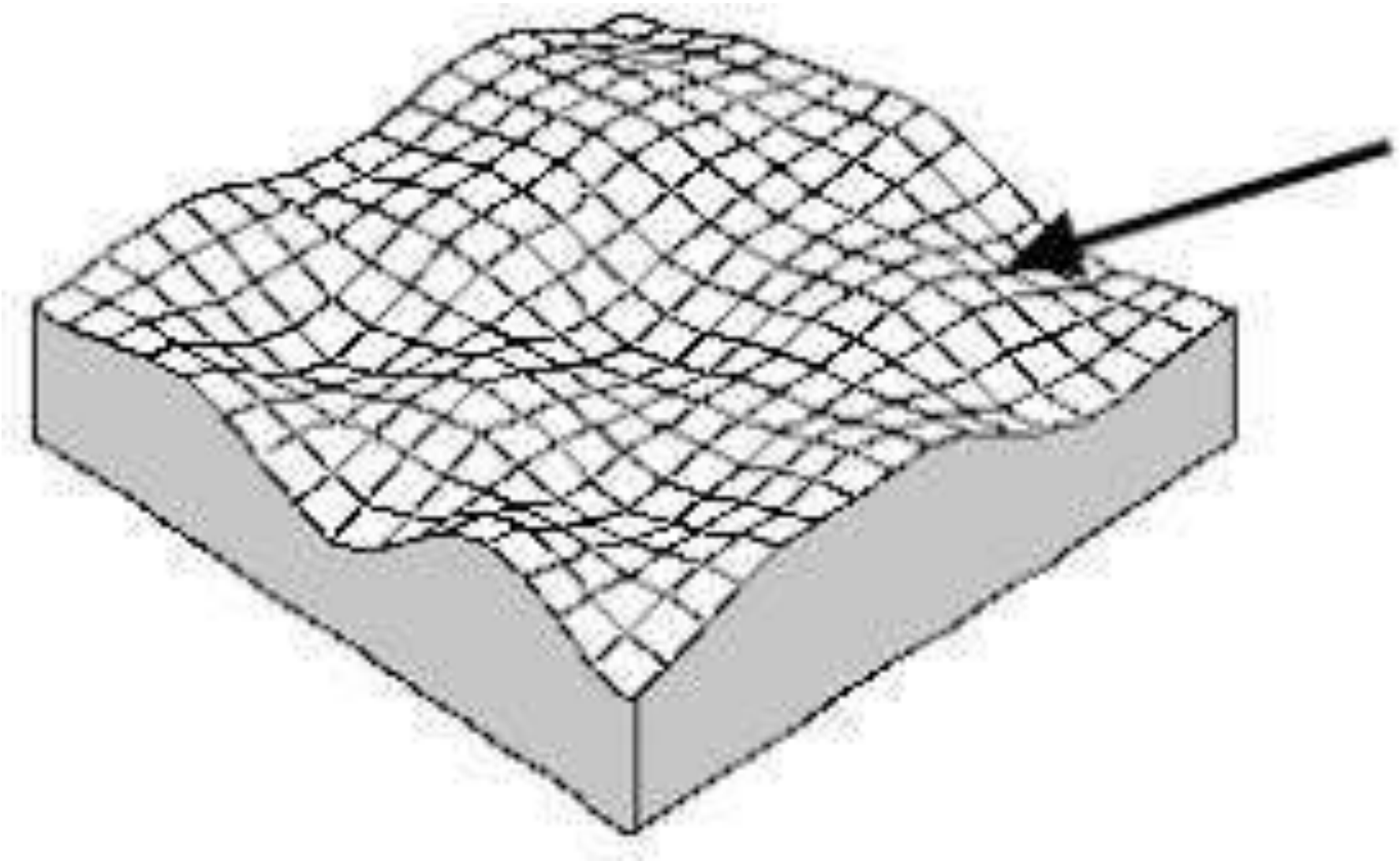
Tabulated cylinder.

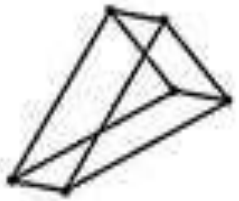
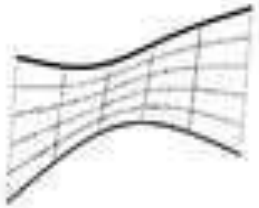
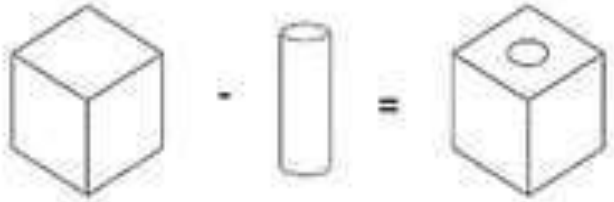
3. Surface of Revolution

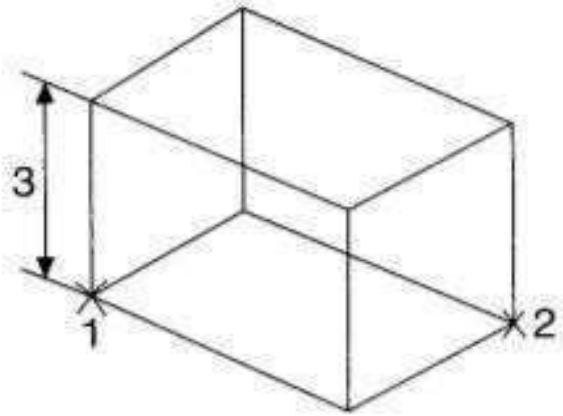
This is an axisymmetric surface that can be model axisymmetric objects.
It is generated by a planar wire frame entity in space about the axis of symmetry of a given angle.



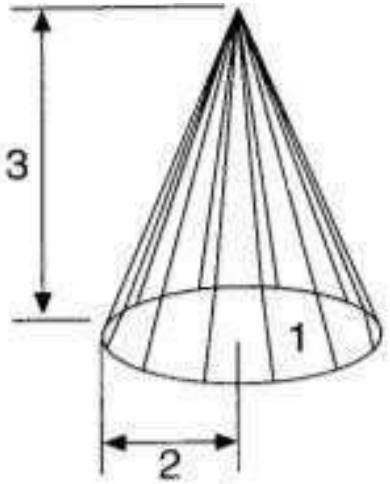
Surfaces of revolution



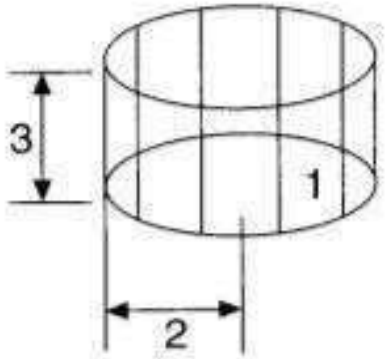
	Wireframe model	Surface model	Solid model
			
1960	Development of wire and surface models		
1970	First use of wire and surface models		Development of solid models modelling
1980	Specific use of wire and surface models		First use of solid models
1990	General use of wire and surface models		Specific use of solid models
2000	General use of wire, surface and solid models		
2010	Introducing special techniques of wire, surface and solid models for product modelling		



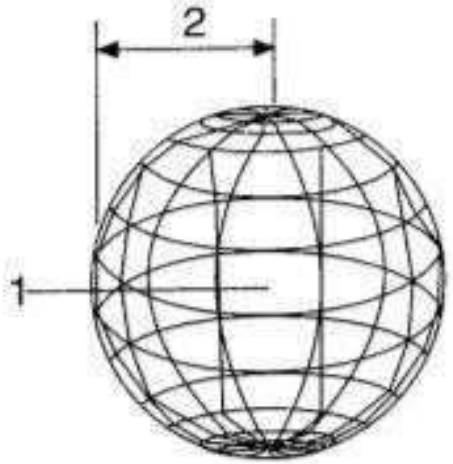
(a) Box



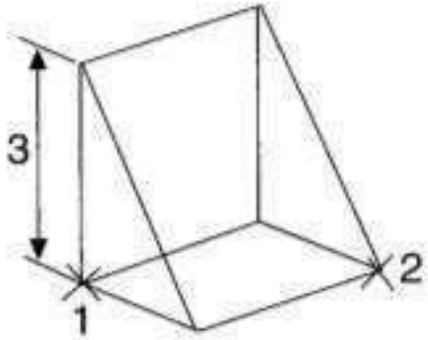
(b) Cone



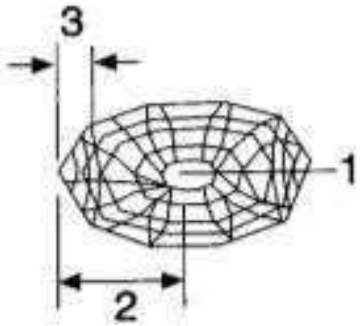
(c) Cylinder



(d) Sphere



(e) Wedge



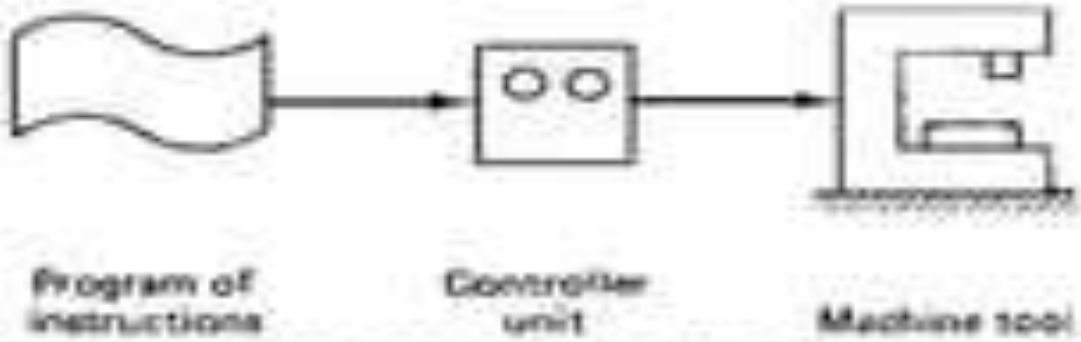
(f) Torus

Solid primitives.

Unit- 3
NUMERICAL CONTROL

What is Numerical control?

- Numerical Control is a system in which actions are controlled by the direct insertion of numerical data at some point.
- In other words Programmable automation in which the mechanical actions of a 'machine tool' are controlled by a program.



7.1 Three basic components of a numerical control system.

Numerical Control

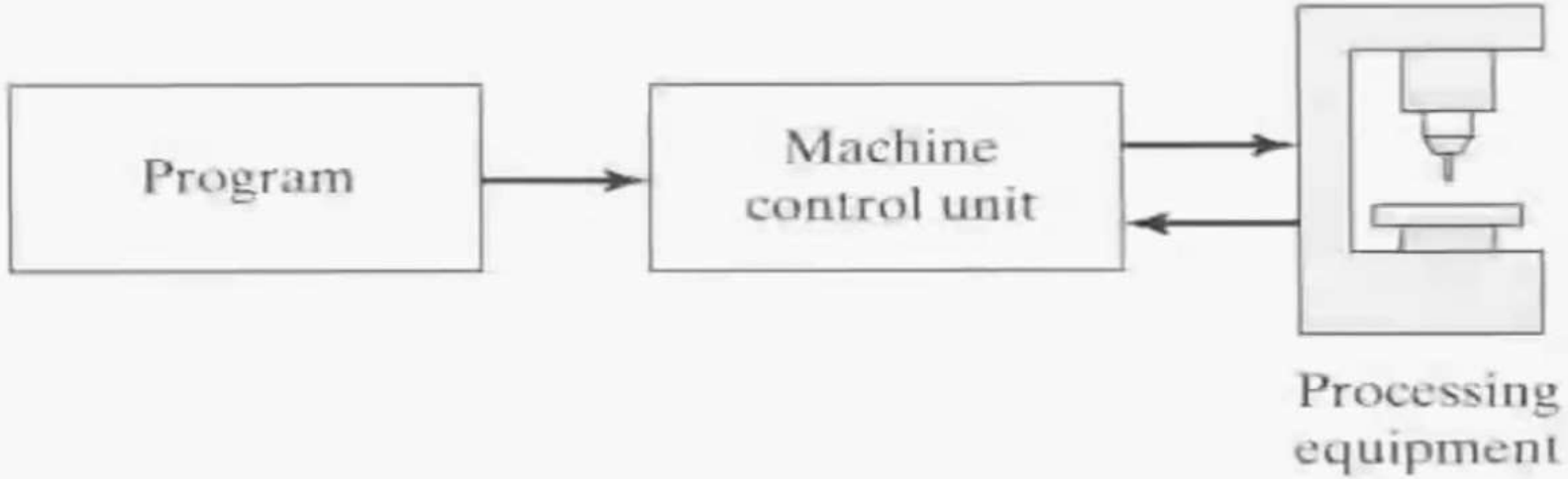


Figure 6.1 Basic components of an NC system.

A Definition of NC

- Numerical Control is a system in which actions are controlled by the direct insertion of numerical data at some point.
- In other words, Programmable automation in which the mechanical actions of a 'machine tool' are controlled by a program
- or
- It is defined Method of programmable automation in which various functions of machine tools are controlled by numbers , letters and symbols.

NUMERICAL CONTROL ELEMENTS

1.Program of instructions.
2.Machine control unit (MCU).
3.NC machine tool.
4.NC Cutting tools.

1.Program of Instructions:

1. The program of instructions is the detailed step - by - step of operations which are implemented by MCU .
2. The program is coded in alphanumerical form on an input medium to the MCU
3. The input medium is a punched tape or a magnetic tape .
4. Two method are used to program for NC
   I. Manual part programming
   II. Computer – aided part programming

Definition of Numerical Control (NC):

- A versatile form of programmable automation in which machine movements and various other functions are controlled by instructions expressed as a series of letters, numbers and symbols initiated via an electronic control system.

Machine Control Unit (MCU)

- NC machine tool has a main unit, which is known as Machine Control Unit.

- It consists of some electronic hardware that reads the NC programme, interprets it and conversely translates it for mechanical actions of the machine tool.

A typical Machine Control Unit may consist of the following units :

- *Input or Reader Unit*
- *Memory*
- *Processor*
- *Output Channels*
- *Control Panel*
- *Feedback Channels*

BASIC REQUIREMENT OF NC MACHINE CONTROL

a. Preparatory functions: which unit, which interpolator, absolute or incremental programming, which circular interpolation plane, cutter compensation, etc.

b. Coordinates: three translational, and three rotational axes.

c. Machining parameters: feed, and speed.

d. Tool control: tool diameter, next tool number, tool change.

e. Cycle functions: drill cycle, ream cycle, bore cycle, mill cycle, clearance plane.

f. Coolant control: coolant on/off, flood, mist.

g. Miscellaneous control: spindle on/off, tape rewind, spindle rotation direction, pallet change, clamps control, etc.

h. Interpolators: linear, circular interpolation

Advantages of CNC Machine tool

- Storage of more than one part program
- Various form of program input
- Program editing at the machine tool
- Positioning features for setup
- Tool length compensation
- Acceleration and deceleration calculations
- Communication interface
- Diagnostics

CLASSIFICATION OF CNC SYSTEMS

- **According to the type of machine:**
  - Point-to-point
  - Straight-cut
  - Continuous path
- **According to the programming method:**
  - Absolute
  - Incremental
- **According to the type of control system:**
  - Open-loop
  - Closed-loop

Unit 4

GROUP TECHNOLOGY

GROUP TECHNOLOGY

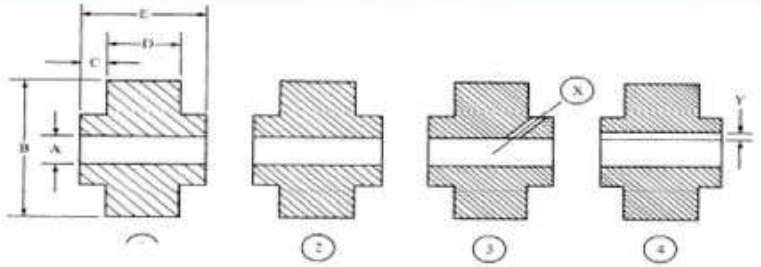
- Group Technology or GT is a manufacturing philosophy in which the parts having similarities (Geometry, manufacturing process and/or function) are grouped together to achieve higher level of integration between the design and manufacturing functions of a firm.

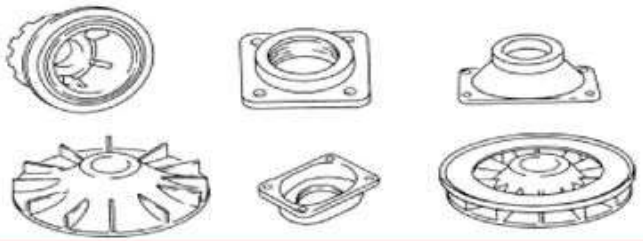
- The group of similar parts is known as part family and the group of machineries used to process an individual part family is known as machine cell.

Part Families

A part family is a collection having similar:

Design Characteristics
(Geometrical Features)





Manufacturing Processes
(Process Similarity)

Three methods for identifying parts families

- **Visual inspection**
- **Classification and coding**
- **Production flow analysis**

1.Visual Inspection Method

- The visual inspection method is the **least sophisticated** and **least expensive method.**
- It involves the classification of parts into families by looking at either the **physical parts or their photographs and arranging them into groups having similar features.**

PROBLEMS IN GROUP TECHNOLOGY

- **Identifying the part families (the biggest problem)**

➢ If the plant makes 10,000 different parts, reviewing all of the part drawings and grouping the parts into families is a substantial task

- **Rearranging production machines in the plant into the appropriate machine cells**

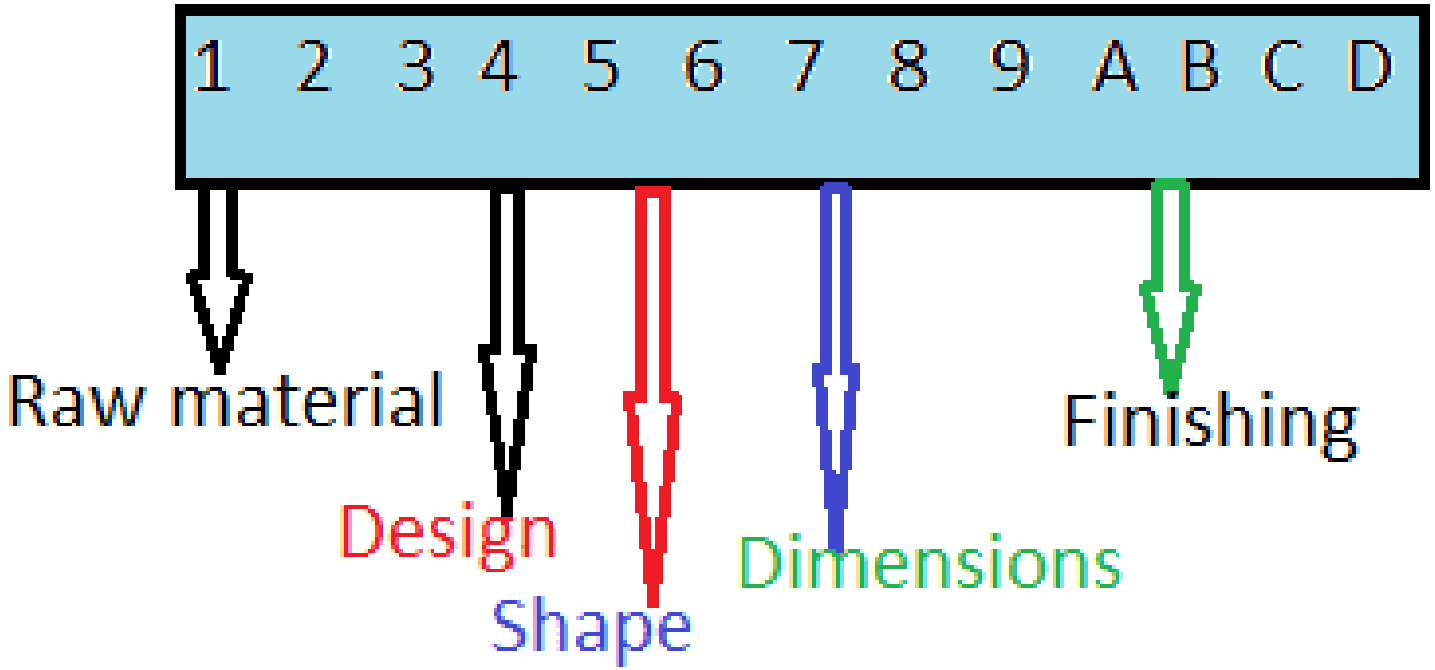
➢ It takes time to plan and accomplish this rearrangement, and the machines are not producing during the changeover

Production Flow Analysis

- It is a process in which part families are identified & associated machine group,

That uses the information contained on production route sheets rater than part drawing.

Similar routings are classified into part families. These can be used to form machine cells in GT layout.


1 2 3 4 5 6 7 8 9 A B C D
Raw material
Design
Shape
Dimensions
Finishing

Code Position	Item
1	Main shape
2	Shape elements
3	
4	Position of shape element
5	Main dimension
6	
7	Dimension ratio
8	Auxiliary dimension
9	Tolerance codes
10	
11	Material codes
12	

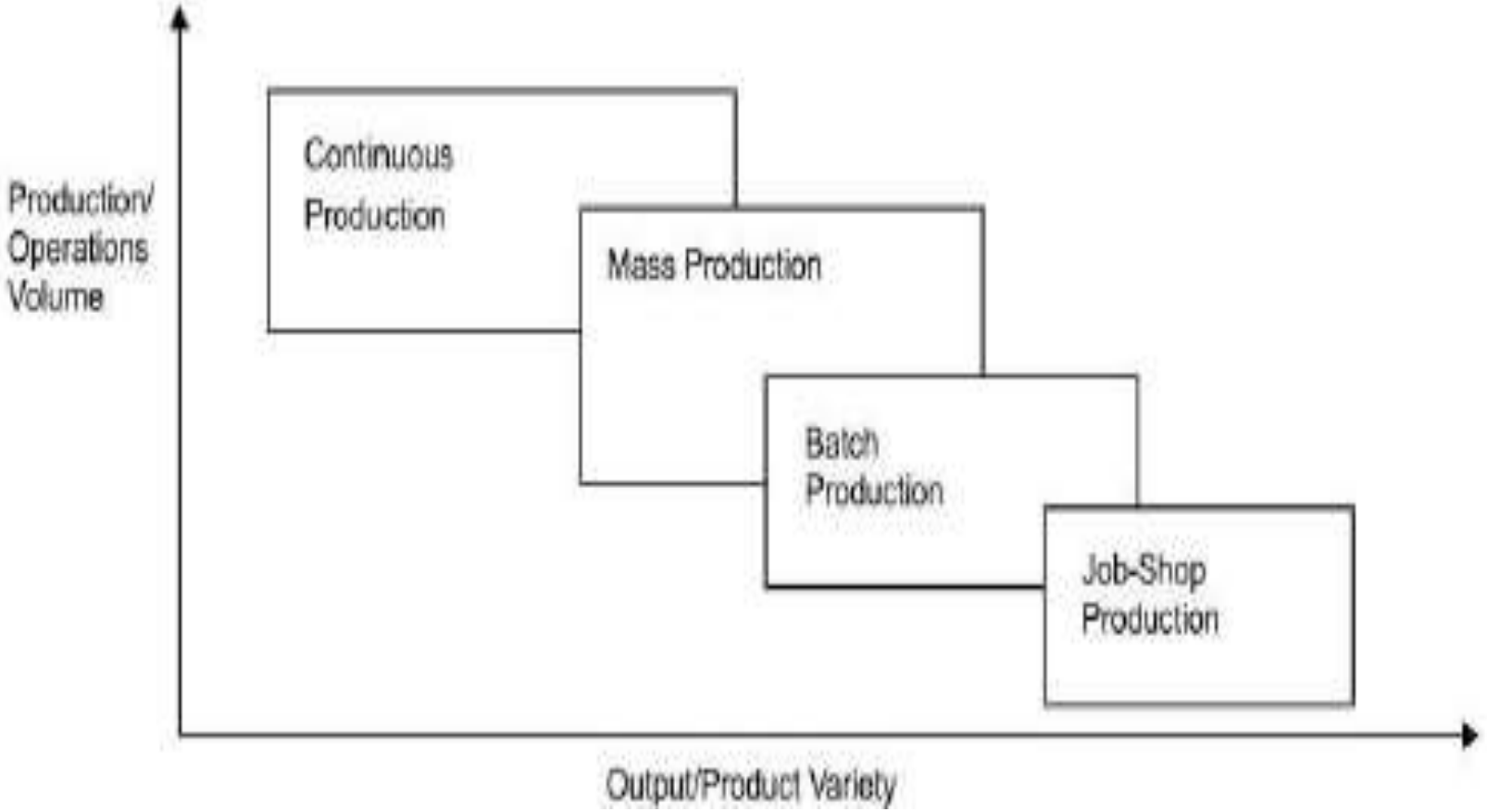
Parts Classification and Coding

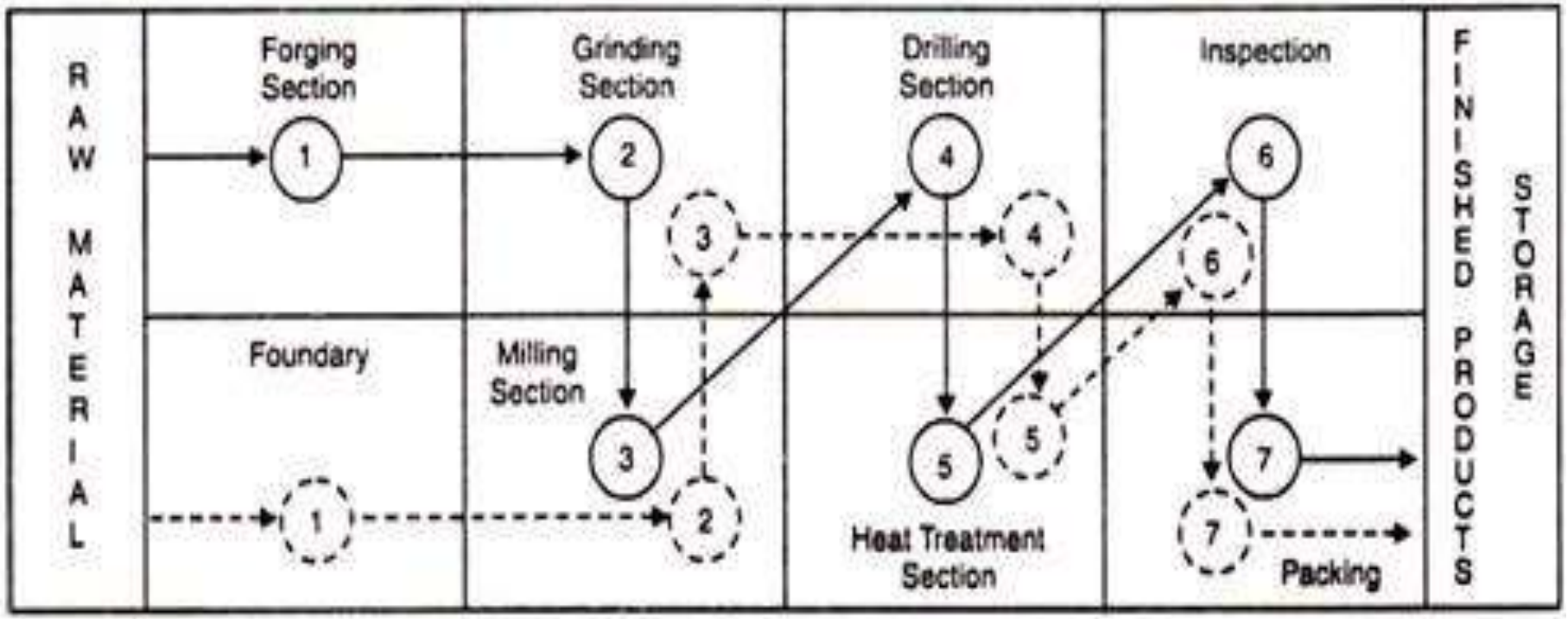
Part Design Attributes

- Major dimensions
- Basic external shape
- Basic internal shape
- Length/diameter ratio
- Aspect Ratio (L/W)
- Material type
- Part function
- Tolerances
- Surface finish

Part Manufacturing Attributes

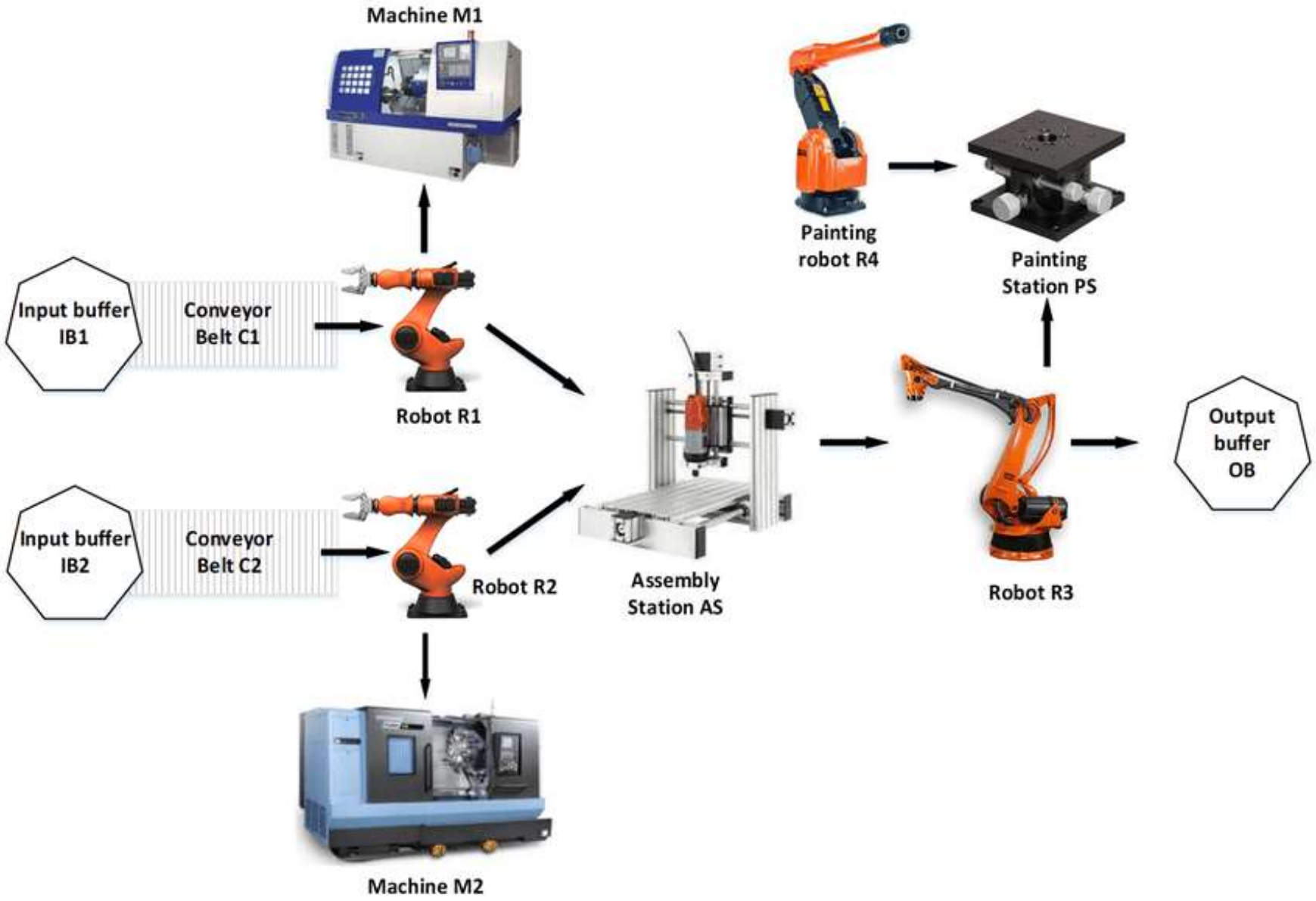
- Major process
- Operation sequence
- Batch size
- Annual production
- Machine tools
- Cutting tools
- Material type


Production/
Operations
Volume
Continuous
Production
Mass Production
Batch
Production
Job-Shop
Production
Output/Product Variety


RAW MATERIAL
Forging Section
Grinding Section
Drilling Section
Inspection
FINISHED PRODUCTS
STORAGE
Foundary
Milling Section
Heat Treatment Section
Packing
1
2
3
4
5
6
7

Unit- 5

FMS

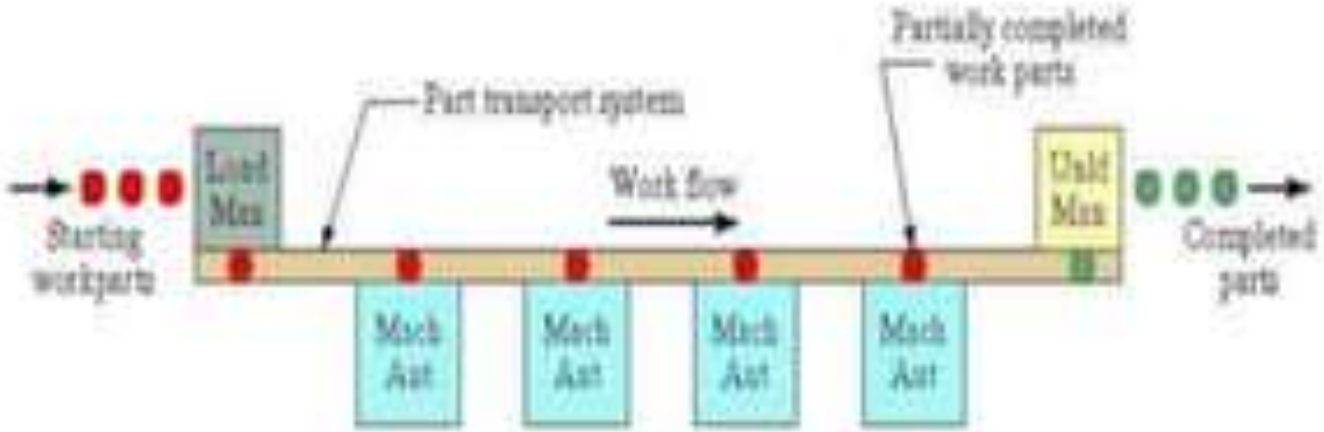

Machine M1
Painting robot R4
Painting Station PS
Input buffer IB1
Conveyor Belt C1
Robot R1
Input buffer IB2
Conveyor Belt C2
Robot R2
Assembly Station AS
Robot R3
Output buffer OB
Machine M2

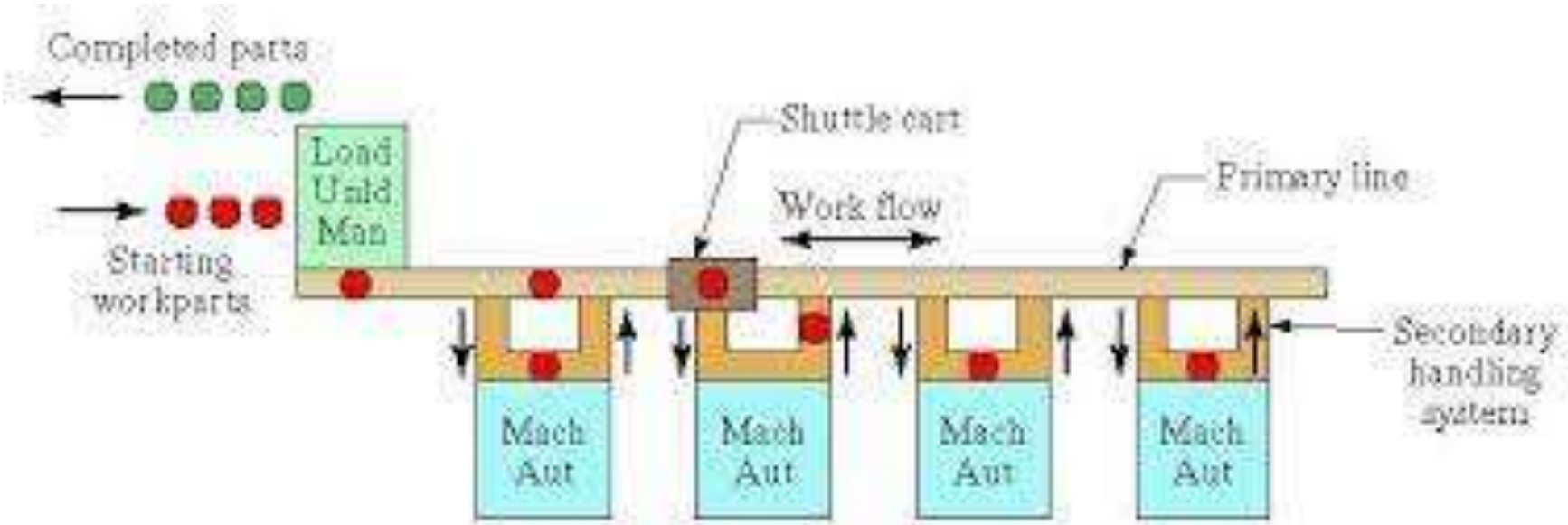
Flexible manufacturing system

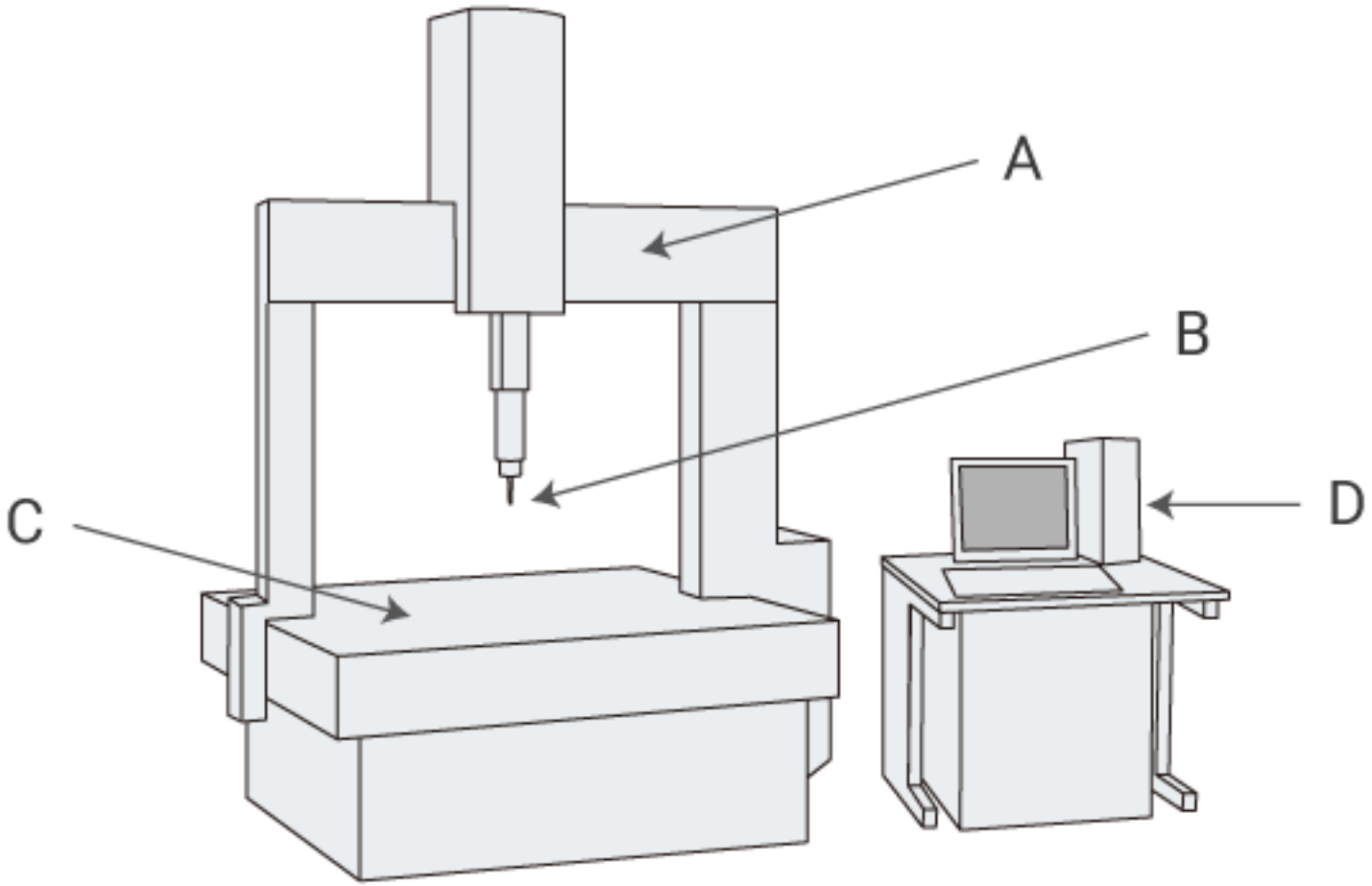
The basic components of an FMS are: workstations, material handling and storage systems, computer control system, and the personnel that manage and operate the system.

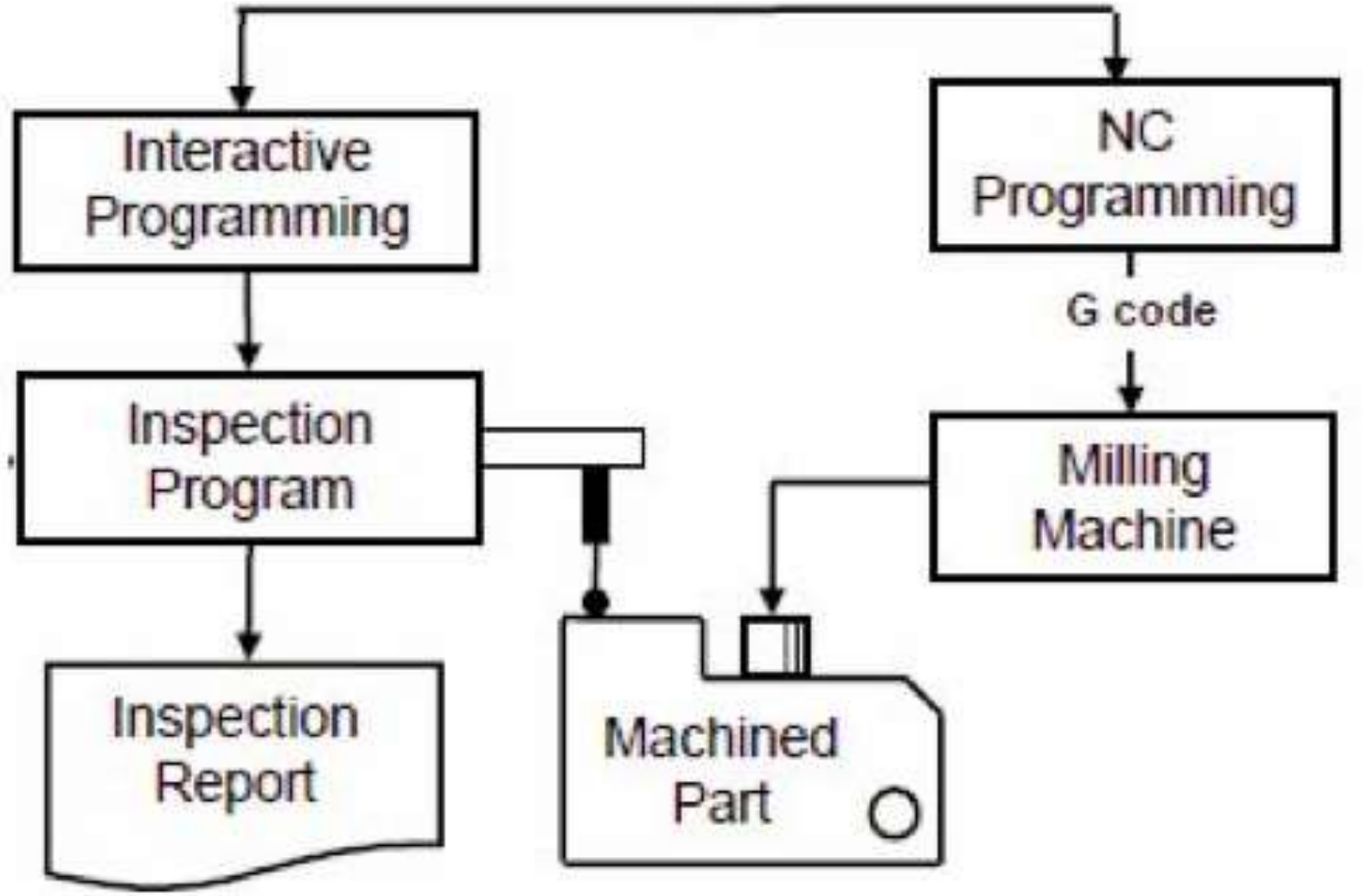
The main objective of the flexible manufacturing system (FMS) is to balance the productivity of the production floor as well as maintaining its flexibility.

1. PROGESSIVE OR LINE TYPE




Completed parts
Load Unld Man
Starting workparts
Shuttle cart
Work flow
Primary line
Secondary handling system
Mach Aut
Mach Aut
Mach Aut
Mach Aut


A
B
C
D


Interactive Programming
NC Programming
G code
Inspection Program
Milling Machine
Inspection Report
Machined Part

Additionally, CAQC means that a 100% inspection can be conducted on every item being manufactured without too much difficulty. In traditional quality control testing, it isn't possible to test every one of the hundreds or thousands of products being made so only a sample can be taken.

Computer-aided engineering (CAE) is the use of computer software to simulate performance in order to improve product designs or assist in the resolution of engineering problems for a wide range of industries. This includes simulation, validation and optimization of products, processes, and manufacturing tools.

Thank You..