

B. TECH. (MECHANICAL / INDUSTRIAL & PRODUCTION ENGINEERING),

SEVENTH SEMESTER, EXAM- 2013.

SOLUTION-SET

COMPUTER AIDED DESIGN AND MANUFACTURING

SECTION-A

A.1. The correct answer (4 Marks)

- (i). **(b)** Times per second
- (ii). **(a)** Close loop control system
- (iii). **(b)** NC milling machine
- (iv). **(a)** Polarization

A.2. Short answer (8 x 2 =16 Marks)

- (i). **Output devices:** (1) Printer (2) Plotter (3) Speakers, (4) Monitors
- (ii). **Image and Screen resolution:** The number of pixel available in a picture / image frame is called image resolution, measured by Pixel per Inch (PPI). The number of dots available in a screen is called screen resolution, measured by Dot per Inch (DPI).
- (iii). **CAPP:** (Computer Aided Process Planning) is the use of computer to generate the process plans for the complete manufacture of the product and parts.
- (iv). **Group Technology (GT):** A manufacturing philosophy in which similar parts are identified and grouped together to take advantage of their similarities in design and production.
- (v). **Advantages of ASRS: (any four)**
 - (1). To increase storage capacity
 - (2). To increase storage density
 - (3). To recover factory floor space presently used for storing work-in-process (WIP)
 - (4). To improve security and reduce pilferage
 - (5). To reduce labor cost and/or increase labor productivity in storage operation
 - (6). To improve safety in the storage function
 - (7). To improve control over inventories
 - (8). To improve stock rotation and customer service
- (vi). **Mechanization** – Human power is replaced by machines, drives, hydraulic or mechanic devices.
Automation – Human control is replaced by sequential machine, cams, computer, and PLC controller.
- (vii). **Numerical Control (NC)** machine is a form of programmable automation in which the mechanical actions of a machine tool or other equipment are controlled by a program containing coded alphanumeric data. **The basic elements of NC machine are:** Program of

Instruction (part program), Machine control unit and Processing equipment (Machine tool & cutting tool).

(viii). **Canned cycle:** Canned cycles give the programmer the option to do some routine functions with a simple G-code instead of writing many lines of information.

For example, if the programmer wanted to drill a hole 3" deep and clear the chip every .300. Without using a canned cycle drill, there would be more than 20 or 30 lines of program information per hole.

Sample Code:

G81 X3.Y1.5Z-2.R.1F3 (Drill at X3 Y1.5 Return to 1 above the R Plane, @ 3.0 IPM)

X2.Y1.5 (move to X2.Y1.5, drill another hole)

X1.Y7. F5 (move to X1, Y7, drill another hole at higher feed rate of 5.0 IPM)

G80 (cancelled canned cycle)

SECTION B

Unit 1

A.3. (i) Solution:(4 Marks)

Here, $n = 2$ and $x_0 = 1, y_0 = 1, x_1 = 2, y_1 = 2$, etc. The polynomial is of a second degree.

Expanding the Lagrange equation, we get,

$$\begin{aligned}
 f_2(x) &= y_0 [(x - x_1)(x - x_2)] / [(x_0 - x_1)(x_0 - x_2)] \\
 &\quad + y_1 [(x - x_0)(x - x_2)] / [(x_1 - x_0)(x_1 - x_2)] \\
 &\quad + y_2 [(x - x_0)(x - x_1)] / [(x_2 - x_0)(x_2 - x_1)] \\
 &= (1) [(x - 2)(x - 3)] / [(1 - 2)(1 - 3)] \\
 &\quad + (2) [(x - 1)(x - 3)] / [(2 - 1)(2 - 3)] \\
 &\quad + (1) [(x - 1)(x - 2)] / [(3 - 1)(3 - 2)] \\
 &= \frac{1}{2}(x^2 - 5x + 6) - 2(x^2 - 4x + 3) + \frac{1}{2}(x^2 - 3x + 2) \text{ or} \\
 f_2(x) &= -x^2 + 4x - 2
 \end{aligned}$$

This is the explicit non-parametric equation of a circle; the given points lie on the circumference.

(ii) Solution: (4 Marks)

$$m \text{ scale factor for } x\text{-dir}^n = 640/300 = 2.133 \text{ pixel/mm}$$

$$n \text{ scale factor for } y\text{-dir}^n = 480/250 = 1.92 \text{ pixel/mm}$$

Here $n < m$ because y scale factor is smaller than the x scale factor now convert start & end point into in to pixel equivalent

$$\text{For start point } (10 \times 1.92, 20 \times 1.92) = (19, 38) \text{ pixel}$$

$$\text{and end point } (30 \times 1.92, 25 \times 1.92) = (58, 48) \text{ pixel}$$

Now slope $m = \Delta y / \Delta x = 0.26$ which is < 1

Therefore; $x_{i+1} = x_i + 1$ & $y_{i+1} = y_i + m$

X_{i+1}	19	20	21	22	23	24	25	26	27	28	29	30
Y cal	38	38.26	38.52	38.78	39.04	39.3	39.56	39.82	40.08	40.34	40.6	40.86
Y r	38	38	39	39	39	39	40	40	40	40	41	41
31	32	33	34	35	36	37	38	39	40	41	42	
41.12	41.38	41.64	41.9	42.16	42.42	42.68	42.94	43.2	43.46	43.72	43.98	
41	41	42	42	42	43	43	43	43	44	44	44	

43	44	45	46	47	48	49	50	51	52	53	54	55	56
44.24	44.5	44.76	45.02	45.28	45.54	45.8	46.06	46.32	46.58	46.84	47.1	47.36	47.62
44	45	45	45	46	46	46	46	46	47	47	47	47	48

57	58
47.88	48.14
48	48

(iii) Solution: (4 Marks)

$$d_1 = 3 - 2R = 3 - 2 \times 10 = -17 \text{ which is } < 0$$

$$d_2 = d_1 + 4x_1 + 6 = -17 + 0 + 6 = -11.$$

$$d_4 = d_3 + 4x_3 + 6 = -1 + 8 + 6 = 13$$

$$d_6 = d_5 + 4x_5 + 6 = -5 + 16 + 6 = 17$$

$$d_3 = d_2 + 4x_2 + 6 = -11 + 4 + 6 = -1$$

$$d_5 = d_4 - 4(y_4 - x_4) - 10 = 13 - 28 + 10 = -5$$

$$d_7 = d_6 - 4(y_6 - x_6) + 10 = 17 - 16 + 10 = 11$$

i	x	y	di	Plot pixel
1	0	10	-17	0,10
2	1	10	-11	1,10
3	2	10	-1	2,10
4	3	10	13	3,10
5	4	9	-5	4,9
6	5	9	17	5,9
7	6	8	11	6,8
8	7	7	-	7,7

Unit 2

A.4. (i) Answer: (4 Marks)

- Representation techniques:** Wireframe representation, Surface representation, Solid representation
- Coordinate systems and inputs:** (1) Coordinates inputs can take the form of: Cartesian (x, y, z), Cylindrical (r, θ , z), Spherical (θ , Φ , z).

- (2) Various types of coordinate systems: World coordinate system (WCS), Working/window/Screen coordinate system (SCS), User defined coordinate system (UCS).
- (3). **Modeling entities:** (1) It is important to know the specific entities provided by each modeling representation technique. (2) The easy to generate these entities.
- (4). **Geometric editing and manipulation:** Set the dimensions.
- (5). **Graphics standard support:** If geometric models databases are to be transferred from one system to another, both systems must support exchange standard like GKS, IGES, PHIGS.....

(ii) Solution: (4 Marks): The transformation matrix will be

$$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix}, \quad T_2 = \begin{bmatrix} \cos 30 & \sin 30 & 0 \\ -\sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad T_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad T_4 = \begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix},$$

$$T_5 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix}$$

$$[T] = T_5 \times T_4 \times T_3 \times T_2 \times T_1$$

$$= \begin{bmatrix} 0.499 & 0.866 & -3.464 \\ 0.866 & -0.499 & 5.996 \\ 0 & 0 & 1 \end{bmatrix}$$

$$[P1] = [T] \times [P]$$

$$= \begin{bmatrix} 0.499 & 0.866 & -3.464 \\ 0.866 & -0.499 & 5.996 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 2 & 8 & 2 \\ 8 & 8 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 4.462 & 7.456 & -0.734 \\ 3.736 & 8.932 & 6.73 \\ 1 & 1 & 1 \end{bmatrix}$$

(iii) Solution: (4 Marks)

Step 1: Translate the fixed axis so that it coincides with the z-axis

$$[T_1] = \begin{bmatrix} 1 & 0 & -dx \\ 0 & 1 & -dy \\ 0 & 0 & 1 \end{bmatrix}$$

Step 2: Rotate the object about the axis

$$[T_2] = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Step 3: Translate the fixed axis back to the original position.

$$[T_3] = \begin{bmatrix} 1 & 0 & dx \\ 0 & 1 & dy \\ 0 & 0 & 1 \end{bmatrix}$$

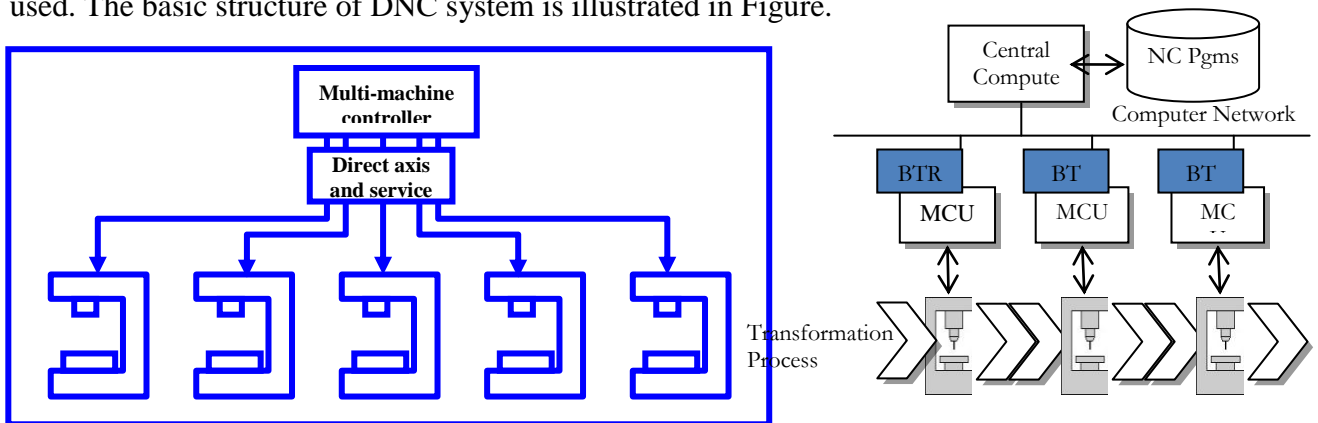
$[T] = [T_3] \cdot [T_2] \cdot [T_1]$

$$[T] = \begin{bmatrix} \cos \theta & -\sin \theta & dx(1 - \cos \theta) + dy \sin \theta \\ \sin \theta & \cos \theta & -dx \sin \theta + dy(1 - \cos \theta) \\ 0 & 0 & 1 \end{bmatrix}$$

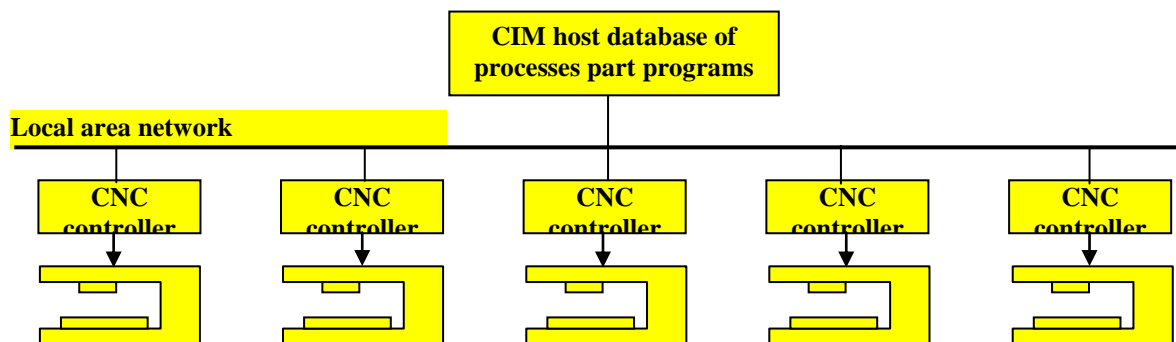
UNIT 3

A.5.(i) Answer: (4 Marks)

Direct Numerical Machine (DNC) can be defined as a set of NC machines that is connected to a main computer system to establish a direct interface between the DNC computer memory and the machine tools. The tape is not used in the DNC system; hence a central time-sharing computer is used. The basic structure of DNC system is illustrated in Figure.



Distributed NC is more advanced than Direct NC and is widely used in many current applications. The distributed NC uses a local area network but not like that in Direct NC. It has been indicated that the main difference between DNC and distributed NC is that because modern NC machines have CNC capability, they have memory and therefore computer programs can be downloaded into the memory of a CNC local computer, rather than one block at a time as in DNC systems. Figure illustrates the Distributed NC system.



(ii): Answer: (4 Marks)

- Role of AGV in FMS:** AGVS is used for material handling system that uses independently operated, self-propelled vehicle guided along defined pathways.
- ASRS:** An AS/RS is a storage system that performs storage and retrieval operation with speed and accuracy under a defined degree of automation.
- Benefits of implementing CIM (any two)**

- Increase in manufacturing productivity.
- Improved customer service.

3. Shorter time to market with new products, shorter flow time.
4. Reduction of lead times which generates a competitive advantage.
5. Shorter vendor lead time & shorter customer lead time.
6. Reduced inventory levels, Lower total cost.
7. Improved schedule performance.
8. Greater flexibility and responsiveness.
9. Decreases work-in process inventory.

(d) **APT and its basic statements:** Automatically Programming Tool (APT) is used to program CNC machine tools to create complex parts using a cutting tool moving in space. It is used to calculate a path that a tool must follow to generate a desired form. Four basic statements in APT:

1. Geometry statements: POINT/x, y, z. LINE/x, y, z. CIRCLE/ x, y, z. PLANE/ xy, yz, zx.
2. Motion statements: GOTO/ x, y, z. GODELTA/ x, y, z. GO/TO, GO/ON, GO/PAST etc.
3. Postprocessor statements: COOLNT/ON, COOLNT/OFF, FEEDRAT/100.0 etc.
1. Auxiliary statements: Symbol = MACRO/ definitions, CALL/symbol, TERMAC etc.

(iii) **Mechanization:** Mechanization is normally defined as the replacement of a human task with a machine. Office machines and equipments are of great value to the modern management experts because these are time and labour saving devices. The adoption of mechanical devices not only makes for greater efficiency and for economy, but also relieves human labour for less monotonous and less tiresome. The use of machine ensures accuracy and speed of operation, and reduce work tension and monotony. The mechanisation process has developed to save time, promote accuracy in work, relieve monotony in work and reduce the chances of frauds.

Automation: The word automation denotes replacement of human labor by the use of machines. The mechanical operations in an office or doing of office work with less human participation are termed as automation. The word mechanization and automation are not synonymous and as such automation includes something more than mechanization. Recording, processing and controlling information through mechanical and electronic devices is called automation. It is a self-regulated process where office work is completed with less human efforts.

UNIT 4

A.6.(i) Answer: (2+2=4 Marks): To verify Part Programming are as follows:

- (1). **Dry cut:** can detect gross programming mistakes, but not the detailed geometric ones.
- (2). **Machine a prototype:** a prototype part is typically machined in wax, machining plastic, wood, foam, or some other soft material. The actual geometry is then measured and compared with the design specification. This approach can verify only the geometry.

(3). **CAD-based verification software:** Real-time simulation of the cutting process can be displayed on screen. However, most simulations are purely geometry-based, where cutting condition is not considered. Thus, only the geometry can be verified.

ADVANTAGES (any two)

- (1). Increase productivity, shorter lead time, faster response time.
- (2). Savings in geometry definition, Immediate visual verification
- (3). Use of automatic programming routines and one-of-a-kind jobs
- (4). Integration with other related functions
- (5). Uniform manufacturing standard, greater accuracy.
- (6). Effective shop floor control creates and tests tool paths and optimizes them.

DISADVANTAGES

- (7). Higher initial cost requirements
- (8). Skilled labor requirements

(ii) Motion statements(2+2=4 Marks):

This statement is used to describe the path taken by the cutting tool. The general form of a motion statement is

Motion command/descriptive data

The motion commands can be broadly divided into

- 1. Set-up commands:
 - a. Start point: FROM/TARG(x, y, z coordinate)
 - b. Cutter: CUTTER/Dia. (25.0)
 - c. Tolerance: INTOL/0.005 OUTTOL/0.005
- 2. Point to point commands: GOTO/P1 or GOTO/2.0, 5.0, 0.0
GODELTA/dx, dy, dz or GODELTA/3.0, 5.0, 0.0
- 3. Contouring motion commands

Post processor statements

These functions are used to specify the machine tool function. For example

COOLNT/ON	COOLNT/OFF	COOLNT/FLOOD
COOLNT/MIST	FEEDRAT/100.0	END
MACHIN/MILL,1	TURRET/T30	SPNDL/3000
REWIND		

Unit 5

A.7(i) Answer:

A *part family* is a collection of parts that are similar either because of geometric shape and size or because similar processing steps are required in their manufacture.

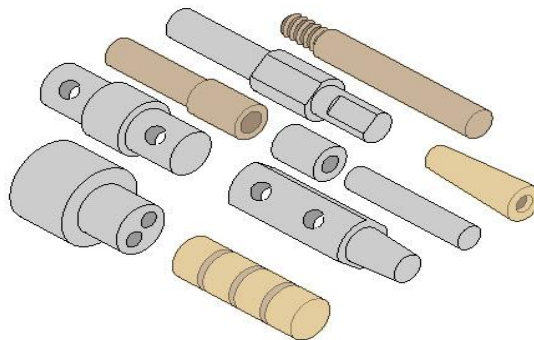
- Part families are a central feature of group technology
 - There are always differences among parts in a family
 - But the similarities are close enough that the parts can be grouped into the same family

Ways to Identify Part Families

There are three general methods for solving part families grouping. All the three are time consuming and involve the analysis of much of data by properly trained personnel. 1) Visual inspection 2) Part coding & 3) PFA

Visual inspection : 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.



Parts classification and coding: In parts classification and coding, similarities among parts are identified, and these similarities are related in a coding system.

Two categories of part similarities can be distinguished:

- 1) Design attributes, which concerned with part characteristics such as geometry, size and material.
- 2) Manufacturing attributes, which consider the sequence of processing steps required to make a part.

(ii) An FMS is a “reprogrammable” manufacturing system capable of producing a variety of products automatically. Conventional manufacturing systems have been marked by one of two distinct features:

The capability of producing a variety of different product types, but at a high cost.

The capability of producing large volumes of a product at a lower cost, but very inflexible in terms of the product types which can be produced (e.g., transfer lines).

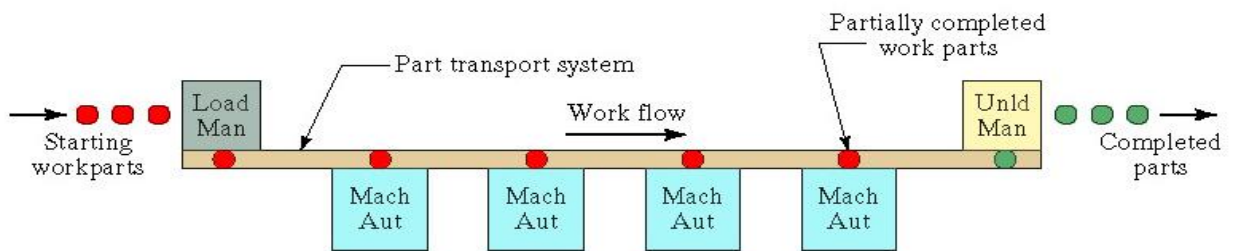
An FMS is designed to provide both of these features.

Five basic types of FMS layouts

1. In-line
2. Loop
3. Ladder
4. Open field
5. Robot centered cell

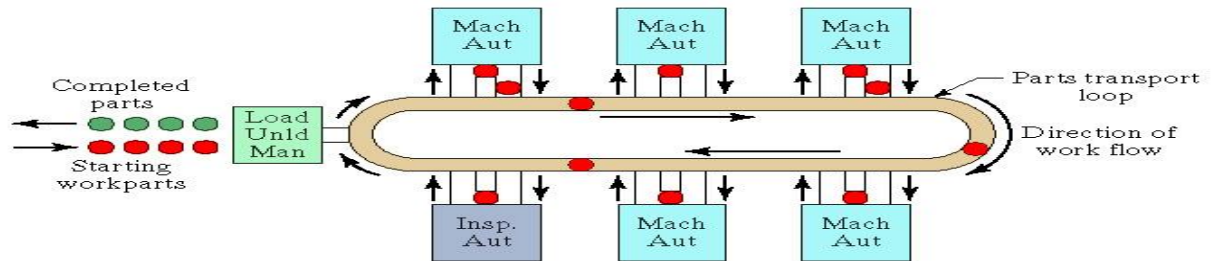
FMS In-line Layouts=Straight line flow, well-defined processing sequence similar for all work units

- i. Work flow is from left to right through the same workstations
- ii. No secondary handling system
- iii. Linear transfer system with secondary parts handling system at each workstation to facilitate flow in two directions



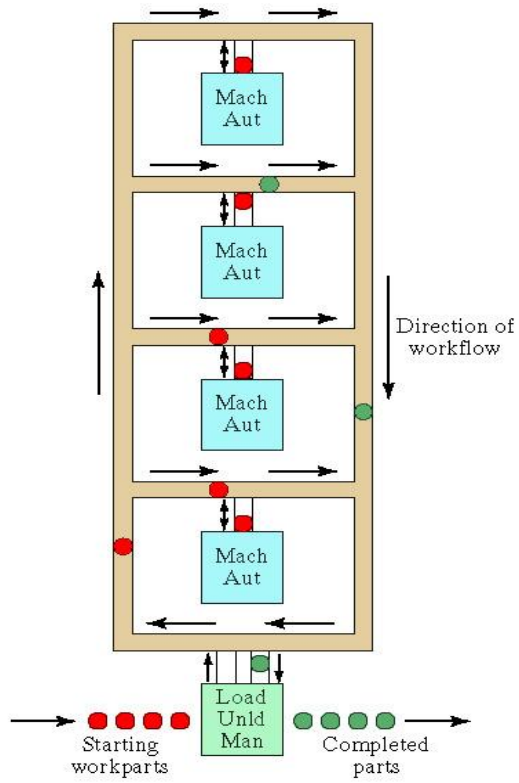
FMS Loop Layout

- i. One direction flow, but variations in processing sequence possible for different part types
- ii. Secondary handling system at each workstation



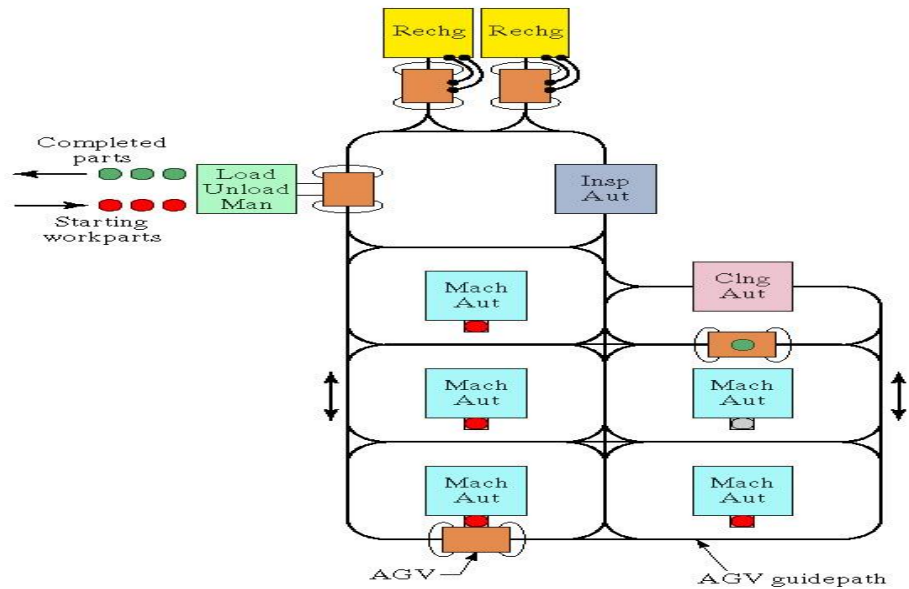
FMS Ladder Layouts

Loop with rungs to allow greater variation in processing sequence



FMS Open-field Layouts

Multiple loops and ladders, suitable for large part families



Robot-Centered Cell

Uses one or more robot for material handling system and it is suited to the handling of rotational parts and turning operations

