CBCS SCHEME

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18ME72

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Computer Aided Design and Manufacturing

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define Automation. Explain different types of automation. **(10 Marks)**

b. The average part produced in a certain batch manufacturing plant must be processed through an average 6 machines. 20 new batches are launched each week. Average operation time is 6 mins average set-up time is 5 hrs, average batch size is 25 parts, average non-operation time per batch is 10 hrs/machine. There are 18 machines in the plant. The plant operates an average of 70 production hours per week. Scrap rate is negligible, determine:
(i) Manufacturing Load Time (MLT) for an average part (ii) Production rate
(iii) Plant capacity (iv) Plant utilization (v) WIP **(10 Marks)**

OR

2 a. What is buffer storage? Explain types of buffer storage with neat sketch. **(08 Marks)**

b. Define Upper bound approach and lower bound approach. **(04 Marks)**

c. For a 10 station transfer line, refer following data:
P = 0.01 (all stations have an equal probability of failure)
$T_c = 0.5$ min, $T_d = 5.0$ min
Using upper bound approach, determine: (i) The frequency of line stop
(ii) The average production rate (iii)The line efficiency **(08 Marks)**

Module-2

3 a. Explain with block diagram, the design process using Computer Aided Design (CAD). **(10 Marks)**

b. Explain the different functions of graphics packages. **(10 Marks)**

OR

4 a. Explain in detail the Retrieval type of CAPP. **(10 Marks)**

b. What is MRP? Explain the different inputs of MRP with block diagram. **(10 Marks)**

Module-3

5 a. Briefly explain different types of manufacturing cells. **(10 Marks)**

b. What is AS/RS? Explain different types of AS/RS. **(10 Marks)**

OR

6 a. By using the given information:
The product demand is 1800 units/week; The industry works 48 hrs/week ;
Number of operators 8 ; Uptime of assembly is 94% ; There is no repositioning required
Determine: (i) Line efficiency (ii) Balance delay (iii) Smoothness index, by using largest candidate rule method. The work elements and their times involved in the assembly operation is as below:

Element	1	2	3	4	5	6	7	8
Tek (min)	1.0	0.5	0.8	0.3	1.2	0.2	0.5	1.5
Predecessor by	-	-	1, 2	2	3	3, 4	4	5, 6, 7

(14 Marks)

b. Define and write the mathematical model of:
   (i) Total work content time (T_{wc})
   (ii) Cycle Time (T_c)
   (iii) Smoothness Index (SI) **(06 Marks)**

Module-4

7 a. Explain briefly the steps involved in the development of a part program. **(10 Marks)**
b. List out the advantages, limitations and applications of CNC's. **(10 Marks)**

OR

8 a. Explain with neat sketches the different joints used in industrial robots. **(10 Marks)**
b. Write a short note on robot programming methods. **(10 Marks)**

Module-5

9 a. Define additive manufacturing systems and list out its advantages, disadvantages and application. **(10 Marks)**
b. With neat sketch, explain sheet lamination type AM process. **(10 Marks)**

OR

10 Write short notes on:
a. Evolution of industry 4.0
b. Big data and cloud computing for IoT
c. Supply chain optimization
d. Cyber physical manufacturing systems **(20 Marks)**

* * * * *

1.a

Automation has been classified into three types

1. Fixed (or) Rigid Automation
2. Programmable Automation
3. Flexible Automation

1. Fixed Automation (OR) Rigid Automation

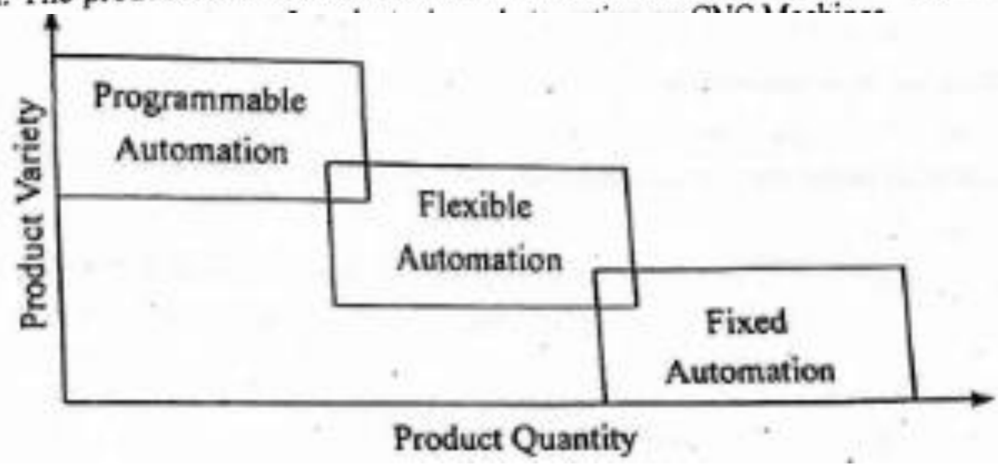
As the name suggests, in this automation the sequence of operations are fixed, and easier to perform. Fixed automation is used when the volume of production is high, and product variety is low. This kind of automation is mostly suitable for Mass Production. Here the equipment is specially designed to produce a particular product. If the product changes the same equipment cannot be used. Fixed automation has very high production rates. Overall investment is less in case of fixed automation when compared to other types of automation. **Ex:** Oil refineries, chemical processing, Assembly lines special purpose machines

2. Programmable Automation

In this type of Automation Sequences of operations can be interchanged. The sequence of operations are controlled by program of instructions. If the product is changed only program of instructions are changed but not the equipment. Programmable automation is used when production volume is low. This kind of automation is more suitable for Batch production. The product variety will be high in this automation compared to fixed automation If the product changes, the same equipment can be used with minimal changes. Ex: NC Machines, Industrial Robots.

3. Flexible Automation

It is an extension of programmable automation. A flexible automation system is capable of producing a large variety of parts with virtually no time lost for change over from one part style to the next. It covers the advantages of both fixed and programmable automation. The production rates are medium in flexible automation. The entire system



1.B

Sol. Given: $n_o = 6$

Number of batches of parts = 20

T_c = 6 min = 0.1 hour

T_{su} = 5 hours

Batch size, Q = 25 parts.

T_{no} = 10 hours/batch

n = 18

Plant operation time, S × H = 70 hours/week. [shift/week × hours/week]

(a) Manufacturing lead time.

$$MLT = n_o(T_{su} + QT_c + T_{no})$$

$$= 6(5+25\times0.1+10)$$

MLT = 105 hours.

(b) Production time.

$$T_p = \frac{QT_c + T_{su}}{Q} \text{ (for batch production)}$$

$$= \frac{25\times0.1+5}{25}$$

T_p = 0.3 hours per unit.

∴ Production rate,

$$R_p = \frac{1}{T_p} = \frac{1}{0.3} = 3.34 \text{ units/hour}$$

∴ Plant capacity

$$P_c = \frac{n.S.H.Rp}{n_o} = \frac{18\times70\times334}{6}$$

P_c = 701.4 ≈ 702 units/week.

(c) Plant Utilization.

$$U = \frac{\text{Actual Production}}{\text{Production Capacity}}$$

Actual Production = Number of batches × Number of units in each batch.

= 20 × 25

Actual Production = 500 units/week

$$\therefore U = \frac{500}{702}\times100$$

U = 71.225%

2.a

Definition: A storage can be used as buffer storage between two processes whose production rates are significantly different, where parts can be collected and temporarily stored before proceeding to subsequent workstations.

Automated production lines may also contain storage buffers, which act as a temporary storage for parts that are being processed in the line.

Storage buffers are either manually operated (or) Automated. In automated versions, a mechanism is used to accept parts from upstream workstations, a place is designated as storage for the incoming parts, and a mechanism subsequently releases the parts, as required, to supply down stream workstations.

Automated versions consists of mechanisms for capturing and releasing parts to the production line and a structure storage buffer for holding the parts.

Fig. 2.15 Buffer storage used in a Automated transfer line

The parts are temporarily stored in the storage buffer before entering into sub sequential work stations.

Storage buffers can be easily accommodated in in-line and segmented in-line configurations, but cannot be accommodated in rotary configuration. Whenever there is a machine break down (or) during the delay in processing operations, storage buffer will be of much advantageous.

Advantages of Buffer Storage : *(VTU Jan 2014)*

The following are the advantages associated with storage buffers in automated production lines.

1. When a particular workstation breakdowns in a transfer line, the entire production on that particular line gets disturbed. Use of storage buffers in such cases will help to supply work parts to the lines with out any breakdowns, while the other lines are down for repair.
2. Whenever a particular workstation completes a processing operation, the storage buffer supplies the work part, thus reducing ideal time (or) waiting time of that particular work station.
3. Storage buffers can provide sufficient time for curing that may be required for some operations (e.g. paint to dry, adhesives to bond).
4. By using storage buffers, delay times can be minimized which reduces the manufacturing lead time.

2.b

2.13.1 Upper bound approach :

- In this type of approach, the workstation breakdown will not have any effect on the part.
- The part can remain on the transfer line for subsequent processing at remaining stations.
- The upper bound approach is applied in situations such as minor electrical (or) mechanical failures at stations, tool changes, tool adjustments, preventive maintenance and so on.
- In case of upper bound approach the frequency of breakdowns is given by,

$$F = np \qquad \text{.... (3.12)}$$

Where, n = number of workstations

p = probability of failure in each workstation.

Production rate is given by,

$$R_p = \frac{1}{T_p} \qquad \text{....(3.13)}$$

Equation 3.12 is applicable only if the probability of failure is same for all the work stations.

If the probability of failure is different for individual workstations, then the frequency of breakdown is given by,

$$F = P_1 + P_2 + P_3 + \text{.........} P_n \qquad \text{.....(3.14)}$$

2.13.2 Lower bound approach :

- In this type of approach, the station breakdown results in the damage of the part and it must therefore be removed from the line.
- The lower bound approach arises in situations such as tool breaks down during processing, which may result in damage of the part. In such cases the broken tool must be replaced at the workstation and the part must be removed from the line and cannot proceed to the next station for further processing.
- In case of lower bound approach the frequency of breakdowns is given as

$$F = 1 - (1-p)^n \qquad \text{....(3.15)}$$

Where, n = number of workstations

p = probability of failure in each workstation

(**Note :** The above formula is applicable only if probability of failure is same for all the workstations.)

- In lower bound approach, the parts are removed from the line. The number of parts coming out of the line will be less than the parts entering into the line.
- Therefore, the production rate formula will be changed to reflect the changes in the out put

$$\therefore \quad R_p = \frac{1-F}{Tp} \qquad \text{....(3.16)}$$

If the probability of failure is different for individual workstations then the frequency of breakdown is given as

$$F = 1 - [(1-p_1)(1-p_2)(1-p_3)\text{.........}(1-p_n)] \qquad \text{.....(3.17)}$$

2.c

Given

$n = 10$ $\quad T_c = 0.5$ min

$P = 0.01$ $\quad T_d = 5$ min

Solution → Upper bound approach

(a) Frequency

$F = n.P$

$= 10 \times 0.01$

$F = 0.1$

(b) Avg. Production Rate

$R_p = \frac{1}{T_p}$

$T_p = T_c + F \times T_d = 0.5 + (0.1 \times 5)$

$T_p = 1$ min/pc

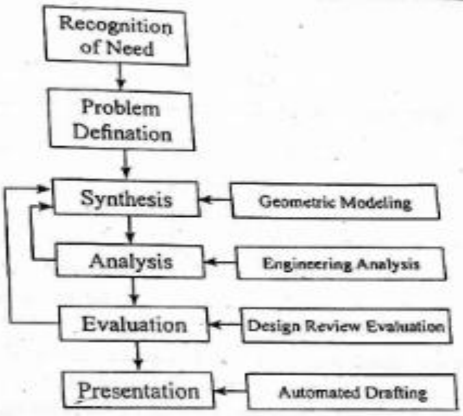
$R_p = \frac{1}{1} = 1$ Pc/min

(c) Line Efficiency

$E = \frac{T_c}{T_p} \times 100 = \frac{0.5}{1} \times 100$

$E = 50\%$

3.a



3.3.1 Geometric Modeling

It is concerned with computer compatible mathematical description of the geometry. These drawings are created in a computer and also computerized model can be developed instead of a prototype model. Here,the designer constructs the graphical image of the object on the screen by giving three types of commands to the computer.

I type of commands : Generates basic geometric elements such as points, lines and circles.

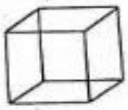
II type of commands : Used for scaling, rotation and other transformation.

III type of commands : Used to join various elements to get desired shape.

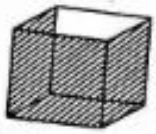
There are different ways of representing the objects in geometric modeling.

1. Wireframe modeling
2. Surface Modeling
3. Solid modeling

1. Wireframe Modeling :



Basic representation form. It is easier to create, but complex to understand. It consists of only points, lines and curves.



Here, the geometry is represented in the form of surfaces, But the object will not have any mass or volume.

3. Solid Modeling :

This is the most advanced method of geometric modeling. Here, the objects will occupy volume.

During the geometric modeling process, computer converts the commands into mathematical models, stores it in computer data files and displays it as an image on the CRT. There are different software which are capable of performing geometric modeling like, ProlE, CATIA, Solid Edge Uni Graphics, Solid Works.

3.3.2 Enginèering Analysis

The analysis involve stress-strain calculations, heat - transfer computations, fluid flow analysis etc. Different types of analysis can be performed on a geometric model, like structural analysis, Thermal analysis, Electro - Magnetic analysis, computational fluid-dynamics etc.

There are mainly two different types of analysis

1. Analysis of mass properties
2. Finite element analysis

Analysis of mass properties provides different properties of a solid model like surface area, weight, volume, center of g.avity, moment of inertia etc.

For planar surfaces we can find out perimeter, area and inertia properties.

Finite element analysis is the most powerful analysis of a CAD system. In this type of analysis the model is divided into a large number of finite elements. Then these small elements are analyzed for different properties and thus by analyzing these elements, the behaviour of the entire object can be accessed.

There are different analysis packages available in the market . They are ,

Ansys, Nastran, COSMOS, Fluent, Hyper Mesh, Star - CD , ...

3.3.3 Design Review and Evaluation

- Checking the accuracy of the design can be easily accomplished by using computers.
- Semiautomatic dimensioning and tolerance will help the user reducing the possibility of dimensioning errors.
- A procedure called layering, is often used to compare similar type of images with each other and helps to find out the defects.
- Interference checking helps to find out if any parts are intersecting with each other in a assembly model.
- Kinematics is one of the most interesting evaluation factor which provides capability to animate the motions of simple designed mechanisms. Commercial software are available to perform kinematics like ADAMS(Automatic Dynamic Analysis of Mechanical Systems).

3.3.4 Automated Drafting

This involves creation of hard - copy drawings of the models from the solid model in a CAD database. Automated drafting helps to generate different orthographic and sectional views directly from a solid mode.

The dimensioning and tolerances including cross hatching is automatically provided to the models. It also takes care of various design standards in the drawing such as thick lines, thin lines, hidden lines, center lines.

The part list can be automatically generated in a CAD system. By using automated drafting, the productivity of a system can be increased rapidly.

3.b

3.8 FUNCTIONS OF A GRAPHICS PACKAGE/SYSTEM

Some of the common functions of a graphics package are

1. Generation of graphic elements
2. Transformations
3. Display control and windwoing functions
4. Segmenting
5. User input functions

1. Generation of graphic elements :

A graphic element in computer graphics is the basic image entity such as dor , line , circle etc.

Graphical elements also include alphanumeric characters, special symbols etc graphic elements in 3-D are referred as primitives, such as sphere, cube cylinder. These primitives are used as building blocks to construct a 3 dimensional model.

Transformations :

Used to change (or) reposition the graphical entities on the database. Transformations include enlargement and reduction of an entity by a process called as scaling, repositioning the image or translation, rotation.

3. Display control and windwoing functions :

These functions help the user to view the image from desired angle and at the desired magnification. These function as are sometimes referred as windwoing, because the graphics screen like a window used to observe the model.

Another aspect of display control is hidden line removal. Hidden line removal is the concept in which the image is divided into visible in visible lines.

In some software, users only will identity which lines are to be removed so that the diagram is more understandable. Most of the other graphic packages are sophisticated enough to remove these hidden lines.

4. Segmenting function :

Provides capability to selectively replace, delete or modify the portions of the image.

Segment - particular portion of the image.

Segmenting functions cannot be used in storage tubes, as there will be no selective erase. If the image to be modified the entire screen must be redrawn, with the changes incorporated.

In case of refresh display, segments functions is possible.

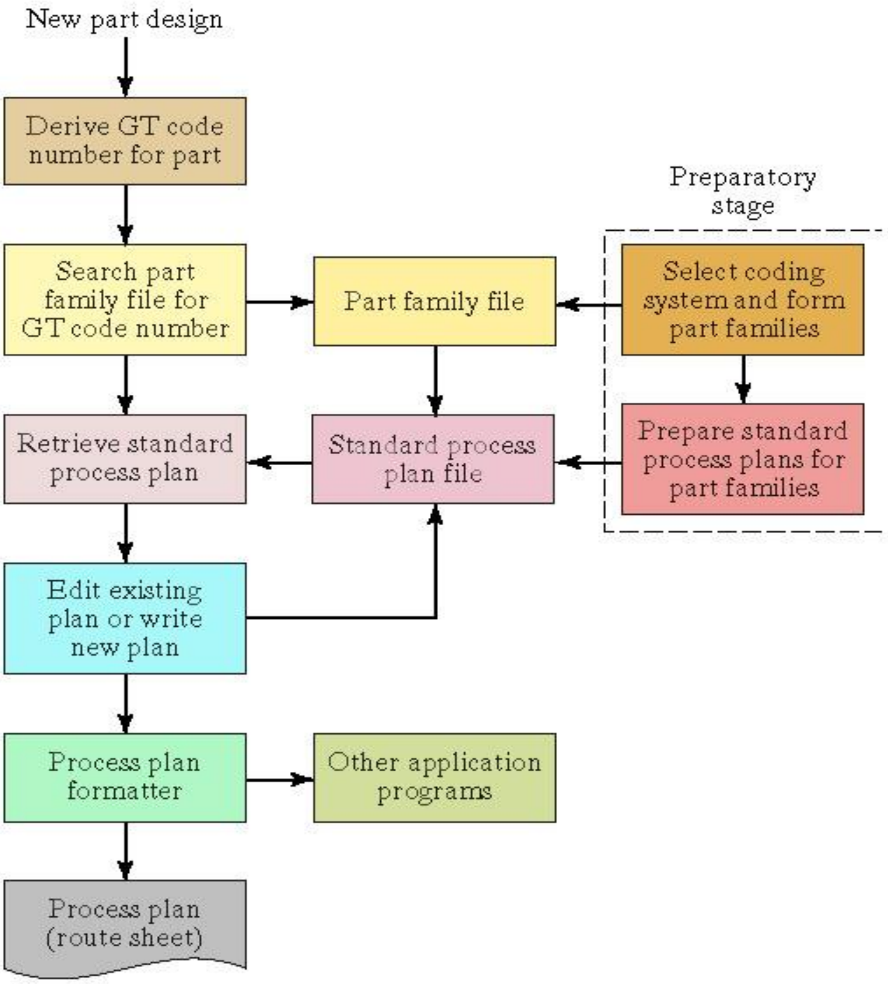
5. User input functions :

These are the functions which help the user to enter commands. The input functions must be written for specific input devices. These input functions are defined in such a way that even the user without any programming experience can also work effectively.

4.a

Variant process planning approach is sometimes referred as a data retrieval method. In this approach, process plan for a new part is generated by recalling, identifying and retrieving an existing plan for a similar part and making necessary modifications for new part. As name suggests a set of standard plans is established and maintained for each part family in a preparatory stage. Such parts are called master part. The similarity in design attributes and manufacturing methods are exploited for the purpose of formation of part families. Using coding and classification schemes of group technology (GT), a number of methods such as coefficient based algorithm and mathematical programming models have been developed for part family formation and plan retrieval. After identifying a new part with a family, the task of developing process plan is simple. It involves retrieving and modifying the process plan of master part of the family.

Form the Part Families by Grouping Parts →Develop Standard Process Plans →Retrieve and Modify the Standard Plans for New Parts



Advantages

(i) Processing and evaluation of complicated activities and managerial issues are done in an efficient manner. Hence lead to the reduction of time and labour requirement. (ii) Structuring manufacturing knowledge of the process plans to company's needs through standardized procedures.

Disadvantages

(i) It is difficult to maintain consistency during editing. (ii) Proper accommodation of various combinations of attributes such as material, geometry, size, precision, quality, alternate processing sequence and machine loading among many other factors are difficult.

4.b

4.15 INPUTS TO MRP SYSTEM

MRP must operate on the data contained in several files.

These files serves as input to MRP processors.

They are :

1. Master Production schedule (MPS).
2. Bill of Materials file (or) product structure file
3. Inventory status file.

4.15.1 Master Production Schedule (MPS)

- The MPS specifies what end products are to be produced and when.
- The production quantities of a major product line is converted into a specific schedule of individual products and is known as Master production schedule.
- MPS is based on the demand of products and the company production capacity.
- MPS is the key input which drives the MRP.
- The general format of MPS for a product line is shown in fig 4.8
- MPS uses weeks or months as time periods and these time periods are called as "Time buckets".

End Item	Week			
	1	2	3	4
Product, P_1	100	120	140	160
Product, P_2		80	90	100
Product, P_3		40		60

Fig 4.8 MPS of products P 1, P 2 and P 3 for one month (4 Weeks)

4.15.2. Bill of Materials file

- The MRP obtains information about the components needed to make an end product from Bill-of-Materials (BOM) file.
- BOM file is also called as product structure file.
- BOM file lists the raw materials and components for the end products listed in Master Production schedule.
- A Bill of material not only lists all the required parts but also is structured to reflect the sequence of steps required to produce the end product.
- The BOM has a series of levels, each of which represents a stage in the manufacture of the end product.
- The product structure for an assembled product is as shown in fig 6.9.

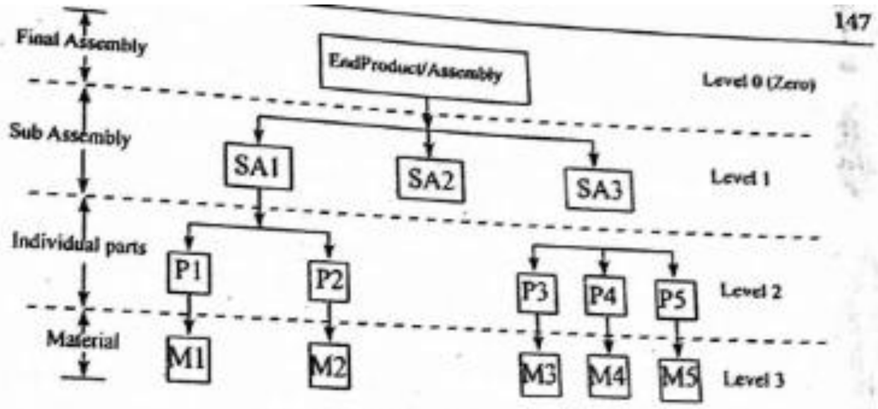


Fig. 4.9 (a) Product Structure Chart

Parts Number	Parts Name	Quantity	Description (Material Type, Dimensions, etc)	Cost

The highest level (or) Zero-Level of the B.O.M represents the final assembly or en product. The next lower level might represent the sub assemblies that are combined make the final assembly. The next lower level might represent the parts needed to ma the sub assemblies and the bottom most level might represent the raw materials fro which the parts are made.

4.15.3. Inventory status file

The inventory status file gives complete and up-to-date information on the on-h quantities, gross requirements, scheduled receipts and planned order releases for the i

It also includes other information such as lot sizes, Lead times, safety stock levels scrap allowances etc.

This file contains important information such as what items should be ordere when the orders should be released.

The inventory status file keeps the data about the projected use and receipts o item and determines the amount of inventory that will be available in each time bu

The inventory file must be kept upto date taking into consideration the daily inv transactions such as receipts, scrapped materials, Order releases and planned orde

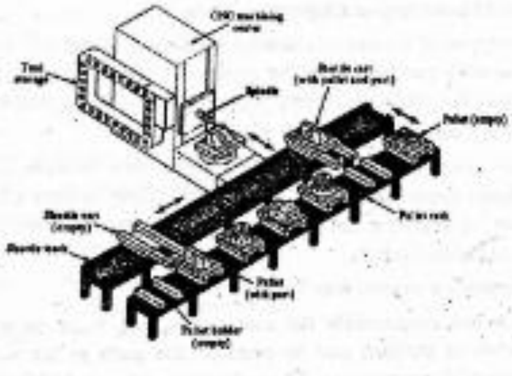
If the projected available inventory is not sufficient to meet the requirement in a the MRP program will recommend that the item be ordered.

5.a

c. Number of machines

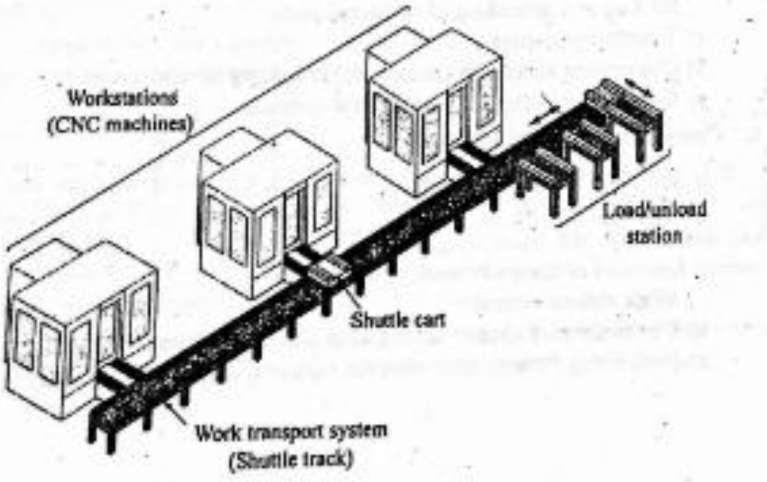
a. Single Machine Cell (SMC)

SMC consists of only one machining center along with a storage system. SMC can operate in either a batch mode or a flexible mode or in combinations of the two. During batch mode, similar components are manufactured in batches and when the product changes, the entire batch has to be changed. During flexible mode, the machine will be able to produce components with various design features. The processing is sequential and not simultaneous. Such systems are capable accepting new product designs and manufacture variety of parts. The system can readily accept changes in production schedule, but cannot recover quickly during machine breakdown.



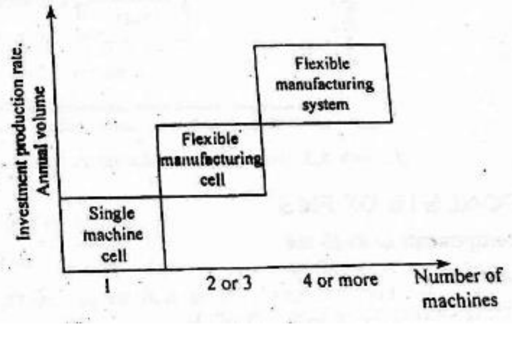
b. Flexible Manufacturing Cell (FMC)

It entails two or three processing workstations along with a material handling system with a limited parts storage capacity. The material handling system is linked to a load / unload station. It is a simultaneous production system. FMCs can recover during machine breakdowns and continue production as there are more than one workstation.



c. Flexible Manufacturing System (FMS)

It has four or more processing stations interconnected with material handling system and controlled by a distributed computer system. It also includes non-processing work stations that support production like pallet washing stations, co-ordinate measuring machines.



5.b

5.11 AUTOMATED STORAGE AND RETRIEVAL SYSTEMS (AS/RS)

The function of a material storage system is to store materials for a period of time and to permit access to those materials when required. Different categories of materials require different storage methods and controls. Many production plants use manual methods for storing and retrieving items. Automated methods are available to improve the efficiency of the storage function. Many conventional storage systems are available such as rack systems, shelves, and bins, bulk storage and draw storage. These storage equipment requires a human worker to access the items in storage. The storage system itself is static. Mechanized and automated storage systems are used to reduce or eliminate the amount of human intervention required to operate the system.

"An automated storage and retrieval system (AS/RS) can be defined as a storage system that performs storage and retrieval operations with speed and accuracy under a defined degree of automation."

5.11.1 Advantages of AS/RS

- Increases storage capacity
- Reduce factory floor space used for storing
- Improves security and reduce pilferage
- Reduce labor cost
- Increase labor productivity in storage function
- Improve safety in the storage function
- Improved control over inventories

5.11.2 AS/RS COMPONENTS AND TERMINOLOGY

An AS/RS consists of one or more storage aisles (passages) that are serviced by a storage/retrieval (S/R) machine. The materials are held in storage racks of aisles. The S/R machines are used to deliver and retrieve materials in and out of inventory. There are one or more input/output stations in each AS/RS aisle for delivering the material into the storage system or moving it out of the system. In AS/RS terminology, the input/output stations are called pickup-and-deposit (P&D) stations.

5.11.3 Types of AS/RS Systems

Several important categories of AS/RS can be distinguished based on certain features and applications. The following are the principle types:

Unit Load AS/RS

The unit load AS/RS is used to store and retrieve the loads that are palletized or stored in standard-sized containers. The system is computer controlled. The S/R machines are automated and designed to handle the unit load containers by employing mechanical clamps, vacuum cups or a magnet-based mechanisms.

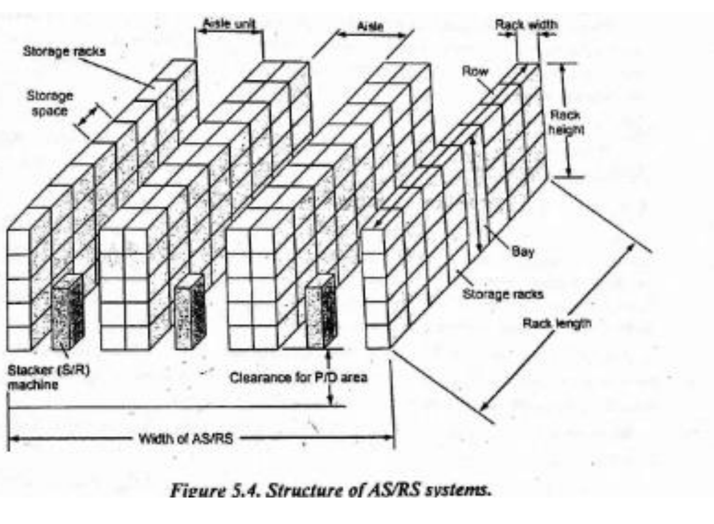


Figure 5.4. Structure of AS/RS systems.

Mini Load AS/RS

This system is designed to handle small loads such as individual parts, tools and supplies that are contained in bins or drawers in the storage system. Such a system is applicable where the availability of space is limited and volume is low. A mini load AS/RS is generally smaller than a unit load AS/RS.

Deep-lane AS/RS

This is a high-density unit load storage system that is appropriate for storing large quantities of stock. The items are stored in multi deep storage with up to 10 items in a single rack, one load behind the next.

Man-on-board AS/RS

In this system, human operator rides on the carriage of the S/R machine to pick up individual items from a bin or drawer. The system permits individual items to be picked directly at their storage locations. The operator can select the items and place them in a module. It is then carried by the S/R machine to the end of the aisle or to a conveyor to reach its destination.

6.a

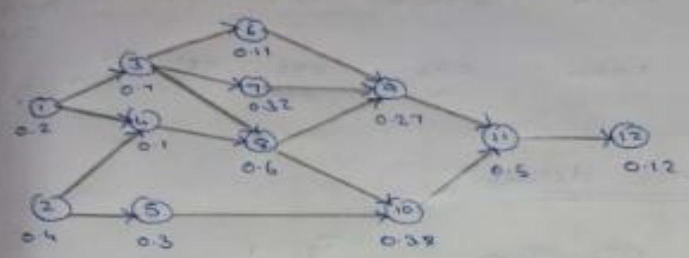
Step 1: Arrange the work elements in the descending order of their element time.

Element no	T_e (min)	Precedence
3	0.7	1
8	0.6	3,4
11	0.5	9,10
2	0.4	—
10	0.38	5,8
7	0.32	3
5	0.3	2
9	[illegible]	[illegible]
1	0.2	—
12	0.12	11
6	0.11	3
4	0.1	1,2

Step 2 : Assigning the work element to work stations [T = 1 min]

Element no	Tc (min)	Precedence	Station	Station time
2	0.4	–	I	0.4+0.3+0.2 +0.1 = 1min
5	0.3	2		
1	0.2	–		
4	0.1	1,2		
3	0.7	1	II	0.7+0.11+0.12 = 0.93 min
12	0.12	11		
6	0.1	3		
8	0.6	3,4	III	0.6+0.32 = 0.92min
7	0.32	3		
10	0.38	5,8	IV	0.38+0.27 = 0.65min
9	0.27	6,7,8		
11	0.5	9,10	V	0.5min

Step 3 : Construct the precedence diagram



Step 5 : Determine the theoretical number of stations required.

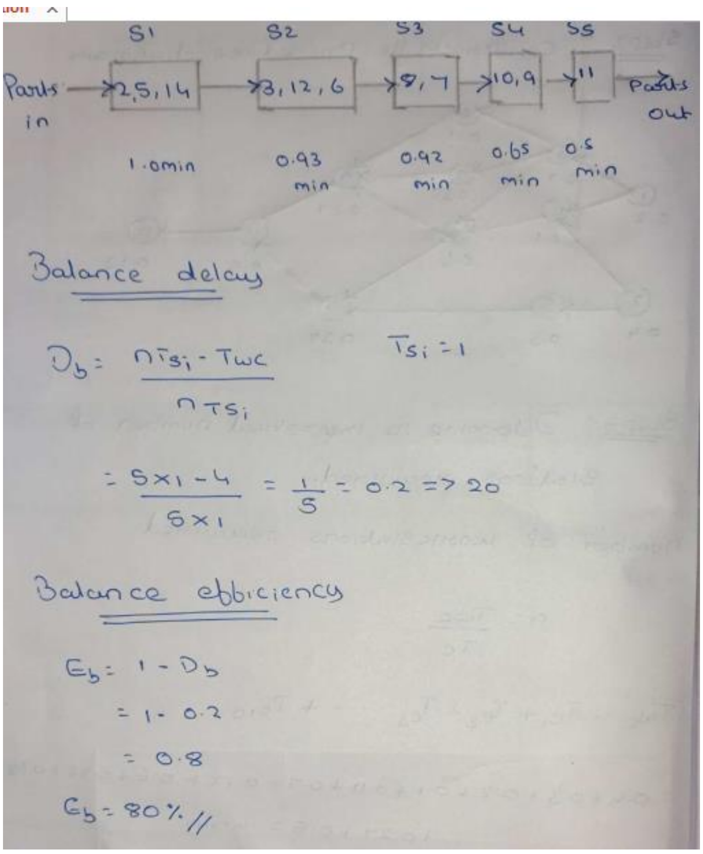
number of work stations required

$$n = \frac{T_{wc}}{T_c}$$

$T_{wc} = T_{e_1} + T_{e_2} + T_{e_3} \cdots + T_{e_{10}}$

$= 0.4+0.3+0.2+0.1+0.11+0.7+0.12+0.6+0.32+0.38$
$+0.27+0.5 = 4 min$

Step 6 : Computing line balancing delay & Line Balancing efficiency.



Balance delay

$$D_b = \frac{nT_{si} - T_{wc}}{nT_{si}} \qquad T_{si} = 1$$

$$= \frac{5\times 1 - 4}{5\times 1} = \frac{1}{5} = 0.2 \Rightarrow 20$$

Balance efficiency

$$E_b = 1 - D_b$$
$$= 1 - 0.2$$
$$= 0.8$$
$$E_b = 80\% //$$

6.b

T_{e2} = Time required to complete work element 2 and so on ....

2. Total Work Content, (T_{wc})

It is the algebraic sum of time of all the work elements on the line.

It is the total time required to accomplish the entire work by completing individual Work elements.

It is denoted by "T_{WC}"

$$T_{WC} = T_{e1} + T_{e2} + T_{e3} + \dots\dots\dots T_{ej}$$

$$T_{wc} = \sum_{j=1}^{n} T_{ej} \qquad \dots\dots\dots\dots\dots (4.1)$$

3. Cycle time (T_c)

Cycle time is the rate of production. This is the time between two successive assemblies coming out of a line. Cycle time can be greater than or equal to the maximum of all times, taken at any station.

$$T_c = T_{si} + T_r \qquad (4.2)$$

$$T_c = E \times T_p \qquad (4.3)$$

$$T_c = \frac{E}{R_p}$$

Where

T_{si} = Processing (or) service time

T_r = repositioning time

Smoothness index was defined as **average of hourly changes divided by standard deviation of those hourly changes during a 24-h time period**. All hourly data for each hour interval from the time when monitoring started and the study drug was taken were averaged to generate a single hourly change.

7.a

7.20 PROGRAMMING PROCEDURE. *(JUNE 2012, JUNE 2011)*

Part programming must be done in a more logical way. The first decisions relate to what tasks have to be done and what goals have to be reached. The other decisions relate to how to achieve the set goals in an efficient and safe manner.

The following steps form a common and logical sequence of tasks done in CNC programming

1. Study of initial information (drawing and methods)
2. Material stock (blank) evaluation
3. Machine tool specifications
4. Control system features
5. Sequence of machining operations.
6. Tooling selection and arrangement of cutting tools
7. Setup of the part.
8. Technological data (speeds, feed rates etc.)
9. Determination of the tool path.
10. Working sketches and mathematical calculations
11. Program writing and preparation for transfer to CNC
12. Program testing and debugging
13. Program documentation

7.b

... can be eliminated by automatic gauging system.

7.9 ADVANTAGES OF CNC MACHINES *(DEC 2012, DEC 2010)*

Some of the advantages of CNC machine tools are briefly discussed below.

(1)Setup time reduction

In many cases, the setup time for a CNC machine can be reduced. It is important to realize that setup is a manual operation, greatly dependent on the performance of CNC operator, the type of fixturing and general practices of the machine shop. The design of CNC machines consists of modular fixturing, standard tooling, fixed locators, automatic tool changers, pallets and other advanced features which makes the setup time more efficient than a comparable setup of a conventional machine.

(2)Reduced lead time

The time required to manufacture a component on the CNC machine is very less compared to other conventional machines.

(3)Accuracy and repeatability

The high degree of accuracy and repeatability of modern CNC machines has been the single major benefit to many users. This particular factors allows high quality of parts to be produced consistently time after time.

(4)Longer tool life :

Tools can be used at optimum speeds and feeds because these functions are controlled by the part program. Programmed speeds and feeds can be overridden by the operator if difficulty in manufacturing is encountered.

(5)Elimination of special jigs and fixtures :

Standard locating fixtures are often not used on CNC machines, and cost of special Jigs and fixtures is frequently eliminated. The capital cost of jig storage facilities is also reduced.

(6)Flexibility in changes of component design :

The modification (or) changes in component design can be readily accommodated by reprogramming and altering the concerned instructions.

7.10 DISADVANTAGES OF CNC MACHINES (DEC 2012, DEC 2010)

As with every system, the CNC system too have certain disadvantages which are given below.

1. Higher investment cost.
2. Higher maintenance cost.
3. Requires highly skilled CNC personnel.
4. Tools on CNC machines do not cut metal faster than conventional machines.
5. CNC machines does not eliminate the need for expensive tools.

However, the advantages of CNC systems outweigh the disadvantages considerably and the CNC machines have been widely accepted by the industry.

8.a

8.5 ROBOT JOINTS

The members of a Robotic manipulator are called as Links. The Links are connected together by joints. The relative motion between the links are mainly due to joints.

Depending on the relative motion between the two adj accent Links, Joints are classified into four types :

1. Prismatic joints 2. Rotational joints
3. Twist joints 4. Revolute joints

1. Prismatic joints : If the relative motion between two links of a joint is linear then that particular type of joint is called as Prismatic joint. Here two links are joined such that they can slide with respect each other. There are two types of prismatic joints

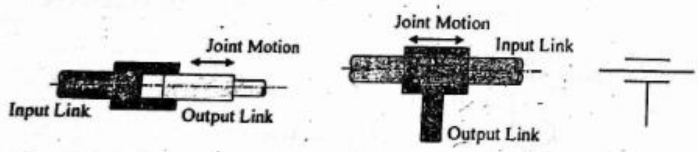
(a) Linear joints

(b) Orthogonal joints.

Linear type prismatic joints are denoted by 'L.

Orthogonal type prismatic joints are denoted by 'O'.

A schematic representation of linear and orthogonal type prismatic joints is show in in the figure 8.3.

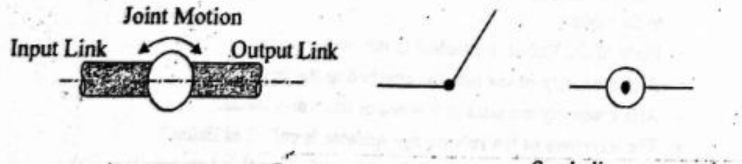


Linear typePrismatic joint **Orthogonal type prismatic joint**

Fig. 8.3 Prismatic joints.

2. Rotational joint : If the relative motion between two links of a joint is rotary then the joint is called as a Rotational joint.

Rotational joints are denoted by " R".

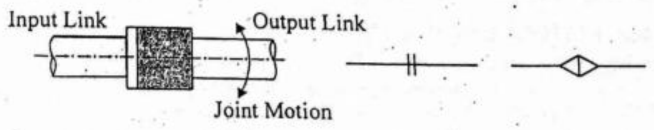


Symbolic representation

Fig. 8.4 shows a rotational joint along with its symbolic representation.

3. Twist joint : If the two links are in a straight line and if there is a twisting motion between the two links, then the joint is called as Twist joint.

Twist joints are indicated by Letter ' T'

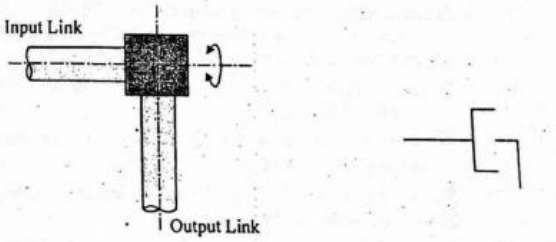


Symbolic representation

Fig 8.5 shows a Twist joint along with its symbolic representation

4. Revolute joint : If the two links are perpendicular to each other and if one link revolves around another link, then the joint is called as "Revolute joint".

Revolute joints are indicated by "V".



Revolute joint **Symbolic Representation**

Fig. 8.6 shows a Revolute joint along with its symbolic representation

8.b

... are necessary to interface them.

8.14 PROGRAMMING THE ROBOT

(JUNE/JULY 2011)

Definition: Robot programming can be defined as the path followed by the robot manipulator along with its peripherals to perform a specific work.

There are four types of programming methods through which robots can be programmed.

1. Manual Method.
2. Walk through Method. (OR) Manual lead through
3. Lead through Method (OR) Powered lead through (OR) ON-line method
4. Off-Line Programming.

1. Manual Method :

- This method is used only for small robots and for simple applications.
- This method involves in setting up the machine rather than actual programming
- This method is accomplished by setting limit switches, Mechanical stops, Cams (or) relays to control the robot motions.
- This method is mainly employed for low technology robots with short work cycles.

Ex : Pick and place robots.

2. Walk through Method (OR) Manual lead through Method.

- This method is employed for programming the robots with continuous path controls.
- In this method the programmer / operator manually move the arms of the robot through a motion sequence.
- Each movement will be recorded in the memory for subsequent play back during production.
- The speed of movements can be controlled (or) varied during actual playback.
- This method is used to program the robots performing spray painting and arc welding applications.

3. Lead through Method (OR) Powered Lead through Method (OR) On-Line Programming Method :

- This method is commonly used to program robots with point-to point control.
- A hand held control box called as teach pendent is used to drive the robot through its motion sequence.
- A teach pendent is a small, hand held device which consists of various switches and dials to control various movements of the robot.
- Each movement is recorded in robots control memory for future play back.
- Advantages of Lead Through Programming :
  - This method is relatively easy and simple.
  - No special programming skills (or) training is required to perform this method.
- Disadvantages of Lead Through Programming :
  - This method cannot be used for large and heavy robots.
  - Complex movements like curves cannot be accurately achieved through this programming.
  - This method requires lot of memory to store the data.

4. Off-Line Programming :

- This type of programming is not accomplished on the shop-floor.
- Off-line programming is performed on a computer, and after the program has been prepared, it is entered to the robot memory.
- The advantage of such programming is that the production time of the robot will not be lost, as in case of other types of programming.
- Case of other types of programming.
- This type of programming can be integrated with various CAD / CAM systems.

9.a

Additive manufacturing has been deemed as one of the most promising technology attracting many industrial applications. Additive manufacturing has a very high potential for directly shaping of complex parts from 3D computer-aided design (CAD) database or 3D scanning system database. Additive manufacturing make a part by depositing the materials layer by layer instead of removing unwanted as in conventional manufacturing. Today additive manufacturing processes have been developed for producing all kinds of parts with different materials

Definition: As per International committee F42 for Additive Manufacturing Technologies, ASTM, "*Additive Manufacturing (AM) refers to a process by which digital 3D design data is used to build up a component in layers by depositing material.*

Advantages

1. One key benefit of using AM is the ability to easily fabricate complex shapes.
2. Additive manufacturing also offers the freedom to design partsand innovate.
3. Another important benefit is the ability to fabricate parts without expensive tooling or long lead times.
4. Cost savings are associated with less production labour, material waste and energy consumption, as well as increased on-demand manufacturing.
5. Because only the material that is needed is used, there is very little (if any) material wasted.
6. A relatively small amount of electricity is required to produce parts especially when compared to more traditional manufacturing thus supporting green manufacturing.
7. This technology is particularly advantageous in low-to-moderate volume markets
8. Elimination of production steps: Even complexobjects will be manufactured in one process step
9. AM enables weight reduction viatopological optimization
10. Potential elimination of tooling: Direct production possible without costly and time-consuming tooling

Disadvantages

1. Slow build rates: Many printers lay down material at a speed of one to five cubic inches per hour
2. Extensive knowledge of material design and the additive manufacturing machine itself is required to make quality parts.
3. The surface finish and dimensional accuracy is low compared to other manufacturing methods.
4. Discontinuous production process: Parts can only be printed one at a time.
5. Limited component size/small build volume
6. Poor mechanical properties: Layering and multiple interfaces can cause defects in the product.

9.b

Process Steps

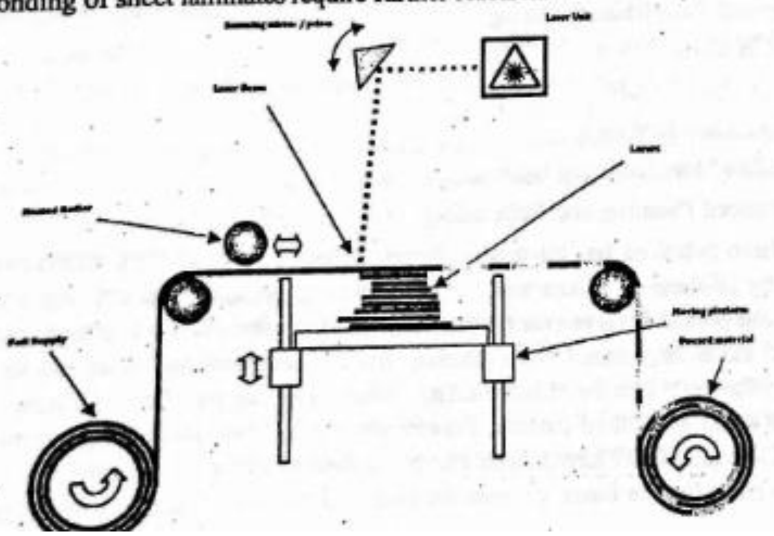
1. During the process, the sheet along with adhesive is positioned in place on the build platform.
2. Laser is employed to cut the required shape from the sheet to from a first layer of the product.
3. On further rotation of the spool, second layer of material is positioned on the top of the first layer.
4. The material is bonded in place, over the previous layer, using the adhesive and heated roller.
5. The required shape is then cut from the layer, by laser.
6. The next layer is added and the process continues until the required thickness is obtained.
7. The build is removed and post processing is carried out to extracthe part from the surrounding sheet material.

Advantages:

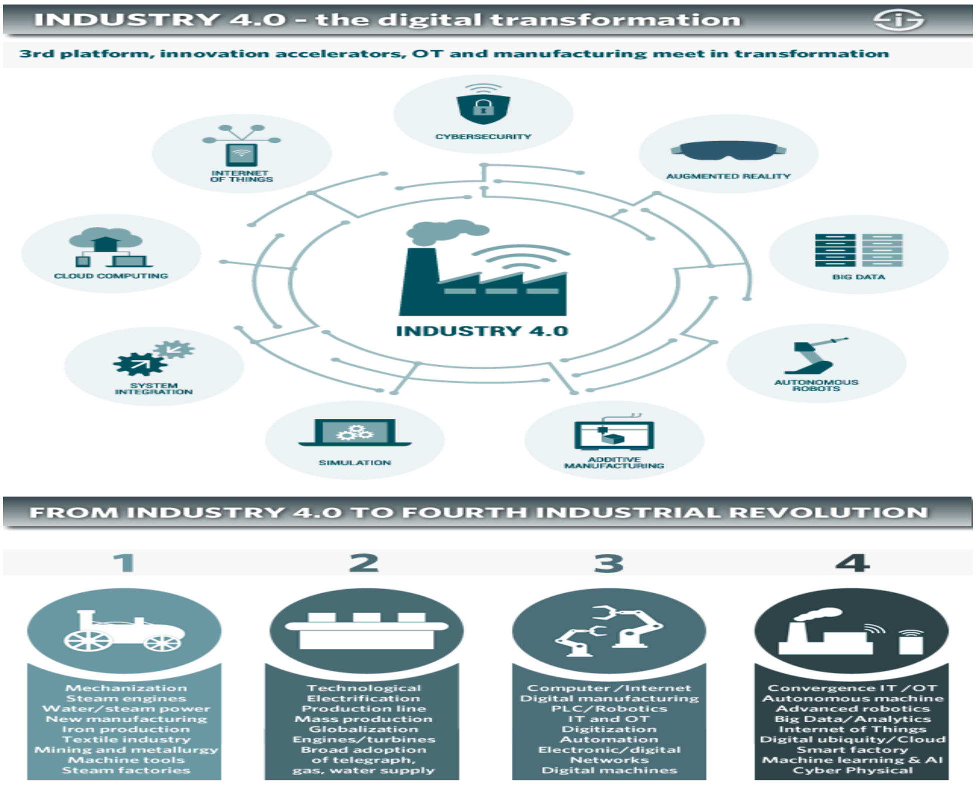
1. The process is faster and economical.
2. Strength of the arts depends on the type of bonding between the sheet laminates.
3. The LOM process does not induce residual stresses in the finished product

Disadvantages:

1. Finishes can vary depending on paper or plastic material but may require post processing to achieve desired effect
2. Limited material use
3. Bonding of sheet laminates require further research.



10 .a



10 .b

10.8 BIG-DATA AND CLOUD COMPUTING FOR IoT

The Internet of Things (IoT) is starting to transform how we live our lives, but all of the added convenience and increased efficiency comes at a cost. The IoT is generating an unprecedented amount of data, which in turn puts a tremendous strain to draw conclusions out of such data and moreover the storage of data on the Internet infrastructure is very difficult. As a result, companies are working to find ways to alleviate that pressure and solve the data problem.

Big data and Cloud computing will be a major part of that, especially by making all of the connected devices work together. But there are some significant differences between Big data and cloud computing.

Big data can be defined as the extremely huge sets of data that are impossible to analyze. For this reason, computers are being used to reveal trends and patterns. It is more about how to organize this data, how to label the data. Cloud computing is the application of utilizing a network of remote servers hosted on the internet to manage, save and process data, rather than a personal computer or a local server. Cloud computing means storing and accessing data and programs over the Internet instead of your computer's hard drive. The cloud is just a metaphor for the Internet.

Data centers will have to be set up to handle all this additional data load. Taking into consideration the enormous impact of IoTon data generation and storage, organizations have begun to move towards a cloud-based solution, as opposed to maintaining their own storage infrastructure. Cloud storage options include public, private, as well as hybrid models.

10 .c

10.12 INFLUENCE OF IoT ON SUPPLY CHAIN

A supply chain is a system of organization, people, activities, information and resources involved in moving a product or service from supplier to customer. Products are handled and transferred between the manufacturer, suppliers, the distribution center, retailer, and customer.

- IoT enables optimizing the supply chain by connecting manufacturers and customers through business-to-business communication channels. Such a system develops a demand-driven model (make-to-stock) that reduces inventory.
- IoT in supply chain allows the stakeholders to be socially aware and make efficient decisions that drive overall productivity. This moves the supply chain process from a reactive mode to a proactive one by offering information well before any activity happens. For example, providing information about a traffic jam and potential delay before the trip starts has much higher value than getting that alert when one is already stuck in the traffic.
- IoT reduces asset loss by knowing about product issues in time and by finding a solution.
- IoT optimizes product routing.
- IoT is used to monitor inventory to reduce out-of-stock situations.
- IoT provides visibility into customer behavior and product usage by embedding sensors in the product.

10 .d

10.14 CYBER-PHYSICAL MANUFACTURING SYSTEMS (CPMS)

Increased product variety requires high level flexibility of manufacturing systems that can be achieved through introduction of reconfigurable manufacturing systems. For effective control of such highly flexible manufacturing systems, virtual model of real world manufacturing systems are developed that provides reliable feedback.

These real-world manufacturing system and its cyber representation combine together into a unique system known as Cyber-Physical Manufacturing System (CPMS). CPMS technology brings the virtual and physical worlds together to create a truly networked