UNIT-III
CELLULAR MANUFACTURING
PART -A

1. Define Group Technology (GT).

Group Technology (GT) is a manufacturing methodology in which identical or similar components grouped processed together during design, process planning and manufacturing so that a wide variety of components can be manufactured, at the least expense of time, inventory, man hours and material handling.

2. Define Part family.

Part-family is defined as" collection of parts which are similar in terms of geometric shape, size, and similar processing steps required in manufacturing, so flow of materials through the plant improves".

3. Define: Cellular Manufacturing. (Nov/Dec 2016)

Cellular manufacturing is an application of group technology in which dissimilar machines have been aggregated into cells, each of which is dedicated to the production of a part family. The machines in a multi station system with variable routing may be manually Operated, semi-automatic, or fully automated. When manually operated or semi automatic the machine groups are often called machine cells, and the use of these cells in a factory is called cellular manufacturing.

4. **Explain opitz coding system**.

The optiz code consists of a form code and supplementary code. The form code can represent parts of the following variety: long, short, cubic, flat, rotational etc. A dimension ratio is further used in classifying the geometry: the length/diameter ratio is used to classify the rotational components and the length/height ratios are used to classify Non rotational components. The optiz form code uses five digits that focus on 1) component class 2) basic shape 3) rotational-surface machining 4) plane surface machining 5) auxiliary holes, gear teeth, and forming.

5. What are the main objectives of cellular manufacturing?

- To shorten manufacturing lead times.
- To reduce work-in-process inventory.

- To improve quality.
- To simplify production scheduling.
- To reduce setup times.

6. What do you mean by PFA?

Production flow analysis is a technique for identifying part families and associated grouping of machine tools. It does not use a classification and system and part drawing to identify families. Production flow analysis makes the use of information contained on route sheets instead of part drawing.

7. What is the most appropriate condition in GT?

GT is most appropriately applied under the following conditions:

1. The plant currently uses traditional batch production and the process type layout.
2. The parts can be grouped into part families.

8. General methods used for part families. (Apr/May 2017)

- Visual inspection,
- Parts classification and coding system, and
- Production flow analysis.

9. Explain the two categories of attributes of parts.

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

10. List out the premises for the developed of DCLASS code.

- A part may be best characterized bytes basic shape, usually is most apartment attribute.
- Each basic shape may have several features, such as holes, slots, threads and grooves.
- A part can be completely characterized by basic shape; size; precision and material type, from and condition.
- Several short code segments can be linked to from classification code that is human recognizable and adequate for human monitoring.

11. Explain composite part concept. (Nov/Dec 2016).

The composite part concept is based on part families. It conceives of a hypothetical part for a given family that includes all of the design and manufacturing attributes of the family. In general, an individual part in the family will have some of the features that characterize the family, but not all of them. The composite part possesses all of the features.

12. What are the problems in implementing group technology? (Apr/May 2017)

- Implementing GT is expensive. Because large costs may be incurred in rearranging the plant into machine cells or groups.
- Installing a coding and classification system is very time-consuming.

PART-B

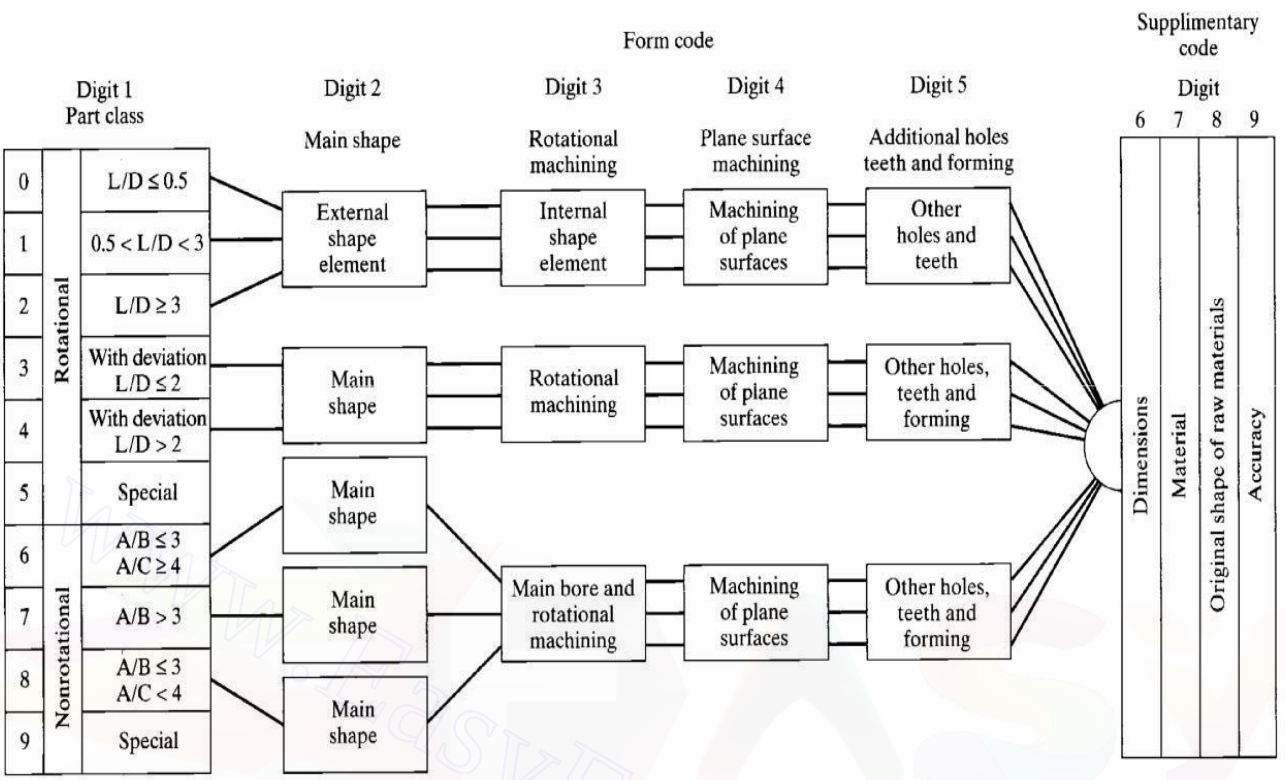
1. Briefly explain the MICLASS and OPITZ coding system with suitable examples. (Apr/May 2017), (Nov/Dec 2016).

MICLASS

Originally TNO of Holland developed MICLASS system, and is maintained in the United States by the organization for industrial research. It is a chain-structured code of 12 digits. It includes both design and manufacturing information. Information such as the main shape, shape elements, position of shape elements, main dimensions, ratio of dimensions, auxiliary dimension, tolerance, and the machinability of the material is included An additional 18 digits of code is also available for user-specified information. These supplementary digits provide flexibility expansion.

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

OPTIZ SYSTEM



The optiz coding is most likely the best-known coding system. It was developed by H. optiz of the Aachen Tech University in West Germany. The code uses a hybrid structure. However, except the first digit, it resembles a chain structure more closely. It has following advantages over the existing system

- It is non proprietary.
- It is widely used.
- It provides a basic framework for understanding the classification and coding process.
- It can be applied to machined parts, non-machined parts, and purchased parts.
- It considers both design and manufacturing information.
- The optiz code consists of a form code and supplementary code the form code can represent parts of the following variety: long, short, cubic, flat, rotational etc. A dimension ratio is further used in classifying the geometry: the length/diameter ratio is used to classify the rotational components and the length/height ratios are used to

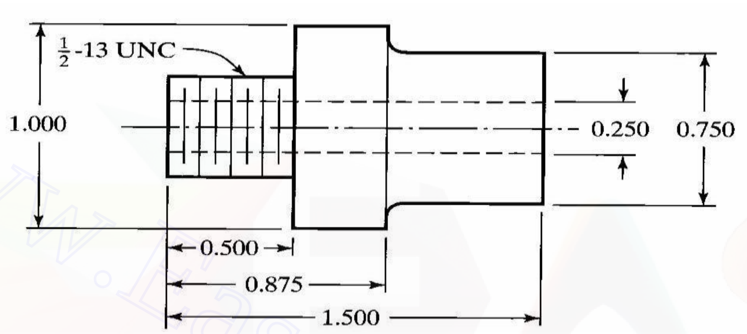
classify Non rotational components. The attributes of rotational parts are described as shown in table 7.2. The optiz form code uses five digits that focused on

1) Component class 2) basic shape 3) rotational-surface machining

4) Plane surface machining 5) auxiliary holes, gear teeth, and forming

A supplementary code is a poly code consisting four digits is usually appended to the optiz systems

Example: Given the part design shown define the "form code" using the Opitz system



Step 1: The total length of the part is 1.75, overall diameter 1.25, L/D = 1.4

Step 2: External shape - a rotational part that is stepped on both with one thread

Step 3: Internal shape - a through hole

Step 4: By examining the drawing of the part

Step 5: No auxiliary holes and gear teeth

2. **List the benefits and applications of group technology.**

- GT promotes standardization of tooling, fixtures and setups.
- Material handling is reduced because parts are moved within a machine cell rather than within the entire factory.
- Process planning and production scheduling are simplified
- Setup times are reduced, resulting in lower manufacturing lead times.
- Work-in-process is reduced.
- Worker satisfaction usually improves when workers collaborate in a OT cell.
- Higher quality work is accomplished using group technology.

Applications of Group Technology

Manufacturing applications: The most common applications of GT are in manufacturing and the most common application III manufacturing involves the formation of cells of one kind or another, not all companies rearrange machines to form cells. There are three ways in which group technology principles can be applied in manufacturing

1. **Informal scheduling and routing of similar parts through selected machines:**

   This approach achieves setup advantages. But no formal part families are defined, and no physical rearrangement of equipment is undertaken.

2. **Virtual machine cells :**

This approach involves the creation of part families and dedication of equipment to the manufacture of these part families, but without the physical re-arrangement of machines into formal cells. The machines in the virtual cell remain in their original locations in the factory. Use of virtual cells seems to facilitate the sharing of machines with other virtual cells producing other part families

3. Formal machine cells:

This is the conventional GT approach in which a group of dissimilar machines are physically relocated into a cell that is dedicated to the production of one or a limited set of part families The machines in a formal machine cell are located in close proximity to minimize part handling, throughput time, setup time, and work-in-process. Other GT applications in manufacturing include process planning family tooling, and numerical control (NC) part programs. Process planning of new parts can be facilitated through the identification of part families. The new part is associated with an existing part family and generation of the process plan for the new part follows the routing of the other members of the part family. This is done in a formalized way through the use of parts classification and coding. The approach is discussed in the context of automated process planning

In the ideal, all members of the same part family require similar setups, tooling, and fixtures. This generally results in a reduction in the amount of tooling and fixtures needed instead of determining a special tool kit for each part, a tool kit is developed for each part family. The concept of a modular fixture can often be exploited, in which a common base fixture is designed and adaptations are made to switch between different parts in the family.

3. Discuss the production flow analysis in detail.

This is an approach to part family identification and machine cell formation. Production flow analysis (PFA) is a method for identifying part families and associated machine groupings that use the information contained 011 production route sheets rather than on part drawings. Work parts with identical or similar routings are classified into part families. These families can then be used to form logical machine cells in a group technology layout. Since PFA uses manufacturing data rather than design data to identify part families, it can overcome two possible anomalies that can occur in parts classification and coding. First, parts whose basic geometries are quite different may never the less require similar or even identical process routings. Second, parts whose Geometries are quite similar may nevertheless require process routings that are quite different.

The procedure in production flow analysis must begin by defining the scope of the study, which means deciding on the population of parts to be analyzed. Should all of the parts in the shop be Included in the study, or should a representative sample be selected for analysis, Once this decision is made, then the procedure in PFA consists of the following steps:

Data collection:

The minimum data needed in the analysis are the part number and operation sequence, which is contained in shop documents called route sheets or operation sheets or some similar name. Each operation is usually associated with a particular machine, so determining the operation sequence also determines the machine sequence .Additional data such as 101size, time standards, and annual demand might be useful for designing machine cells of the required production capacity.

Sortation of process routings:

In this step, the parts are arranged into groups according to the similarity of their process routings. To facilitate this step, all operations or machines included in the shop are reduced to code numbers, for each part, the operation codes are listed in the order in which they are performed. A sortation procedure is then used to arrange parts into "packs," which are groups of parts with identical routings. Some packs may contain only one part number, indicating the uniqueness of the processing of that part. Other packs will contain many parts, and these will constitute a part family.

PFA chart:

The chart is a tabulation of the process or machine code numbers for all of the part packs. PFA chart has been referred to as part-machine incidence matrix. In this matrix, the entries have a value X_{ii} = l or 0: a value of $X_{ij} = 1$ indicates that the corresponding part i requires processing on machine j, and $X_{ij} = 0$ indicates that no processing of component i is accomplished on machine j. For clarity of presenting the matrix, the D's are often indicated as blank (empty) entries, as in our table.

Cluster analysis:

From the pattern of data in the PFA chart. Related groupings are identified and rearranged into a new pattern that brings together packs with similar machine sequences. The blocks might be considered as possible machine cells. It is often the case. These parts might be analyzed to see if a revised process sequence can be developed that fits into one of the groups. If not, these parts must continue to be fabricated through a conventional process layout. We examine a systematic technique called rank order Cluster that can be used to perform the cluster analysis.

Operation or Machine	*Code*
Cutoff	01
Lathe	02
Turret lathe	03
Mill	04
Drill manual	05
NC drill	06
Grind	07

4. Explain Cellular Manufacturing in detail. (Apr/May 2017), (Nov/Dec 2016).

Cellular manufacturing is an application of group technology in which dissimilar machines or processes have been aggregated into cells, each of which is dedicated to the production of a part or product family or a limited group of families.

The typical objectives in cellular manufacturing are similar to those of group technology:

• To shorten manufacturing lead times, by reducing setup, work part handling, waiting times, and batch sizes

• To reduce work-in-process smaller batch sizes and shorter lead times reduce work-in-process.

• To prove quality. This is accomplished by allowing each cell to specialize in producing a smaller number of different parts. This reduces process variations.

• To simplify production scheduling. The similarity among parts in the family reduces the complexity of production scheduling. Instead of scheduling parts through a sequence of machines in a process-type shop layout, the parts are simply scheduled though the cell.

• To reduce setup times. This is accomplished by using group tooling (cutting tools, jigs, and fixtures) that have been designed to process the part family, rather than part tooling, which is designed for an individual part. This reduces the number

Grouping Parts and Machines by Rank Order Clustering Algorithm:

It is an efficient and easy-to-use algorithm for grouping machines into cells. In a starting part-machine incidence matrix that might be compiled to document the part routings in a machine shop (or other job shop), the occupied locations in the matrix are organized in a seemingly random fashion. Rank order clustering works by reducing the part-machine incidence matrix to a set of diagonal blocks that represent part families and associated machine groups. Starting with the initial part-machine incidence matrix. The algorithm consists, of the following steps:

1. In each row of the matrix. Read the series of is and G's (blank entries = D's) from left to fight as a binary number. Rank the rows in order of decreasing value. In case of a tie, rank the rows in the same order as they appear in the current matrix

2. Numbering from top to bottom, is the current order of rows the same as the rank order determined in the previous step? If yes, go to step 7, If no, go to the following step.

3. Reorder the rows in the part-machine incidence matrix by listing them in decreasing rank order, starting from the top

4. In each column of the matrix. Read the series of I's and O's (blank entries = (j's) from top to bottom as a binary number. Rank the columns in order of decreasing value, In case of a tie. Rank the columns in the same order as they appear in the current matrix.

5. Numbering from left to right, is the current order of columns the same as the rank order determined in the previous step? If Yes go to step 7. If No go to the following step.

6. Reorder the columns in the part-machine incidence matrix by listing them in decreasing rank order, starting with the left column. Go to step I.

7. Stop

Binary values	2^6	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Decimal equivalent	Rank
	parts										
Machines	A	B	C	D	E	F	G	H	I		
1	1			1				1		290	1
2					1				1	17	7
3			1		1					81	5
4		1				1				136	4
5	1							1		258	2
6			1						1	65	6
7		1				1	1			140	3

Machines	parts								
	A	H	D	B	F	G	I	C	E
1	1	1	1						
5	1	1							
7				1	1	1			
4				1	1				
3							1	1	1
6							1	1	
2							1		1

	PARTS									
machines	A	B	C	D	E	F	G	H	I	Binary values
1	1							1		2^6
5	1							1		2^5
7		1				1	1			2^4
4		1				1				2^3
3			1		1				1	2^2
6			1						1	2^1
						1			1	2^0
Decimal equivalent	96	24	6	64	5	24	16	96	7	
rank	1	4	8	3	9	5	6	2	7	

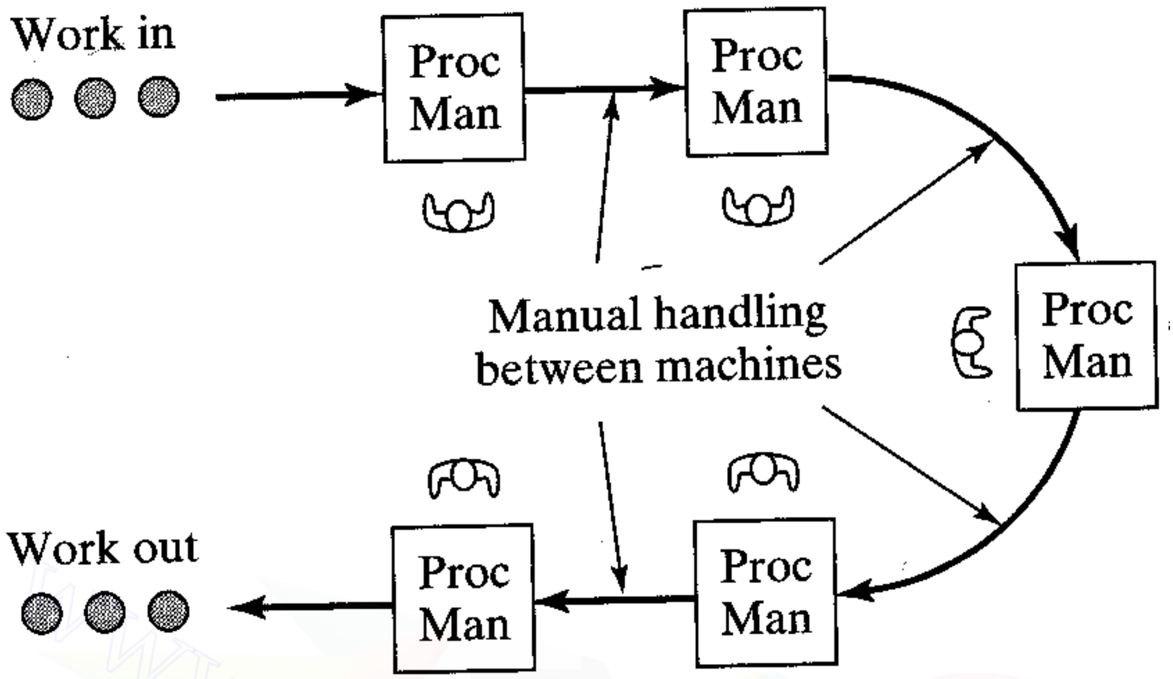
5. Explain Machine Cell Design and Layouts

Machine Cells and Layouts:

GT manufacturing cells can be classified According to the number of machines and the degree to which the material flow is mechanized between machines. In our classification scheme for manufacturing systems all GT cells are classified as type X in terms of part or product variety. Here we identify four common GT cell configurations

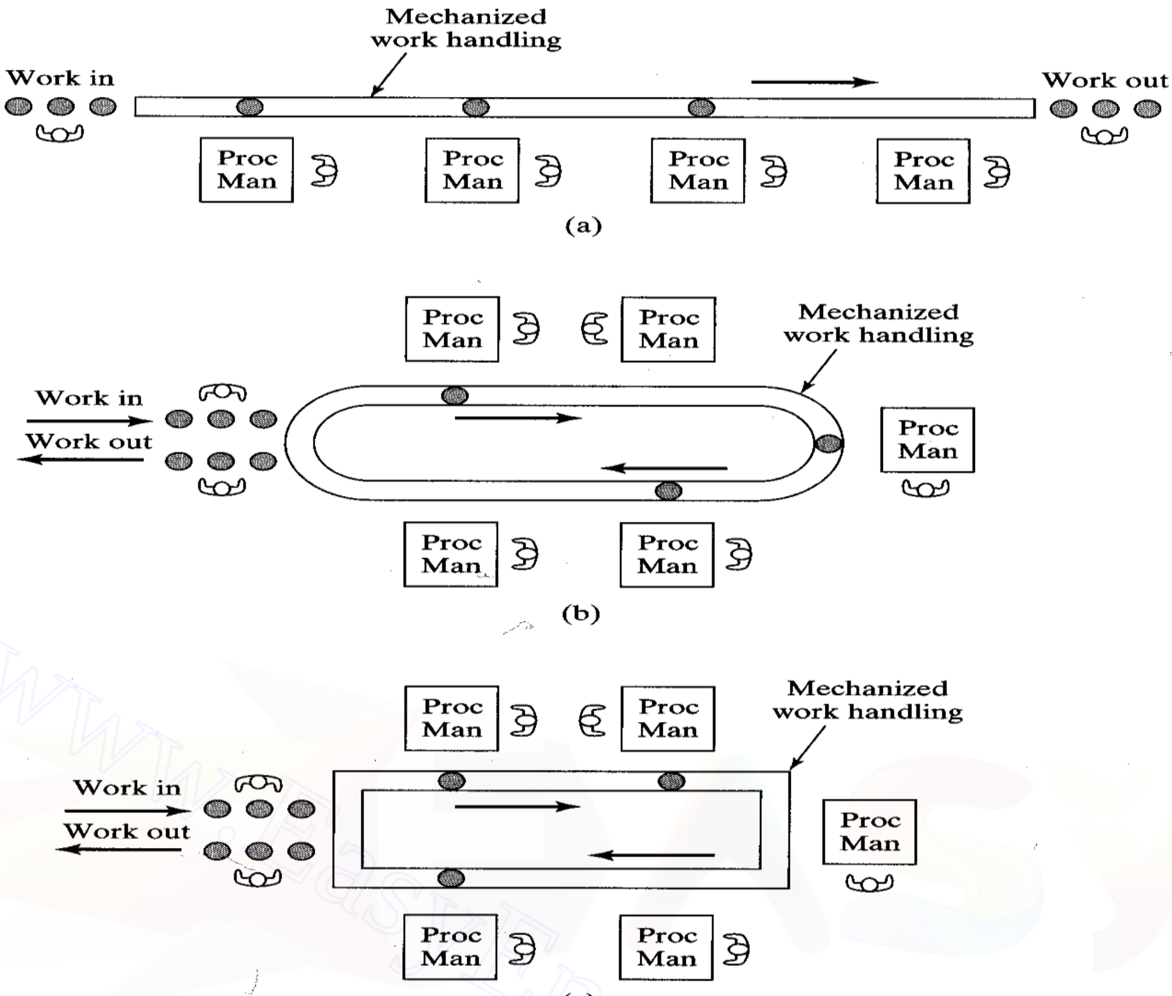
1. Single machine cell (type I M)
2. Group machine cell with manual handling (type n M generally, type III M less common)
3. Group machine cell with semi-integrated handling (type II M generally, type III M less common)
4. Flexible manufacturing cell or flexible manufacturing system.

As its name indicates, the single machine cell consists of one machine plus supporting fixtures and tooling. This type of cell can be applied to work parts whose attributes allow them to be made on one basic type of process, such as turning or milling. The group machine cell with manual handling is an arrangement of more than one machine used collectively to produce one or more part families. There is no provision for mechanized parts movement between the machines in the cell. Instead, the human operators who run the cell perform the material handling function. The cell is often organized into a U-shaped layout, this layout is considered appropriate when there is variation in the work flow among the parts made in the cell. It also allows the multi functional workers in the cell to move easily between machines. The group machine cell with manual handling is sometimes achieved in a conventional process type layout without rearranging the equipment. This is done simply by assigning certain machines to be included in the machine group and restricting their work to specified part families. This allows many of the benefits of cellular manufacturing to be achieved without the expense of rearranging equipment in the shop. Obviously, the material handling benefits of OT are minimized with this organization.



Machine cell with manual handling between machines. Shown is a If-shaped machine layout. (Key: "Proc" 0= processing Operation (e.g., mill. turn, etc.), "Man" = manual operation; arrows indicate work flow.)

The group machine cell with semi-integrated handling uses a mechanized handling system, such as a conveyor, to move parts between machines in the cell. The flexible manufacturing system (FMS) combines a fully integrated material handling system with automated processing stations. The FMS is the most highly automated of the group technology. Other GT layouts include in-line, loop, and rectangular Machine cells with semi-integrated handling: (a) in line layout, (b) loop layout, and (c) rectangular layout. (Key"Proc" = processing operation (e.g., mill, turn, etc.]. "Man" = manual operation; arrows indicate work now)


Mechanized
work handling
Work in
Work out
Proc
Man
Proc
Man
Proc
Man
Proc
Man
Mechanized
work handling
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Mechanized
work handling
Work in
Work out
Proc
Man

(a) (b) (c)