CIM refers to a production system that consists of:

1. A group of NC machines connected together by
2. An automated materials handling system
3. And operating under computer control

CIM System discussed:

Computer Numerical Control (CNC)
Direct Numerical Control (DNC)
Computer Process Control
Computer Integrated Production Management
Automated Inspection Methods
Industrial Robots etc.

A CIM System consists of the following basic components:

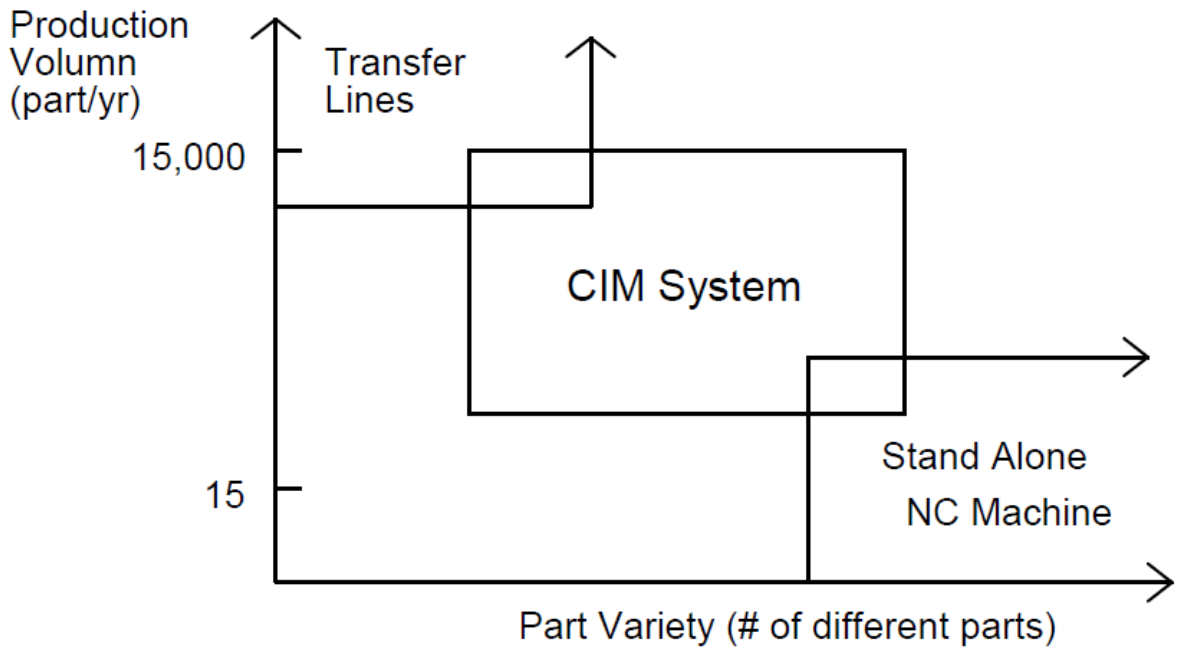
I. Machine tools and related equipment
II. Material Handling System (MHS)
III. Computer Control System
IV. Human factor/labor

CIMS Benefits:

1. Increased machine utilization
2. Reduced direct and indirect labor
3. Reduce mfg. lead time
4. Lower in process inventory
5. Scheduling flexibility
6. etc.

In Production Systems

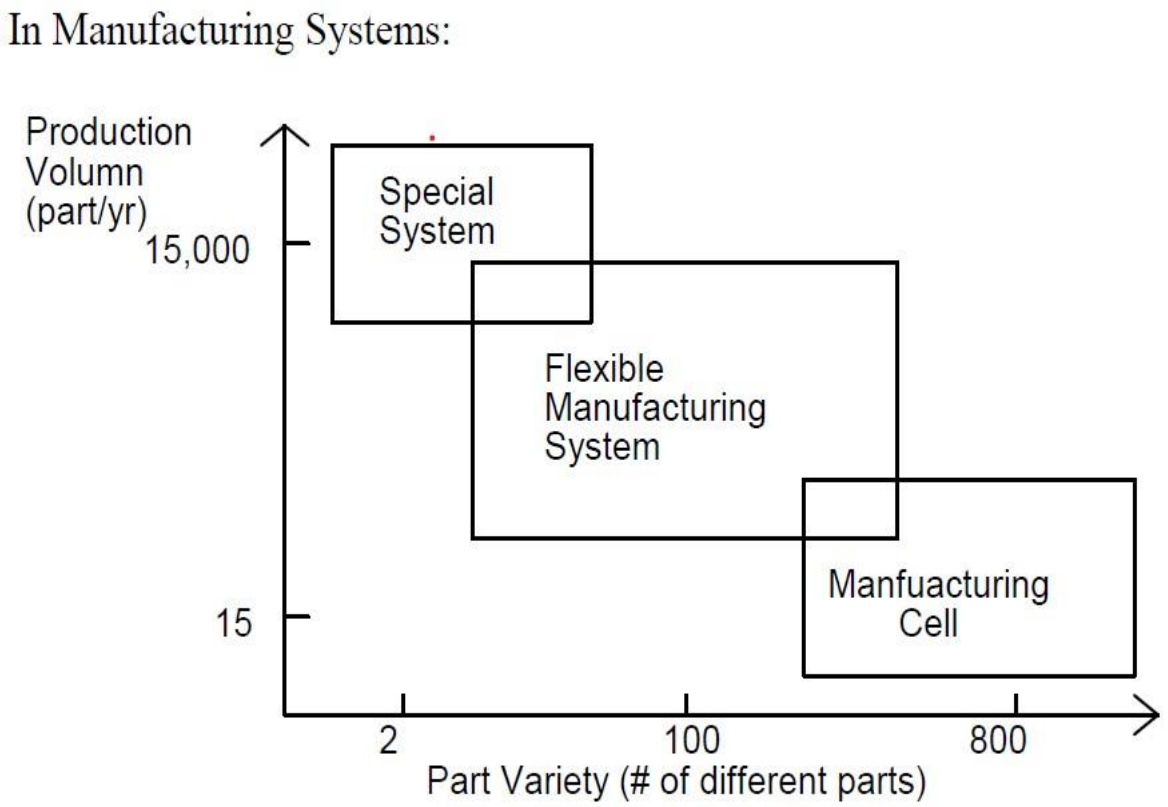
1. Transfer Lines: is very efficient when producing "identical" parts in large volumes at high product rates.
2. Stand Alone: NC machine: are ideally suited for variations in work part configuration.



In Manufacturing Systems:

1. Special Mfg. System: the least flexible CIM system. It is designed to produce a very limited number of different parts (2 - 8).

2. Mfg. Cell: the most flexible but generally has the lowest number of different parts manufactured in the cell would be between 40 - 80. Annual production rates rough from 200 - 500.
3. Flexible Mfg. System: A typical FMS will be used to process several part families with 4 to 100 different part numbers being the usual case.



Conventional Approaches to Manufacturing

Conventional approaches to manufacturing have generally centered around machines laid out in logical arrangements in a manufacturing facility. These machine layouts are classified by:

Function –

- Machines organized by function will typically perform the same function, and the location of these departments relative to each other is normally arranged so as to minimize interdepartmental material handling.
- Workpiece produced in functional layout departments and factories are generally manufactured in small batches up to fifty pieces (a great variety of parts).

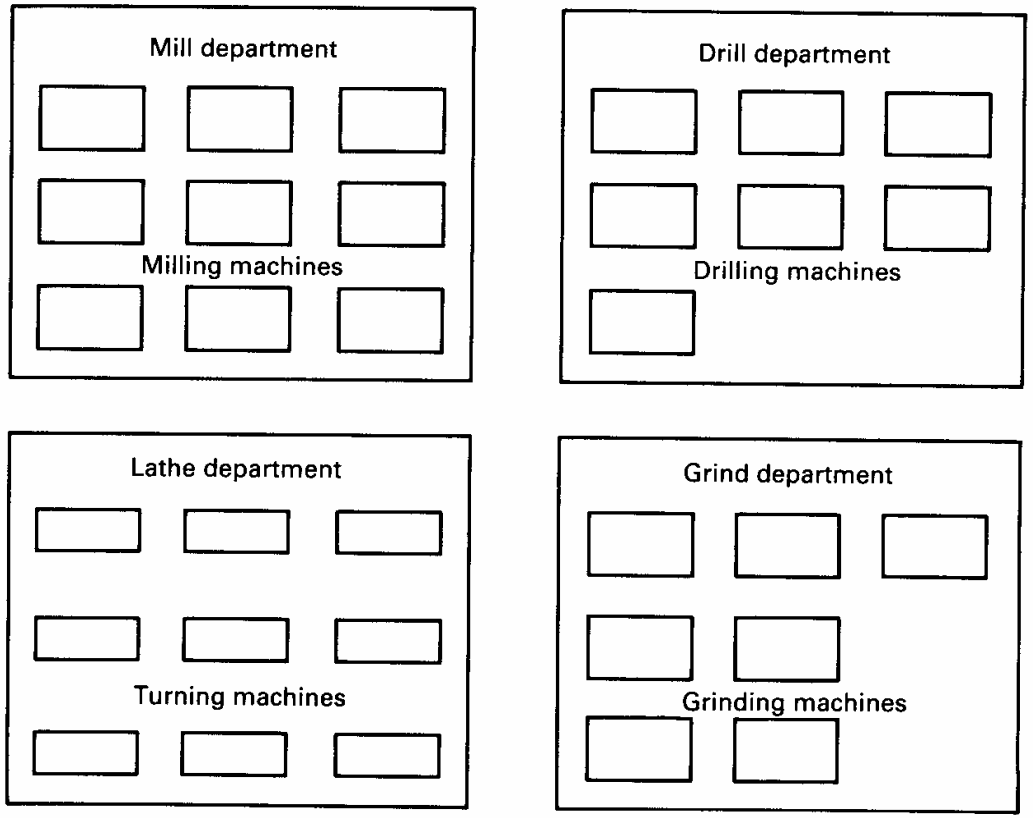


Figure 2-1 Machine layout by function.

Line or flow layout

- The arrangement of machines in the part processing order or sequence required. A transfer line is an example of a line layout.
- Parts progressively move from one machine to another in a line or flow layout by means of a roller conveyor or through manual material handling.
- Typically, one or very few different parts are produced on a line or flow type of layout, as all parts processed require the same processing sequence of operations.
- All machining is performed in one department, thereby minimizing interdepartmental material handling.

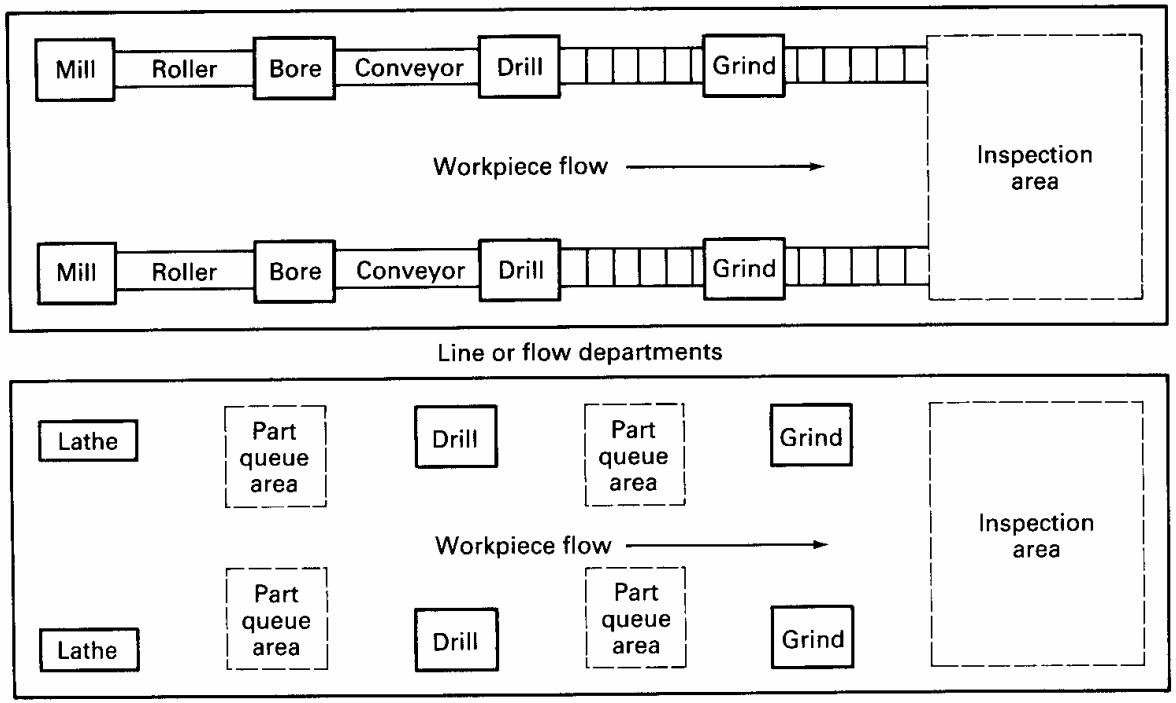


Figure 2-2 Line or flow machine layout.

Cell

- It combines the efficiencies of both layouts into a single multi-functional unit.
- It referred to as a group technology cell, each individual cell or department is comprised of different machines that may not be identical or even similar. Each cell is essentially a factory within a factory, and parts are grouped or arranged into families requiring the same type of processes, regardless of processing order.
- Cellular layouts are highly advantageous over both function and line machine layouts because they can eliminate complex material flow patterns and consolidate material movement from machine to machine within the cell.

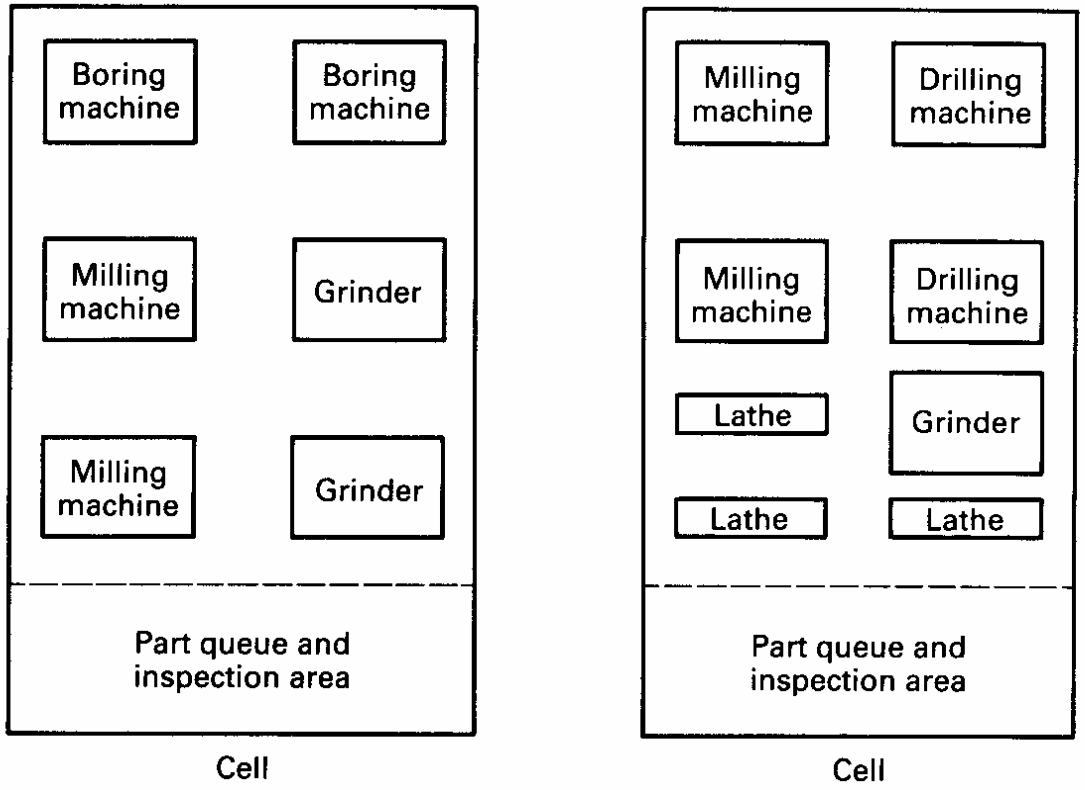
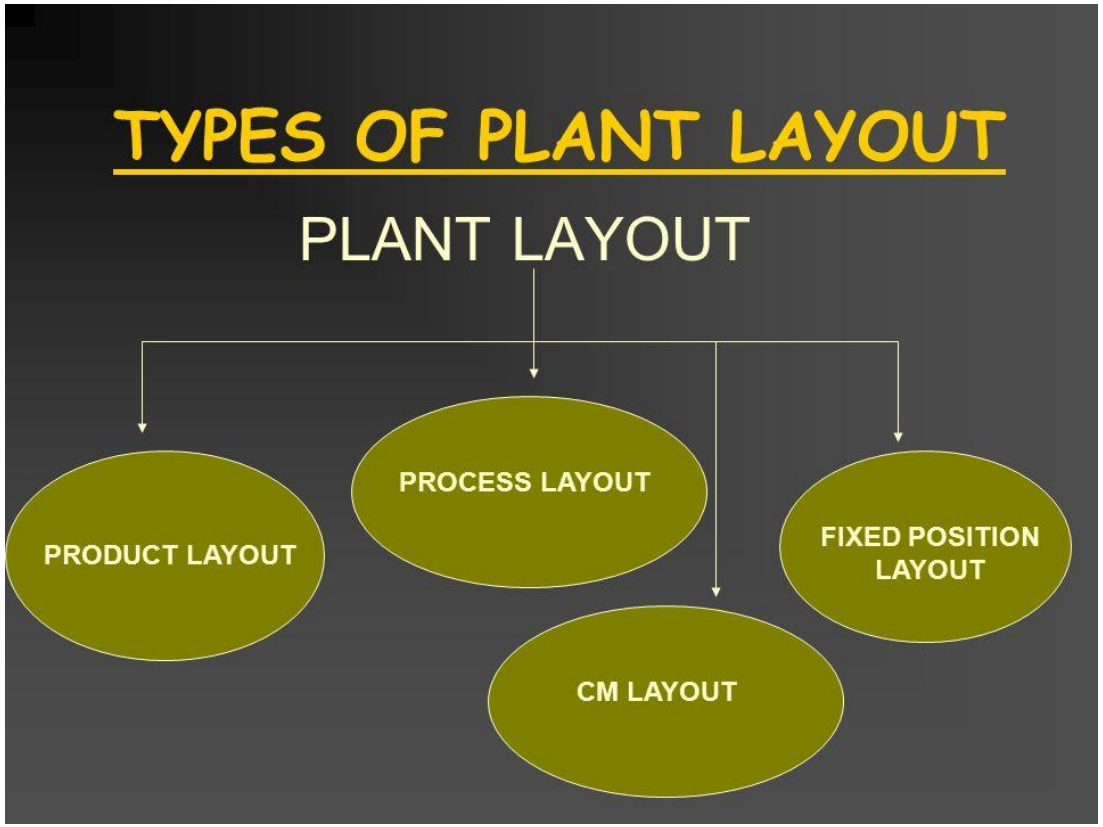
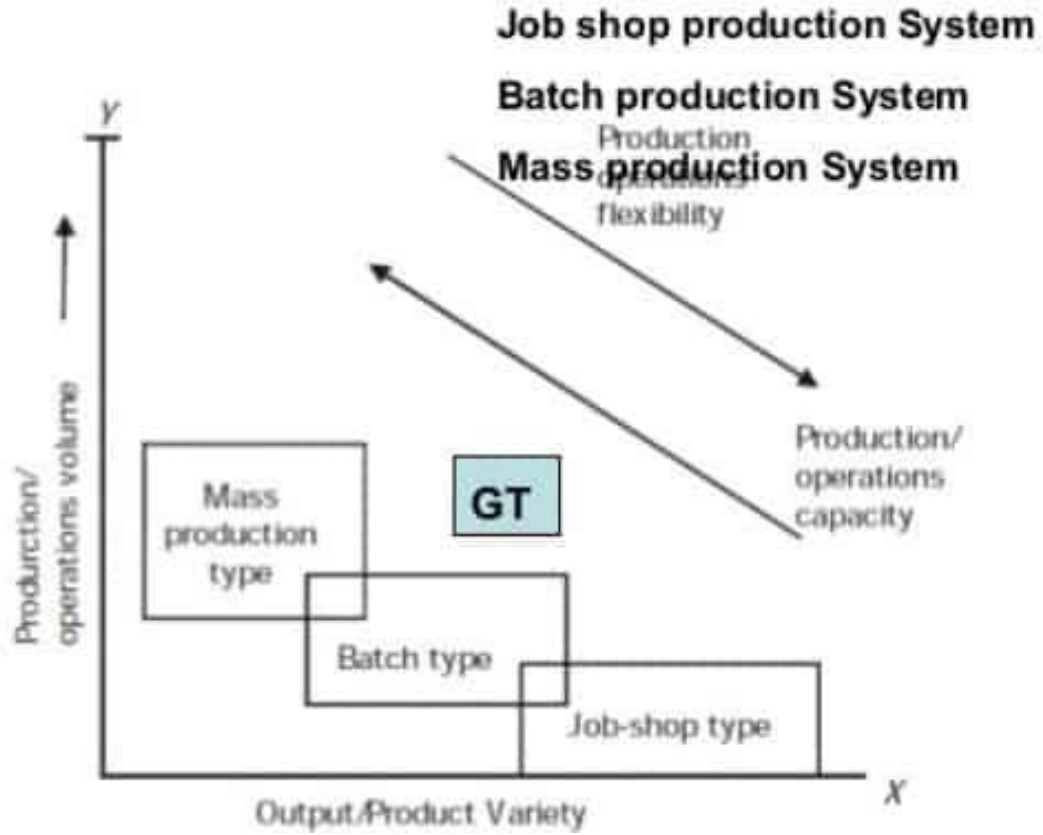


Figure 2-3 Machine layout by cell based on part families to be processed in each cell



Group Technology

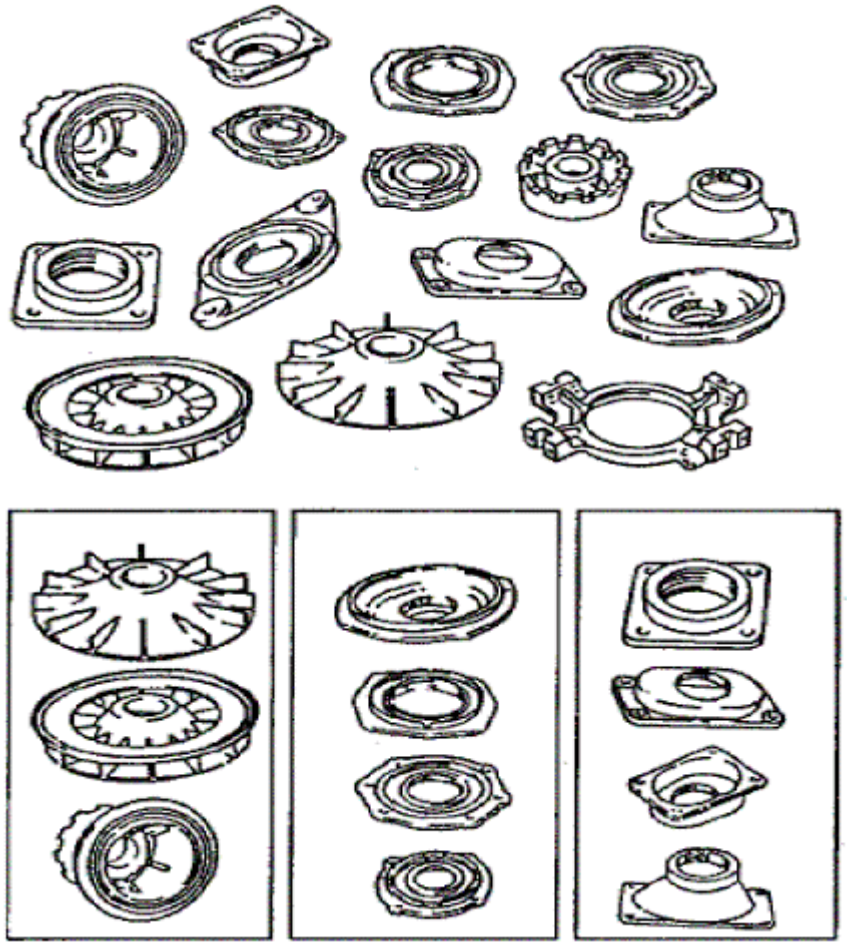


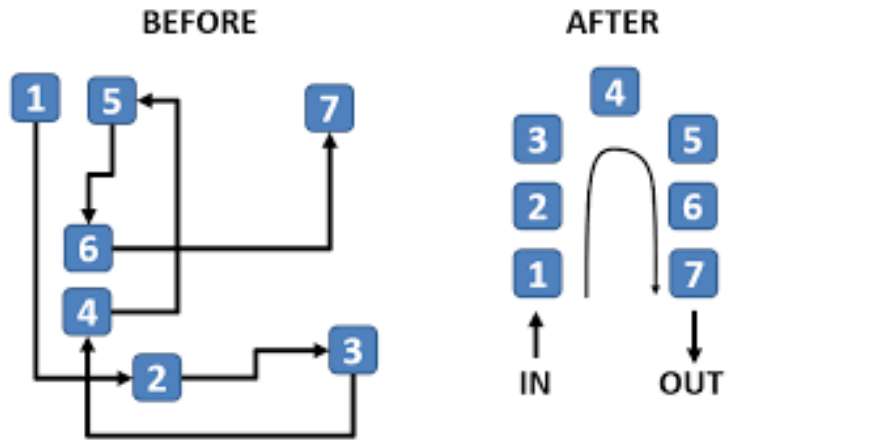
Comparison of Main Layouts

	Fixed Position	Process	Cell	Product
Advantages	Very high product and mix flexibility Product/customer not moved High variety of tasks for staff	High product and mix flexibility. Relatively robust in the case of disruptions. Easy to supervise.	Can give good compromise. Fast throughput. Group work can result in good motivation.	Low unit costs for high volume. Opportunities for specialization of equipment.
Disadvantages	Very high unit costs Scheduling space and activities can be difficult.	Low utilization. Can have very high work in progress Complex flow.	Can be costly to rearrange existing layout. Can need more plant.	Can have low mix flexibility. Not very robust to disruption. Work can be very repetitive.

GROUP TECHNOLOGY (GT)

- GT is a manufacturing philosophy in which similar parts are identified & grouped together to make advantage of their similarities in design and production.
- Similar parts bare arranged into part families, where each part family possesses similar design and/or manufacturing characteristics.
- Grouping the production equipment into machine cells, where each cell specializes in the production of a part family, is called cellular manufacturing




BEFORE
AFTER
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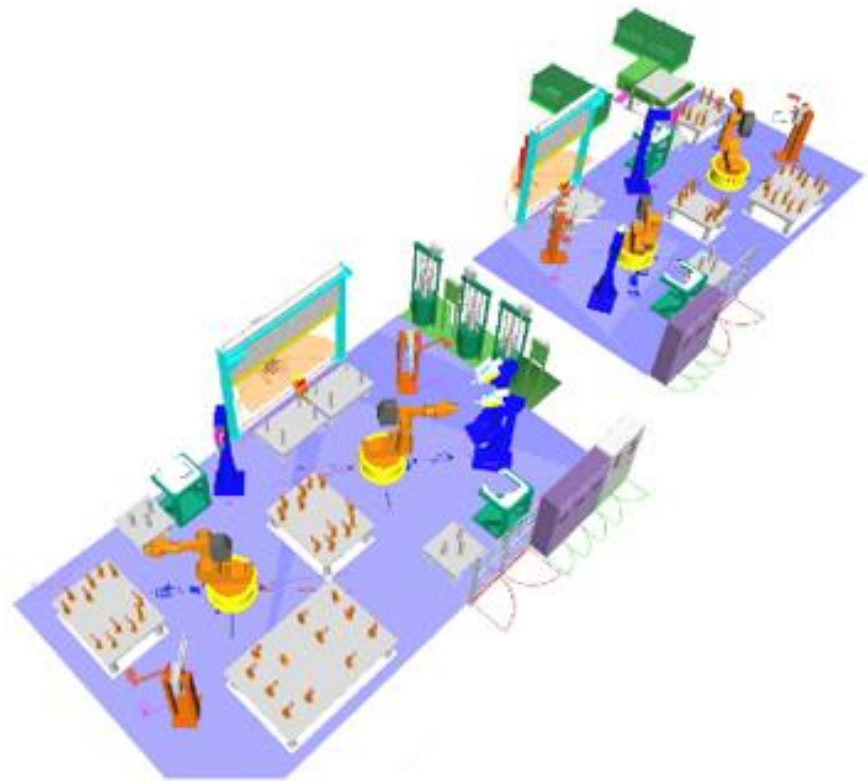
2
6
1
7
IN
OUT



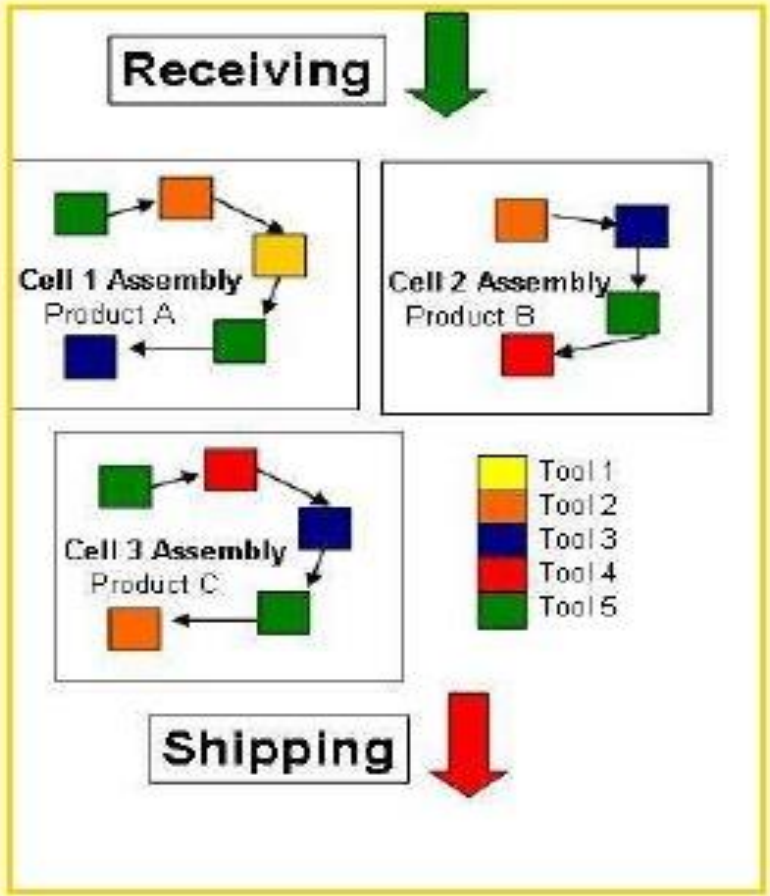
What is Group Technology ?

- Group technology(GT) is a manufacturing philosophy to increase production efficiency by grouping a variety of parts having similarities of shape, dimension, and/or process route.
- Thus in GT, similar parts are identified and grouped together to take advantages of their similarities in design and production.
- GT may be defined as a manufacturing philosophy that justifies batch production by capitalizing on design and/or manufacturing similarities among component parts.
- For example, a plant producing many parts(say, 5000 different parts) may be grouped into several distinct (say, 20 to 25 part families).Each family possesses similar design and manufacturing characteristics.

Cellular Manufacturing

Cellular Manufacturing is an approach in which equipment and workstations necessary to produce a product are arranged closely together to facilitate small lot continuous flow production.

The goal is to have the necessary flexibility to produce a variety of low demand products, while maintaining the same productivity obtained with a large scale production.



Picture from Wikipedia

Classification and Coding

- ***Coding*** refers to the process of assigning symbols to the parts
- The ***symbols*** represent ***design attributes*** of parts or ***manufacturing features*** of part families

- Although well over 100 classification and coding systems have been developed for group technology applications, all of them can be grouped into three basic types:
  - **Monocode or hierarchical code**
  - **Polycode or attribute**
  - **Hybrid or mixed code**

Parts Classification and Coding Method

- 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. (Basic external and internal shape Rotational or rectangular shape, L/D ratio, Aspect ratio, Dimensions and Tolerances)
    2. ***Manufacturing attributes***, which consider the sequence of processing steps required to make a part.(Major processes, Minor operations, Operation sequence, Dimension, Surface finish, Machine tool Production cycle time)

- There are three basic code structures used in group technology
    - Monocode or hierarchical code
    - Polycode or attribute
    - Hybrid or mixed code

Part Design and Manufacturing Attributes

Design Attributes

- Major dimensions
- Basic external shape
- Basic internal shape
- Length/diameter ratio
- Material type
- Part function
- Tolerances
- Surface finish

Manufacturing Attributes

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

Manufacturing Attributes

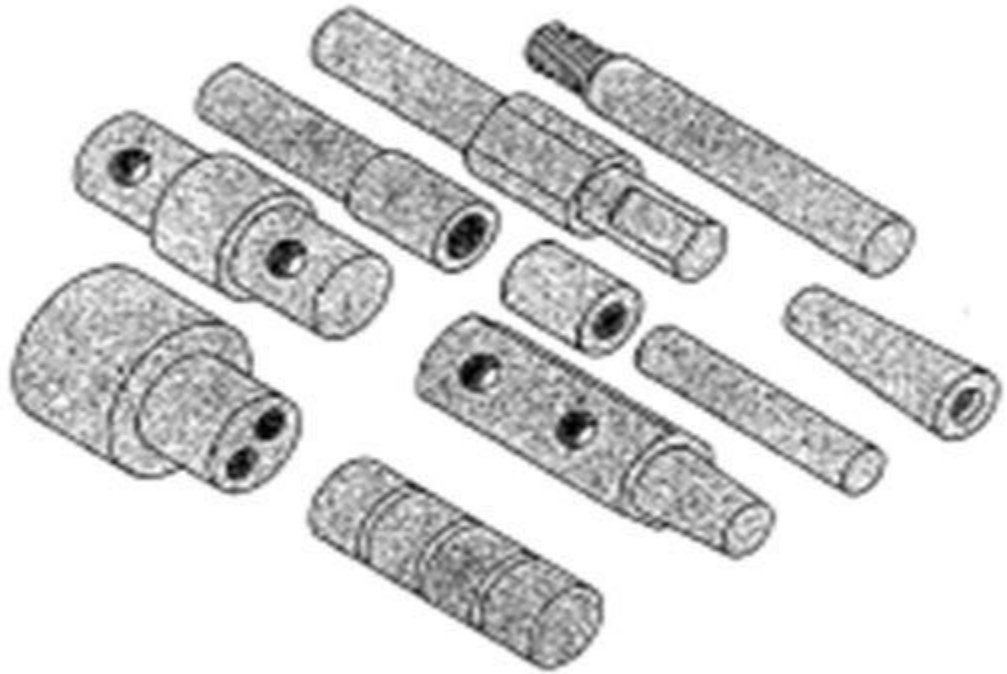
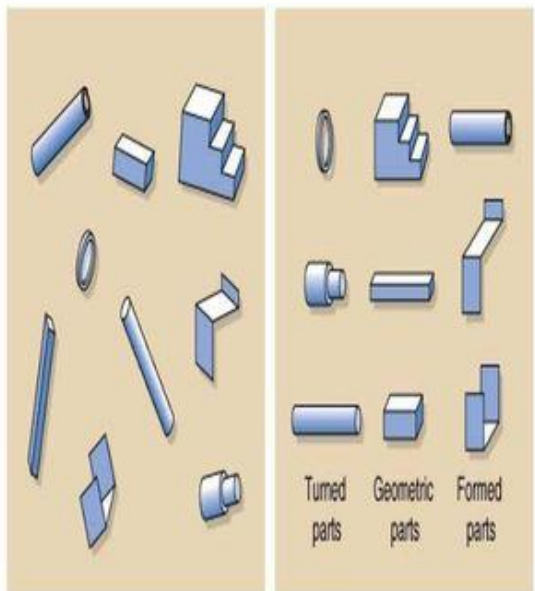


Figure 15.2 A family of parts with similar manufacturing process requirements but different design attributes. All parts are machined from cylindrical stock by turning; some parts require drilling and/or milling.

Group layout
Hybrid Layout

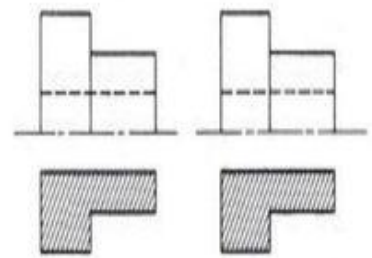
Group Technology – Cellular Manufacturing

- *Group technology (product family) departments* aggregate medium volume-variety parts into families based on **similar manufacturing operations and design attributes.**



Unorganized parts

Parts organized by families



Two parts of identical shape and size but different manufacturing requirements.

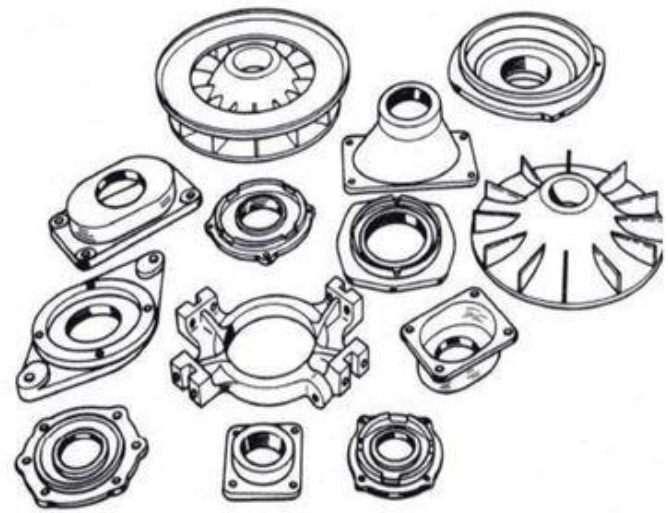
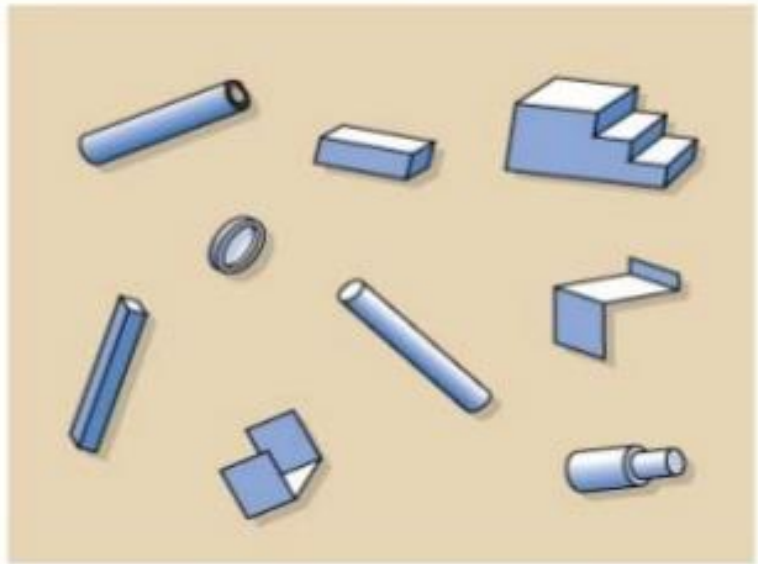


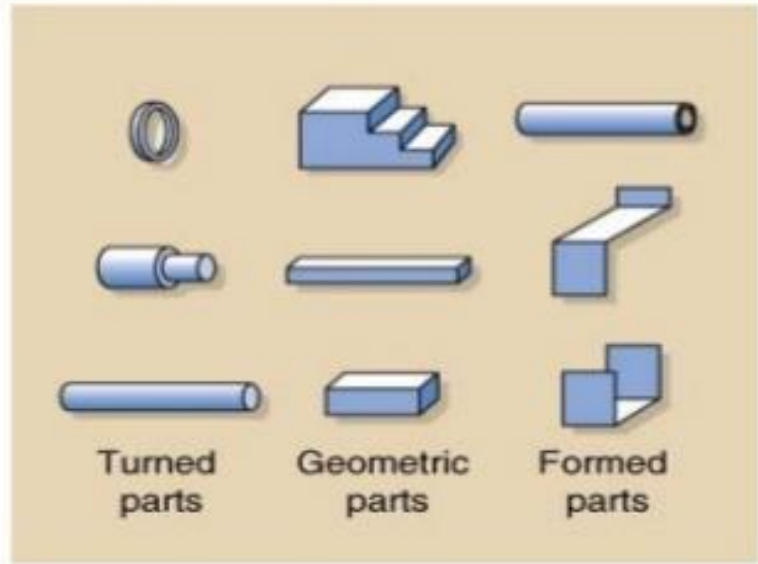
FIGURE 12.2 Thirteen parts with similar manufacturing process requirements but different design attributes.
(Source: Groover & Zimmers, *CAD/CAM*, Prentice Hall, 1984.)

Designing Hybrid Layouts

- **One of the most popular hybrid layouts uses Group Technology (GT) and a cellular layout**
- **GT has the advantage of bringing the efficiencies of a product layout to a process layout environment**

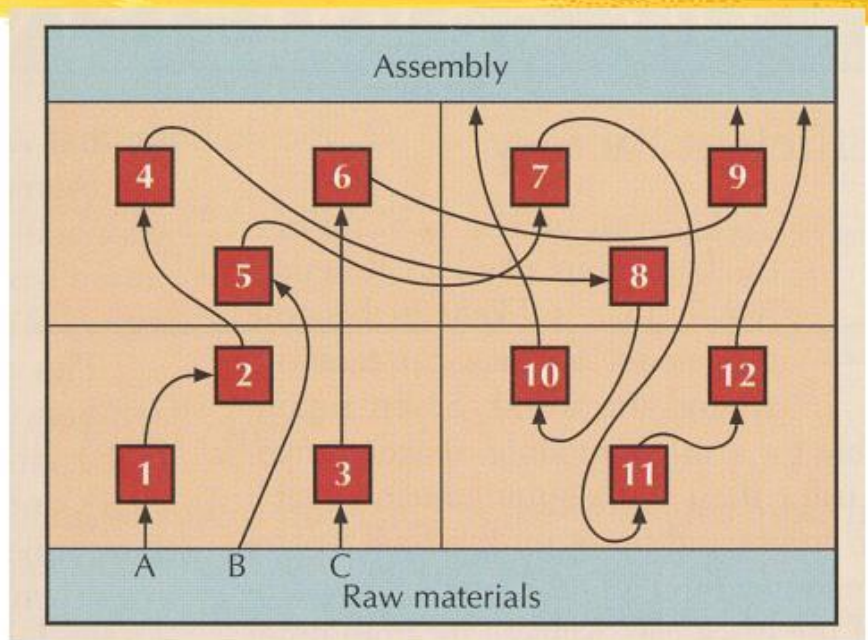


Unorganized parts



Parts organized by families

Hybrid Layouts: Cellular layouts



Original Process Layouts

- Notice:
  - The distance that each part must travel before completion
  - the irregularity of the part routings
  - Amount of "paperwork" needed to direct the flow of each individual part and to confirm that the right operation has been performed

Hybrid Layouts: Cellular layouts

Parts	Machines											
	1	2	3	4	5	6	7	8	9	10	11	12
A	×	×		×				×		×		
B					×		×				×	×
C			×			×			×			
D	×	×		×				×		×		
E					×	×						×
F	×			×				×				
G			×			×			×			×
H							×				×	×

Part Routing Matrix

- In its current form, there is no apparent pattern to the routings.
- **PRODUCT FLOW ANALYSIS (PFA) reorders part routing matrices to identify families of parts with similar processing requirements.**

If we reorder the matrix listing which parts have four machines in common, three...

Hybrid Layouts: Cellular layouts

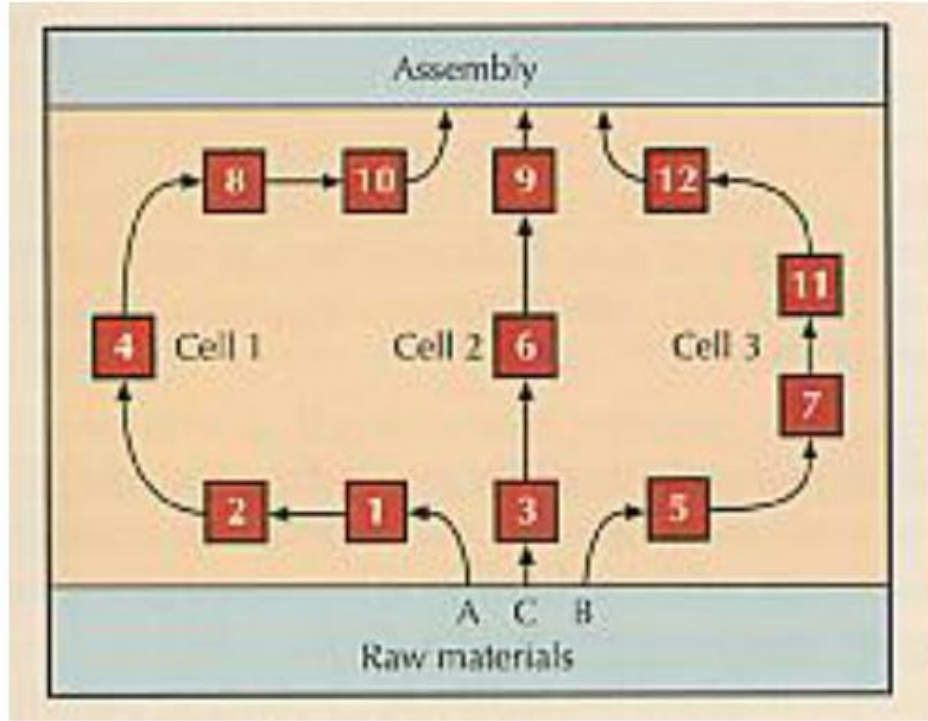
Parts	Machines											
	1	2	4	8	10	3	6	9	5	7	11	12
A	×	×	×	×	×							
D	×	×	×	×	×							
F	×		×	×								
C						×	×	×				
G						×	×	×				×
B									×	×	×	×
H										×	×	×
E							×		×			×

Cell 1: Parts A, D, F
Machines 1, 2, 4, 8, 10

Cell 2: Parts C, G
Machines 3, 6, 9

Cell 3: Parts B, H, E
Machines 5, 7, 11, 12

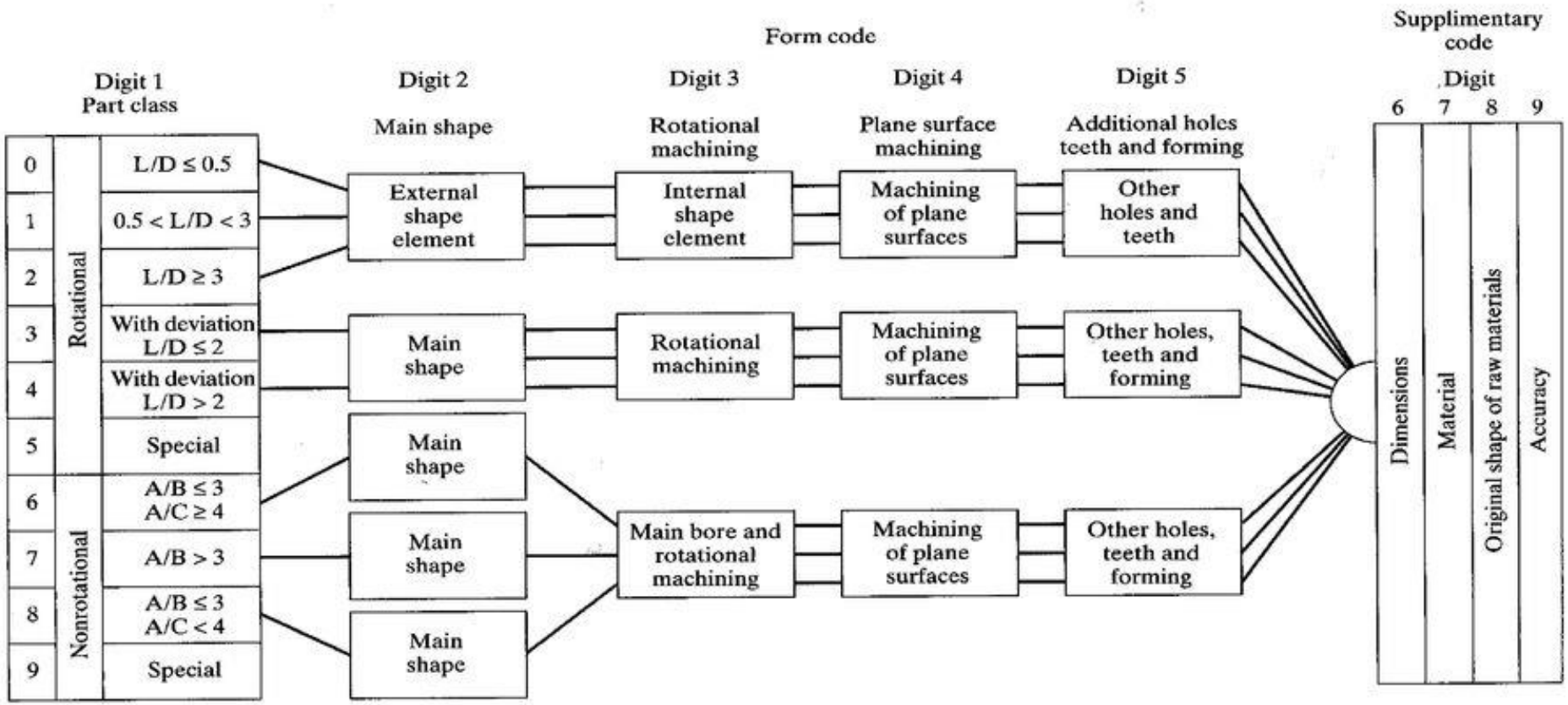
Part Routing Matrix Reordered to Highlight Cells



Revised Layout with Three Cells

Opitz Classification System (H.opitz university of Aachen in Germany)

Form Code 1 2 3 4 5 *for design attributes*
Supplementary Code 6 7 8 9 *for manufacturing attributes*
Secondary Code A B C D for production operation type & sequence



ADVANTAGES OF GT.

- Reduction in number of drawings
- Reduction in set up and production time
- Improved machine loading
- Reduces manufacturing lead time
- Leads to automated process planning
- Less material movement
- Reduces change in set up
- Better utilisation of tools and equipment
- Less number of defects and rejections