CH 8 Facility Layout Part 1

Integrated Manufacturing System Class

Facility Layout

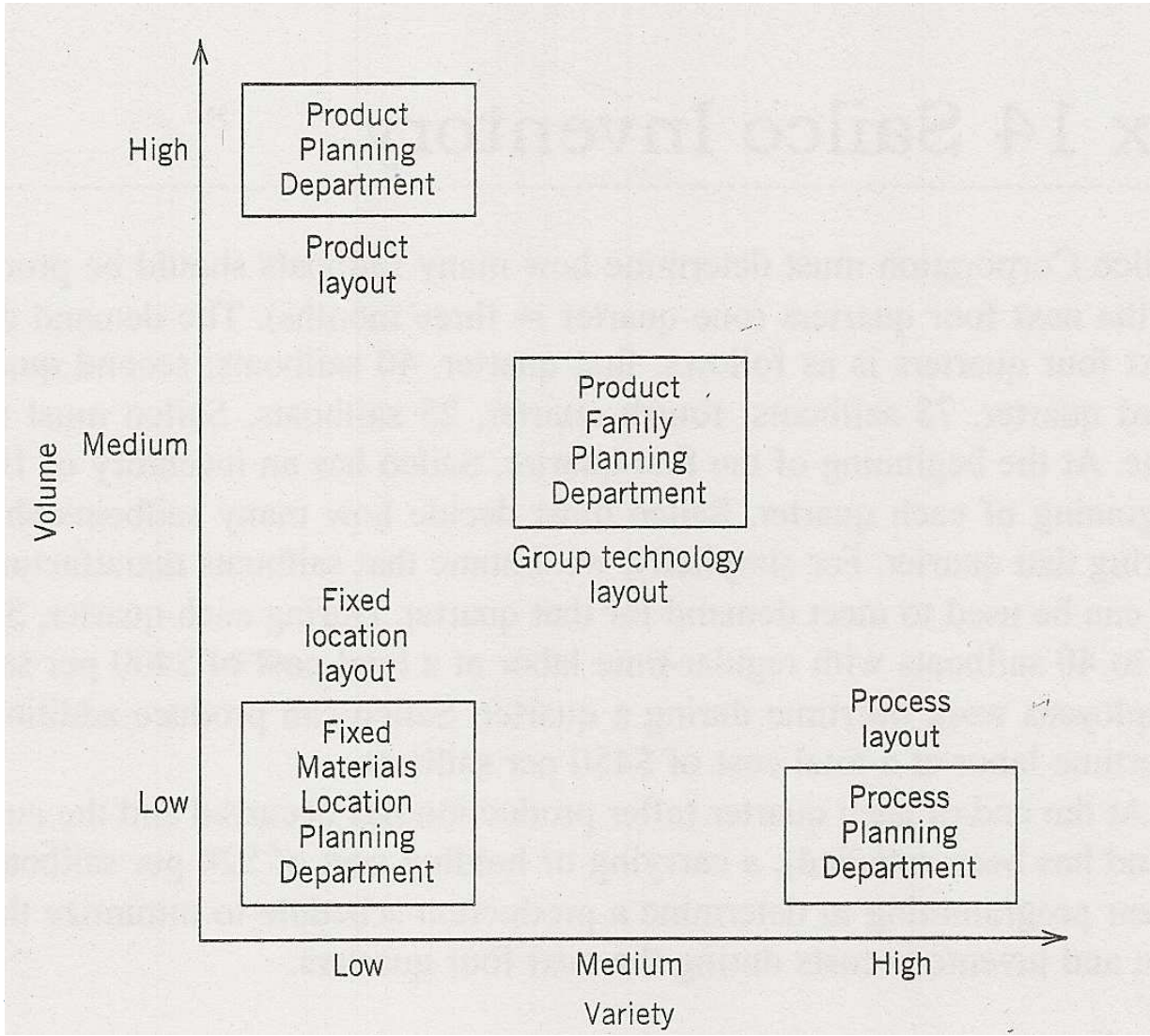
- Means planning for the location of all machines, utilities, employee work stations, customer service area, material storage areas, aisles, restrooms, lunchrooms, drinking fountains, offices and computer rooms, and for the flow patterns of materials and people around, into and within buildings.
- Objectives of facility layout is to minimize the cost of processing, transporting, and storing material throughout the production system.

Manufacturing Facility Layouts

- Materials Handling
  - The materials used in manufacturing are many: raw materials, purchased components, materials-in-process, finished goods, packaging materials, maintenance and repair supplies, and scrap and waste.
  - The layout of facilities is directly affected by the nature of these materials. Large and bulky materials, heavy materials, fluids, solids and materials requiring special handling to protect them.
  - All affect the layout of facilities for handing, storing, and processing these materials.
  - A material-handling system is *the entire network of transportation that receives material, store material in inventories, moves them about between processing points within and between buildings and finally deposits the finished products into vehicles that will deliver them to customer.*

Manufacturing Facility Layouts

- Depending on product volume-variety, facility layout can be classified as product, fixed materials location, product family (group technology), and process layout



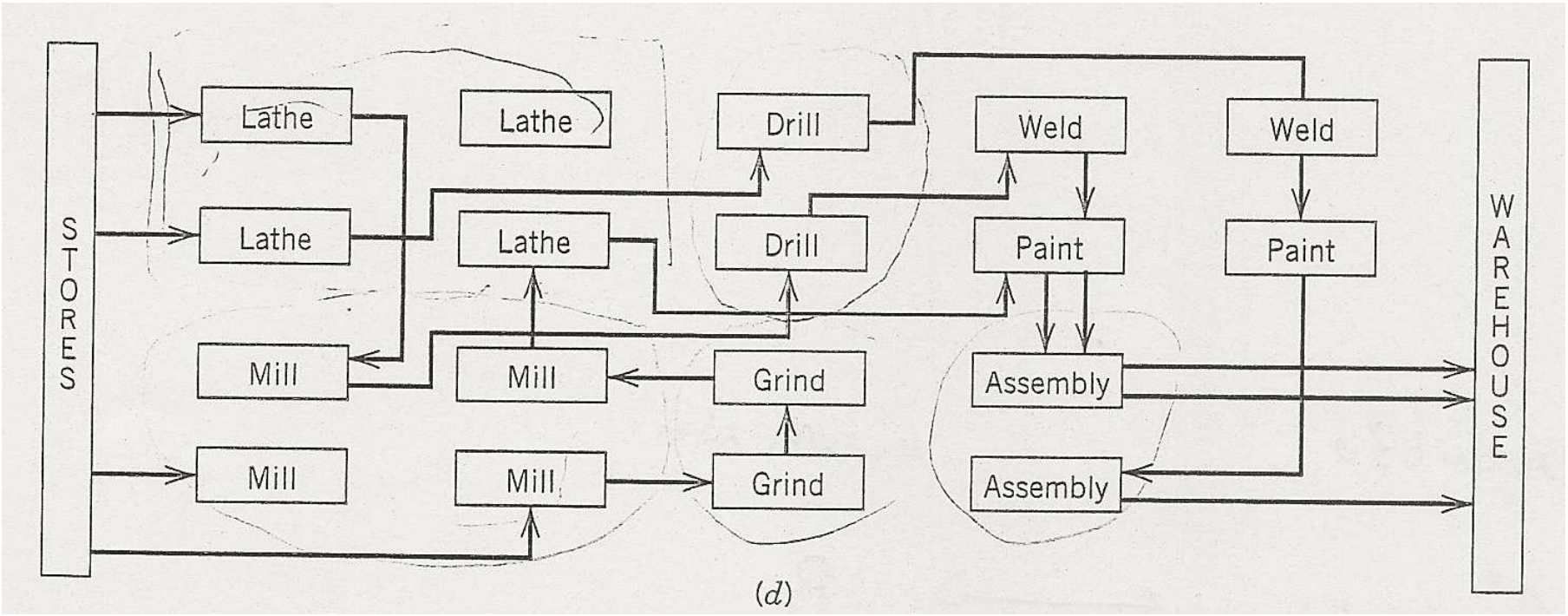
Process Layout

- Functional layouts, or job shops as they are sometimes called.
- *If a manufacturing facility produces a variety of customer products in relatively small batches, the facility probably will use a process layout.*
- Process layout typically use general-purpose machines that can be change over rapidly to new operations for different product design.
- These machines are usually arranged according to the type of process being performed. Ex, all machining would be in one department, all assembly in another department, and all painting in another department.

Process Layout (Cont.)

- The materials handling consists of forklift trucks and other mobile vehicles.
- The workers must change and adapt quickly to the multitude of operations to be performed on each unique batch of products being produced.
- These workers must be highly skilled and require intensive job instructions and technical supervision.

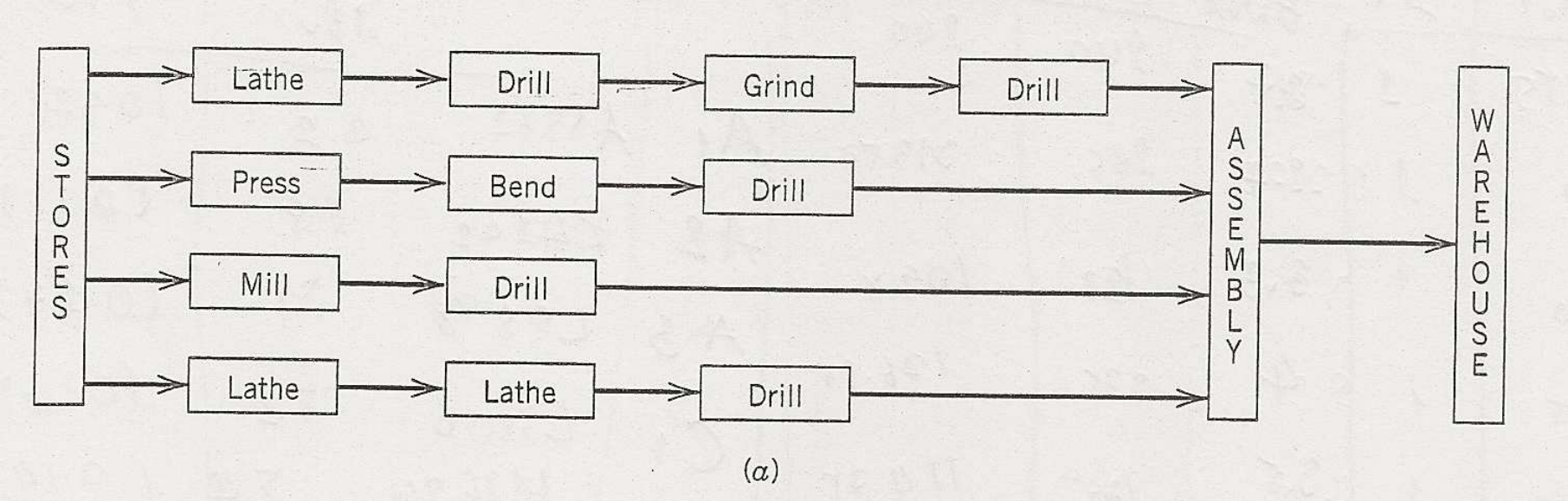
Process Layout (Cont.)



Product Layout

- Product layout are designed to accommodate only a few product designs.
- Such layouts are design to allow a *direct material flow through the facility for productions*. Auto-manufacturing plants are good examples of facility that use a product layout.
- Product layouts typically use specialized machines that are set up once to perform a specific operation for a long period of time on one product.
- With one product department several processes, such as forming machining, and assembly, could be performed.
- The amount of skill, training and supervision required is small.

Product Layout (Cont.)

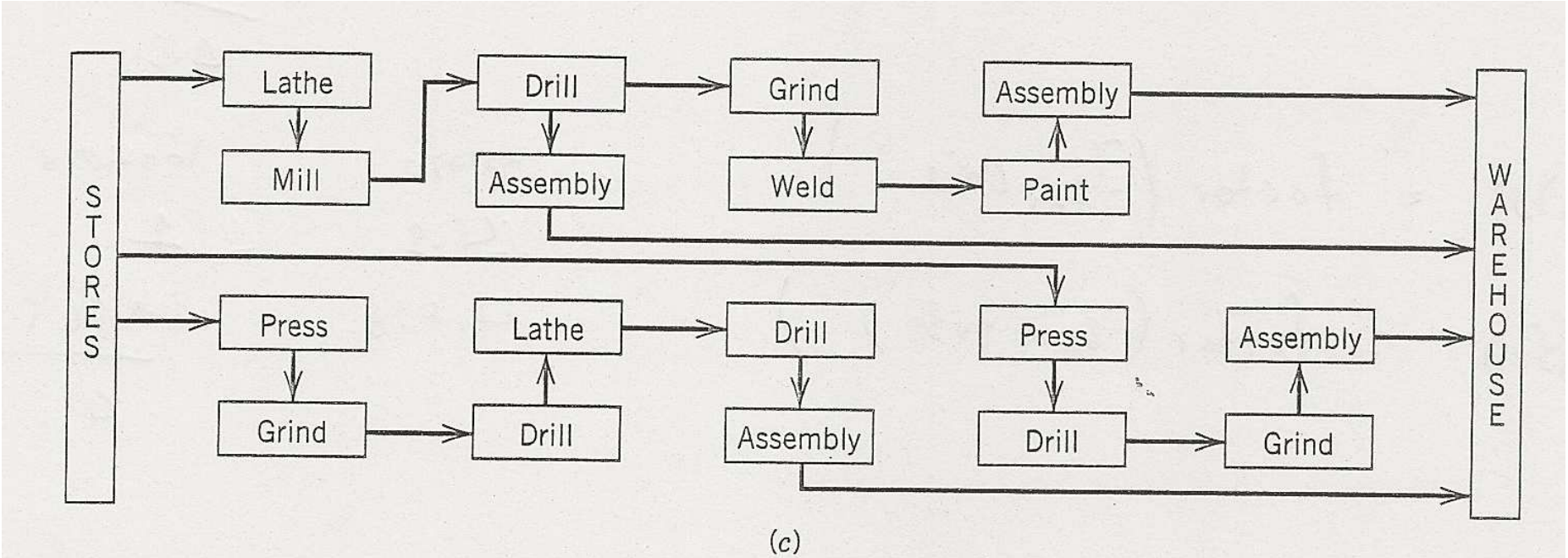


(a)

Cellular Manufacturing (CM) Layouts

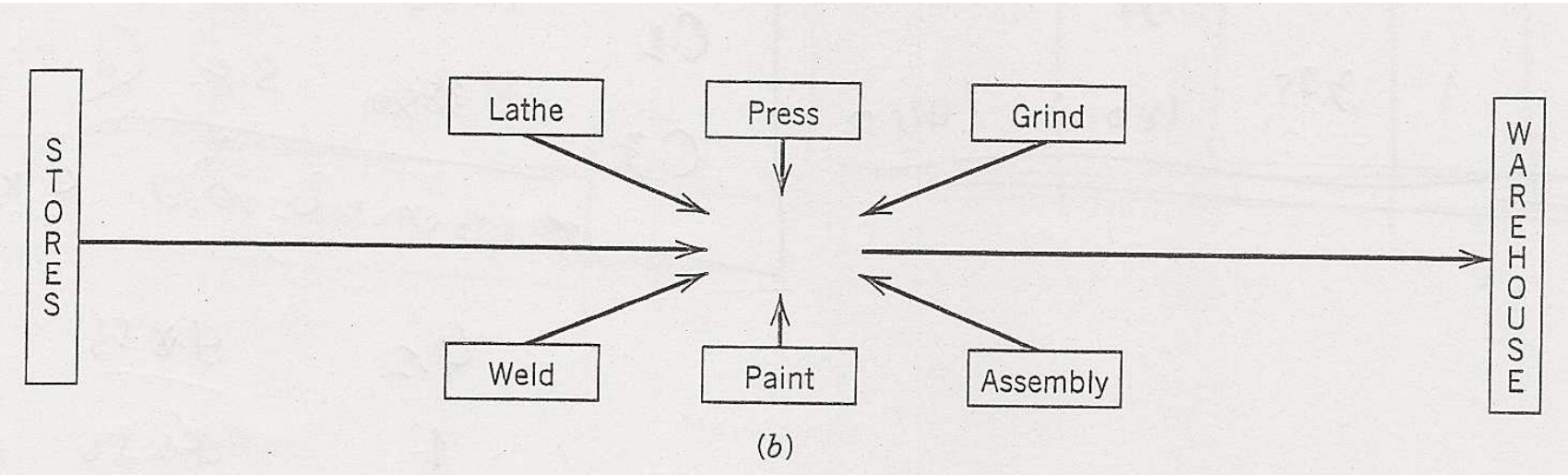
- *Machines are grouped into cells, and the cells function somewhat like a product layout island within a larger job shop or process layout.*
- Called product family layout. Each cell in a CM layout is formed to produce a single **parts family-**a few parts all with common characteristics, which usually means that they require the same machines and have similar machine setting.
- The reasons why a CM layout would be attempted are:
  - Machine changeovers are simplified.
  - Training periods for workers are shortened.
  - Materials-handling costs are reduced.
  - Parts can be made faster and shipped more quickly.
  - Less in-process inventory is required.
  - Production is easier to automate.

Cellular Manufacturing (CM) Layouts (Cont.)



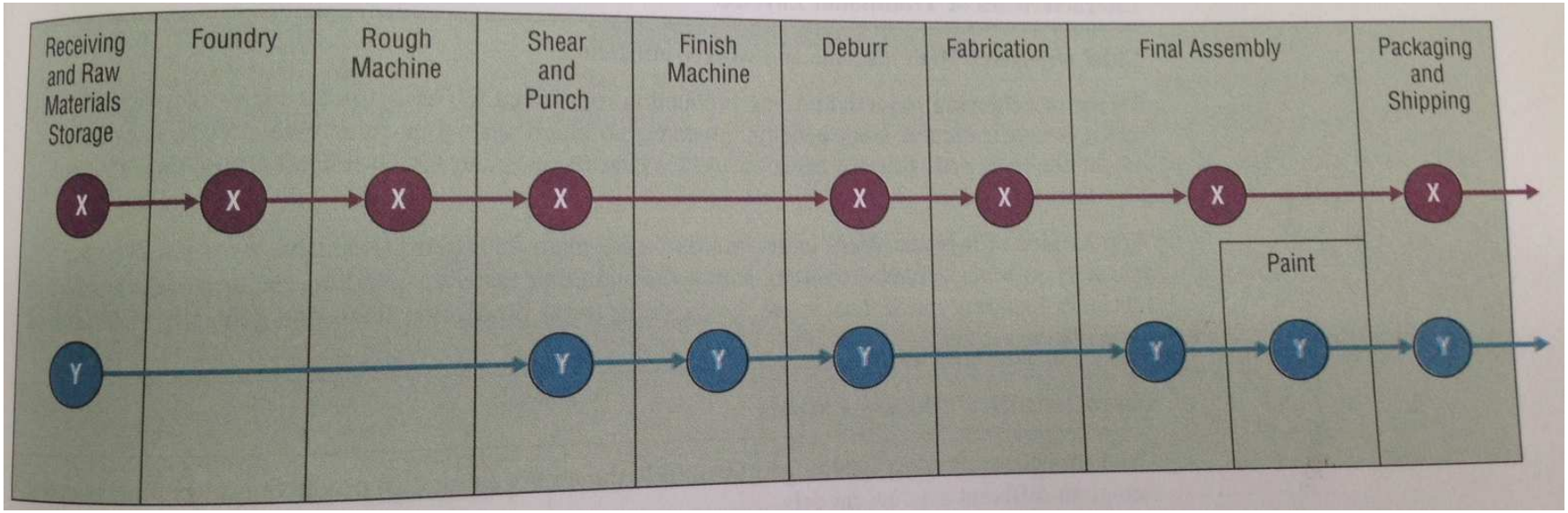
Fixed – Position Layouts

- Some manufacturing and construction firms use a layout for arranging work that locates the product in a fixed positon and transports workers, materials, machines, an subcontractors to and from the product



Hybrid Layout

- Most manufacturing facilities use a combination of layout types. Hybrid layout are arranged according to the types of processes but the products flow through on a product layout.
- Although hybrid layout make the identification of layout types fuzzy, it is important to understand the characteristics, advantages, and disadvantages of each type of layout.



Advantages and Limitations of Each Type of Layouts

Fixed Product Layout	
Advantages	**Limitations**
1. Material movement is reduced.	1. Personal and equipment movement is increased.
2. When a team approach is used, continuity of operations and responsibility results.	2. May serult in duplicate equipment.
3. Provides job enrichment opportunities.	3. Requires greater skill for personnel.
4. Promotes pride and quality because and individual can complete the "whole job."	4. Requires general supervision.
5. Highly flexible; can accommodate changes in product design, product mix, and product volume.	5. May result in increased space and greater work in process.
	6. Requires close control and coordination in scheduling production

Advantages and Limitations of Each Type of Layouts (Cont.)

Product Layout	
Advantages	**Limitations**
1. Smooth, simple, logical and direct flow lines result.	1. Machine stoppage stops the line.
2. Small work in process inventories should result.	2. Product design changes cause the layout to become obsolete.
3. Total production time per unit is short.	3. Slowest station paces the line.
4. Material handling requirments are reduced.	4. Gerneral supervision is required.
5. Less skill is required for personnel.	5. Higher equipment investment usually results.
6. Simple production control is possible	
7. Special-purpose equipment can be used	

Advantages and Limitations of Each Type of Layouts (Cont.)

Group Layout	
Advantages	**Limitations**
1. By grouping products, higher machine utilization can result.	1. General supervision required.
2. Smoother flow lines and shorter travel distances are expected than for process layouts.	2. Greater labor skills required for team members to be skilled on all operations.
3. Team atmosphere and job enlargement benefits often result.	3. Critically dependent on production control balancing the flows throught the individual cells
4. Has some of the benefits of product layouts and process layout: it is a compromise between the two.	4. If flow is not balanced in each cell, bufers and work in process storage are required in the call to eliminate the need for added material handling to and from the cell.
5. Encourages consideration of general purpose equipment	5. Has some of the disadvantages of product layouts and process layouts: it is a compromise between the two.
	6. Decrease the opportunity to use special-purpose equipment.

Advantages and Limitations of Each Type of Layouts (Cont.)

Process Layout	
Advantages	**Limitations**
1. Increased machine utilization.	1. Increased material Handling requirements.
2. General-purpose equipement can be used.	2. More complicated production control required.
3. Highly flexible in allocating personnel and equipment.	3. Increased work in process.
4. Diversity of tasks for personnel.	4. Longer production lines.
5. Specialized supervision is possible.	5. Higher skills required to accommodate diversity of tasks required.

Cellular Manufacturing (CM) Layouts

- Product family or group technology aggregate medium volume-variety parts into *families* based on similar manufacturing operations.
- Machines required to manufacture the part family are grouped together to form a "*cell*."
- Manufacturing cells involve grouping of machines, employees, materials, tooling and material handling and storage equipment to produce families of parts.
- Selection refers to the identification of machine and part types for a particular cell.
- Cell design refers to layout and production and material handling requirements.

Cellular Manufacturing (CM) Layouts

- *Clustering methodologies* are used to group parts together so they can be processed as a family.
- This methodology lists part and machines in rows and columns, and interchanges them based on some criterion like similarity coefficients.
- For ex, *the direct clustering algorithm (DCA)* forms clustered groups based on sequentially moving rows and columns to the top and left.
- The DCA is based on a machine-part matrix in which indicates that the part requires processing by the indicated machine: a blank indicates the machine is not used for the particular part.

The direct clustering algorithm (DCA)

- The DCA methodology consists of the following steps:
  1. Step 1. Order the rows and columns. Sum the 1s in each column and in each row of the machine-part matrix. Order the rows (top to bottom) in descending order of the number of 1s in the rows and order the columns (left to right) in ascending order of the number of 1s in each. Where ties exist, break the ties in descending numerical sequence.
  2. Step 2. Sort the columns. Beginning with the first row of the matrix, shift to the left of the matrix all columns having a 1 in the first now. Continue the process row-by-row until no further opportunity exists for shifting columns.
  3. Step 3. Sort the rows. Column-by- column, beginning with the leftmost column, shift rows upward when opportunities exist to form blocks of 1s. (It should be noted that performing the column and row sortation is facilitated by using spreadsheets, such as Excel.
  4. Step 4. Form cells. Look for opportunities to form cells such that all processing for each part occurs in a single cell.

Ex 1: The direct clustering algorithm (DCA)

Part #	Machine # 1	2	3	4	5	# of 1s
1	1		1			2
2	1					1
3		1		1	1	3
4	1		1			2
5		1				1
6				1	1	2
# of 1s	3	2	2	2	2	

Figure 3.2 Machine-part matrix for Example 3.1.

Part #	Machine # 5	4	3	1	1	# of 1s
3	1	1		1		3
6	1	1				2
4			1		1	2
1			1		1	2
5				1		1
2					1	1
# of 1s	2	2	2	2	3	

Figure 3.3 Ordered machine-part matrix.

Part #	Machine # 5	4	2	3	1	# of 1s
3	1	1	1			3
6	1	1				2
4				1	1	2
1				1	1	2
5			1			1
2					1	1
# of 1s	2	2	2	2	3	

Figure 3.4 Column-sorted machine-part matrix.

Ex 1: The direct clustering algorithm (DCA)

	Machine #					
Part #	5	4	2	3	1	# of 1s
3	1	1	1			3
6	1	1				2
5			1			1
4				1	1	2
1				1	1	2
2					1	1
# of 1s	2	2	2	2	3	

Figure 3.5 Row-sorted machine-part matrix.

	Machine #				
Part #	5	4	2	3	1
3	1	1	1		
6	1	1			
5			1		
4				1	1
1				1	1
2					1

Figure 3.6 Formation of two cells.

Ex 2: The direct clustering algorithm (DCA)

	Machine #					
Part #	1	2	3	4	5	# of 1s
1	1		1			2
2	1					1
3		1		1	1	3
4	1		1			2
5		1	1			2
6				1	1	2
# of 1s	3	2	3	2	2	

Figure 3.7 Machine-part matrix.

	Machine #					
Part #	5	4	2	3	1	# of 1s
3	1	1	1			3
6	1	1				2
5			1	1		1
4				1	1	2
1				1	1	2
2					1	1
# of 1s	2	2	2	2	3	

Figure 3.8 Ordered machine-part matrix.

Ex 2: The direct clustering algorithm (DCA)

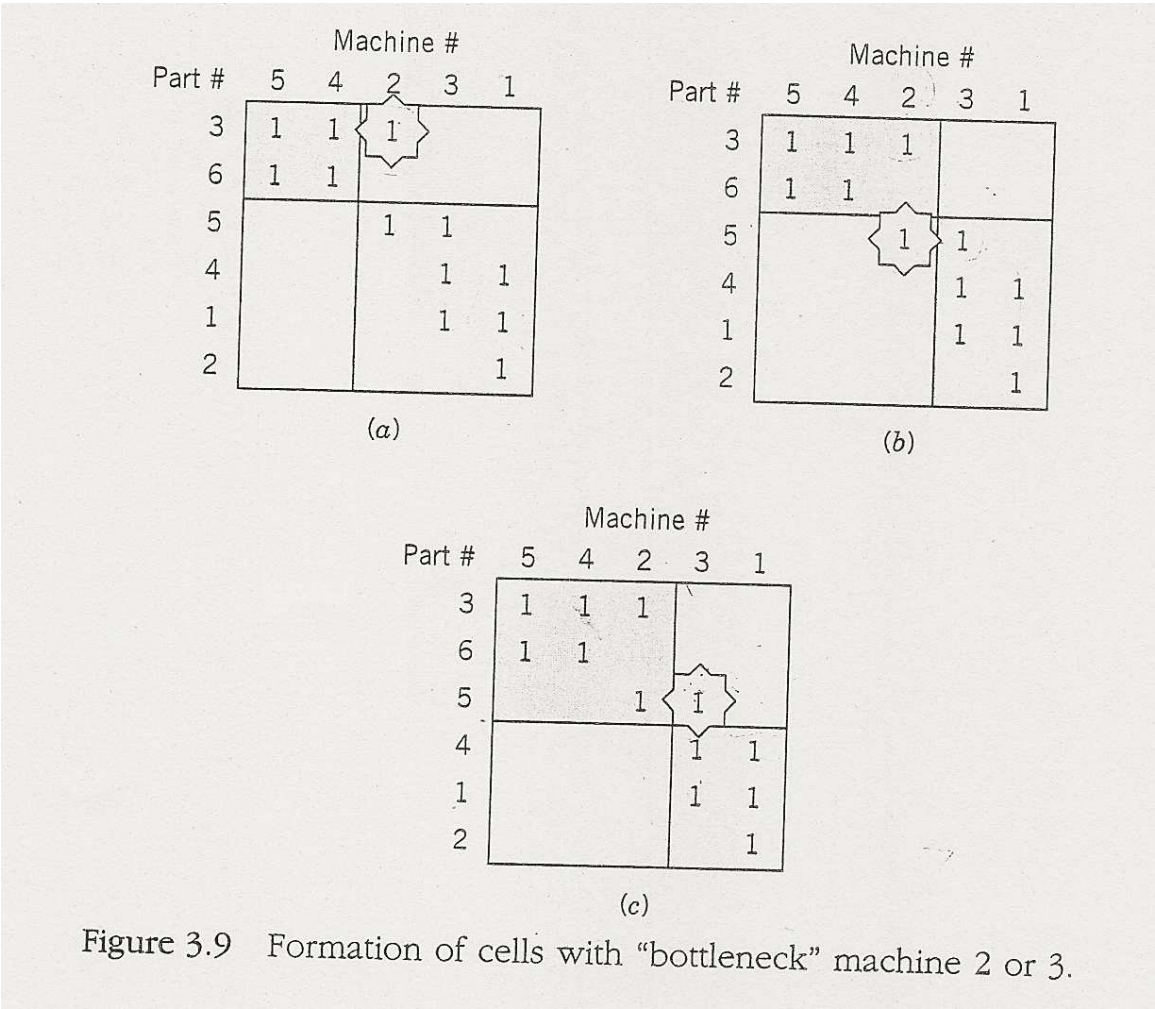
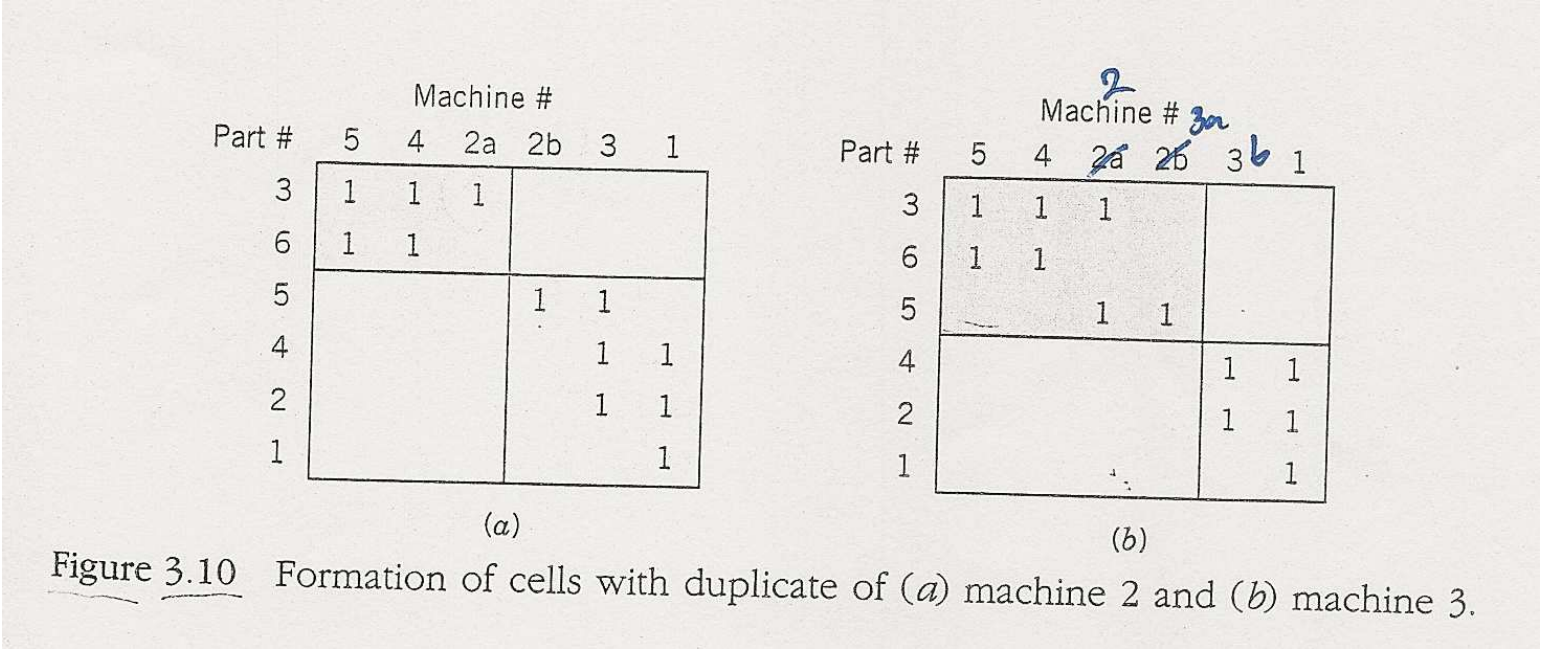


Figure 3.9 Formation of cells with "bottleneck" machine 2 or 3.

Ex 2: The direct clustering algorithm (DCA)



Machine #

Part #	5	4	2a	2b	3	1
3	1	1	1			
6	1	1				
5				1	1	
4					1	1
2					1	1
1						1

(a)

Machine # 2 3a 3b

Part #	5	4	2a	2b	3	1
3	1	1	1			
6	1	1				
5			1	1		
4					1	1
2					1	1
1						1

(b)

Figure 3.10 Formation of cells with duplicate of (*a*) machine 2 and (*b*) machine 3.

Ex 3 The direct clustering algorithm (DCA)

	Machine #																									
Part #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	# of 1s
1	1		1		1			1	1		1						1	1				1					9
2	1		1		1			1	1		1						1	1				1					9
3	1		1		1			1	1		1						1	1				1					9
4	1		1		1			1	1		1						1	1				1					9
5	1		1			1		1	1		1						1	1				1					9
6	1		1			1		1	1		1						1	1				1					9
7	1		1			1		1	1		1						1	1				1					9
8		1		1			1			1		1							1	1			1				8
9		1		1			1			1		1							1	1			1				8
10	1		1										1	1	1	1					1			1	1	1	10
11	1		1										1	1	1	1					1			1	1	1	10
12	1		1										1	1	1	1					1			1	1	1	10
13	1		1										1	1	1	1					1			1	1	1	10
# of 1s	11	2	11	2	4	3	2	7	7	2	7	2	4	4	4	4	7	7	2	2	4	7	2	4	4	4	

Figure 3.11 Machine-part matrix.

	Machine #																									
Part #	23	20	19	12	10	7	4	2	6	26	25	24	21	16	15	14	13	5	22	18	21	17	11	9	3	1	# of 1s
13										1	1	1	1	1	1	1	1								1	1	10
12										1	1	1	1	1	1	1	1								1	1	10
11										1	1	1	1	1	1	1	1								1	1	10
10										1	1	1	1	1	1	1	1								1	1	10
7									1										1	1	1	1	1	1	1	1	9
6									1										1	1	1	1	1	1	1	1	9
5									1										1	1	1	1	1	1	1	1	9
4																		1	1	1	1	1	1	1	1	1	9
3																		1	1	1	1	1	1	1	1	1	9
2																		1	1	1	1	1	1	1	1	1	9
1																		1	1	1	1	1	1	1	1	1	9
9	1	1	1	1	1	1	1	1																			8
8	1	1	1	1	1	1	1	1																			8
# of 1s	2	2	2	2	2	2	2	2	3	4	4	4	4	4	4	4	4	4	7	7	7	7	7	7	11	11	

Figure 3.12 Ordered machine-part matrix.

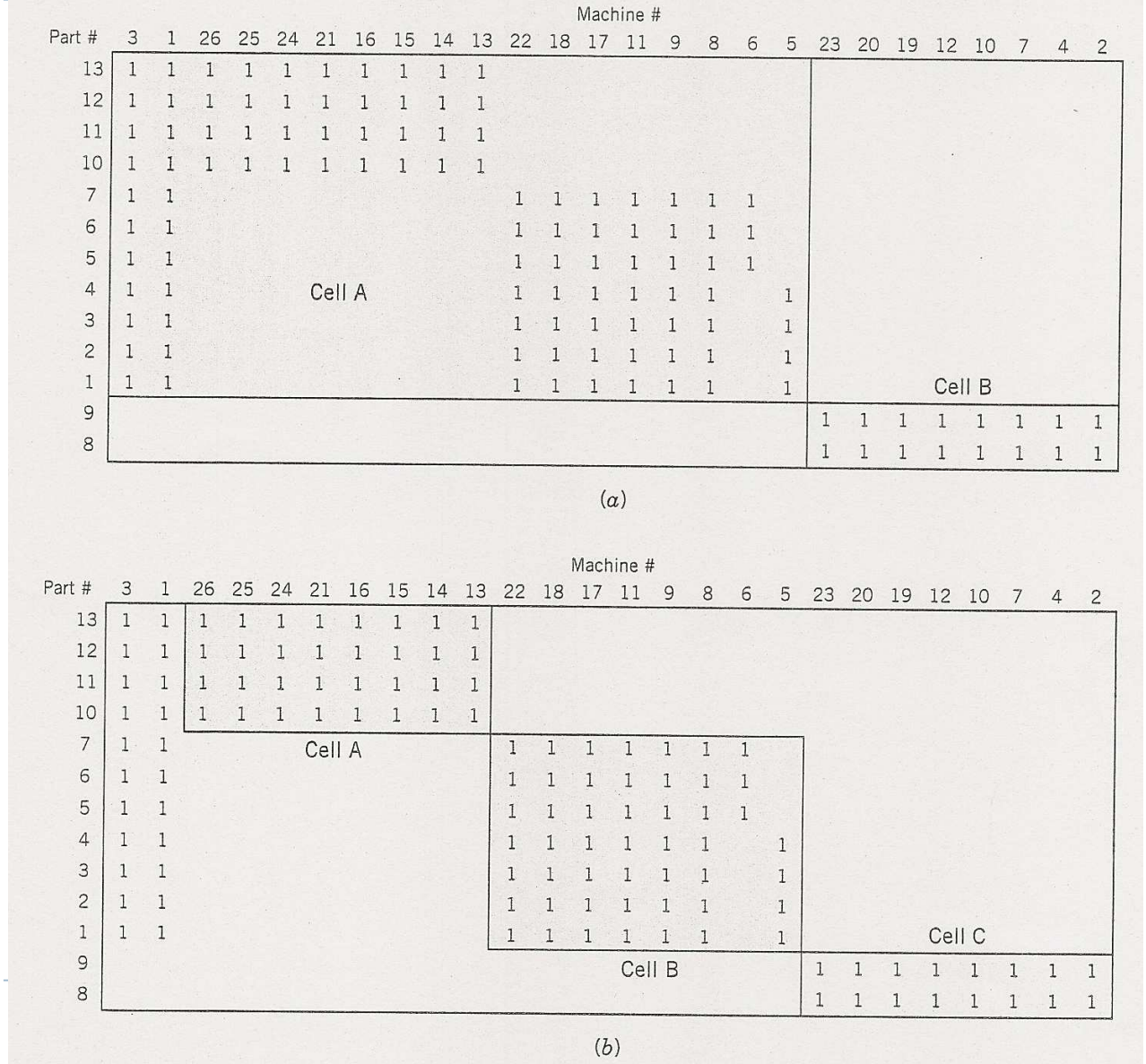
Ex 3 The direct clustering algorithm (DCA)

Machine #

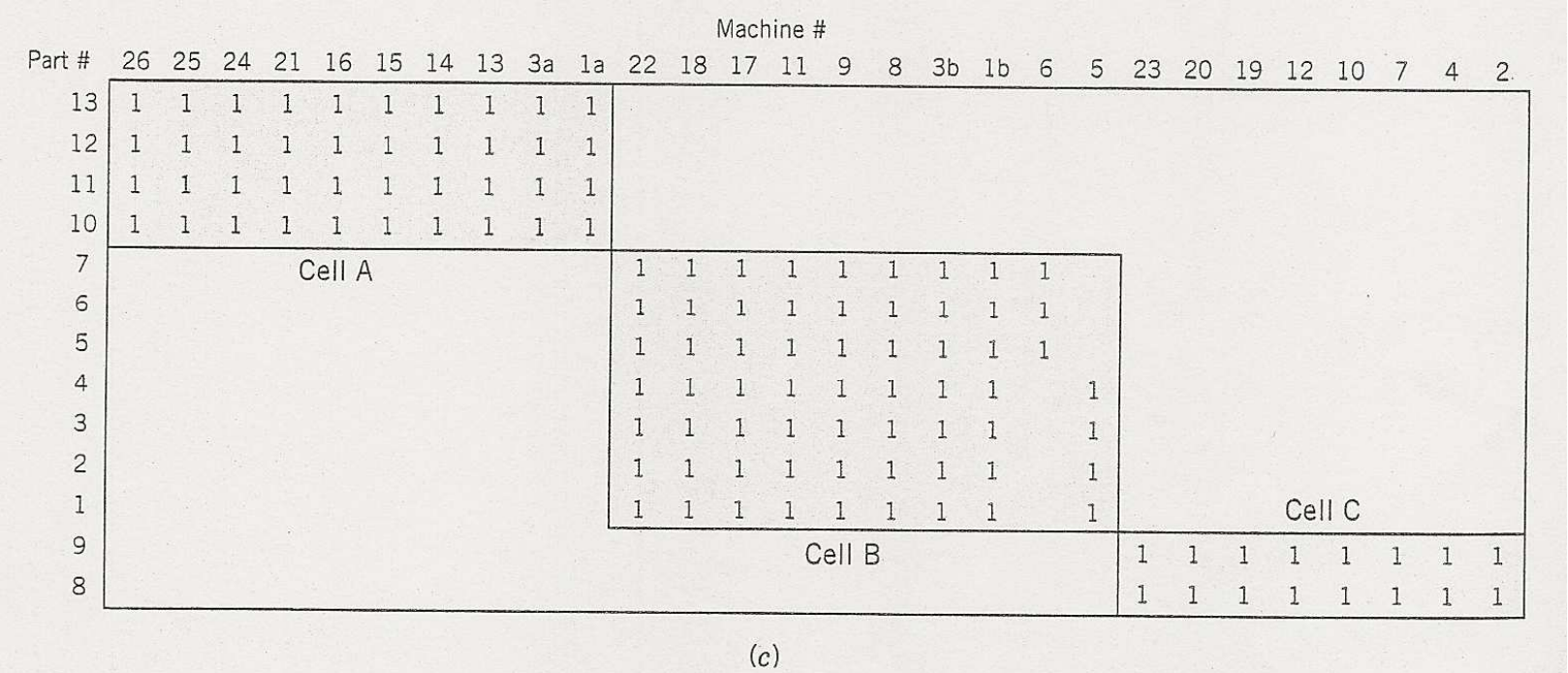
Part #	3	1	26	25	24	21	16	15	14	13	22	18	17	11	9	8	6	5	23	20	19	12	10	7	4	2	# of 1s
13	1	1	1	1	1	1	1	1	1	1																	10
12	1	1	1	1	1	1	1	1	1	1																	10
11	1	1	1	1	1	1	1	1	1	1																	10
10	1	1	1	1	1	1	1	1	1	1																	10
7	1	1									1	1	1	1	1	1	1										9
6	1	1									1	1	1	1	1	1	1										9
5	1	1									1	1	1	1	1	1	1										9
4	1	1									1	1	1	1	1	1		1									9
3	1	1									1	1	1	1	1	1		1									9
2	1	1									1	1	1	1	1	1		1									9
1	1	1									1	1	1	1	1	1		1									9
9																			1	1	1	1	1	1	1	1	8
8																			1	1	1	1	1	1	1	1	8
# of 1s	11	11	4	4	4	4	4	4	4	4	7	7	7	7	7	7	3	4	2	2	2	2	2	2	2	2	

Figure 3.13 Column-sorted machine-part matrix.

Ex 3 The direct clustering algorithm (DCA)



Ex 3 The direct clustering algorithm (DCA)



(c)

Figure 3.14 Final solution to Example 3.3.