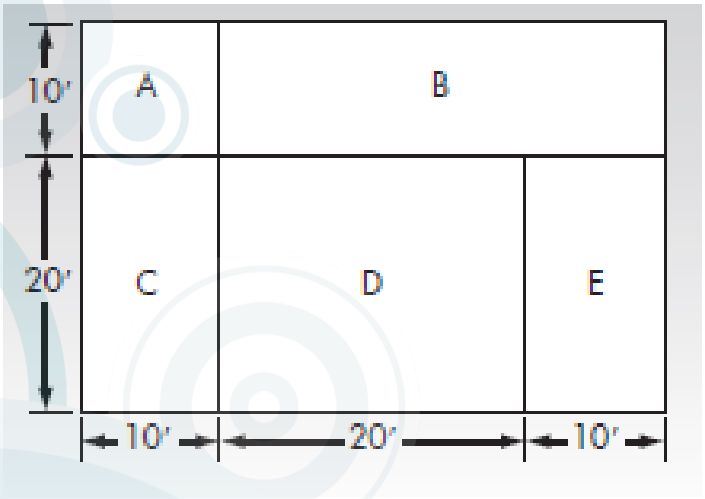
Craft Example:

Suppose the following layout is provided as the initial layout for CRAFT. The flow-between matrix is given below. (All the *cij* values are equal to $2/ (unite load. unite distance).

Flow-Between Matrix					
	A	**B**	**C**	**D**	**E**
A	**----**	**8**	**2**	**8**	**14**
B		**----**	**12**	**8**	**16**
C			**----**	**6**	**10**
D				**----**	**4**
E					**----**



1. Suppose the following layout is provided as the initial layout to CRAFT. Number of department pairs that will be considered for exchange that satisfy exchange requirements is:

   Answer: 7

2. The cost of the initial layout is:

   Answer: 4980

3. The estimated layout cost assuming that departments C and E are exchanged.

   Answer: 4340

4. The actual layout cost assuming that departments C and E are exchanged.

   Answer: 4340

5. The estimated layout cost assuming that departments C and D are exchanged.

   Answer: 4500

6. The actual layout cost assuming that departments C and D are exchanged.

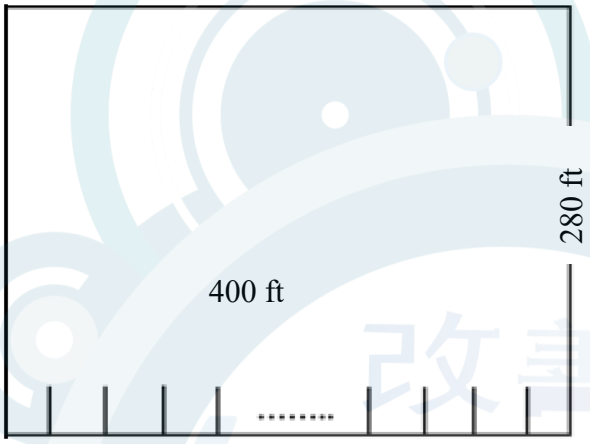
   Answer: 4260

Key Solutions

Online lecture: Aprill 27th/2026

Problem:

A parking lot is to be 400 feet wide and 280 feet deep. The manager wants exactly one module for compact cars and the remaining area for standard cars. How many compact and standard-sized cars fit in this lot? Use W4 Module, where the parking is angular with angle of 70, assume a stall depth of 16 feet. Determine the best parking layout using stall width for standard car, SW=9'0". Managers want exactly 8 stalls for handicapped and all are in the first row of the first module with standard cars.



a) Number of Modules for standard and compact cars in the parking Lot?

1 Module for compact cars

4 Module for standard cars

b) What is the parking width of the parking lot?

- For standard parking module:

$$PW_{\text{standard}} = \frac{SW_{\text{standard}}}{\sin\theta} = \frac{9}{\sin 70} = 9.578\text{ft}$$

- For compact parking module:

$$PW_{\text{compact}} = \frac{SW_{\text{compact}}}{\sin\theta} = \frac{8}{\sin 70} = 8.5134\text{ ft}$$

c) What is the distance lost due to parking at an angle?

$$Y = SD\cos\theta = 16\cos 70 = 5.4723\text{ft}$$

d) Determine the number of stalls available at each row.

Row #	Number of parking spaces (Stall)
Row 1	8 HC, 30 S
Row 2	38S
Row 3	38S
Row 4	38S
Row 5	38S
Row 6	38S
Row 7	38S
Row 8	38S
Row 9	42 Compact
Row10	46 Compact

$PW_{\text{HC}} = \frac{SW_{\text{HC}}}{\sin\theta} = \frac{12}{\sin 70} = 12.776$

$PW_{\text{standard}} = 9.578$

$PW_{\text{compact}} = 8.5134$

$Row_1 = \frac{400-(8\times 12.776)-5.47}{9.578} = 30.93$, Round down to 30

$Row_2 - Row_8 = \frac{400-5.47-(15*2)}{9.578} = 38.06$, , Round down to 38

$Row_9 = \frac{400-5.47-(15*2)}{8.5134} = 42.8$, Round down to 42

$Row_{10} = \frac{400-5.47}{8.5134} = 46.34$, Round down to 46

Problem 2:
If three nurses and three part-time physicians are to be employed in a health services area, how much space should be allowed in the facilities plan?

$$First\ aid\ room\ (250\ ft^2/nurse, we\ have\ 3\ nurses)\ = 250 * 3 = 750\ ft^2$$
$$Waiting\ area\ (75ft^2\ for\ the\ first\ nurse\ and\ for\ additional\ 25\ ft^2/additional\ nurse)$$
$$= 75\ ft^2 + 25ft^2 * (2)\ = 125\ ft^2$$
$$Exam\ room\ (Three\ part-time\ physician) =\ 150\ ft^2 * 3 = 450\ ft^2$$
$$Total\ area\ required =\ (750\ ft^2 + 125\ ft^2 + 450\ ft^2)\ = 1{,}325\ ft2$$

Parking Dimensions for Each Car Group as a Function of Single and Double Loaded Module Options

			θ ANGLE OF PARK									
	SW	W	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Group I: small cars	8′0″	1	25′9′	26′6″	27′2″	29′4″	31′9″	34′0″	36′2″	38′2″	40′0″	41′9″
		2	40′10″	42′0″	43′1″	45′8″	48′2″	50′6″	52′7″	54′4″	55′11″	57′2″
		3	38′9″	40′2″	41′5″	44′2″	47′0″	49′6″	51′10″	53′10″	55′8″	57′2″
		4	36′8″	38′3″	39′9″	42′9″	45′9″	48′6″	51′1″	53′4″	55′5″	57′2
Group II: standard cars	8′6″	1	32′0″	32′11″	34′2″	36′2″	38′5″	41′0″	43′6″	45′6″	46′11″	48′0″
		2	49′10″	51′9″	53′10″	56′0″	58′4″	60′2″	62′0″	63′6″	64′9″	66′0″
		3	47′8″	49′4″	51′6″	54′0″	56′6″	59′0″	61′2″	63′0″	64′6″	66′0″
		4	45′3″	46′10′	49′0″	51′8″	54′6″	57′10″	60′0″	62′6″	64′3″	66′0″
	9′0″	1	32′0″	32′9″	34′0″	35′4″	37′6″	39′8″	42′0″	44′4″	46′2″	48′0″
		2	49′4″	51′0″	53′2″	55′6″	57′10″	60′0″	61′10″	63′4″	64′9″	66′0″
		3	46′4″	48′10″	51′4″	53′10″	56′0″	58′8″	61′0″	63′0″	64′6″	66′0″
		4	44′8″	46′6″	49′0″	51′6″	54′0″	57′0″	59′8″	62′0″	64′2″	66′0″
	9′6″	1	32′0″	32′8″	34′0″	35′0″	36′10″	38′10″	41′6″	43′8″	46′0″	48′0″
		2	49′2″	50′6″	51′10″	53′6″	55′4″	58′0″	60′6″	62′8″	64′6″	65′11″
		3	47′0″	48′2″	49′10″	51′6″	53′11″	57′0″	59′8″	62′0″	64′3″	65′11″
		4	44′8″	45′10″	47′6″	49′10″	52′6″	55′9″	58′9″	61′6″	63′10″	65′11″
Group III: large cars	9′0″	1	32′7″	33′0″	34′0″	35′11″	38′3″	40′11″	43′6″	45′5″	46′9″	48′0″
		2	50′2″	51′2″	53′3″	55′4″	58′0″	60′4″	62′9″	64′3″	65′5″	66′0″
		3	47′9″	49′1″	52′3″	53′8″	56′2″	59′2″	61′11″	63′9″	65′2″	66′0″
		4	45′5″	46′11″	49′0″	51′8″	54′9″	58′0″	61′0″	63′2″	64′10″	66′0″
	9′6″	1	32′4″	32′8″	33′10″	34′11″	37′2″	39′11″	42′5″	45′0″	46′6″	48′0″
		2	49′11″	50′11″	52′2″	54′0″	56′6″	59′3″	61′9″	63′4″	64′8″	66′0″
		3	47′7″	48′9″	50′2″	52′4″	55′1″	58′4″	60′11″	62′10″	64′6″	66′0″
		4	45′3″	46′8″	48′5″	50′8″	53′8″	57′0″	59′10″	52′2″	64′1″	66′0″
	10′0″	1	32′4″	32′8″	33′10″	34′11″	37′2″	39′11″	42′5″	45′0″	46′6″	48′0″
		2	49′11″	50′11″	52′2″	54′0″	56′6″	59′3″	61′9″	63′4″	64′8″	66′0″
		3	57′7″	48′9″	50′2″	52′4″	55′1″	58′4″	60′11″	62′11″	64′6″	66′0″
		4	45′3″	46′8″	48′5″	50′8″	53′8″	57′0″	59′10″	62′2″	64′1″	66′0″

Source: Ramsey et al. [8]

Questions on Creating manufacturing cells using clustering

Question 1: Create manufacturing cells based on the machine-part matrix below. If conflicts or exceptional parts exist, propose alternative approaches. Use Direct order clustering algorithm.

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

Question 2: Use the Rank Order Clustering algorithm to create manufacturing cells based on the machine-part matrix below. If conflicts or exceptional parts exist, propose alternative approaches.

Parts-Machines Matrix

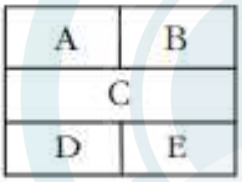
Machines \ Parts	1	2	3	4	5	6	7	8
A	x			x		x		
B	x			x				
C			x				x	
D	x			x	x	x		
E		x						
F			x				x	
G		x						x
H	x			x		x		
I			x				x	
J	x			x				
K								x
L		x					x	x

Question 3: Use the cluster identification algorithm to create manufacturing cells based on the machine-part matrix below. If conflicts or exceptional parts exist, propose alternative approaches. (you need to determine manufacturing cells).

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
P1	1	1		1				1		1		
P2					1		1				1	1
P3			1			1			1			
P4	1	1		1				1		1		
P5					1						1	1
P6	1			1				1				
P7			1			1			1			
P8							1				1	1

SECTION 6.4

6.12 Suppose five departments labeled A through E are located as shown in the layout below. Given the corresponding flow-between chart, compute the efficiency rating for the layout.



	A	B	C	D	E
A	—	5	0	4	−3
B		—	6	−1	2
C			—	−6	0
D				—	3
E					—

For the positive flow

$\sum^{+} f_{ij}x_{ij}$ =(5)*(1)+(4)*(0)+(6)*(1)+(2)*(0)+(3)*(1)= 14

For the negative flow

$\sum^{-} f_{ij}(1 - x_{ij})$= (-3)*(1-0)+(-1)*(1-0)+(-6)*(1-1) = -4

For the positive

$\sum^{+} f_{ij} = 20$

For the negative

$\sum^{-} f_{ij} =$ -10

$$z = \frac{\sum^{+} f_{ij} x_{ij} - \sum^{-} f_{ij}(1 - x_{ij})}{\sum^{+} f_{ij} - \sum^{-} f_{ij}}$$

$$z = \frac{(14 - -4)}{(20 - -10)} = \frac{18}{30}$$

Key answers

Question 1: Create manufacturing cells based on the machine-part matrix below. If conflicts or exceptional parts exist, propose alternative approaches. Use Direct order clustering algorithm.

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

Solution : Cell 1{M1, M4}, Solution : Cell 2{M2, M3, M5}

Question 2: Use the Rank Order Clustering algorithm to create manufacturing cells based on the machine-part matrix below. If conflicts or exceptional parts exist, propose alternative approaches.

Parts-Machines Matrix

Machines \ Parts	1	2	3	4	5	6	7	8
A	x			x		x		
B	x			x				
C			x				x	
D	x			x	x	x		
E		x						
F			x				x	
G		x						x
H	x			x		x		
I			x				x	
J	x			x				
K								x
L		x					x	x

Solution:

You have 3 Cells

	5	6	1	4	7	3	2	8
D	x	x	x	x				
A		x	x	x				
H		x	x	x				
B			x	x				
J			x	x				
C					x	x		
F					x	x		
I					x	x		
E						x	x	x
L							x	x
G							x	x
K								x

There is a conflicts, You need to duplicate machine L:

	5	6	1	4	2	8	7	3
D	x	x	x	x				
A		x	x	x				
H		x	x	x				
B			x	x				
J			x	x				
L1					x	x		
G					x	x		
K						x		
L2							x	
C							x	x
F							x	x
I							x	x
E								x

Question 3: Use the cluster identification algorithm to create manufacturing cells based on the machine-part matrix below. If conflicts or exceptional parts exist, propose alternative approaches. (you need to determine manufacturing cells).

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
P1	1	1		1				1		1		
P2					1		1				1	1
P3			1			1			1			
P4	1	1		1				1		1		
P5					1						1	1
P6	1			1				1				
P7			1			1			1			
P8							1				1	1

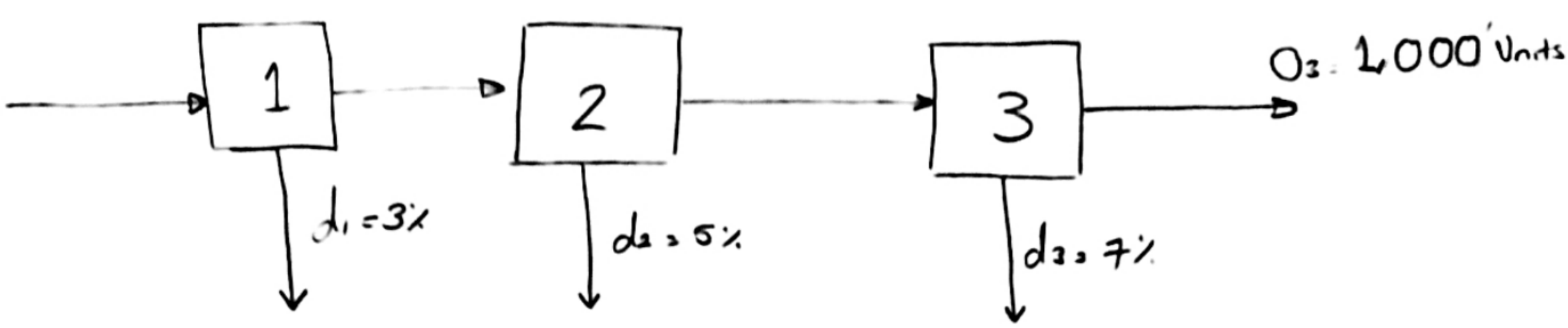
Solution:

Cell 1: { M1, M2, M4, M8, M10}

Cell 2: { M5, M7, M11,M12}

Cell 3: { M3, M6, M9}

2.13



Cost of scrap at process 1 = $5 / Unit

Cost of scrap at process 2 = $10 / Unit

Cost of scrap at process 3 = $15 / Unit

$$I_3 = \frac{1,000}{1-d_3} = \frac{1,000}{0.93} = 1,075.269 \xrightarrow{\text{Round up}} 1,076 \text{ Units}$$

$$I_2 = \frac{1,076}{1-d_2} = \frac{1,076}{0.95} = 1,131.58 \Rightarrow 1,132 \text{ Units}$$

$$I_1 = \frac{1,132}{1-d_1} = \frac{1,132}{0.97} = 1,167.01 \Rightarrow \underline{1,168} \text{ Units}$$

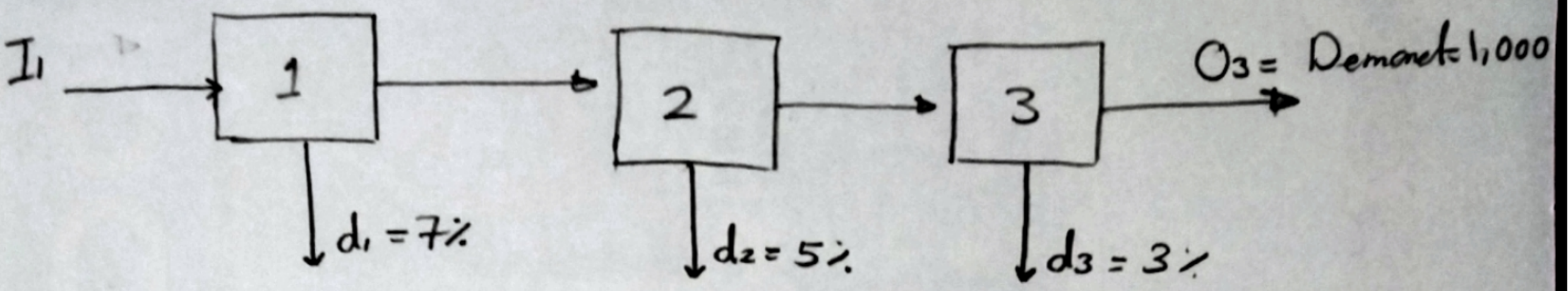
Amount of scrap and its cost

Process	# of scrap	Cost of scrap	total Cost = $1880
1	$I_1 - O_1 \overset{(I_2)}{=} 1,168 - 1,132 = 36$	$36 \times 5 = \$180$	
2	$I_2 - O_2 \overset{(I_3)}{=} d_2 I_2 = 1,132 - 1,076 = 56$	$56 \times 10 = \$560$	
3	$I_3 - O_3 = d_3 I_3 = 1,076 - 1000 = 76$	$76 \times 15 = \$1,140$	

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2.13

If scrap rates are reversed. then:



$$I_3 = \frac{1,000}{1-d_3} = \frac{1,000}{0.97} = 1,030.93 \xrightarrow{\text{Round up}} 1,031$$

$$I_2 = \frac{1,031}{1-d_2} = \frac{1,031}{0.95} = 1,085.26 \xrightarrow{\text{Round up}} 1,086$$

$$I_1 = \frac{1,086}{1-d_1} = \frac{1,086}{0.93} = 1,167.74 \longrightarrow 1,168$$

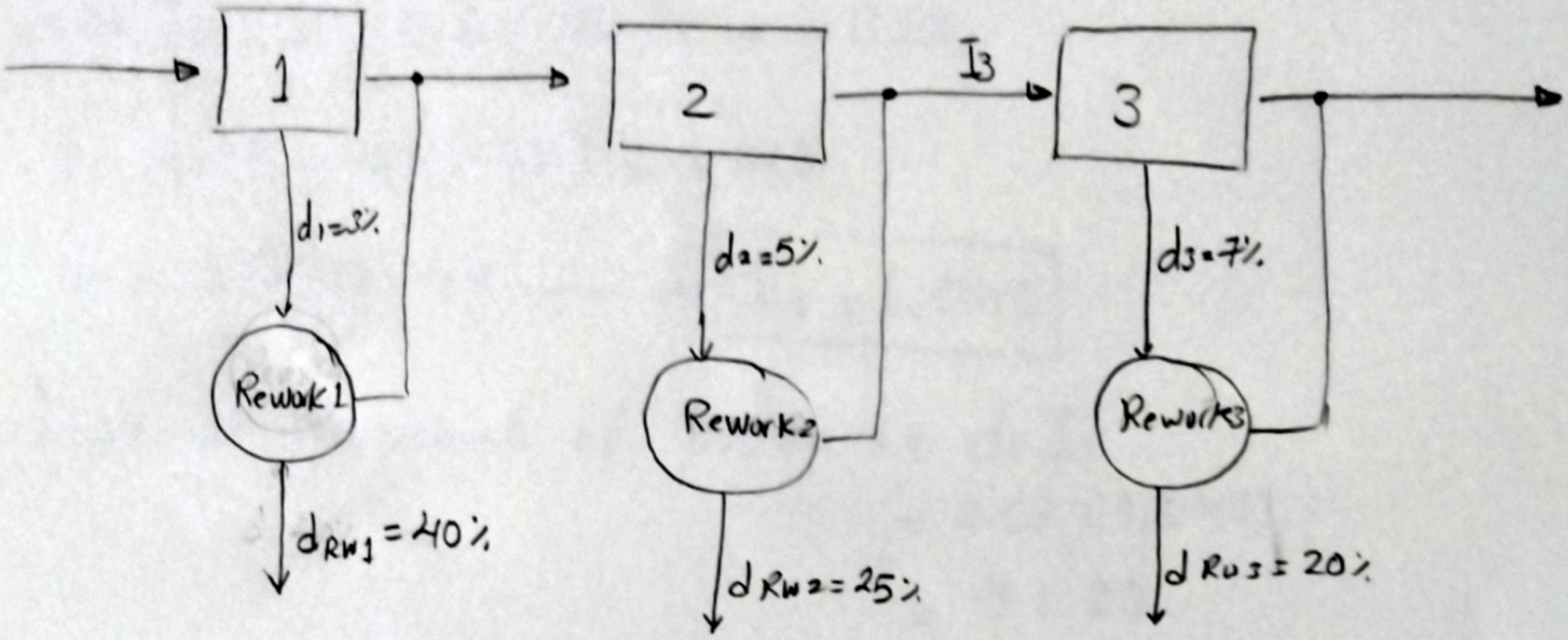
Scrap value and cost for the new System:

Process	# of Scrap	Cost of Scrap
1	$I_1 - O_1 \overset{(I_2)}{\sim} = d_1 I_1 = 1,168 - 1,086 = 82$	$82 \times 5 = \$410$
2	$I_2 - O_2 = d_2 I_2 = 1,086 - 1,031 = 55$	$55 \times 10 = \$550$
3	$I_3 - O_3 = d_3 I_3 = 1,031 - 1,000 = 31$	$31 \times 15 = \$465$
	Total Scrap cost =	$1,425

* The System with reversed scrap rates has Lower scrap cost So it would be preferred.

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2.14



$$(1-d_3)I_3 + (1-d_{RW3})\,d_3 I_3 = 1{,}000$$

$$0.93\,I_3 + (0.8)(.07)\,I_3 = 1{,}000$$

$$I_3 \cdot \big((0.93 + 0.8(.07))\big) = 1{,}000 \Rightarrow 0.986\,I_3 = 1{,}000$$

$$I_3 = 1{,}014.199$$

Round up $\Rightarrow$ $\boxed{I_3 = 1{,}015}$

Input to rework of process $3 = d_3 I_3 = 0.07(1{,}015)$

$= 71.05 \Rightarrow 72$ Units

$$(1-d_2)I_2 + (1-d_{RW2})\,d_2 I_2 = 1{,}015$$

$$0.95 I_2 + (0.75)(.05) I_2 = 1{,}015$$

$$I_2(0.95 + .75(.05)) = 1{,}015$$

$$0.9875\,I_2 = 1{,}015 \Rightarrow I_2 = 1{,}027.85 \Rightarrow \boxed{I_2 = 1{,}028 \text{ Units}}$$

Input to rework of process $2 = d_2 I_2 = 0.05\,(1{,}028)$

$= 51.4 \Rightarrow$ 52 Units

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2.14

$$(1-d_1)I_1 + (1-d_{RW1})d_1 I_1 = 1,028$$

$$0.97\ I_1 + 0.6\ (.03)\ I_1 = 1,028$$

$$I_1\ (0.97 + 0.6\ (.03)) = 1,028$$

$$I_1 = 1,040.49 \rightsquigarrow \boxed{I_1 = 1,041}$$

Input to the rework of process 1 = $d_1 I_1$

$= 0.03\ (1,041)$

$= 31.23$

32 Units

So the total cost of reworked parts =

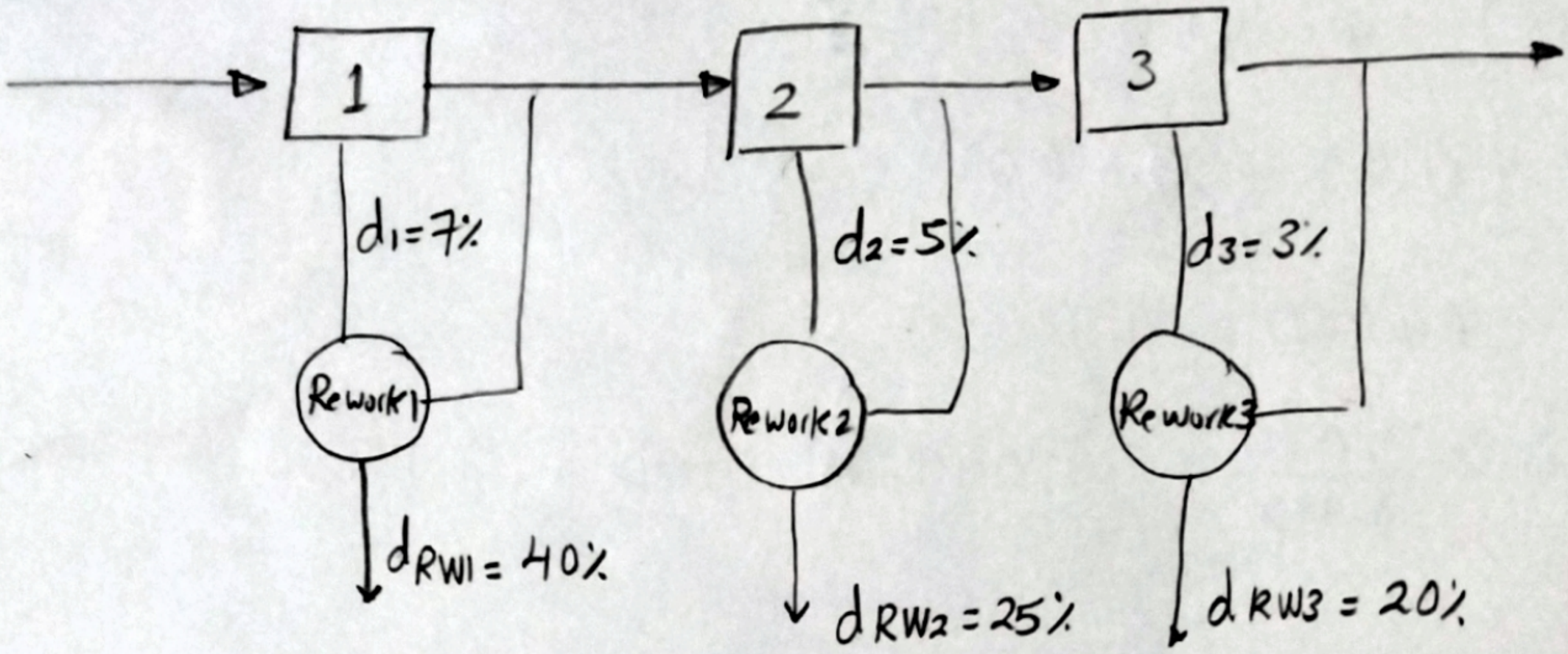
$$\underline{32 \times 2} + 52 \times 3 + 72 \times 4 =$$

$$64 + 156 + 288 = 508$$

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2.14

For the system with reversed scrap rates.



$(1-d_3)I_3 + (1-d_{RW3})d_3 I_3 = 1{,}000$

$0.97\, I_3 + (0.8)(.03) I_3 = 1{,}000 \Rightarrow I_3 (.97 + 0.8(.03)) = 1{,}000$

$I_3 = 1{,}006.04$

$\boxed{I_3 = 1{,}007}$

Input to rework of process 3 $= d_3 I_3 = 0.03\,(1{,}007) = \underline{30.21}$

$= 31$ parts

$(1-d_2) I_2 + (1 - d_{RW2}) d_2 I_2 = 1{,}007$

$0.95\, I_2 + (0.75)(.05) I_2 = 1{,}007$

$I_2 (0.95 + (.75)(0.05)) = 1{,}007$

$I_2 (0.9875) = 1{,}007$

$I_2 = -1{,}019.75 \Rightarrow I_2 = 1{,}020$

input to the rework of process 2 $= d_2 I_2$

$= 0.05\,(1{,}020)$

$= 51$ parts

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2.14

$$(1-d_1)I_1 + (1-d_{RW1})\,d_1 I_1 = 1{,}020$$

$$0.93\,I_1 + (0.6)(0.07)\,I_1 = 1{,}020$$

$$I_1\,(0.93 + 0.6\,(0.07)) = 1{,}020$$

$$I_1\,(0.972) = 1{,}020$$

$$I_1 = \frac{1{,}020}{0.972} = 1{,}049.38 \Rightarrow I_1 = 1{,}050$$

input to rework of process 1 $= d_1 I_1 = 0.07\,(1{,}050)$

$= 73.5$

$= 74$ Units

The total cost of reworked parts for the reversed system =

$$\begin{array}{lll} \underline{74\ (2)} & +51\ (3) & +31\ (4) = \\ 148 & +\ 153 & +\ 124 = 425 \end{array}$$

Based on the total rework cost, the reversed system is preferred.

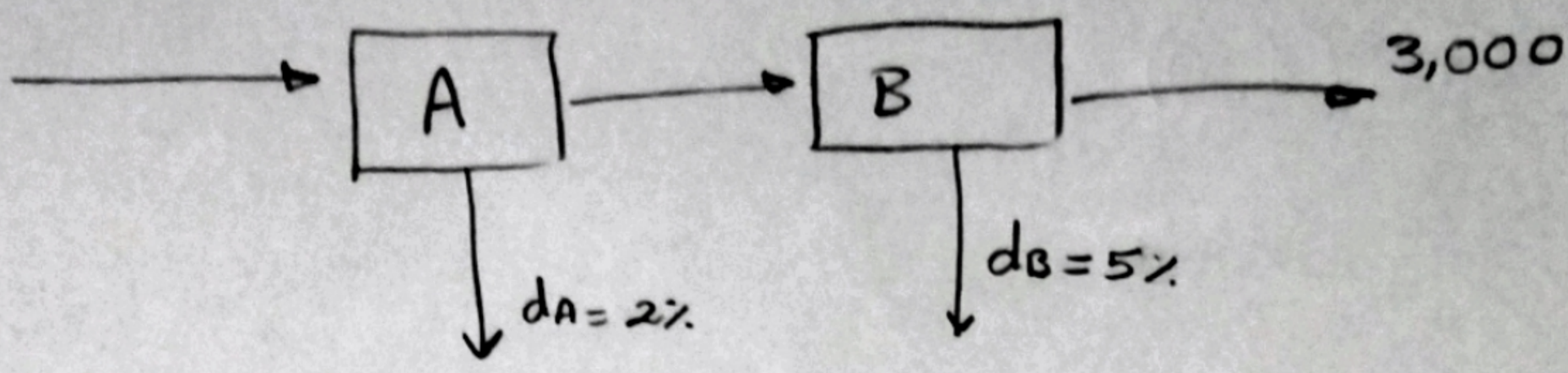
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2.15

$S_A = 3$ min | $E_A = 0.95$ | $R_A = 0.95$

$S_B = 5$ min | $E_B = 0.95$ | $R_B = 0.90$



$$I_B = \frac{3000}{1-d_B} = \frac{3{,}000}{0.95} = 3{,}157.895 \Rightarrow \boxed{I_B = 3{,}158}$$

$$I_A = \frac{3{,}158}{1-d_A} = \frac{3{,}158}{0.98} = 3{,}222.45 \Rightarrow \boxed{I_A = 3\,223}$$

$$H_A = \frac{5\ \text{day}}{\text{week}} \times \frac{18\ \text{hr}}{\text{day}} \times 60\ \frac{\text{min}}{\text{hr}} - \boxed{\left(\frac{3{,}158}{500}\right) \times 30} =$$

(# of PM; time for PM)

$$= 5{,}400 - 189.48$$

$$\boxed{H_B = 5{,}210.52}\ \text{min/week}$$

$H_A = 5{,}400 - 193.38 = 5{,}206.62$

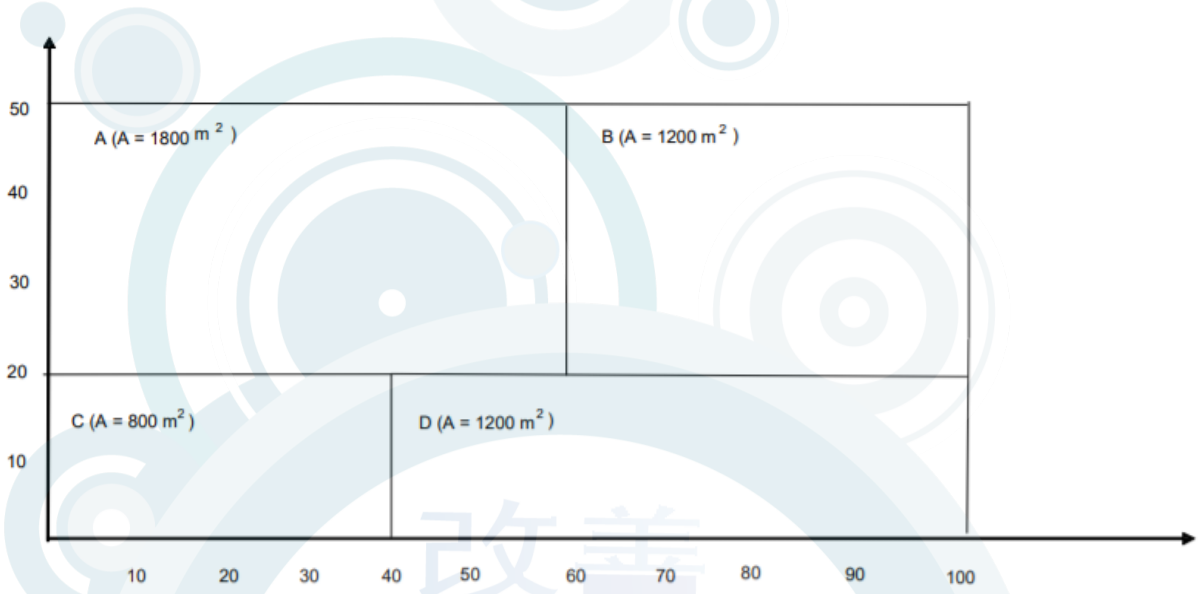
$$F_A = \frac{S_A Q_A}{E_A H R_A} = \frac{3\ (3{,}223)}{0.95\ (5{,}206.62)\ (0.95)} = \underline{2.058}$$

$$F_B = \frac{S_B Q_B}{E_B H R_B} = \frac{5\ (3{,}158)}{0.95 \times 5{,}210.52 \times 0.9} = 3.5443$$

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Example:

A local manufacturing firm has recently completed construction of a new wing of an existing building to house four departments: A, B, C and D. The wing is 100 m by 50 m. The initial layout and flow matrix is given in below. **Assume unit cost matrix**. Using CRAFT algorithm do one iteration to obtain an improved layout.



Material Flow	A	B	C	D
A	0	2	7	4
B	3	0	5	5
C	6	7	0	3
D	8	2	3	0

Step 1: Determine department centroids.

Dept	centroid
A	(30,35)
B	(80,35)
C	(20,10)
D	(70,10)

Step 2: Calculate rectilinear distance between centroids.

	A	B	C	D
A	-----	50	35	65
B	50	-----	85	35
C	35	85	----	50
D	65	35	50	-----

Step 3: Calculate transportation cost for the layout.

Material Flow	A	B	C	D
A	0	2	7	4
B	3	0	5	5
C	6	7	0	3
D	8	2	3	0

Transportation cost matrix

	A	B	C	D
A	-----	100	245	260
B	150	-----	425	175
C	210	595	----	150
D	520	70	150	-----

Total cost of the initial layout (Distance based cost for the initial layout) is = $3,050

Step 4:

Possible exchange:
1. equal area departments

2. departments sharing a common border.

Possible Exchange	Comments
A-B	sharing a common border
A-C	sharing a common border
A-D	sharing a common border
B-C	No exchange
B-D	sharing a common border and same area
C-D	sharing a common border

Step 5:

Exchange #1: (A and B)

Dept	centroid
B	(30,35)
A	(80,35)
C	(20,10)
D	(70,10)

Distance matrix after Exchanging A and B

	A	B	C	D
A	-----	50	85	35
B	50	-----	35	65
C	85	35	----	50
D	35	65	50	-----

Material Flow	A	B	C	D
A	0	2	7	4
B	3	0	5	5
C	6	7	0	3
D	8	2	3	0

Predicted transportation cost matrix after Exchanging A and B

	A	B	C	D
A	-----	100	595	140
B	150	-----	175	325
C	510	245	----	150
D	280	130	150	-----

The predicted Transportation cost after exchanger dept A-B= $ 2,950

Exchange #1: (A and C)

Dept	centroid
C	(30,35)
B	(80,35)
A	(20,10)
D	(70,10)

Distance matrix after Exchanging A and C

	A	B	C	D
A	-----	85	35	50
B	85	-----	50	35
C	35	50	----	65
D	50	35	65	-----

Material Flow	A	B	C	D
A	0	2	7	4
B	3	0	5	5
C	6	7	0	3
D	8	2	3	0

Predicted transportation cost matrix after Exchanging A and B

	A	B	C	D
A	-----	170	245	200
B	255	-----	250	175
C	210	350	----	195
D	400	70	195	-----

The cost after exchanger dept A-C= $ 2,715

Possible exchange	Predicated (estimated) total cost	Reduction in transportation cost = Initial cost – predicted cost of the layout after exchange
A-B	2,950	100
A-C	2,715	335
A-D	**3,185**	**-135**
B-C	No exchange	No exchange
B-D	**2,735**	**315**
C-D	**2,830**	**220**

We choose to exchange A-C because it has the highest reduction in transportation cost.

C : (20,40)

A, A1(20,15)

A2(50,35)

	Area	x	y	Ax	Ay
A1	40*30=1,200	20	15	24,000	18,000
A2	20*30=600	50	35	30,000	21,000
total	1,800	70	50	54,000	39,000

$x_c = \frac{A_x}{A} = \frac{54,000}{1,800} = 30$

$y_c = \frac{A_y}{A} = \frac{39,000}{1,800} = 21.67$

Actual center for A after exchanging A and C is (30,21.67)

Dept	centroid
A	(30,21.67)
B	(80,35)
C	(20,40)
D	(70,10)

Actual Distance matrix after Exchanging A and C

Dept	A	B	C	D
A	-------	63.333	28.33	51.67
B	63.333	-------	65	35
C	28.333	65	-------	80
D	51.667	35	80	-------

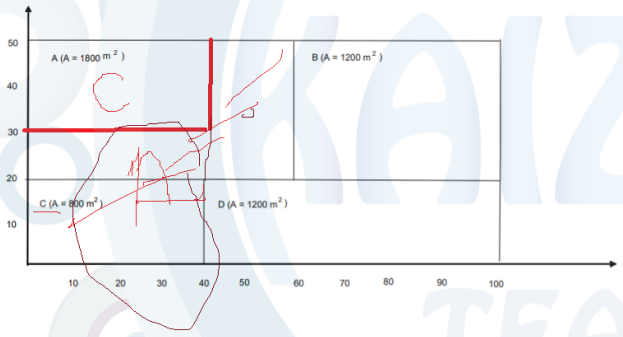
Material Flow	A	B	C	D
A	0	2	7	4
B	3	0	5	5
C	6	7	0	3
D	8	2	3	0

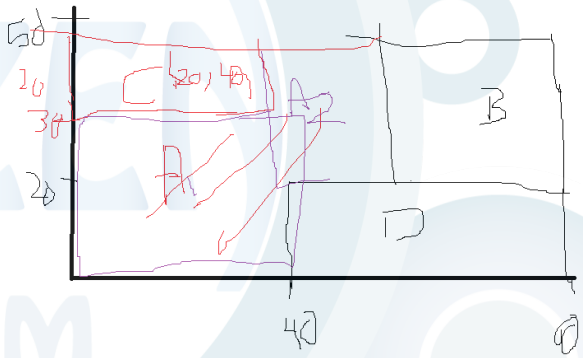
Actual cost matrix after exchanger dept A-C

Dept	A	B	C	D
A	-------	126.67	198.31	206.68
B	189.9	-------	325	175
C	169.99	455	-------	240
D	413.33	70	240	-------

Actual transportation cost after Exchanging A and C is 2809.9,

Total costs of 2809.9, we do not achieve the estimated cost (2,715), but compared to the initial layout (3,050) we have cost reduction.
This layout (after exchanging A and C) will be considered as an initial for the second iteration.





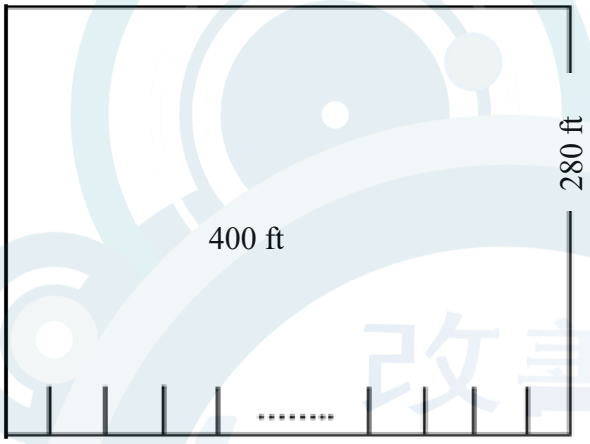
1. Determine department centroids.
2. Calculate rectilinear distance between centroids.
3. Calculate transportation cost for the layout.
4. Consider department exchanges of either **equal area departments** or **departments sharing a common border**.
5. Determine the estimated change in transportation cost of each possible exchange.
6. Select and implement the departmental exchange that offers the greatest reduction in transportation cost.
7. Repeat the procedure for the new layout until no interchange is able to reduce the transportation cost.

改善 KAIZEN TEAM

Online lecture: April 27th/2026

Problem:

A parking lot is to be 400 feet wide and 280 feet deep. The manager wants exactly one module for compact cars and the remaining area for standard cars. How many compact and standard-sized cars fit in this lot? Use W4 Module, where the parking is angular with angle of 70, assume a stall depth of 16 feet. Determine the best parking layout using stall width for standard car, SW=9'0". Managers want exactly 8 stalls for handicapped and all are in the first row of the first module with standard cars.



a) Number of Modules for standard and compact cars in the parking Lot?

b) What is the parking width of the parking lot?

c) What is the distance lost due to parking at an angle?

d) Determine the number of stalls available in each row.

Problem 2:
If three nurses and three part-time physicians are to be employed in a health services area, how much space should be allowed in the facilities plan?

Parking Dimensions for Each Car Group as a Function of Single and Double Loaded Module Options

			θ ANGLE OF PARK									
	SW	W	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Group I: small cars	8′0″	1	25′9′	26′6″	27′2″	29′4″	31′9″	34′0″	36′2″	38′2″	40′0″	41′9″
		2	40′10″	42′0″	43′1″	45′8″	48′2″	50′6″	52′7″	54′4″	55′11″	57′2″
		3	38′9″	40′2″	41′5″	44′2″	47′0″	49′6″	51′10″	53′10″	55′8″	57′2″
		4	36′8″	38′3″	39′9″	42′9″	45′9″	48′6″	51′1″	53′4″	55′5″	57′2
Group II: standard cars	8′6″	1	32′0″	32′11″	34′2″	36′2″	38′5″	41′0″	43′6″	45′6″	46′11″	48′0″
		2	49′10″	51′9″	53′10″	56′0″	58′4″	60′2″	62′0″	63′6″	64′9″	66′0″
		3	47′8″	49′4″	51′6″	54′0″	56′6″	59′0″	61′2″	63′0″	64′6″	66′0″
		4	45′3″	46′10′	49′0″	51′8″	54′6″	57′10″	60′0″	62′6″	64′3″	66′0″
	9′0″	1	32′0″	32′9″	34′0″	35′4″	37′6″	39′8″	42′0″	44′4″	46′2″	48′0″
		2	49′4″	51′0″	53′2″	55′6″	57′10″	60′0″	61′10″	63′4″	64′9″	66′0″
		3	46′4″	48′10″	51′4″	53′10″	56′0″	58′8″	61′0″	63′0″	64′6″	66′0″
		4	44′8″	46′6″	49′0″	51′6″	54′0″	57′0″	59′8″	62′0″	64′2″	66′0″
	9′6″	1	32′0″	32′8″	34′0″	35′0″	36′10″	38′10″	41′6″	43′8″	46′0″	48′0″
		2	49′2″	50′6″	51′10″	53′6″	55′4″	58′0″	60′6″	62′8″	64′6″	65′11″
		3	47′0″	48′2″	49′10″	51′6″	53′11″	57′0″	59′8″	62′0″	64′3″	65′11″
		4	44′8″	45′10″	47′6″	49′10″	52′6″	55′9″	58′9″	61′6″	63′10″	65′11″
Group III: large cars	9′0″	1	32′7″	33′0″	34′0″	35′11″	38′3″	40′11″	43′6″	45′5″	46′9″	48′0″
		2	50′2″	51′2″	53′3″	55′4″	58′0″	60′4″	62′9″	64′3″	65′5″	66′0″
		3	47′9″	49′1″	52′3″	53′8″	56′2″	59′2″	61′11″	63′9″	65′2″	66′0″
		4	45′5″	46′11″	49′0″	51′8″	54′9″	58′0″	61′0″	63′2″	64′10″	66′0″
	9′6″	1	32′4″	32′8″	33′10″	34′11″	37′2″	39′11″	42′5″	45′0″	46′6″	48′0″
		2	49′11″	50′11″	52′2″	54′0″	56′6″	59′3″	61′9″	63′4″	64′8″	66′0″
		3	47′7″	48′9″	50′2″	52′4″	55′1″	58′4″	60′11″	62′10″	64′6″	66′0″
		4	45′3″	46′8″	48′5″	50′8″	53′8″	57′0″	59′10″	52′2″	64′1″	66′0″
	10′0″	1	32′4″	32′8″	33′10″	34′11″	37′2″	39′11″	42′5″	45′0″	46′6″	48′0″
		2	49′11″	50′11″	52′2″	54′0″	56′6″	59′3″	61′9″	63′4″	64′8″	66′0″
		3	57′7″	48′9″	50′2″	52′4″	55′1″	58′4″	60′11″	62′11″	64′6″	66′0″
		4	45′3″	46′8″	48′5″	50′8″	53′8″	57′0″	59′10″	62′2″	64′1″	66′0″

Source: Ramsey et al. [8]