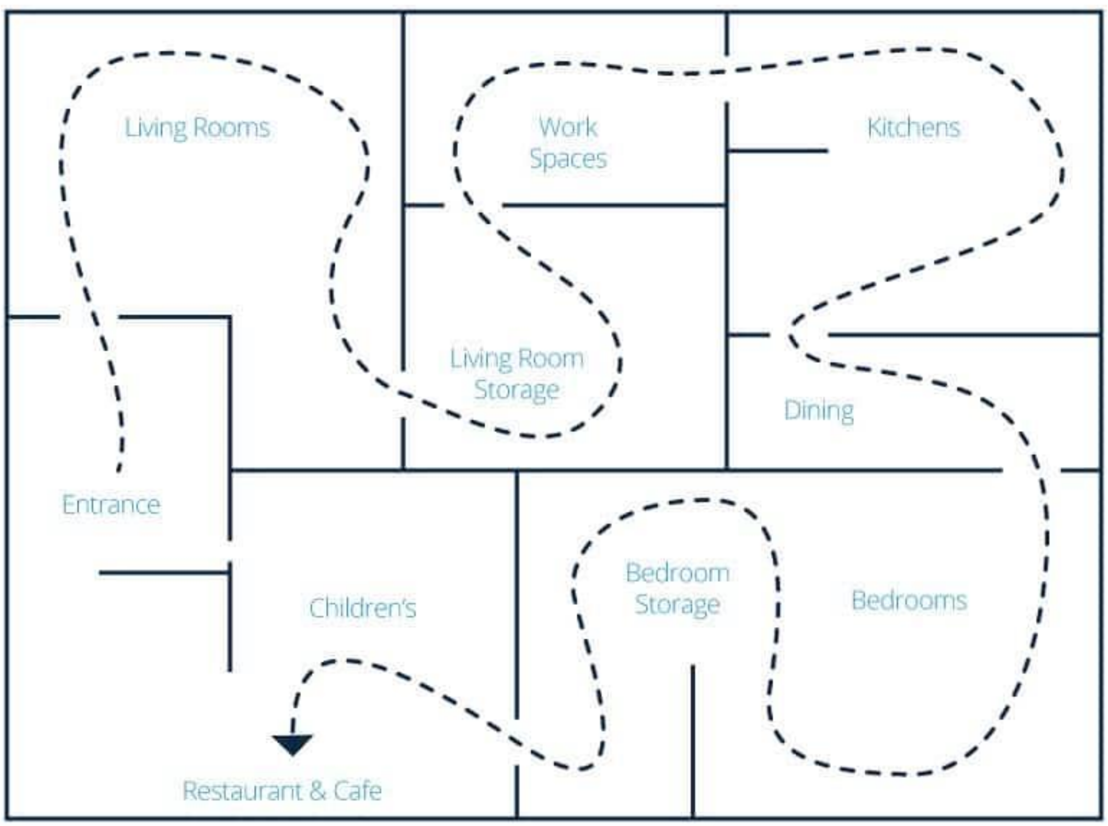
DR. ALVIN'S PUBLICATIONS

HOW TO DESIGN A PROCESS ORIENTED FACTORY LAYOUT

DR. ALVIN ANG

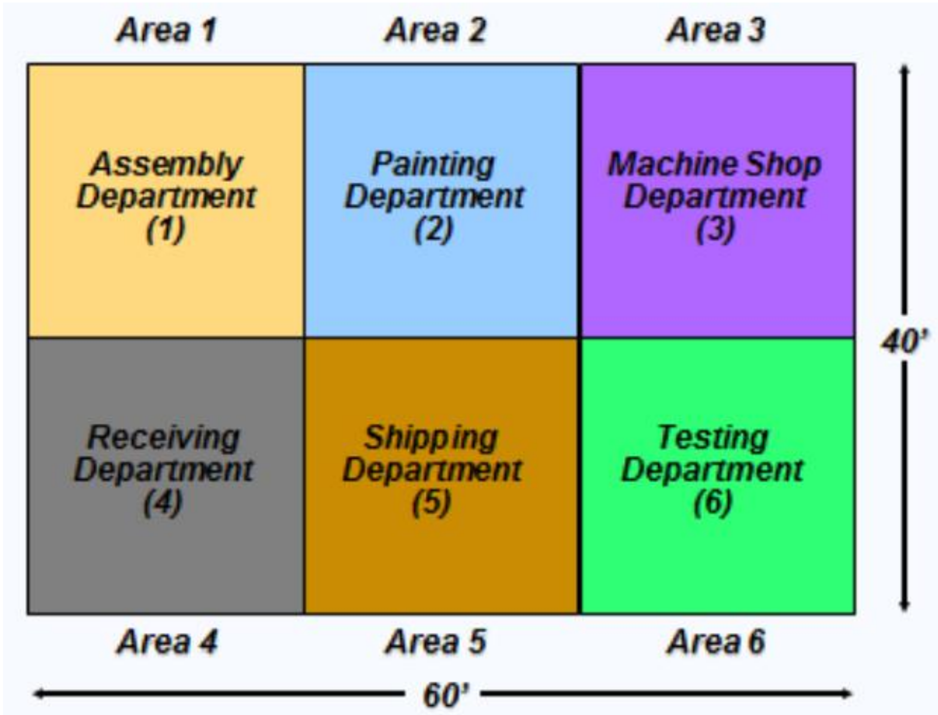


CONTENTS

INTRODUCTION

This manuscript is an excerpt of concepts taken from Operations Management Textbook by Heizer, Render et al. (2017).

EXAMPLE 1

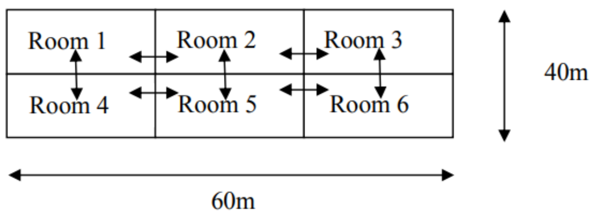


- A company has six departments, which can be placed into any of six available rooms.
- The departments are named A, B, C, D, E, and F and the rooms are numbered 1, 2, 3, 4, 5, and 6.
- Assumption → No Diagonal Movement.
- The current set of assignments is
  - A-1
  - B-2
  - C-3
  - D-4

- E-5
- F-6

- Assume that each room is 20 X 20 meters, and the movement from one room to the adjacent room is 20 meters.

Dept A-Room 1	Dept B-Room 2	Dept C-Room 3
Dept D-Room 4	Dept E-Room 5	Dept F-Room 6



- The following table shows the matrix of work flow (estimated trips per day) among departments:

	A	B	C	D	E	F
A	--	50	0	0	100	0
B		--	0	20	30	0
C			--	0	10	20
D				--	30	0
E					--	40
F						--

QUESTION

How can we re-assign the departments within the rooms? (to minimize walking)?

STEP 1: CREATE THE ROOM DISTANCE MATRIX

Room	1	2	3	4	5	6
1	-	20	40	20	40	60
2		-	20	40	20	40
3			-	60	40	20
4				-	20	40
5					-	20
6						-

STEP 2: CREATE THE WORK FLOW MATRIX

Room	A	B	C	D	E	F
A	-	50	0	0	100	0
B		-	0	20	30	0
C			-	0	10	20
D				-	30	0
E					-	40
F						-

STEP 3: CALCULATE THE CURRENT TOTAL DISTANCE TRAVELLED

$$\text{Total Distance} = \sum(\text{Work Flow} \times \text{Room Distance})$$

$$\begin{aligned}
&= (50 \times 20) \\
&+ (20 \times 40) \\
&+ (100 \times 40) \\
&+ (30 \times 20) \\
&+ (10 \times 40) \\
&+ (30 \times 20) \\
&+ (20 \times 20) \\
&+ (40 \times 20)
\end{aligned}$$

$$= 8,600m$$

STEP 4: USE DR. ALVIN'S METHOD TO FIND ONE IMPROVED ASSIGNMENT

- Highest Workflow → A – E = 100
- 2nd Highest → A – B = 50
- 3rd Highest → E – F = 40
- 4th Highest → B – E or D – E = 30
- 5th Highest → B – D = 20
- 6th Highest → C – E = 10
- Therefore:
    - "A" must be next to "B" and "E"

- "E" must be next to "B" and "D" (or "F")

- The rest are of lesser priority, so you can put them randomly.

STEP 5: DRAW THE NEW IMPROVED LAYOUT

Room 1	Room 2	Room 3
A	E	F
Room 4	**Room 5**	**Room 6**
B	D	C

STEP 6: CALCULATE THE NEW TOTAL DISTANCE TRAVELLED

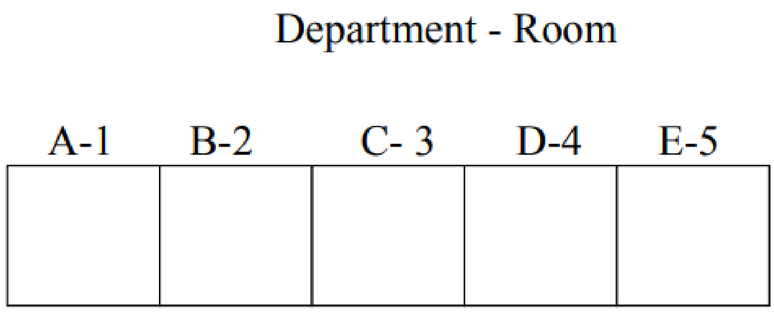
Room	A	E	F	B	D	C
A	-	100	0	50	0	0
E		-	40	30	30	10
F			-	0	0	20
B				-	20	0
D					-	0
C						-

Room	1	2	3	4	5	6
1	-	20	40	20	40	60
2		-	20	40	20	40
3			-	60	40	20
4				-	20	40
5					-	20
6						-

$$\text{Total Distance} = \sum(\text{Work Flow} \times \text{Room Distance})$$

$$\begin{aligned} &= (100 \times 20) \\ &+ (40 \times 20) \\ &+ (50 \times 20) \\ &+ (30 \times 40) \\ &+ (30 \times 20) \\ &+ (20 \times 20) \\ &+ (10 \times 40) \\ &+ (20 \times 20) \end{aligned}$$

$$= 6{,}800m$$



- A company has five departments, which can be placed into any of five available rooms.
- The departments are named A, B, C, D, and E.
- The rooms are numbered 1, 2, 3, 4 and 5.
- The current set of assignments is
    - A-1
    - B-2
    - C-3
    - D-4
    - E-5
- Assumption → No Diagonal Movement.
- The rooms are fixed, while the departments may shift to any of the rooms.
- Assume that each room is 10 X 10 meters, and the movement from one room to the adjacent room is 10 meters.

- The following table shows the matrix of work flow (estimated trips per day) among departments:

	A	B	C	D	E
A	--	20	10	50	0
B		--	10	0	0
C			--	0	10
D				--	20
E					--

QUESTION

How can we re-assign the departments within the rooms? (to minimize walking)?

STEP 1: CREATE THE ROOM DISTANCE MATRIX

Room	1	2	3	4	5
1	-	10	20	30	40
2		-	10	20	30
3			-	10	20
4				-	10
5					-

STEP 2: CREATE THE WORK FLOW MATRIX

	A	B	C	D	E
A	--	20	10	50	0
B		--	10	0	0
C			--	0	10
D				--	20
E					--

STEP 3: CALCULATE THE CURRENT TOTAL DISTANCE TRAVELLED

$$\text{Total Distance} = \sum(\text{Work Flow} \times \text{Room Distance})$$

$$\begin{aligned} &= (20 \times 10) \\ &+ (10 \times 20) \\ &+ (10 \times 10) \\ &+ (50 \times 30) \\ &+ (10 \times 20) \\ &+ (20 \times 10) \end{aligned}$$

$$= 2,400m$$

STEP 4: USE DR. ALVIN'S METHOD TO FIND ONE IMPROVED ASSIGNMENT

- Highest Workflow → A – D = 50
- 2nd Highest → A – B or D – E = 20
- 3rd Highest → A – C or B – C or C – E = 10
- Therefore:
  - "A" must be next to "D" and "B"
  - The rest are of lesser priority, so you can put them randomly.

STEP 5: DRAW THE NEW IMPROVED LAYOUT

Room 1	Room 2	Room 3	Room 4	Room 5
C	B	A	D	E

STEP 6: CALCULATE THE NEW TOTAL DISTANCE TRAVELLED

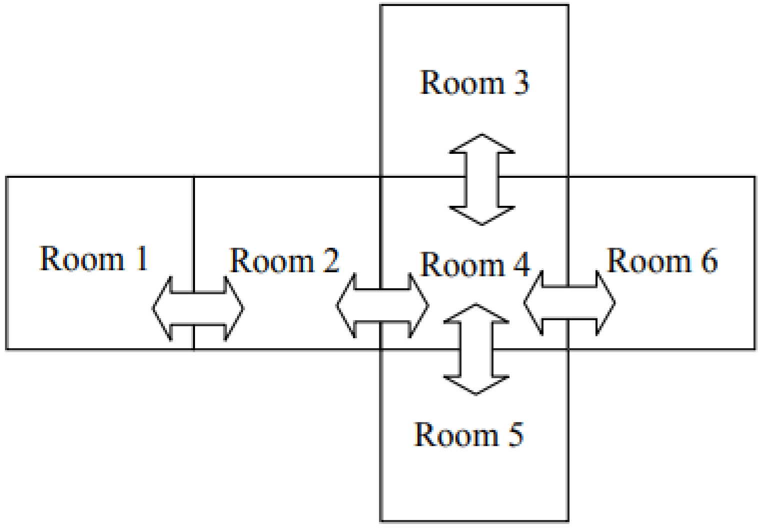
Department	C	B	A	D	E
C	-	10	10	0	10
B		-	20	0	0
A			-	50	0
D				-	20
E					-

$$\text{Total Distance} = \sum(\text{Work Flow} \times \text{Room Distance})$$

$$\begin{aligned} &= (10 \times 10) \\ &+ (10 \times 20) \\ &+ (20 \times 10) \\ &+ (50 \times 10) \\ &+ (10 \times 40) \\ &+ (20 \times 10) \end{aligned}$$

$$= 1,600m$$

EXAMPLE 3



- A company has six departments, which can be placed into any of six available rooms.
- The departments are named A, B, C, D, E and F and the rooms are numbered 1, 2, 3, 4, 5 and 6.
- The current set of assignments is
  - A-1
  - B-2
  - C-3
  - D-4
  - E-5
  - F-6
- The rooms are fixed, while the departments may shift to any of the rooms.
- Assume that each room is 10 X 10 meters, and the movement from one room to the adjacent room is 10 meters.

- Only horizontal or vertical movements are allowed, as indicated by the arrows in the diagram.
- The following table shows the matrix of work flow (estimated trips per day) among departments:

Department	A	B	C	D	E	F
A	--	50	0	0	50	90
B		--	30	20	0	20
C			--	40	0	20
D				--	20	0
E					--	40
F						--

QUESTION

How can we re-assign the departments within the rooms? (to minimize walking)?

STEP 1: CREATE THE ROOM DISTANCE MATRIX

Room	1	2	3	4	5	6
1	-	10	30	30	30	30
2		-	20	10	20	20
3			-	10	20	20
4				-	10	10
5					-	20
6						-

STEP 2: CREATE THE WORK FLOW MATRIX

Department	A	B	C	D	E	F
A	--	50	0	0	50	90
B		--	30	20	0	20
C			--	40	0	20
D				--	20	0
E					--	40
F						--

STEP 3: CALCULATE THE CURRENT TOTAL DISTANCE TRAVELLED

$$\text{Total Distance} = \sum(\text{Work Flow} \times \text{Room Distance})$$

$$\begin{aligned} &= (50 \times 10) \\ &+ (30 \times 20) \\ &+ (20 \times 10) \\ &+ (40 \times 10) \\ &+ (50 \times 30) \\ &+ (20 \times 10) \\ &+ (90 \times 30) \\ &+ (20 \times 20) \\ &+ (20 \times 20) \\ &+ (40 \times 20) \end{aligned}$$

$$= 7,700m$$

STEP 4: USE DR. ALVIN'S METHOD TO FIND ONE IMPROVED ASSIGNMENT

- Highest Workflow → A – F = 90
- 2nd Highest → A – B or A – E = 50
- 3rd Highest → C – D or E – F = 40
- 4th Highest → B – C = 30
- 5th Highest → B – D or D – E or B – F or C – F = 20
- Therefore:
    - "A" must be next to "F" and "E" (or "B")

- "E" must be next to "F" OR "C" must be next to "D"
- The rest are of lesser priority, so you can put them randomly.

STEP 5: DRAW THE NEW IMPROVED LAYOUT

		Room 3 **C**	
Room 1 **F**	**Room 2** **A**	**Room 4** **B**	**Room 6** **E**
		Room 5 **D**	

STEP 6: CALCULATE THE NEW TOTAL DISTANCE TRAVELLED

NEW Workflow Table

	F	A	C	B	D	E
F	--	90	20	20	0	40
A		--	0	50	0	50
C			--	30	40	0
B				--	20	0
D					--	20
E						--

Distance Table

	1	2	3	4	5	6
1	--	10	30	30	30	30
2		--	20	10	20	20
3			--	10	20	20
4				--	10	10
5					--	20
6						--

New Total Distance Travelled =

(90 x 10)

+ (20 x 30)

+ (20 x 30)

+ (50 x 10)

+ (30 x 10)

+ (40 x 20)

+ (20 x 10)

+ (40 x 30)

+ (50 x 20)

+ (20 x 20)

= 6,500 m

REFERENCES

Heizer, J. H., et al. (2017). Operations management : sustainability and supply chain management.

ABOUT THE AUTHOR

Dr. Alvin Ang earned his Ph.D., Masters and Bachelor degrees from NTU, Singapore. He is a scientist, entrepreneur, as well as a personal/business advisor. More about him at www.AlvinAng.sg.