TEST Engineering & Management

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An Improved Heuristic Approach towards Plant Layout Optimization

[1]Prof. Sachin S. Pund, [2]Dr. D. R. Zanwar

[1]Assistant Professor, Department of Industrial Engineering. Shri Ramdeobaba College of Engineering and Management,Nagpur.

[2]Associate Professor, Department of Industrial Engineering. Shri Ramdeobaba College of Engineering and Management,Nagpur.

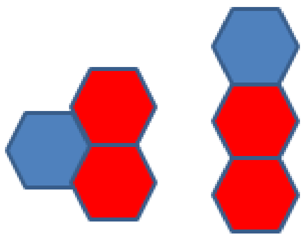
Article Info
Volume 82
Page Number: 7785 - 7799
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 04 February 2020*

Abstract:

An improved heuristic approach is planned and experimented for plant layout optimization. One of the alternatives to find out optimum solution in the area of plant layout could be achieved by trying different shapes and arrangement in plant layout location. The various shapes and sizes and its analysis is discussed in the paper. The idea of this alternative of placing departments in other than rectangular shapes are experimented and analyzed. It is not discussed in such logic before. It is novel idea which is being incorporated and set up a new scope for the researchers to look for this dimension of incorporation in optimization of plant layout. Traditional approach of plant layout optimization considers rectangular shapes. In this paper the emphasis is given to hexagonal shape instead of rectangular. Heuristic approach is experimented Honeycomb way. We know that a Hexagon has six sides and it can accommodate six departments near it.

1. Introduction: To achieve maximum closeness rating the various orientation of hexagonal shape are discussed. The data is taken from the case study and incorporated accordingly. Let us assume that we have one hexagon of area 50 sq mt, then clearly 2 hexagons will give area 100 sq-mt this arrangement has highest TCR rating with the maximum TCR department and also can accommodate more number of departments with the highest TCR department. There are only 2 cases possible in this discussion. In Case 1 there are 2 sides occupies and by plotting the graph we got the value of CD as 2 and this is even less than obtained from the accepted arrangement.



In Case 2 one side is occupied and Centroid distance measured is 3.8, which is behind acceptable value. The following data is considered from the industry for experimenting and validating the result.

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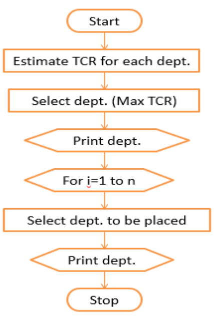
2. Data table:

Department Name	Size	No. of Hexagons
1. Furnace	100	2
2. Hot rolling	50	1
3. Shearing	50	1
4. Cold rolling	50	1
5. Circle machining	50	1
6. Annealing	50	1
7. Pressing	50	1
8. Lathe machine	250	5
9. Collar cutting m/c	50	1
10. Semi finished storage	200	4
11. Finishing	50	1
12. Chemical Finishing	100	2
13. Dispatch	100	2
14. Scrap	150	3
15. Raw Material	100	2

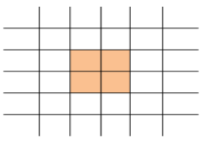
3.0 Algorithm Logic for designing New Facility

Step 1 - Estimate the TCR for each department.

Step 2 - Select department with maximum TCR. Place the selected in the centre for department [i=1 to n] Select an department to be placed, place the selected in the layout end for.



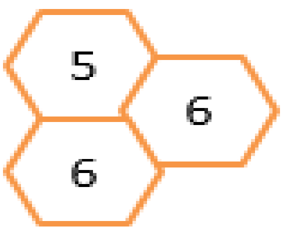

```
Estimate TCR for each dept.
temp=0;
For (i=0, i<n, i++)
{
For(j=0, j<n, j++)
{
temp = temp + a[i][j];
}
temp 1 = temp
}
```



Step 3 – Selection rules Choose the next activity having largest number of A, E,I,O,U,X, etc] relationships with the department already in the layout. Supplement above procedure with TCR for choosing first department and breaking ties.

Step 4 – Placement rules

Contiguity Rule: If an activity is represented by more than one unit area hexagon, every unit area hexagon must share at least one edge with at least one unit area representing the activity.



Example: D5:- 1 Hexagon D6:- 2 Hexagon

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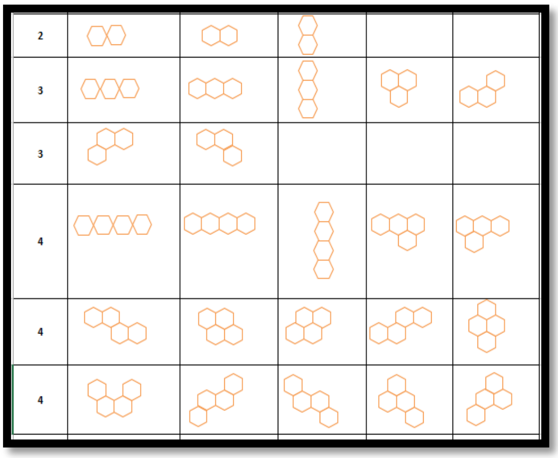
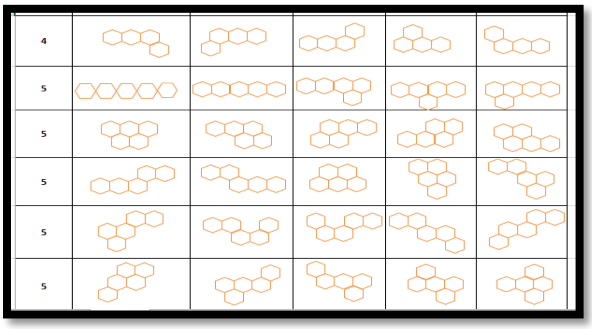
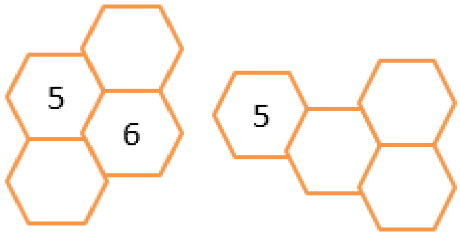
3.1 Placement Combinations alternatives:





Connectedness Rule: The perimeter of an department must be a closed loop that is always in contact with some edge of some unit area hexagon representing the activity.



Open loop Closed loop

Determining possible shapes becomes non trivial for department more than 5 unit hexagon and some shapes bizarre configuration. Therefore additional rules are used.

Enclosed Void Rule: No department contains an enclosed void.

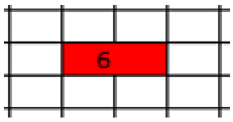
4. Placement Sequence of the departments with Honeycomb shape and its comparison:

The logic of CORELAP is used and experimented to find out placement location with both the shapes and it is shown as below:

EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE - 6

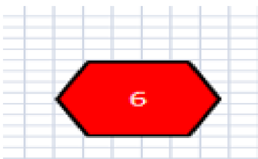


Department 6 has the maximum TCR value hence it is placed in the middle of the the area so that it is able to arrange maximum departments near it .

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE - 6



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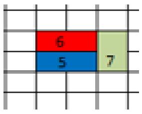
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE = 6-5-7



- D7 has max. CR with D5 & D6
- CR → A(6) + E(5) = 9
- Centroid Distance → (7,6)= 4.81 m
  (7,5)= 3.30 m
- D6 (max TCR) has only 2 sides left (adjacency) problem.

PROPOSED:-

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1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

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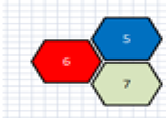

- D7 has max. CR with D5 & D6.
- CR →A(6) + E(5) → 9
- Centroid Distance →(7,6)= 3.55 m
  (7,5)= 3.7 m
- D6 can still accommodate 4 more D.

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2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
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5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
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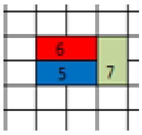
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE = 6-5-7



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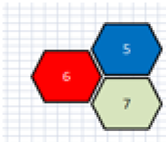
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE = 6-5-7



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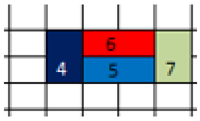
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4

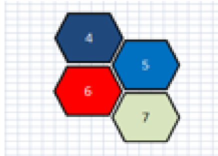


- D4 has highest score with D5,6 &7.
- CR→ A(6) + E(5) → 9
- Centroid Distance → (4,5)→ 3.24 m
  (4,6)→ 3.16 m
  (4,7)→ 5.3 m

PROPOSED:-

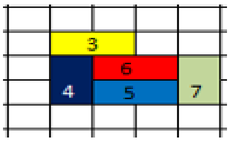
SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4



- D4 has highest score with D5,6 &7.
- CR→ A(6) + E(5) → 9
- Centroid Distance → (4,5)→ 3.49 m
  (4,6)→ 3.6 m
  (4,7)→ 6.26 m

PLACEMENT SEQUENCE : 6-5-7-4-3



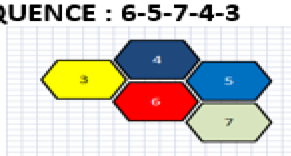
EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

- D3 now has max. CR with D4 & D6.
- CR → A(4) + A(6) = 10
- Centroid Distance →(3,4) = 5.33 m
  (3,6) = 4.03 m
  (3,5) = 7.4 m
- Cumulative CR = 33

PROPOSED:-

PLACEMENT SEQUENCE : 6-5-7-4-3



SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

- D3 now has max. CR with D4 & D6.
- CR → A(4) + A(6) = 10
- Centroid Distance →(3,4) = 3.49 m
  (3,6) = 3.49 m
  (3,5) = 6 m
- Cumulative CR = 33

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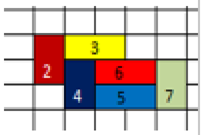
EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE -> 6-5-7-4-3-2



- D2 now has max. CR with D3 & D4.
- CR → A(4) + E(3) = 9
- Centroid Distance →(2,3) = 2.94 m
  (2,4) = 4.02 m
  (2,5) = 7.05 m
  (2,6) = 4.75 m
  (2,7) = 8 m
- Cumulative CR = 42

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

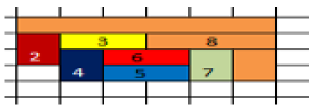
PLACEMENT SEQUENCE -> 6-5-7-4-3-2

- D2 now has max. CR with D3 & D4.
- CR → A(4) + E(3) = 9
- Centroid Distance →(2,3) = 3.6 m
  (2,4) = 3.49 m , (2,5) = 6.99 m
  (2,6) = 6.17 m , (2,7) = 8 m
- Cumulative CR = 42

EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4-3-2-8

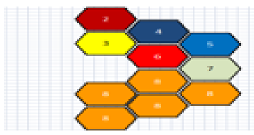


- D8 now has max. CR with D7 & D3.
- CR → A(7) + I(3) = 8
- Centroid Distance →(7,8) = 6.35 m
  (3,8) = 2.33 m
- Cumulative CR = 50

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4-3-2-8



- D8 now has max. CR with D7 & D3.
- CR → A(7) + I(3) = 8
- Centroid Distance →(7,8) = 5.62 m
  (3,8) = 8.47 m
- Cumulative CR = 50

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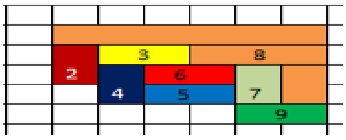
EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4-3-2-8-9



- D9 has A relation with D8 , E with D6 , I with 7 and O with 2 .
- CR → I(7) + A(8) = 8
- Centroid Distance → (9,8) = 11.81 m
  (9,6) = 8.18 m , (9,5) = 5.16 m
  (9,7) = 5.49 m
- Cumulative CR = 58

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

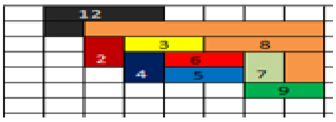
PLACEMENT SEQUENCE – 6-5-7-4-3-2-8-9

- D9 could be placed with D6 in this case improving the TCR rating .
- CR → E(6) + A(8) = 9
- Centroid Distance
  →(9,8) = 5.06 m
  (9,6) = 3.55 m
  (9,5) = 7.04 m , (9,7) =6
- Cumulative CR = 59

EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4-3-2-8-9-12



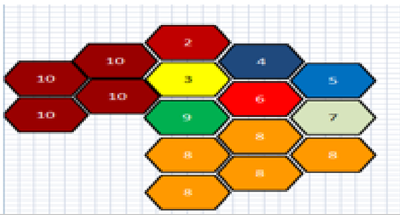
- D 12 now has max. CR with D8 & D2.
- CR → E(2) + E(8) = 8
  (It has A relation with 11 but cannot be placed with it as it is not placed)
- Cumulative CR = 64

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-10

- D 10 gave more CR in this new arrangement .
- CR → A(9) + I (3) = 8
- Cumulative CR = 65



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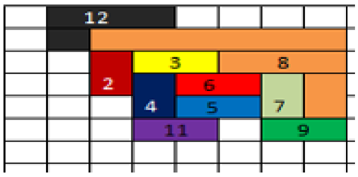
EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE – 6-5-7-4-3-2-8-9-10 -12-11



- D11 had A rating with D12 but still it could not be placed with it which was required . It gave max. CR with 4 & 5.
- CR → E(4) + I(5) = 7
- Cumulative CR = 71

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

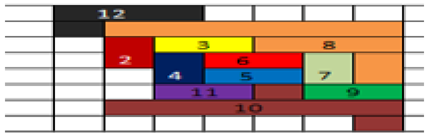
PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-10-1

- D1 is placed with D2 & D10.
- CR→ A(2)+I(10)= 8
- Cumulative CR=73

EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE —6-5-7-4-3-2-8-9-12-11-10



- CR→ A(9) + A(11) =10
- Cumulative CR = 81

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-10-1-11

- CR → A(10) + E(9) = 9
- ***In Corelap method 11 was arranged with D4 & D5 with CR =7 .***
- Cumulative CR→ 82

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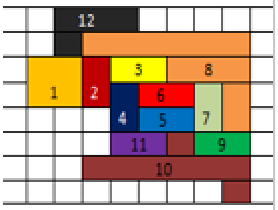
EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-12-11-10-1



- CR→ A(2)=5
- Cumulative CR = 86
- ***In Honeycomb D1 was placed D2 & D10 with CR=7***

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

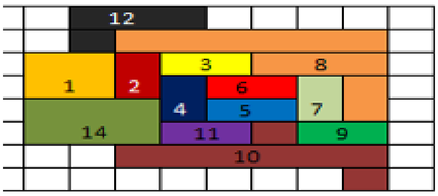
PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-10-1-11-12

- CR→ A(11) + E(8) = 9
- Cumulative CR = 91
- ***In Corelap D12 was placed with D8 & D2 with CR =8***

EXISTING:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-12-11-10-1-14



- D14 is placed with D10 & 1
- CR→ I(1) + I(10) = 6
- Cumulative CR = 92

PROPOSED:-

SR NO	DEPARTMENT	DEPARTMENT RELATIONSHIP															SUMMARY					TCR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-10-1-11-12-14

- D14 is placed with D5 & 1
- CR→ I(1) + E(5) = 7
- Cumulative CR = 98

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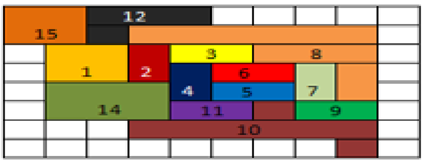
EXISTING:-

SR NO	DEPARTMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	TCR
		DEPARTMENT RELATIONSHIP															SUMMARY					
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-12-11-10-1-14-15



- D15 is placed with D12 & 1
- CR→ E(1) = 4
- Cumulative CR = 96

PROPOSED:-

SR NO	DEPARTMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	TCR
		DEPARTMENT RELATIONSHIP															SUMMARY					
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

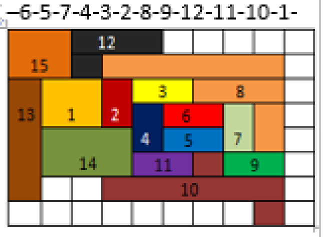
PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-10-1-11-12-14-15

- D15 is placed with D14 & 1
- CR→ E(1)+O(14)= 6
- Cumulative CR = 104

EXISTING:-

SR NO	DEPARTMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	TCR
		DEPARTMENT RELATIONSHIP															SUMMARY					
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-12-11-10-1-14-15-13



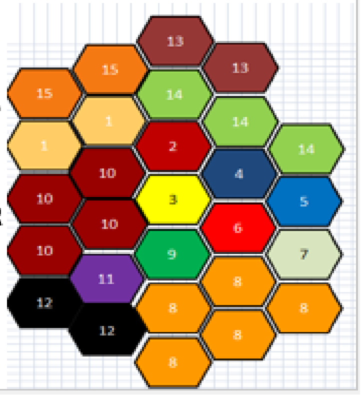
- D13 is placed with D14 & 1 &15
- CR→ E(15) + 0 (14) = 6
- Cumulative CR = 102

PROPOSED:-

SR NO	DEPARTMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A	E	I	O	U	TCR
		DEPARTMENT RELATIONSHIP															SUMMARY					
1	FURNACE	-	A	U	U	U	U	E	U	U	I	U	U	U	I	E	1	2	2	-	9	14
2	HOT ROLLING	A	-	A	E	I	O	U	U	O	U	U	E	U	U	U	2	2	1	2	7	18
3	SHEARING	U	A	-	A	O	A	U	I	U	I	O	U	I	U	U	3	-	3	2	6	20
4	COLD ROLL	U	E	A	-	A	E	I	U	U	U	E	U	U	U	U	2	3	1	-	8	18
5	CIRCLE M/C	U	I	O	A	-	A	E	U	I	U	I	U	O	E	U	2	2	3	2	5	22
6	ANNEALING	U	O	A	E	A	-	A	U	E	I	U	E	U	E	U	3	4	1	1	5	27
7	PRESSING	E	U	U	I	E	A	-	A	I	U	U	O	U	U	U	2	2	2	1	7	19
8	LATHE M/C	U	U	A	U	U	U	A	-	A	U	U	E	U	O	U	2	1	1	1	9	14
9	CUTTING M/C	U	O	U	U	I	E	I	A	-	A	E	U	U	U	U	2	2	2	1	7	19
10	SEMIFINISHED STORAGE	I	U	I	U	U	I	U	U	A	-	A	U	U	I	U	2	-	4	-	8	16
11	FINISHING	U	U	O	E	U	U	U	U	E	A	-	A	I	U	U	2	2	2	-	7	18
12	CHEMICAL FINISHING	U	E	U	U	I	E	O	E	U	U	A	-	O	U	U	1	3	-	2	8	15
13	DISPATCH	U	E	I	U	U	U	U	U	U	U	I	O	-	O	E	-	1	2	3	8	10
14	SCRAP	I	U	U	U	O	E	U	O	I	I	U	U	O	-	O	-	2	2	2	6	9
15	RAW MATERIAL	E	U	U	U	U	U	U	U	U	U	U	U	E	O	-	-	2	-	1	11	7

PLACEMENT SEQUENCE –6-5-7-4-3-2-8-9-12-11-10-1-14-15-13

- D13 is placed with D14 & D15
- CR→ E(15)+O(14) = 6
- Cumulative CR = 110



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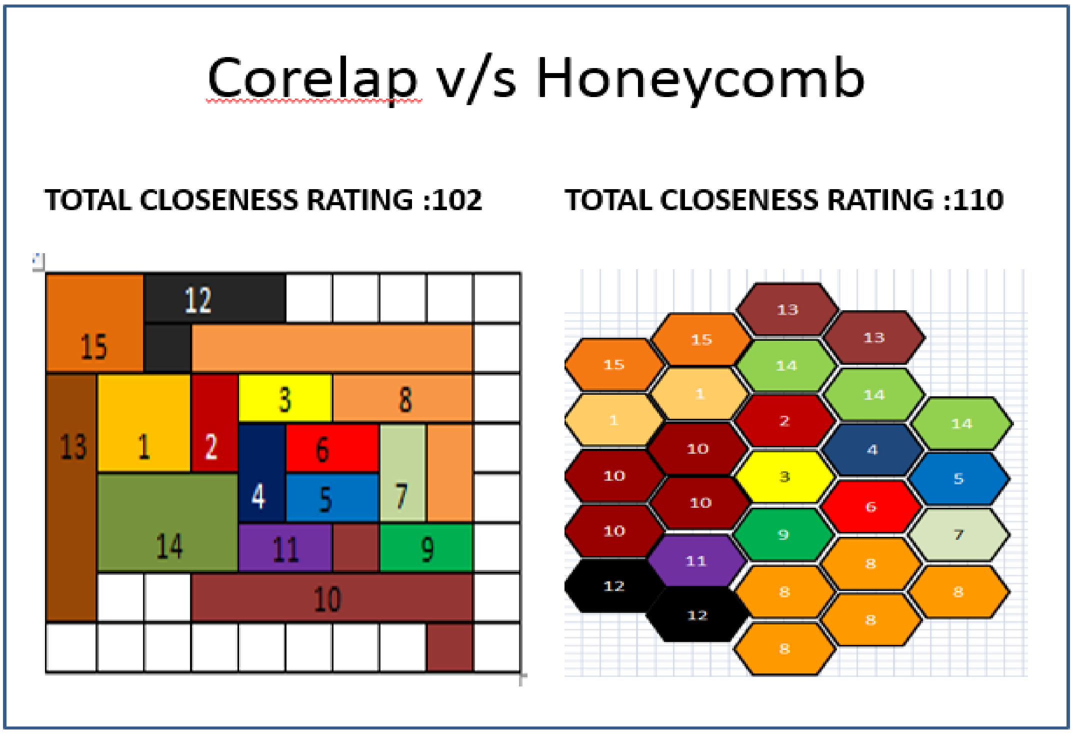
5. Corelap v/s Honeycomb and their values:



6.0. Previous and Present Relationship's chart and its Centroid distance achieved is shown below:

Previous Relationship Chart's Centroid Distance:-

						Previous Centroid Distance										
co ordinates	Depts	1	2	3	4	6	7	8	9	10	11	12	13	14	15	Total
10.2,5.5	1	-	2.6	-	-	-	10.47	-	-	13.29	-	-	-	7.35	6.91	40.62
10.3,8.1	2		-	4.97	4.02	5.99	-	-	12.18	-	-	7.6	-	-	-	39.51
8.6,10.5	3			-	5.32	7.09	-	2.67	-	13.04	10.79	-	9.15	-	-	52.08
13.9,9.9	4				-	1.95	5.26	-	-	-	8.33	-	-	-	-	18.67
15.71,2.6	5					3.6	3.11	-	5.16	-	4.11	-	9.9	6.46	-	32.34
12.1,12.5	6					-	3.3	-	7.49	9.4	-	10.5	-	8.15	-	38.84
14,15.2	7						-	6.36	5.49	-	-	13.5	-	-	-	25.35
8,13.1	8							-	11.81	-	-	7.49	-	-	-	19.3
19.4,16.2	9								-	4.25	5.4	-	-	-	-	9.65
21.5,12.5	10									-	2.7	-	-	7.29	-	9.99
19.4,10.8	11										-	16.96	9.74	-	-	26.7
2.7,7.8	12											-	12.04	-	-	12.04
13.7,2.9	13												-	5.17	10.24	15.41
17.5,6.4	14													-	14.24	14.24
3.5,3.8	15														-	
																354.74

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Present Relationship Chart's Centroid Distance

Present Relationship Chart																
Depts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1	-	4.59	-	-	-	-	13.3	-	-	5.3	-	-	-	7.56	3.8	34.55
2		-	3.6	3.5	7	6.17	-	-	7.3	-	-	12.6	-	-	-	40.17
3			-	3.49	6	3.5	-	8.47	-	4.86	6.17	-	10.12	-	-	42.61
4				-	3.49	3.6	6.26	-	-	-	9.37	-	-	-	-	22.72
5					-	3.5	3.7	-	7.04	-	10.5	-	10.9	6.26	-	41.9
6						-	2.32	-	5.69	7.86	-	3.91	-	11.72	-	31.5
7							-	5.16	6	-	-	11.42	-	-	-	22.58
8								-	4.71	-	-	7	-	13.6	-	25.31
9									-	5.6	3.4	-	-	-	-	9
10										-	4.9	-	-	10	-	14.9
11											-	3.17	12.4	-	-	15.57
12												-	19	-	-	19
13													-	4.71	6.4	11.11
14														-	7.9	7.9
15															-	
																338.82

7. Department sequence and closeness rating achieved is shown as below:

Department	Sequence	CR Previous		Sequence	CR New		
1	13_14_2_12_15	12		15_14_2_10_13	15		A=5
2	1_3_8_4_14	14		1_10_3_4_14	14		E=4
3	2_4_6_8	18		2_4_6_9_10	18		I=3
4	2_3_5_6_11_14	22		2_3_5_6_14	18		O=2
5	4_6_7_9_11_10	20		4_6_7_14	18		U=0
6	3_4_5_7_8	19		3_4_5_7_8_9	23		
7	5_6_8_9_10	17		5_6_8	14		
8	3_6_7_12_9	17		7_6_9_11_12	14		
9	7_10	8		3_10_11_8_6	18		
10	14_11_9	13		3_9_11	13		
11	4_5_10_14	11		10_12_8_9	14		
12	1_8_15	4		10_11_8	9		
13	15_1_14	6		15_14	6		
14	13_1_2_4_11_10	8		15_13_1_2_4_5	11		
15	13_1_12	8		1_14_13	10		
		ERV=197			ERV=215		

ERV= End Relationship value, CR= closeness Rating

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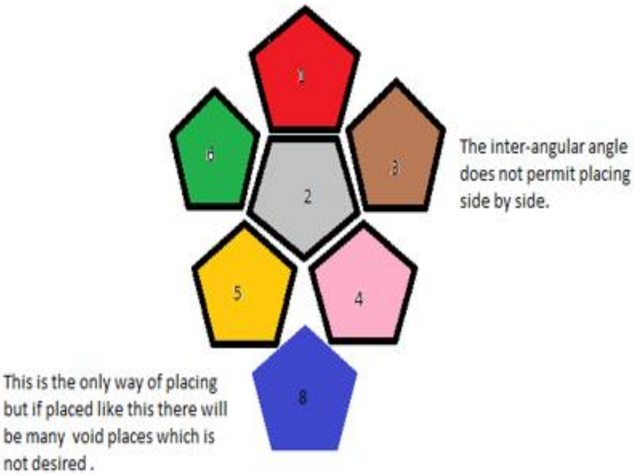
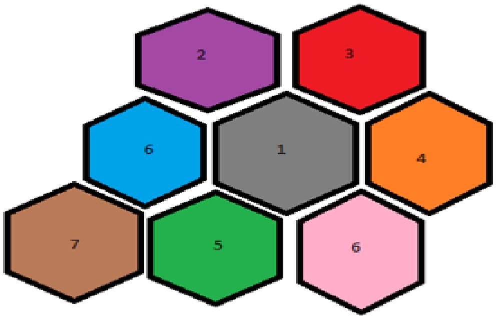
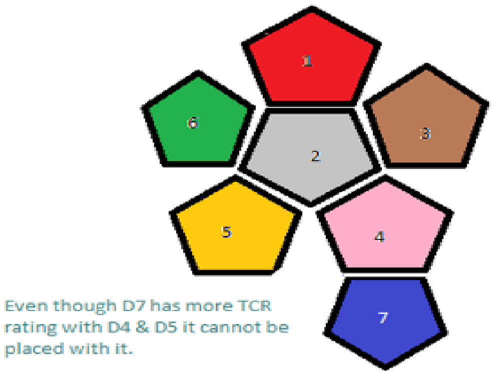
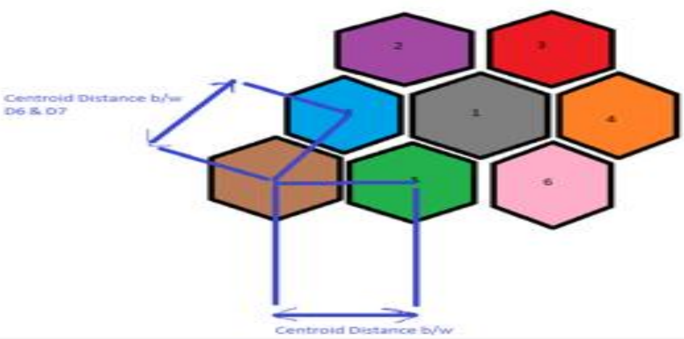
8. Comparison of Pentagonal and Hexagonal shapes and its outcome is

Shown as below:









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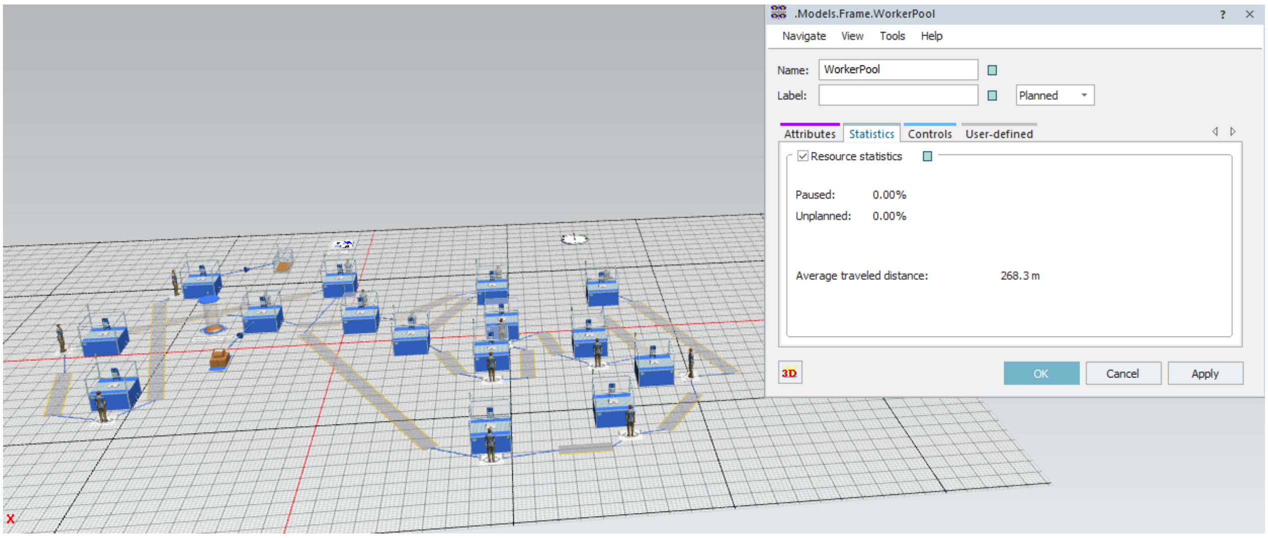
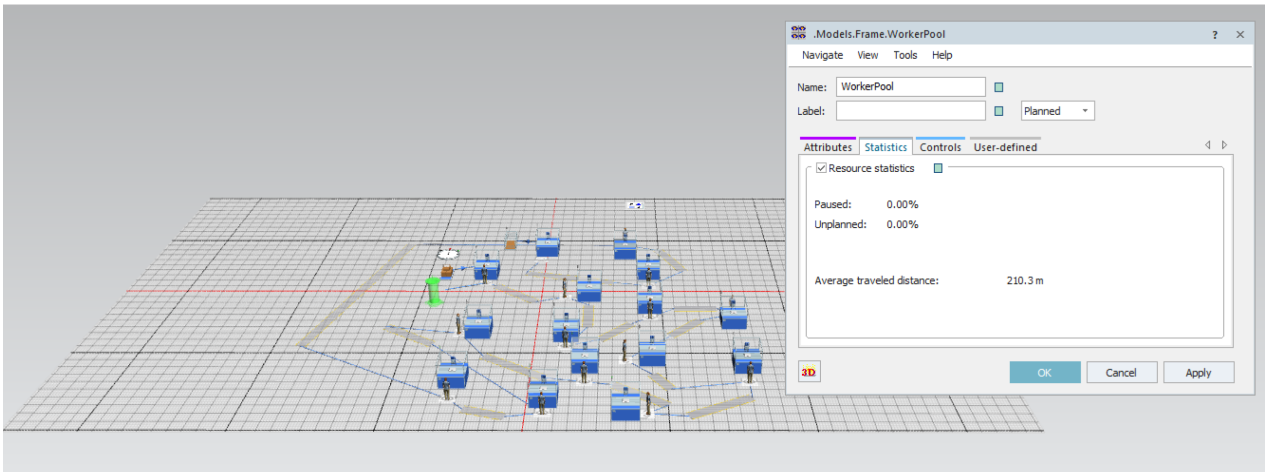
9. Comparison of values and experimentation is done using Technomatix Plant Layout Simulation tool. The results are obtained and discussed:



The average distance traveled by the worker comes out to be 268.3 m.



The average travel distance of worker by Honeycomb Model comes out to be 210.3 m which is considerably low.

10. Results:

In this paper it has been experimented with the various algorithms for plant layout optimization. These algorithms include CRAFT, ALDEP and CORELAP. After the implementation of all these algorithms the results are as follows:

10.1 Result outcome with CRAFT:

	Initial	**Final**
Distance	182	162.32
Cost Travelling	16,244	14,488

Total Savings/Batch	1,756
Daily Savings	7,024
Monthly Savings	1,82,624
Yearly Savings	21,91,488

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10.2 Comparison of distance with ALDEP, CORELAP and honeycomb shape as option:

Algorithm	ALDEP	CORELAP	Honeycomb
Total Closeness Rating(TCR)	96	102	110
End Relationship Value	-	197	215
Centroid Distance	-	354 m	338 m
Avg. Travelled Distance (by worker per batch) from Simulation	-	268 m	210 m

11. CONCLUSION:

The end relationship value obtained by CORELAP was 197 while that obtained by Honeycomb method is 215.

- The centroid distance for CORELAP was estimated to be 354.74.
- The centroid distance for Honeycomb method is 338.82
- TCR value from Corelap was found to be 102 and with Honeycomb method it is 110.
- Simulation shows the average travel distance by worker to be 268 and 210 for corelap and honeycomb model respectively.

12. References:

1. Gordon C. Armour, Elwood S. Buffa, (1963) A Heuristic Algorithm and Simulation Approach to Relative Location of Facilities, Management Science 9(2):294-309.
2. Hari Prasad.N, Rajyalakshmi.G, Sreenivasulu Reddy.A, A Typical Manufacturing Plant Layout Design Using CRAFT Algorithm, 12th.
3. Global Congress On Manufacturing And Management, GCMM 2014, Procedia Engineering 97 (2014) 1808 – 1814.
4. Bobby John, Jubin James, Mahesh Rengaraj, Analysis and Optimization of Plant Layout using Relative Allocation of Facilities Technique, International Journal of Emerging
5. Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 8, August 2013.
6. K Balamurugan, V Selladurai, and B Ilamathi, Design and optimization of manufacturing facilities layouts, Department of Mechanical Engineering, Bannari Amman Institute of Technology,
7. Sathyamangalam, India, 2 May 2006
8. G Chryssolouris, D Mavrikios, N Papakostas, and K Georgoulias, Digital manufacturing:
9. History, perspectives, and outlook, Proceedings of the Institution of Mechanical Engineers, Part B.
10. Journal of Engineering Manufacture 2009 223: 451, 20 June 2008 Milan Gregor and Stefan Medvecky (2010). Digital Factory –Theory and Practice, Engineering the Future, Laszlo Dudas (Ed.),ISBN: 978-953-307-210-4, InTech, Available from:
11. http://www.intechopen.com/books/engineering-the-future/digitalfactory-theory-andpractice Tullio Tolio, Marco Sacco, Walter Terkaj, Marcello Urgo, Virtual
12. Dassaults Systems Case Study, Tata Motors Adopts DELMIA Solutions for Digital Manufacturing , Tata Motors Ltd., 2008
13. SIEMENS PLM Case Study, Digital manufacturing solution optimizes plant management, SKODA AUTO, 2009