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Optimization of Shop Floor Layout Based on Material Movement

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Abstract**: *Layout planning is the systematical arrangement of various machines, equipment and services in industries. It is important to have accurate plant layout for all available resources for increasing the efficiency of industry. The aim is to study and improve the material handling cost of current plant layout by using flow process chart, outline process chart, etc. The present plant layout and operation process of each station have been studied to make optimum space utilization, it is necessary to eliminate the obstruction in material flow to obtain maximum productivity. The best method used for improving efficiency is the systematic layout planning, based on this method various practical methods which are universally applicable to any type of layout. This method mainly focused on the parameters like better material flow, expanding facilities.***
Keywords**: *Plant Layout, Efficiency, Optimum, Obstruction, Productivity, Material Flow***

I. INTRODUCTION

One of the major roles of lean manufacturing in a factory is to perform space planning for the better material flow and improving the efficiency of the factory. Particularly for cases where a certain production floor or area is designated for a specific product, space becomes a subject of greater apprehension when the product volume expands beyond the designated area.

When there is a variation between demand and capacity from the planning systems, it is time for the Industrial Engineer to try to find actions needed for productivity enhancement. By understanding the factors contributing to productivity losses, an Industrial Engineer can then work with the operations and engineering teams to identify the opening based on existing problems on the production floor and efficiency of the material handling tackle.

For this problem some terms are very essential Described as follows:

A. Work station

Work station is an area with equipment for the performance of the particular task generally by one person. Work station has materials, machines, tools, jigs/fixtures, instructions and operators needed for the operation(s) assigned.

B. Material handling

Material handling refers to activities, equipment, and procedure related to the moving, storing, protecting, and controlling of materials in a system. It utilizes a wide range of manual, semi-automated and automated equipment's.

C. Material flow

Material flow is the description of the transportation of raw materials, parts, components, integrates objects and final products as a flow of entities.

D. Product process pattern:

Process patterns can be defined as the set of activities, actions, work tasks or work products and similar related behavior. Process patterns can be more easily understood by dividing it into terms, process, which followed to achieve a task and patterns. Thus in more universal term process patterns are common or general solution for a complexity.

II. OBJECTIVES

According to the problem definition our objective is listed below-

To evaluate different layout possibilities for new material flow patterns.

To utilize existing space most effectively.

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To achieve the efficient logistic process by eliminating the unnecessary material handling flow paths followed in existing layout.
To minimize the material handling cost
And to perform these tasks with minimum costs

III. EXISTING SYSTEM

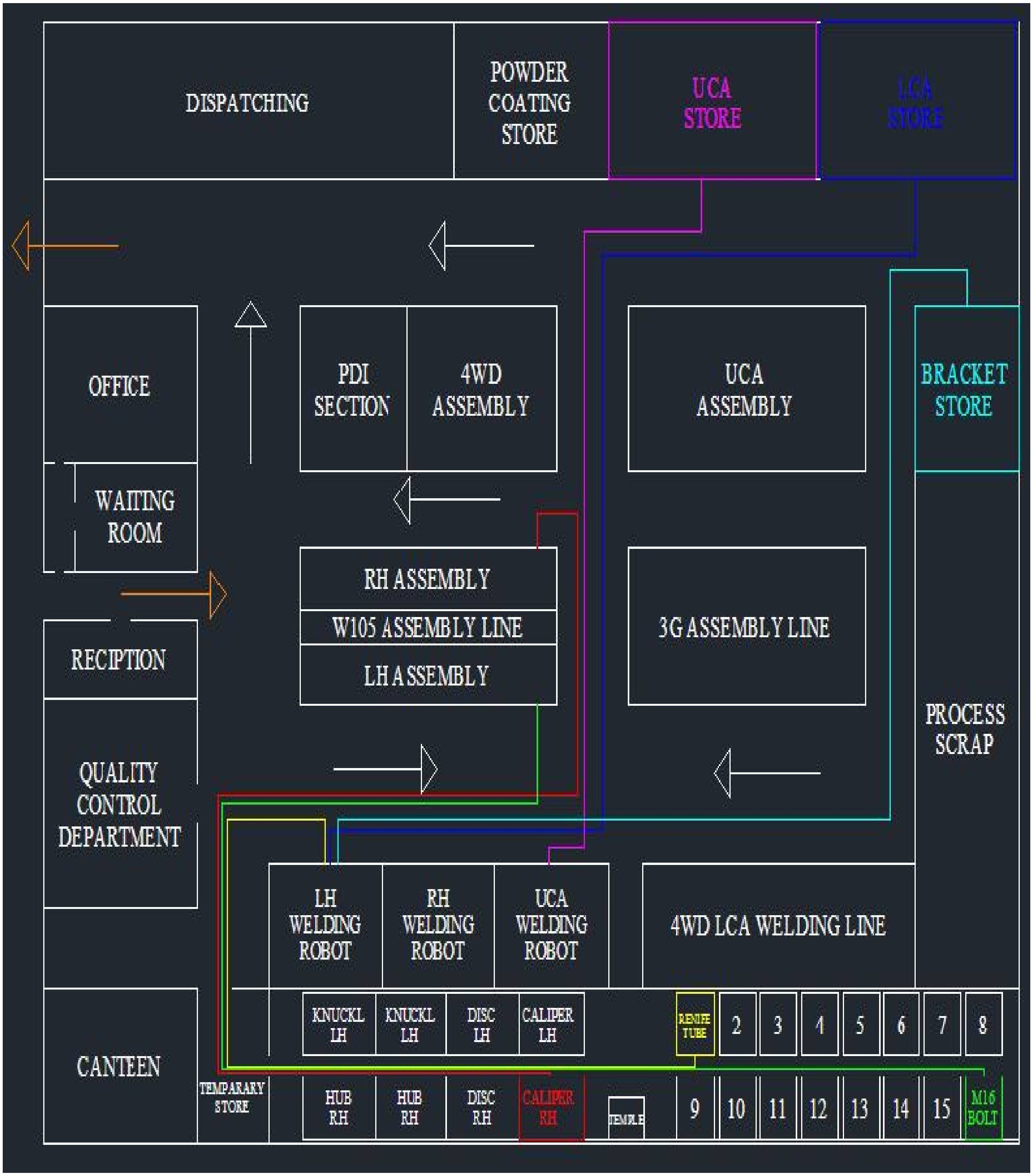

Fig: Company Layout for the Existing System

Volume 5 Issue IV, April 2017
ISSN: 2321-9653

A. Following Table Represents the Distance Travelled by the Parts from Facility I to J:

Sr.No	Part Name	Quantity Required Per Shift	No. Of Trips Per Shift	Loading Time (min)	Unloading Time (min)	Distance (m)
1	Caliper	125	5.2	2.2	1.8	62.8
2	Knuckle	125	5.2	2.4	1.3	49.6
3	Hub	125	5.2	4.2	1.6	82.2
4	Disc	60	2.8	15.5	6.2	90.2
5	Lower Arm	216	1.28	2.6	0.8	161.2
6	Reinf Tube	108	2.2	1.5	0.6	95.1
7	Front Reinf Tube	108	2.2	2.3	1.2	78.1
8	Rear Reinf Tube	108	2.2	1.8	0.7	67 .3
9	Stab Bar	108	2	2.6	1.2	93.9
10	Bracket	108	2	3.5	0.8	102.9
TOTAL	-	1191	30.28	38.6	16.2	883.3

B. Terminology used For the Calculations of Material Handling Cost.[6]:

Fij=No of trips required to transport material from facility I to J (30.28)
Dij=Distance in (m) from I to J (883.3)
LULT=Average loading & unloading time in (m)/move (27.4)
S=Average speed in (m/min) of material handling equipment (16.94)
C=Investment cost for the material handling equipment (5Rs/Trip)
OP=Labor operating cost per min(1.04 Rs/Trip)
Tij=Time in (min) to transport material from facility I to j.
MHCij=Total material handling cost to transport material from facility I to j.

C. Transportation and Material Handling Cost Calculations for Existing System:

1) Tij=[LULT+(Dij/S)]
=[27.4+ (883.3/16.94)]
=79.54 Min

2) MHCij=[C+(Tij*Fij*OP)]
= [5+ (79.54*30.28*1.04)]
=2509.90 Rs./Shift

According to this calculations the total material handling cost for the existing system = 2509.90 Rs./Shift

IV. DEVELOPMENT OF ALTERNATING LAYOUTS

In this chapter we follow SLP step-by-step to develop alternative layouts. The steps in SLP can be grouped into three main phases: analysis, search, and evaluation. The analysis phase involves all of the data collection required to produce a good layout. Within the analysis phase, facility data is utilized to define the possible paths of material movement. The search phase of the SLP involves the actual alternative layout generation. Once alternative layouts are generated, in the evaluation phase, we choose the final layout that is going to be implemented based on the cost and non-cost criteria.

According to brainstorming we can collect the information about changes of martial storing and material flow pattern of our company. During the brainstorming we can notice three points which are to be helpful for deciding the layout changes or we can say changes of flow patterns. These three points are listed below,

Change the stored position of bracket

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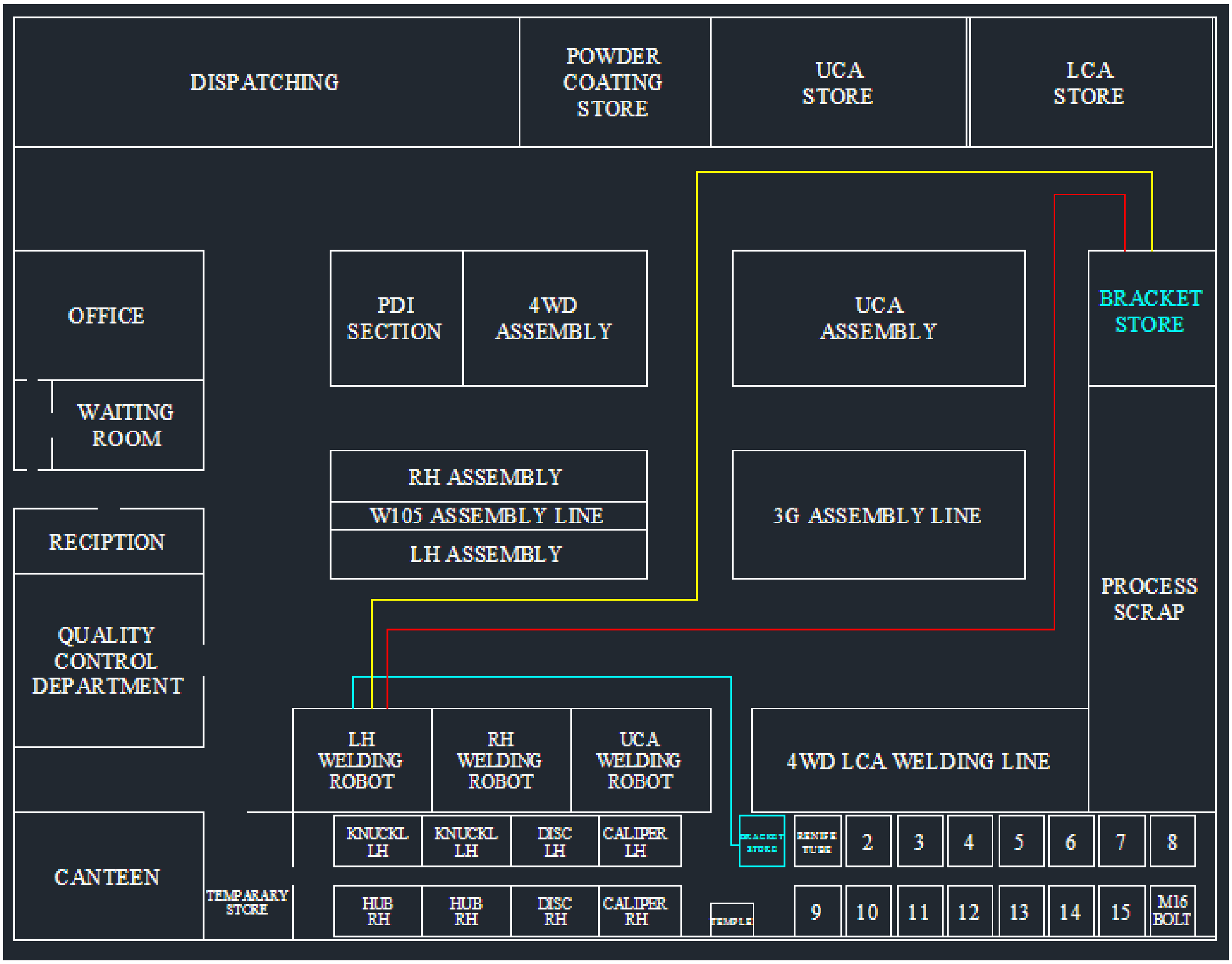
Interchange the location of lower control arm (LCA) and Upper control arm (UCA)
Enlarging path which is the midway of store room

A. Proposed Layout 1

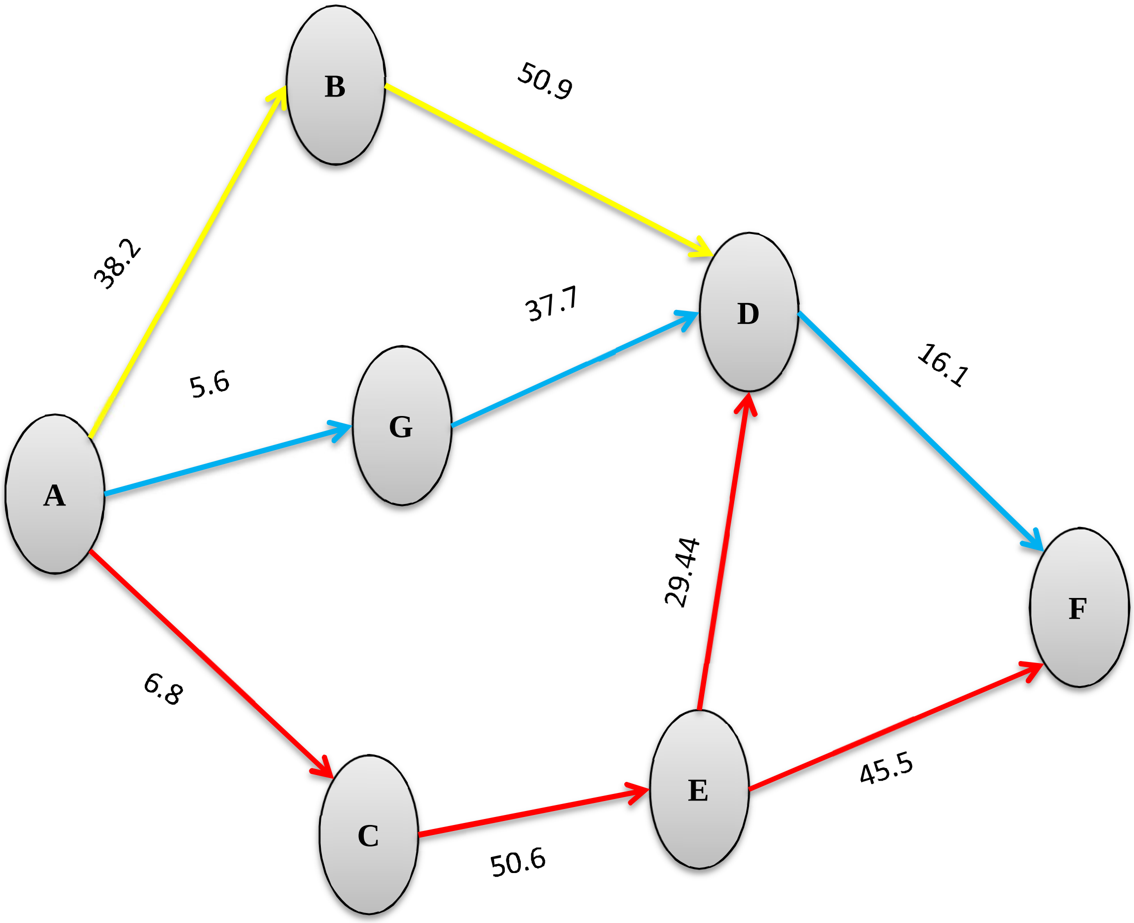
In this Section, we have to consider first change which is nothing but change the stored position of bracket. According to shortest path method we select shortest path for travelling bracket from store room to welding section.

First we collect the information in terms of distance for no of possible ways to travelled bracket from store room to welding section and construct network diagram. after constructing the network diagram, we can select the shortest path by using Dijkastra`s Algorithm, and calculating transportation time as well as material handling cost for proposed changes.



1) Transportation paths of bracket and network diagram:

Sr.no	Contain	Symbol used during tracking	Distance from store to welding section
1	Path 1		102.9
2	Path 2		105.2
3	Path 3		59.4



2) *Determination of shortest path:* According to above network diagram we have to find out shortest path by using Dijkastra's Algorithm which are already explain in section 3.2. on the basis of this we can explain the following algorithm result by using chart

Steps	A	B	C	D	E	F	G	Selected	Precursor
0	0	∞	∞	∞	∞	∞	∞	**A**	-
1		38.2	6.8	∞	∞	∞	5.6	G	A
2		38.2	6.8	43.3	∞	∞		C	A
3		38.2		43.3	57.4	∞		B	A
4				43.3	57.4	∞		**D**	G
5					57.4	59.4		E	C
6						59.4		**F**	D

Above chart shows the shortest path of bracket (i.e. a-g-d-f) from store room(a) to welding section(f) on the basis of change the location of bracket store.

3) *Following Table Represents the Distance Travelled By the Parts from Facility I to J*

Volume 5 Issue IV, April 2017
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Sr.No	Part Name	Quantity Required Per Shift	No. Of Trips Per Shift	Loading Time (min)	Unloading Time (min)	Distance (m)
1	Caliper	125	5.2	2.2	1.8	62.8
2	Knuckle	125	5.2	2.4	1.3	49.6
3	Hub	125	5.2	4.2	1.6	82.2
4	Disc	60	2.8	15.5	6.2	90.2
5	Lower Arm	216	1.28	2.6	0.8	161.2
6	Reinf Tube	108	2.2	1.5	0.6	95.1
7	Front Reinf Tube	108	2.2	2.3	1.2	78.1
8	Rear Reinf Tube	108	2.2	1.8	0.7	67 .3
9	Stab Bar	108	2	2.6	1.2	93.9
10	Bracket	108	2	3.5	0.8	59.4
TOTAL	-	1191	30.28	38.6	16.2	839.8

As our procedures for calculating the material handling cost for the existing and proposed system is same, the terminology remains similar to the existing system. There is only difference is in the material handling cost, which is depends on the distance required to travel the various parts.

4) Transportation and Material Handling Cost Calculations for Proposed System 1:

a) Tij=[LULT+(Dij/S)]

= [27.4+ (839.8/16.94)]

=76.97 Min

b) MHCij=[C+(Tij*Fij*OP)]

= [5+ (76.97*30.28*1.04)]

=2429.03 Rs./Shift

According to this calculations the total material handling cost for the Proposed system 1= 2429.03 Rs./Shift

So,% Saving of MHC=[(Existing MHC-Proposed MHC)/(Existing MHC)]*100

= (2509.90-2429.03)/(2509.90)*100

=3.22 %

Volume 5 Issue IV, April 2017
ISSN: 2321-9653
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B. Proposed Layout 2

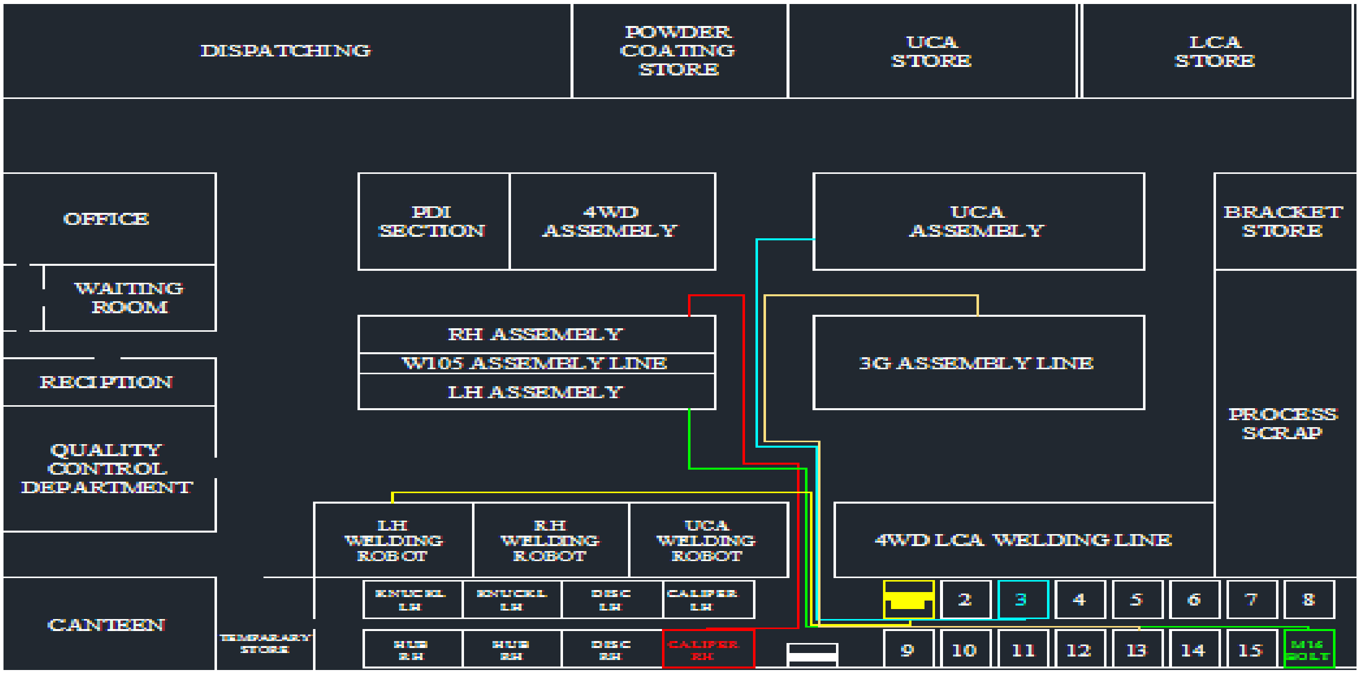

Fig: Layout for the Proposed System Layout 2

1) Following Table Represents the Distance Travelled By the Parts from Facility I to J

Sr.No	Part Name	Quantity Required Per Shift	No. Of Trips Per Shift	Loading Time (min)	Unloading Time (min)	Distance (m)
1	Caliper	125	5.2	2.2	1.8	70.7
2	Knuckle	125	5.2	2.4	1.3	49.6
3	Hub	125	5.2	4.2	1.6	82.2
4	Disc	60	2.8	15.5	6.2	90.2
5	Lower Arm	216	1.28	2.6	0.8	161.2
6	Reinf Tube	108	2.2	1.5	0.6	46.3
7	Front Reinf Tube	108	2.2	2.3	1.2	53.5
8	Rear Reinf Tube	108	2.2	1.8	0.7	50.1
9	Stab Bar	108	2	2.6	1.2	84.5
10	Bracket	108	2	3.5	0.8	102.9
TOTAL	-	1191	30.28	38.6	16.2	791.2

According to the section 4.1.1 & 4.1.2, we have construct network diagram and find out shortest path of proposed layout 2, based on section 4.1.2 by using Dijkastra's algorithm.

2) Transportation and Material Handling Cost Calculations for proposed System2

a) Tij=[LULT+(Dij/S)]

= [27.4+ (791.2/16.94)]

=74.10 Min

b) MHCij=[C+(Tij*Fij*OP)]

Volume 5 Issue IV, April 2017
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= [5+ (74.10*30.28*1.04)]

=2338.68 Rs./Shift

According to this calculations the total material handling cost for the proposed system 2= 2338.68 Rs./Shift

So,% Saving of MHC=[(Existing MHC-Proposed MHC)/(Existing MHC)]*100

= (2509.90-2338.68)/(2509.90)*100

=6.82 %

C. For proposed layout 3

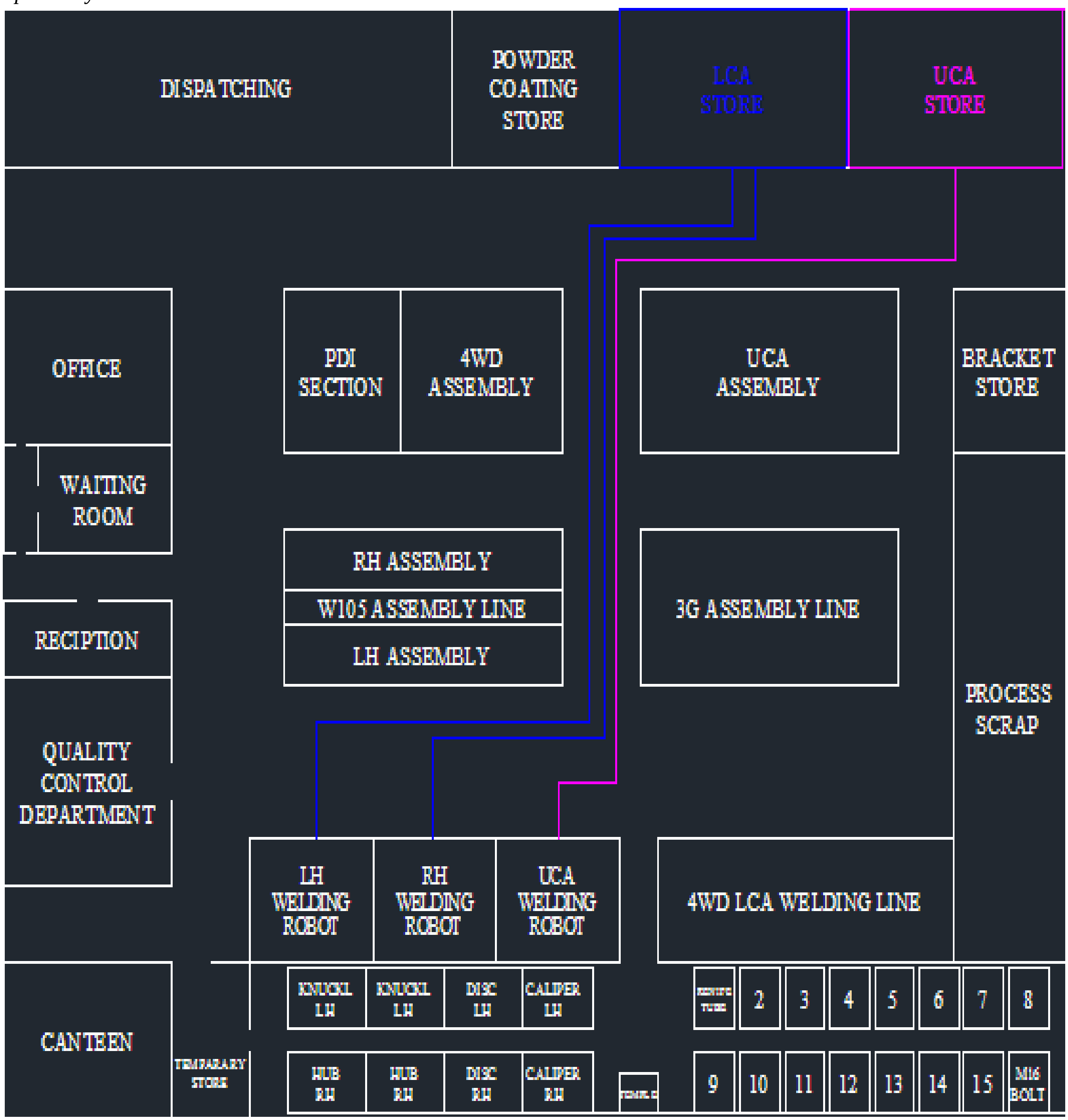

Fig: Layout for the Proposed System Layout 3

Volume 5 Issue IV, April 2017
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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

1) Following Table Represents the Distance Travelled By the Parts from Facility I to J:

Sr.No	Part Name	Quantity Required Per Shift	No. Of Trips Per Shift	Loading Time (min)	Unloading Time (min)	Distance (m)
1	Caliper	125	5.2	2.2	1.8	62.8
2	Knuckle	125	5.2	2.4	1.3	49.6
3	Hub	125	5.2	4.2	1.6	82.2
4	Disc	60	2.8	15.5	6.2	90.2
5	Lower Arm	216	1.28	2.6	0.8	148
6	Reinf Tube	108	2.2	1.5	0.6	95.1
7	Front Reinf Tube	108	2.2	2.3	1.2	78.1
8	Rear Reinf Tube	108	2.2	1.8	0.7	67 .3
9	Stab Bar	108	2	2.6	1.2	93.9
10	Bracket	108	2	3.5	0.8	102.9
TOTAL	-	1191	30.28	38.6	16.2	870.1

According to the section 4.1.1 & 4.1.2, we have construct network diagram and find out shortest path of proposed layout 3, based on section 4.1.2 by using Dijkastra's algorithm

2) Transportation and Material Handling Cost Calculations for Proposed System

a) Tij=[LULT+(Dij/S)]

= [27.4+ (870.1/16.94)]

=78.76 Min

b) MHCij=[C+(Tij*Fij*OP)]

= [5+ (78.76*30.28*1.04)]

=2485.36Rs./Shift

According to this calculations the total material handling cost for the Proposed system 3= 2485.36 Rs./Shift

So,% Saving of MHC=[(Existing MHC-Proposed MHC)/(Existing MHC)]*100

= (2509.90-2485.36)/(2509.90)*100

=0.97 %

V. RESULTS

As we calculated above the material handling cost for existing system and proposed system are listed below:

Material Handling Cost	Existing	Layout no 1	Layout No 2	Layout No 3
-	2509.90	2429.03	2338.68	2485.36

From above table we can see that, the minimum material handling cost from these three proposed layout is 2338.68 for layout 2.

VI. CONCLUSIONS

Our plan has provided good coverage to facility planning and layout design for the improvement of efficiency of the industry. The study of layout is the very important parameter for any type of industry. The most important objective of layout design is to minimize the distance travelled. The existing layout has been improved by using flow process, material flow pattern and considering the material handling cost. By implementing, 1st Layout the Material Handling Cost (MHC) is reduced by 80.87 Rs/shift. Similarly, by implementing 2nd Layout the MHC is reduced by 170.61 Rs/shift & implementing 3rd Layout MHC is reduced by 24.54 Rs/shift On the basis of this material handling cost the 2nd layout will be considered as optimum. This results in savings of amount of resources used. As a result the productivity or efficiency will be increased

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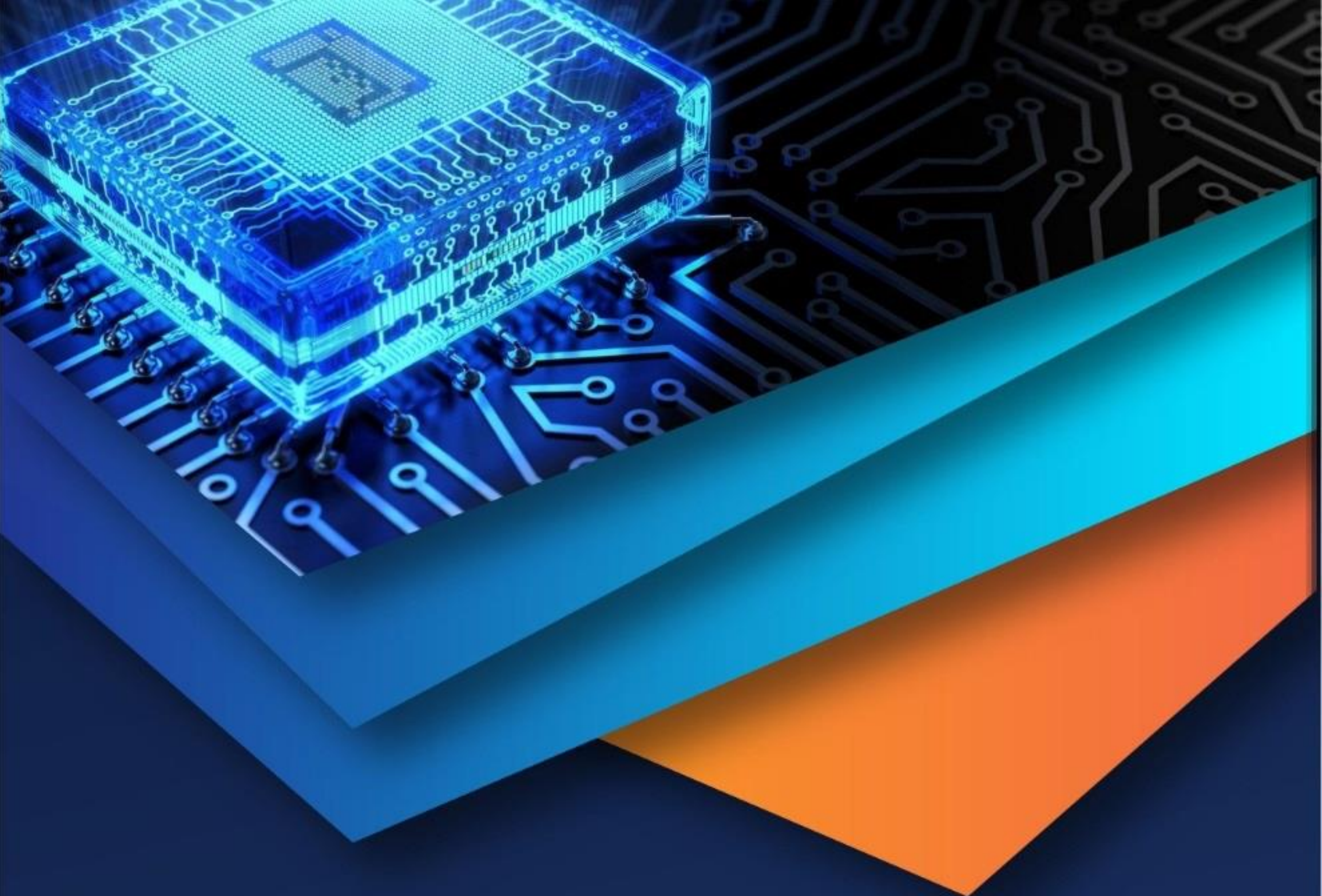

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