A PROJECT REPORT

ON

"OPTIMIZATION OF PLANT LAYOUT"

Submitted by

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In partial fulfillment for the award of the Degree

Of

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UNDER THE GUIDANCE

Of

Prof. ZAKIR ANSARI & Prof. ASIF GANDHI

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

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APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

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Date: ___________

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ABSTRACT

The objective of this project is to study plant layout of Pratap Re-Rollers and based on the systematic layout planning method, design a new layout for increased productivity and reduction in material handling. The detailed study of the plant layout such as operation process chart, flow of material and activity relationship chart has been investigated. The systematic layout planning method showed that new plant layout significantly decrease the distance of material flow from stores until usage spots.

It is vitally important to have a well-developed plant layout for all the available resources in an optimum manner and get the maximum out of the capacity of the facilities. The problem is of particular importance for Small and Medium Enterprises such as Pratap Re-Rollers where major constraint such as cost and space play an important role.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

List of Nomenclature

g=acceleration due to gravity (m/s^2)

v=velocity of water (m/s)

d=diameter of pipe (m)

l=length of pipe (m)

Q=Discharge of water (m^3/s)

H_m=Manometric head (m)

H_s=Suction Head (m)

H_d= Discharge head (m)

h_{fs}= head loss due to friction in suction pipe(m)

h_{fd}= head loss due to friction in suction pipe (m)

h_{fl} = head loss due to fittings in pipe (m)

h_s= Suction pipe height (m)

h_d= Delivery pipe height (m)

DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(NAME AND ROLL NO.)	**(SIGNATURE)**
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Date:

Chapter 1 - Introduction

1.1 Company's Introduction

1.2 Aim and objective

1.3 Scope

1.4 Introduction of Plant Layout

1.1 Company’s Introduction

We are working at “PRATAP RE-ROLLERS PVT LTD” Mumbai’s leading manufacturer, exporter & whole sellers of iron and steel hot re rolled & bright bar sections and 50 years in Trading & Supply of steel material.

Establishment: 6th February 1993

Product manufactured: Iron and Steel Products, Equal Angle, Flat Bars, H Beam, I Beam, Bright Steel Bars, Square Steel Bars and Steel Round Bars, Rectangular flat bars, Steel round bar, Squares steel bar, Hexagon, Beams, Angles, Channels.
(Mild Steel, Alloy Steel, Carbon Steel)

Applications of products:

- Automobile Industry
- Engine components
- Nuts, Bolts and Shafts
- All Heavy Engineering Industries
- Textile Machine Manufacturing
- Pumps / Electric Motor Industries
- Railways for manufacture of Engines as well as Coaches
- Defence Sector for making various Arms and Ammunitions
- Fan Industries
- For various fabrication jobs where accuracy is important
- For making shafts in Conveyors

1.2 Introduction of Plant Layout

“Think of a rope. When it's tugged, knotted, coiled, or shaped to take a form, the entire length is affected. Facility layout is similar: all parts make up one interconnected whole.”

Plant layout optimization means getting the things in its appropriate position so that there is a ease of future expansions, there is effectiveness in material handling in terms of cost and time, proper space utilization, safety and housekeeping, proper working conditions, proper appearance, proper equipment utilization, higher pay-out, return and profitability.

At Pratap Re-rollers we found out that due to improper plant layout there is no scope for further expansion, there is a lot of material handling by skilled workers which adds on the cost of production, a lot of space is wasted in the plant in keeping scraps at any positions, due to the scraps located anywhere in the plant it gives bad appearance to the plant, also that the working conditions for the workers is not suitable as they are handling material of around 1200-1400^{o}C without proper protections suits. All of these reasons justify the idea of relocation of certain facilities to have an improvement in all of the area stated above.

Hence a properly planned facility would be beneficial to both the industry management and the employees. It would reduce the investment in equipment and utilizing the existing space most effectively which is of great importance to the industry and for the employees reduction in stress and proper working conditions is very beneficial safety point of view.

Principles of a good plant layout are –

1. A good plant layout is the one which sees very little or minimum possible movement of the materials during the operations.
2. A good layout is the one that is able to make effective and proper use of the space that is available for use.
3. A good layout is the one which involves unidirectional flow of the materials during operations without involving any back tracking.
4. A good plant layout is the one which ensures proper security with maximum flexibility.
5. Maximum visibility, minimum handling and maximum accessibility, all form other important features of a good plant layout.

1.3 Aim

To optimize the layout of the plant for minimizing material handling cost, overall production time and facilitating the organizational structure.

1.4 Objectives

1. To have most effective and optimum utilization of available floor space.

2. To achieve economies in handling of raw materials, work in- progress and finished goods.

3. To workout possibilities of future expansion of the plant.

4. To provide better quality products at lesser costs to the consumers.

1.5 Scope

To study the existing plant layout and to suggest some improvements at Pratap Re-Rollers which would reduce the handling and improve working conditions.

1.6 Plant Layout

1.6.1 Definition

A plant layout study is an engineering study used to analyse different physical configurations for a manufacturing plant. It is also known as Facilities Planning and Layout. Plant layout is primarily concerned with the internal set up of an enterprise in a proper manner.

It is concerned with the orderly and proper arrangement and use of available resources viz., men, money, machines, materials and methods of production inside the factory. A well designed plant layout is concerned with maximum and effective utilization of available resources at minimum operating costs.

In order to clearly understand the concept of Plant layout, a few definitions can be enumerated here:

"Plant layout is the arrangement of machines, work areas and service areas within a factory".

—**George R. Terry**

"Plant layout involves the development of physical relationship among building, equipment and production operations, which will enable the manufacturing process to be carried on efficiently". —**Morris E. Hurley**

"Any arrangement of machines and facilities is layout". —**F.G. Moore**

"Plant layout can be defined as a technique of locating machines, processes and plant services within the factory so as to achieve the greatest possible output of high quality at the lowest possible total cost of manufacturing". —**Sprigal and Lansburg**

"Plant layout ideally involves the allocation of space and the arrangement of equipment in such a manner that overall operations cost can be minimised**."** **—J. Lundy**

From these definitions it is clear that plant layout is arrangement and optimum utilisation of available resources in such a manner so as to ensure maximum output with minimum input.

1.6.2 Advantages:

1. **Smooth flow of production**: There must be a smooth flow of production. Raw materials and workers must have access to each machine without any different and delay.

2. **Maximum utilization of available space:** An efficient plant layout must be such that may utilize the maximum of the space available.

3. **Facilities the movement of men:** Materials and machines, etc., there must be sufficient space left in between different machines so that raw materials, workers and machines very easily from one place to another, without the fear of accident.

4. **Involves minimum handling:** The various machines in a good layout must be arranged in such manner that the product of one operation may pass on to the next operation with a minimum of handling. It will reduce wastage of raw material and save time.

5. **Provides better working conditions**: A good plan layout must have facilities such as water, ventilation, retiring room, etc., in the plant. It should also safeguard the health of the workers.

6. **Flexibility:** A good layout must be flexible enough so as to incorporate any change in the management policies. It must be capable of incorporating, without major change, new equipment to meet technological progress, (or) increased production requirements (or) to eliminate waste.

7. **Location of stores:** The stores in a plant must be located in such a place from where raw materials, tools, equipment and other materials may be supplied to the department concerned, without and delay.

8. **Facilities supervision and control:** The position of workers must be arranged in such a way that if facilities supervision, coordination and control.

9. **Provision of safety:** There must be complete safety for workers engaged on a machine. Necessary instructions must be given to them about the risks involved while working in certain type of machines. Provisions of factories Act must be followed in real spirit

10. **Co-ordination and integration**: There must be an effective co-ordination and integration among men, materials and machines so that their maximum could become a possibility.

1.6.3 Types of Plant Layout

Product or Line Layout:

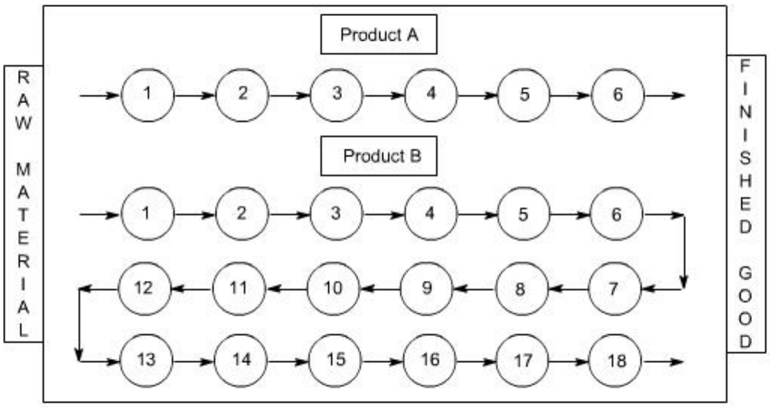

Figure 1: Product or Line Layout

Product or Line Layout is the arrangement of machines in a line (not always straight) or a sequence in which they would be used in the process of manufacture of the product. This type of layout is most appropriate in case of continuous type of industries where raw materials is fed at one end and taken out as finished product at the other end. For each type of product a separate line of production will have to be maintained.

This type of layout is most suitable in case of metal extraction industry, chemical industry, soap manufacturing industry, sugar industry and electric industry. It should be noted that this method is most suitable in case of mass production industries.

Process or Functional Layout:

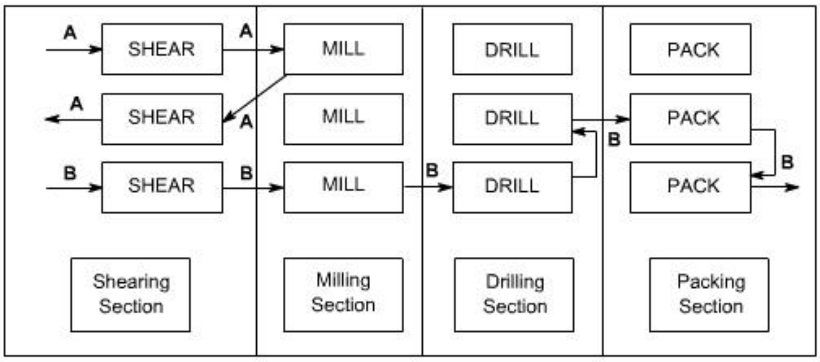

Figure 2: Process or Functional Layout

The process layout is particularly useful where low volume of production is needed. If the products are not standardized, the process layout is lower desirable, because it has creator process flexibility than other. In this type of layout, the machines and not arranged according to the sequence of operations but are arranged according to the nature or type of the operations. This layout is commonly suitable for non-repetitive jobs.

Same type of operation facilities are grouped together such as lathes will be placed at one place; all the drill machines are at another place and so on. Therefore, the process carried out in that area is according to the machine available in that area.

Fixed Position Layout:

This type of layout is the least important for today's manufacturing industries. In this type of layout the major component remain in a fixed location, other materials, parts, tools, machinery, man power and other supporting equipment's are brought to this location.

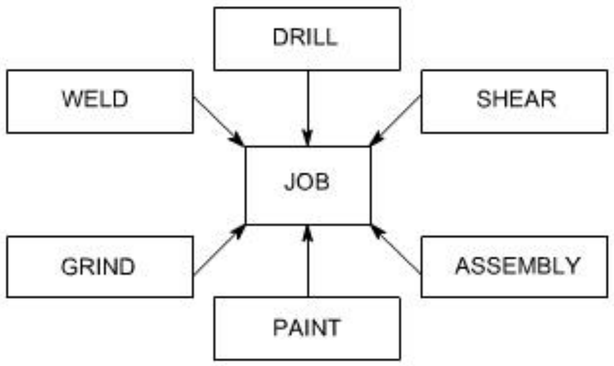

Figure 3 Fixed Position Layout

The major component or body of the product remain in a fixed position because it is too heavy or too big and as such it is economical and convenient to bring the necessary tools and equipment's to work place along with the man power. This type of layout is used in the manufacture of boilers, hydraulic and steam turbines and ships etc.

Combination Type of Layout:

Now-a -days in pure state any one form of layouts discussed above is rarely found. Therefore, generally the layouts used in industries are the compromise of the above mentioned layouts. Every layout has got certain advantages and limitations. Therefore, industries would to like use any type of layout as such. Flexibility is a very important factory, so layout should be such which can be molded according to the requirements of industry, without much investment. If the good features of all types of layouts are connected, a compromise solution can be obtained which will be more economical and flexible.

1.6.4 Different types of Layout features

A number of methods have been developed to facilitate the design of plant layouts:

- **Nadler's ideal system approach**

Although it was developed initially for designing work systems Nadler's ideal systems approach is also applicable for designing plant layouts. Although more a philosophy than a procedure, the ideal systems approach is based on the following hierarchical approach towards design:

1. Aim for the "theoretical ideal system."
2. Conceptualized the "Ultimate ideal system."
3. Design the "technologically workable ideal system."
4. Install the "recommended system."

As Shown in the figure, the ideal systems approach is a top down approach. The focus is the opposite of that typically used in practice, where the layout designer concentrates initially on the present method rather than aiming for the theoretical ideal. We believe it important to focus initially on "what can be" instead of "what has been"

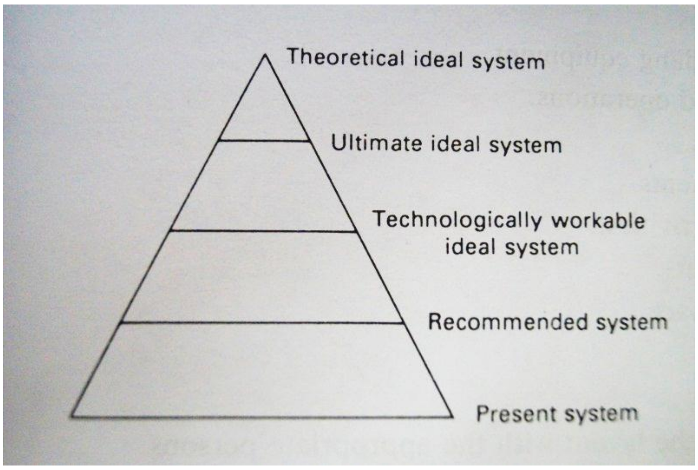

Figure 4: Hierarchical Diagram for Nadler's Plant Layout Method

- Immer’s Basic Step

In an early book on the subject, Immer described the analysis of a layout problem as follows: “This analysis should be composed of three simple steps, which can be applied to any type of layout problem. These steps are:

1. Put the problem on paper.
2. Show lines of flow.
3. Convert flow lines to machine lines.

Immer quoted Mallick and Sansonetti as follows "Good plant layout, as defined at Westinghouse Electric Corporation, means (a)placing the right equipment,(b)coupled with the right method,(c)in the right place,(d)to permit the processing of a product unit in the most effective manner,(e)through the shortest possible distance, and (f)in the shortest possible time. The importance of good layout as a factor in insuring low cost production is thus well established, and its need is well understood"

- **Apples Plant layout Procedure**

Apple recommended that the following detailed sequence of steps be used in the designing of plant layout.

1. Procure the basic data.
2. Analyse the basic data.
3. Design the productive process.
4. Plan the material flow pattern.
5. Consider the general material handling pattern.
6. Calculate equipment requirements.

7. Plan individual work stations.

8. Select specific material handling equipment.

9. Coordinate groups of related operations.

10. Design the activity relationship.

11. Determine storage requirements

12. Plan service and auxiliary activities.

13. Determine space requirements.

14. Allocate activities to total space.

15. Consider building types.

16. Construct master layout.

17. Evaluate, adjust and check the layout with appropriate persons.

18. Obtain approvals.

19. Install the layouts.

20. Follow up implementations on the layout.

- **Reed's plant layout procedure**

In "planning for and preparing the layout," Reed recommended that the following steps be taken in his systematic plan of attack":

1. Analyse the produce or process to be produced.

2. Determine the process required to manufacture the product.

3. Prepare layout planning charts.
4. Determine work stations
5. Analyse storage area requirements.
6. Establish minimum aisle widths.
7. Establish office requirements
8. Consider personnel facilities and services.
9. Survey plant services
10. Provide for future expansion

The layout planning chart incorporates the following: operations, transportations, storage, and inspection: standard for each work element; machine selection and balance; labour selection and balance; and material handling requirements.

- **Systematic plant layout method:**

The above layout planning procedures vary in their degree of specificity. However, they are alike in the design aspects of layout planning. Taken together, and coupled with the engineering design approach, a comprehensive layout planning would emerge.

Over the years, the most popular approach used in designing plant layouts has been the systematic layout planning approach developed by Muthur. Referred to as SLP, The procedure has been applied to production, transportation, storing, supporting services, and office activities among others.

Chapter 2 - Review of Literature

(Carlo, Antonietta, Borgia, & Tucci, 2013)[1] One of the main goals of a manufacturing system is the maximization of its productivity. This depends upon several factors, such as the kind and the complexity of the product made, the quality of the raw materials, the complexity of the manufacturing process and the arrangement of the workstations constituting the production process. Some of these parameters are determined by the product and, for this reason, are unchangeable; others, however, are variable and thus improvable. The challenge of determining the best arrangement of the workstations is one of the elements that has a great impact on system performance. It is known as the "facility layout problem", namely the problem of the arrangement of everything that is required for the production process. A facility, in fact, is any element that simplifies an activity's execution, such as a machine tool, a work center, a division, a manufacturing unit, and so on. The literature gives lot of definitions of various *layout problems*: one of the first dates back to 1957, when it was defined as an ordinary industrial problem with the aim of minimizing the cost of transporting materials between the different workstations. Transportation, as a matter of fact, is the key factor in the facility layout problem. A well-known study of the 1970s, in fact, has highlighted that from 20% to 50% of total operating manufacturing costs are related to the material handling activities and that these costs could be reduced by 10% to 30% annually with efficient facility planning.

(Carlo, Antonietta, Borgia, & Tucci, 2013)[1] A more recent description defines the facility layout problem as an optimization problem that tries to improve layout efficiency, considering all the interactions between facilities and material handling systems while designing layouts. During this optimization phase, there are a lot of elements to be considered: safety, flexibility for future design changes, noise and aesthetics are examples of basic qualitative factors in the facility layout planning process .The industrial significance of the facility layout problem is attested also to by the numerous references in the literature: some texts offer an exposition of the plant layout principles or a review of all the different approaches to the facility layout problem; others present case studies with possible optimal solutions to the problem. The choice of the best facility layout configuration is clearly a decision to be made during the early plant design phase, even if it could be modified during a redesign phase due, for example, to a plant extension.

(Dwijaynati, Dawal, Jamasri, & Aoyama, 2010)[2] It was estimated that over $250 billion is spent annual in the United States on facilities planning and re-planning. Further, between 20% - 50% of the total costs within manufacturing are related to material handling and effective facility planning can reduce these costs 10-30% Many researches have been done in facility planning area. However, these are some difficulties and limitation in finding the optimum layout configuration.

(Dwijaynati, Dawal, Jamasri, & Aoyama, 2010)[2] In today's competition market, manufacturing industries have to satisfy more diverse queries from the market, such as widening the product ranges, increasing quality and precise the delivery time, the international competition also requires a large variety of types and variants in large volume products. A research suggests that manufacturing companies need to be knowledge-intensive and highly creative to develop new products. To remain competitive, upgrading the process and adopting the information technology are also the challenge of small and medium industries.

(Singh, 2012)[7] A good factory layout can provide a real competitive advantage by facilitating material and information flow processes. Plant layout is one way to reduce the cost of manufacturing. In era of increasing demand in production, Industrial factories need to increase their potentials in production and effectiveness to compete against their market rivals. Plant layout decisions entail determining the placement of departments, workgroups within the departments, workstations, machines and stock holding points within a production facility. The Objective is to arrange these elements in a way that ensures smooth workflow in a manufacturing unit or a particular traffic pattern in a service organization.

(Singh, 2012)[7] Few of the plant layout problems, numerical flow of items between departments either is impractical to obtain or does not reveal the qualitative factors that may be crucial to the placement decision. In these situations, the venerable technique known as systematic layout planning (SLP)can be used, Which is carried on developing a relationship chart showing the degree of importance of having each department located adjacent to every other department. From this informational chart, an activity relationship diagram, flow graph is developed. The activity relationship diagram is then adjusted by trial and error until a satisfactory adjacency pattern is obtained. This pattern, in turn, is modified department by department to meet building space limitations.

(Singh, 2012)[7] The production process needs to be equipped with the ability to have lower cost with higher effectiveness. Therefore, the way to solve the problem about the production is very important. There are many ways that is Quality control, total quality management, standard time, plant layout to solve the problems concerning productivity. Out of these entire plant layout being the cheapest method to increase productivity. According to the study of manufacturing process, it was found that the long distance could be reduced for moving raw materials and the problem about useless area could be solved. The way to improve the plant was to apply SLP method to make the workflow continually by arranging the important sequence of the manufacturing.

(Wiyaratn & Watanapa, 2010)[7] In the present, there are several methods for plant layout design such as systematic layout planning (SLP) algorithms and arena simulation can apply to design plant. Nowadays few researches for SLP because using program computer to simulate is more popular. However SLP method seems interesting to design the plant layout, it is basic fundamental and quite simple method, including it can use into practice.

(Wiyaratn & Watanapa, 2010)[7] The important sequence of each activity was rearranged from the most important one to the least important one, followed the activity relationship chart. Based on SLP method the modifying plant layout and practical limitations was developed.

Chapter 3 - Report on Present Investigation

3.1 Methodology

Of all the above methods stated SLP is an organized way of plant payout. All the other methods are primitive and short methods of plant layout hence we have selected the systematic way of plant layout.

We also see that once the information is gathered, a flow analysis can be combined with an activity analysis to develop the relationship diagram. Space consideration, when combined with the relationship diagram, lead to the construction of the space requirement diagram. Based on the Space relationship diagram, modifying considerations, and practical limitations, a number of alternatives layouts are designed and evaluate. In comparison with the steps of design process, we see that SLP is formulated. The first five steps of SLP involve the analysis of the problem, steps 6 through 9 including the generation of alternative layouts; constitute the search phase of the design process. The selection phase of the design coincides with step 10 of SLP.

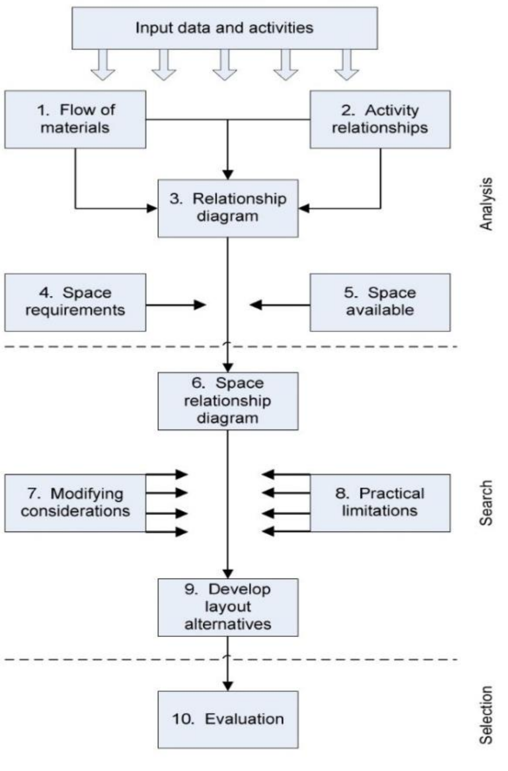

Figure 5: Systematic Plant Layout Methodology

1. Data Gathering:

   In our early visits to Pratap Re-Rollers we tried to get all the possible dimensions of the plant which would help us in developing the new layout. We also identified their problems of improper utilization of floor space and the workshop shifting on which we have worked successfully.

2. Flow Study:

   For designing the plant layout the most important study is the flow of material in the entire plant. Flow analysis concentrates on some quantitative measure of movement between departments or activities, whereas activity analysis is primarily concerned with the non-quantitative factors that influence the location of department or activities .The material flow of the industry is shown in the below figure.

Figure 6: Material Flow of Pratap Re-Rollers

3. Activity Study:

In order to plan a layout all the activities of this plant have been studied in depth. We identified all the workstation in this industry. These activities are used to construct the activity relation chart which is the main component of the Plant layout method. The Activities/Workstations are listed below:

1. Oxygen storage near vehicle entry gate.
2. Finish product storage near vehicle entry gate.
3. Scraps near finish line.
4. Finish product.
5. Scrap.
6. Finish product.
7. Raw material billets.
8. Red oxide painted products.
9. Hammering.
10. Billets.
11. Dies/scrap
12. Stand scrap.
13. Coal storage.
14. Powder making/ pulverization.
15. Storage of Raw material.
16. Gas cylinders.
17. Big furnace.
18. Coal supply for big furnace.
19. Cutting of raw material as per size.
20. Big rolling stands.
21. Small furnace.
22. Coal supply for small furnace.
23. Rolling mills for small furnace.
24. Conveyor for both furnace
25. Water cooling system for both systems.
26. Lathe -1
27. Lathe -2
28. Lathe -3
29. Lathe -4
30. Grinding machine
31. Shaper machine
32. Drilling machine
33. Die storage near machine small die
34. Shearing machine
35. Storage area for finished product
36. 1 Bend Saw cutting machine (straight cutting)
37. 2 Bend Saw cutting machine (Inclined cutting)
38. 3 Big shaper
39. Lathe machine (Maintenance)
40. Lathe machine (Die)
41. Lathe machine (Die)
42. Drilling machine
43. Grinding machine
44. Small die welding machine
45. Big die welding machine
46. Big die storage
47. EOT for big rolling mill
48. Chain pulley arrangement for small lathe
49. Chain pulley arrangement for small rolling mill
50. Hydra cranes (2 no.)
51. Welding machine
52. Acid bath
53. Water bath
54. Lime water bath
55. Pointing (2 no.)
56. Draw bench (3 no.)
57. Straightening machine for square shaped products (2 no.)
58. Polishing machine for round shaped products(3 no)
59. Cutting machine (1 no.)
60. Welding machine
61. Pickling EOT
62. Small shearing machine
63. Big shearing machine
64. Cutting mill

4. Activity Relationship Chart:

A plant is designed on the basis of an Activity relationship chart. This chart shows us the proximity between any workstations located throughout the plant. It shows us whether these workstations should be in close proximity or not so as to reduce the material handling time and cost.

Benefits of an Activity Relationship Chart:

a. Material handling and transport is minimized and efficiently controlled, so that the handling cost is minimized.

b. Work stations are designed and located suitably, so that there will be least resistance to the smooth flow of material and movement of man.

c. Sufficient space and proper location should be allocated to production centres and service centres.

d. Waiting line of semi-finished goods should be minimized.

e. Safe and proper working conditions are provided to avoid accidents and causalities.

f. Designed layout should be provided with sufficient flexibility to accommodate future minute changes in product design or change in the material specification.

g. Care should be taken to see that the space available is used optimally not only length and breadth of the building but the height of the building also to be used.

h. The layout should make the plant maintenance simple and easy.

i. It should be designed in such a way that the productivity and quality of the product is increased.

j. It should promote effective utilization of manpower.

k. A good layout should maintain high turnover of work in process.

Method of Construction:

1) Draw a vertical line and divide it into the number of workstations.

2) Then draw a horizontal line from the mid-point of the vertical line up-to a suitable distance.

3) Say there are 16 workstations then draw a horizontal line from the 8^{th} workstation.

4) Now complete the triangle by joining the vertices.

5) Further, draw parallel lines with respect to both the inclined sides of the triangle from each of the workstations.

6) Now fill all the blank spaces with the respective notations.

Activity Relationship Chart for Pratap Re-Rollers PVT LTD.

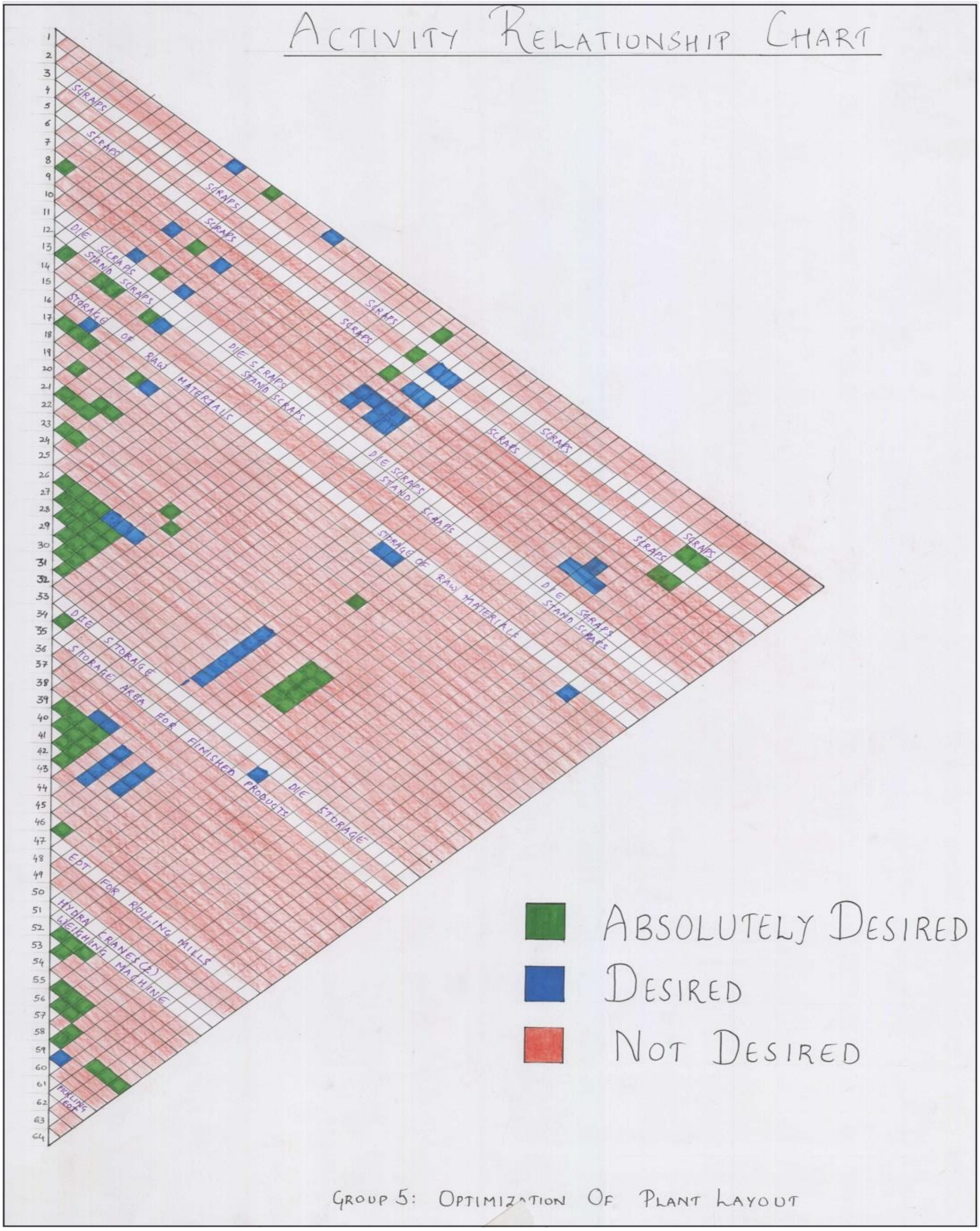

Figure 7: Activity Relationship Chart

Inference from Activity Relationship Chart:

Now since the relationship chart has been constructed it can be used as the main component and a powerful tool in laying down and designing the new plant layout. Since the closeness relations between the workstations are studied it would be much easier in deciding the positions of workstations in the plant.

Certain workstations which are far in the actual layout but should be close as per the activity relationship chart are:

- Stations 1-19(Oxygen Storage near entry gate/Cutting of raw material as per size): Oxygen cylinders should be stored directly near the usage spot so as to reduce the material handling. In our new layout we shall try to incorporate the oxygen storage nearest to the cutting spots as it shall reduce the cylinder handling.

- Stations 1-16(Gas storage/Oxygen storage): Since for cutting both the gases are required to be used together hence for the aesthetic appearance of the plant both the gas cylinders should be stored together in one place and not everywhere in the plant.

- Station 4, 6-36, 37(Finished product/Bend saw cutting machine straight and inclined): As the finished product is to be cut as per the requirements of the customers it is desired to be close and we shall plan the new layout accordingly.

- Station 13-18,22(Coal Storage/Coal Supply to both small and big furnace): The closeness between these work stations is absolutely desired since the working of furnace depends solely on the coal supply and if this process is man handled a lot of handling cost is incurred to the company thereby increasing its product cost. Hence in our proposal of the new plant layout we shall incorporate the coal storage in such a way that this cost is minimized.

5. Space requirements:

Big Furnace	= 174.46 m^2
Small Furnace	= 72.93 m^2
Raw Material Storage	= 260.76 m^2
Finished Product Storage	= 537.67 m^2
Cooling Bed	= 147.00 m^2
Workshop	= 238.00 m^2
Die Storage (Combine)	= 60.00 m^2
Small Mill stands	= 48.27 m^2
Big mill stands	= 73.47 m^2
Coal Storage	= 148.03 m^2
Cooling Water Storage	= 52.50 m^2
Office	= 55.08 m^2
Acid Pickling plant	= 48.40 m^2
Bright bar plant	= 154.00 m^2
Shearing Machine	= 16.10 m^2
Hammering	= 101.85 m^2
Cutting as per size	= 98.60 m^2
Workers Houses	= 99.20 m^2

3.2 Detailed study of benefits achieved due to layout change:

3.2.1 Crane Path Reductions:

At Pratap, two cranes are used. One crane is used at raw material side and one at the finished product side. In the existing layout, crane was made to travel through places where it was not required. Hence, there is unnecessary crane movement. On calculating, we found out that crane occupied a path of approx. 1191.56 m^2.

So we have designed the plant is such a way that crane path will be reduced and it will add to the efficiency of plant. In proposed layout, the crane will be required to operate only on the finished product side and very occasionally for unloading of raw materials in the raw material side. Hence by calculation, the crane is estimated to occupy a path of 678.4215m^2, hence enabling us to save an area of 513.1385m^2(1191.56-678.4215).

Also, when the crane path will be reduced, danger to workers is also reduced, because crane always has hanging parts which may prove fatal if it collides with a worker or machines. So, less the crane movement, less the danger to labour.

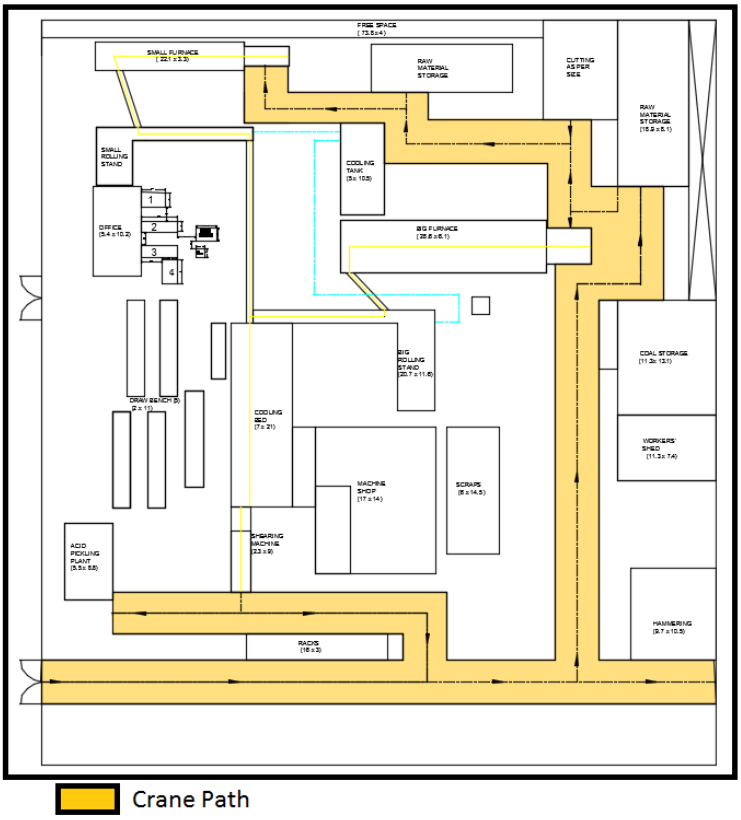

Figure 8: Existing Crane Path

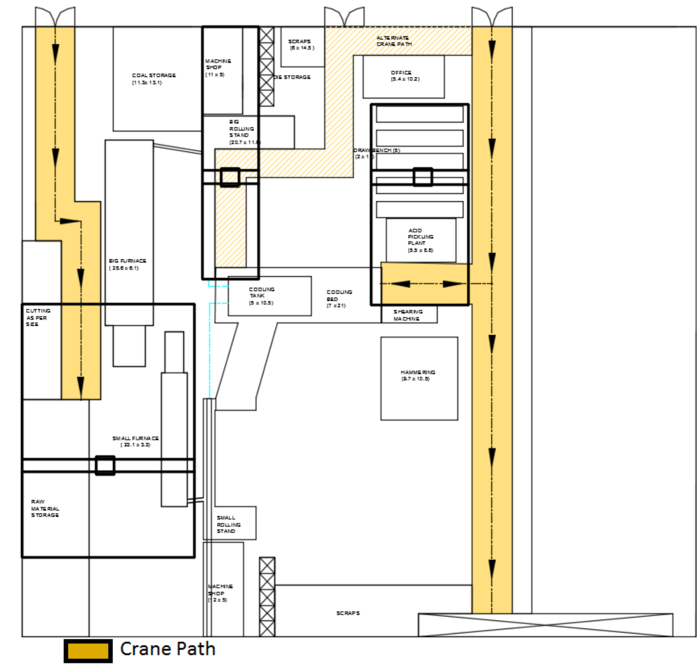

Figure 9: Crane Path in Proposed Layout

Raw Material Side Crane:

Rented at Rs. 50,000/- p.m.

Data:

#HydraCrane

Loading and unloading crane time is 5 and 2mins respectively.

Crane speed=10km/hr.

	Time (mins.)		Distance (mtr.)	
Unloading from container trucks and stacking in raw material area. Load-16 tones Frequency-Every alternate days early mornings.	1hr		-	
Picking up from raw material area bringing it in cutting area. Load-1 bundle of 4 pieces	0.13+7=7.13		21.76	
Picking up from cutting area and placing on the furnace push table.	Small Furnace	Big Furnace	Small Furnace	Big Furnace
	7.2742	7.07452	45.7	12.42

Table 1: Time and Distance for Hydra Cranes

#Electric overhead travel cranes:

Loading and unloading crane time is eliminated as magnetic lifters are proposed. Hydra crane is completely eliminated at raw material side.

Cost for 600kg magnetic lifter is Rs. 20,150. (New Man trading company, Sold at www.ebay.com)

EOT Crane speed=20m/min

	Time (mins.)		Distance (mtr.)	
Unloading from container trucks and stacking in raw material area. Load-16 tones Frequency-Every alternate days early mornings.	1hr		-	
Picking up from raw material area bringing it in cutting area. Load-1 bundle of 4 pieces	1.5		30	
Picking up from cutting area and placing on the furnace push table.	Small Furnace	Big Furnace	Small Furnace	Big Furnace
	0.66	0.325	13.2	6.5

Table 2: Time and Distance for EOT

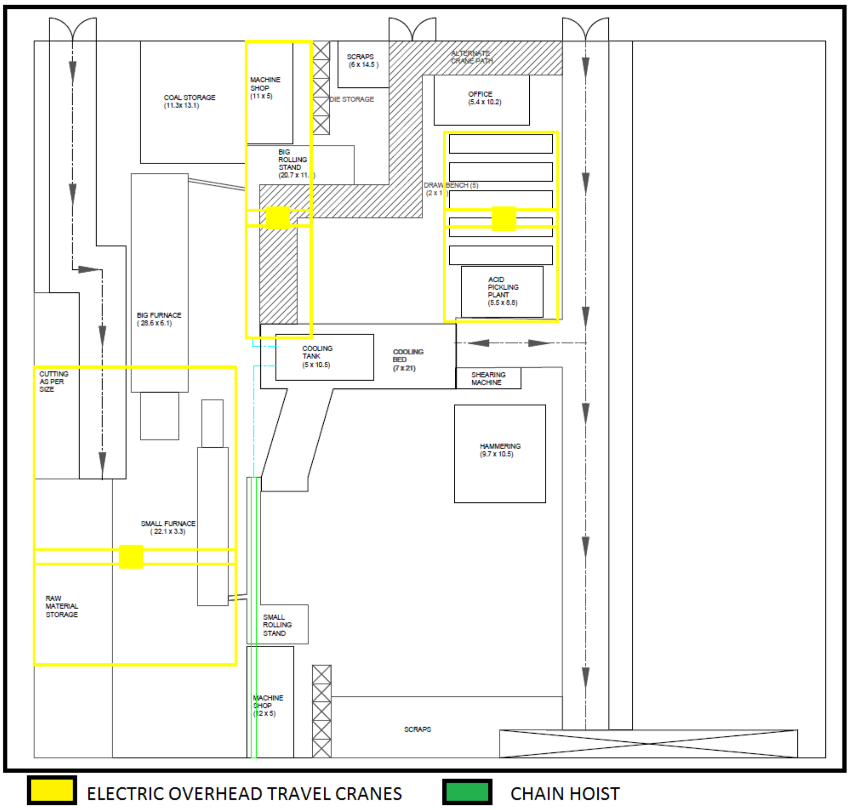

Figure 10: Proposed Layout for usage of EOT for Raw Material Entry to the Furnaces

Payback Calculations:

Cost savings per day: 50000/26=Rs.1923.07

Cost saving x Payback Period = Investment.

1923.07 x Payback Period = 20,150.

Therefore, Payback Period is 11 days.

Time Efficiency Calculations:

Efficiency calculated on proposed plant layout values.

Big Furnace:

$$\text{Efficiency}=\frac{Existing\ time\ value}{Proposed\ time\ value} \times 100|$$

=767.783%

Small Furnace:

$$\text{Efficiency}=\frac{Existing\ time\ value}{Proposed\ time\ value} \times 100|$$

=666.86%

Summary:

Raw Material Side crane				
	Big Furnace		Small Furnace	
	Existing	Proposed	Existing	Proposed
Distance (mtr.)	34.18	36.5	67.46	43.2
Time (min.)	14.204	1.825	14.404	2.16
Time Efficiency	767.783%		666.86%	
Cost Saving after 11 day Payback Period	Rs. 50,000 p.m.			

Table 3: Summary of Distance, Time and Cost saving by using EOT on Raw Material Side

Hence we saved Rs.50,000 per month by replacing the hydra crane with an EOT in the raw material side. Also the safety factor for the workers will be increased noticeably.

3.2.2 Die Changing EOT:

In the existing layout, the lathe workshop and milling stands are quite far away. So what workers do is, they dismantle the dies from the lathe onto a trolley and then transport it to the small mill stands. Also the flooring in Pratap is uneven and just adds up to the problems. For big milling stands, a Hydra crane does the above mentioned work of transporting the dies.

At present, the distance between the big milling stand and the first lathe machine is 10.36 m and between the small milling stands and lathe machine is 56.7 m.

So our proposal for this is to place the lathe machine near the milling stands which would be accessed by an EOT placed above both the lathes and milling stands. This EOT would also access the Roll out die storage on both the milling stands.

Hence, by incorporating this the time for assembly and disassembly would be considerably reduced, thereby reducing the tedious work for workers, since handling time is reduced.

Data:

- Lathe Workshop to Mill stands

	Distance(m)		Time(min)		Savings
	Existing	Proposed	Existing	Proposed	
Big Furnace	10.36	4.36	0.06	0.22	Crane operator and helper + Crane fuel
Small Furnace	56.7	4.54	1.5	0.23	2 Workers

- Mill stands to Die Storage

	Distance(m)		Time(min)		Savings
	Existing	Proposed	Existing	Proposed	
Big Furnace	28.63	15.01	10.15	0.09	Crane operator and helper + Crane fuel
Small Furnace	33.17	12.23	12	0.07	2 Workers

- Lathe Workshop to Die Storage

	Distance(m)		Time(min)		Savings
	Existing	Proposed	Existing	Proposed	
Big Furnace	28.63	2	0.17	0.1	Crane operator and helper + Crane fuel
Small Furnace	10	2	0.2	0.1	2 Workers

Summary:

	Existing Labour Requirements	Proposed Labour Requirements
Big Furnace	Crane operator (1) Crane Helper (1)	EOT Operator(1)
Small Furnace	Helper (2)	EOT Operator(1)

Table 4: Summary of labour saving by using a Die changing EOT

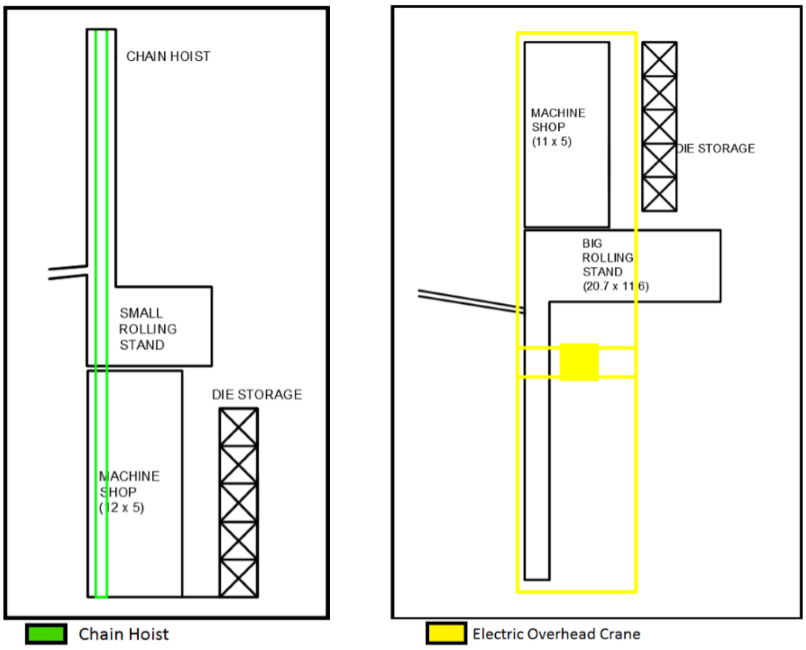

Figure 11: Proposed Usage of chain Hoist and EOT for Die Change and Storage at Both Stands

Hereby we eliminate the hydra crane for all die works. There by saving labour and utilizing the labour in an efficient way.

3.2.3 Die Storage:

Problem:

Dies are stored in this industry random fashion at various places. So in the present scenario, it is very difficult to access the dies and is quite a tedious job.

Troubleshooting:

So, one of the solutions to this problem is the use of Roll out Storage racks. Through online survey we came across a company called 'Rid Gurak'. This company manufactures Roll out storage racks for pressed rolling dies and can also be used for dies at Pratap.

The capacity of 1 rack is approx. 1300kgs which is well above the capacity of dies at Pratap viz. 200kgs per die Therefore 600kgs for per shelf.

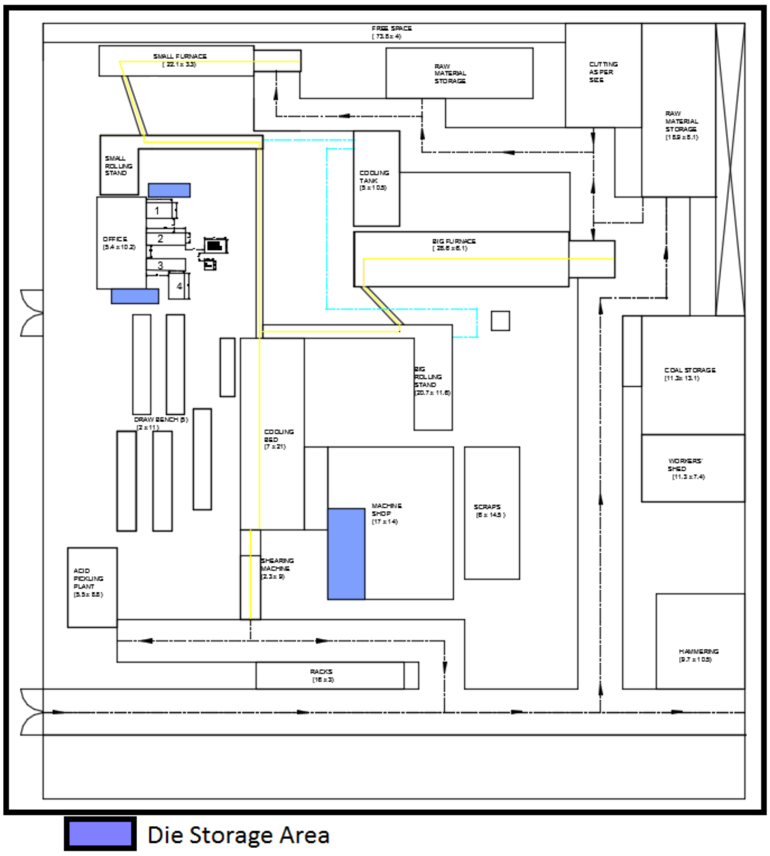

Figure 12: Die Storage in Existing Layout

Figure 13: Roll out Die storage racks for our proposal

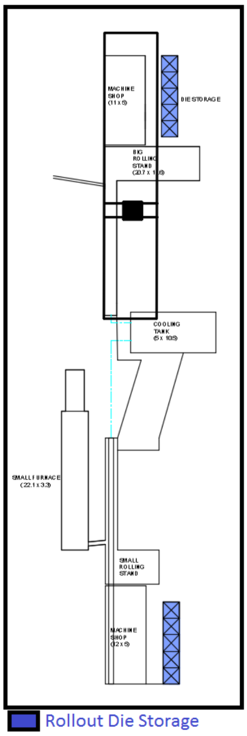

Figure 14: Proposed Die Storage Area

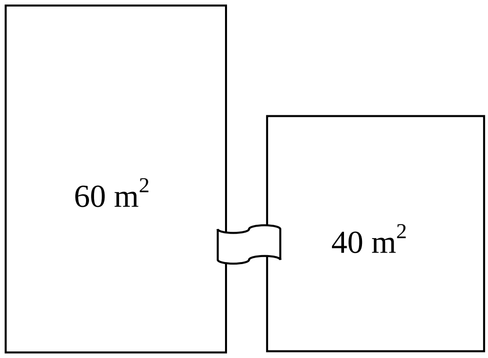

Figure 15: Block diagram showing reduction in area by usage of Roll out Storage racks

Area Savings:

Existing	Proposed
Area for die storage= $60m^2$	• Area for die storage= $20m^2$ (at 1 place) • Overall area of die storage= $40m^2$ (at 2 places)

Table 5: Area Saving by Using Roll out Storage Over stacking

3.2.4 Cooling Water Storage:

As per International Journal of Advanced Engineering Research and Studies, it is stated that cooling water storage should be located at the periphery of the plant as it hampers efficient movement in the plant.

At Pratap, Cooling water tank is situated somewhat in the middle and also it cannot be placed at the periphery as we have incorporated raw material storage at the same.

So our solution to this problem is placing the Cooling water tank beneath the Cooling bed, as Cooling bed is a table some level above the ground and area below the table is free or there is empty space.

Existing area (m^2)	Proposed free area (m^2)
52.5	52.5

Table 6: Area Saving by Laying Cooling Water tank below the Cooling bed

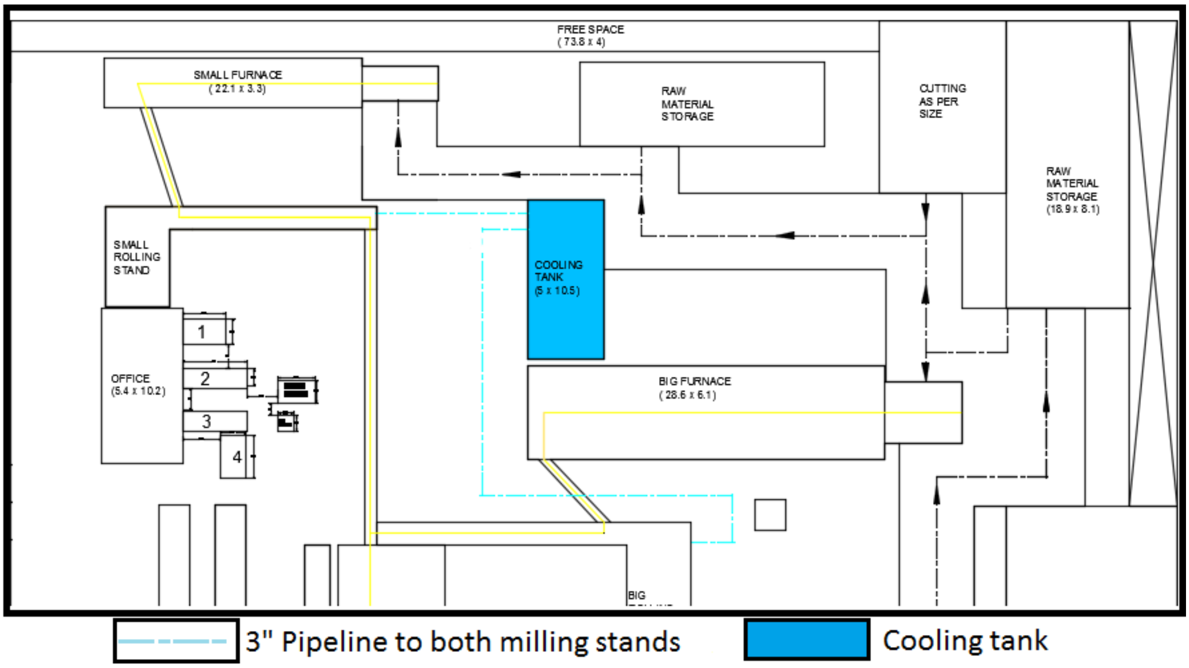

Figure 16: Existing Cooling water and pipe line layout

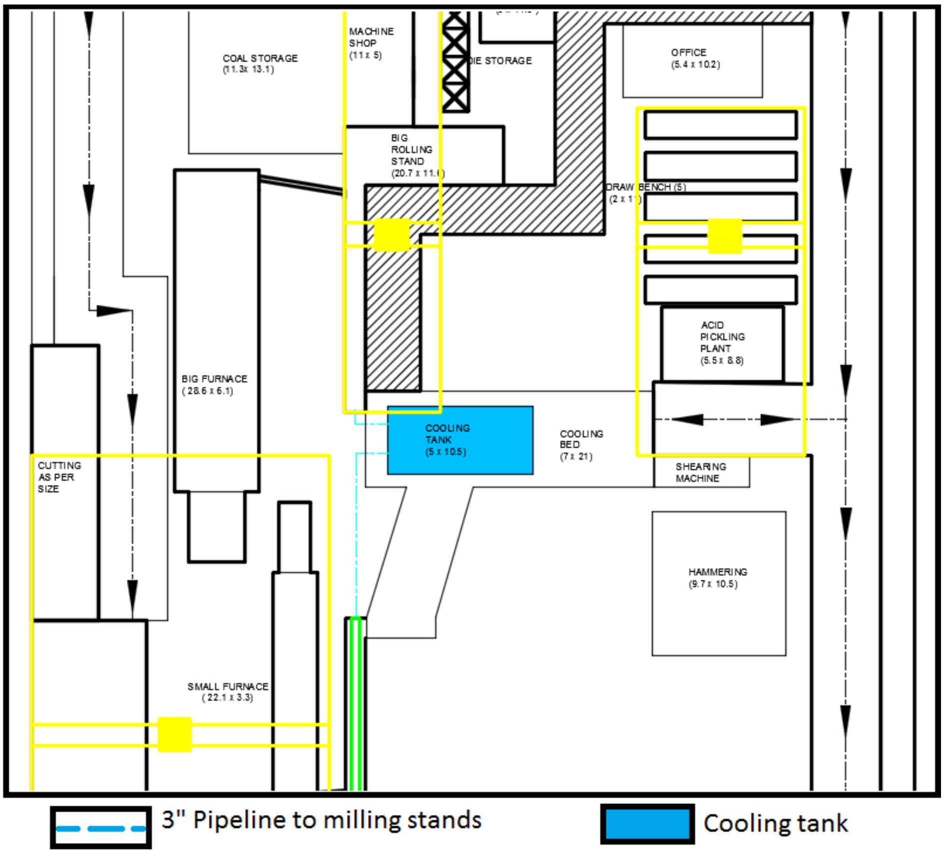

Figure 17: Proposed Pipe line and cooling water tank layout.

Water transportation cost saving Calculations:

Since the distances between the cooling water tank and stands have changed also the motor requirements to impart head to the water will change and hence the cost of this handling will also change. The cost calculations are as follows.

	Big Stands (m)	Small stands(m)	Discharge Q m^3/s
Existing layout pipe distance	34.12	9.9	0.025
Proposed layout pipe distance	3.4	14.27	0.025

Table 7: Distances between cooling water tank and mill stands in existing and proposed layout

Calculation of Motor Horsepower

Data

f=0.0863 f; friction for 3" pipe

Velocity in suction pipe = 3 m/s

Velocity in delivery pipe = 5.5 m/s

Big Stands Existing Calculations:

$H_s = h_s + h_{fs} + h_{fl} + \frac{\bar{v_s}^2}{2g}$

$= 3 + \frac{flv^2}{2gd} + \frac{3^2}{2*9.81}$; neglecting losses due to fittings.

$= 3 + \frac{0.0863*3*3^2}{2*9.81*0.762} + \frac{3^2}{2*9.81}$

$= 3.613$ m

$H_d = h_d + h_{fd} + h_{fl} + \frac{\bar{v_s}^2}{2g}$; head imparted to delivery is zero as pipe in horizontal plane.

$= \frac{0.0863*43.12*5.5^2}{2*9.81*0.762} + \frac{5.5^2}{2*9.81}$

$= 9.069$ m

$H = H_s + H_d$

$= 3.613 + 9.069$

$= 12.682$ m

$HP = \frac{W[Q]H_m}{\eta_{overall}}$

$= \frac{9810*0.025*12.682}{.7}$

≈ 6 HP

Big Stands Proposed Calculations:

$H_s = h_s + h_{fs} + h_{fl} + \frac{\bar{v_s}^2}{2g}$

$= 3 + \frac{flv^2}{2gd} + \frac{3^2}{2*9.81}$; neglecting losses due to fittings.

$= 3 + \frac{0.0863*3*3^2}{2*9.81*0.762} + \frac{3^2}{2*9.81}$

$= 3.613$ m

$H_d = h_d + h_{fd} + h_{fl} + \frac{\overline{V_S}^2}{2g}$; head imparted to delivery is zero as pipe in horizontal plane.

$= \frac{0.0863*9.93*5.5^2}{2*9.81*0.762} + \frac{5.5^2}{2*9.81}$

$= 3.274$ m

$H_m = H_s + H_d$

$= 3.613 + 3.274$

$= 6.88$ m

$HP = \frac{W[Q]H_m}{\eta_{overall}}$

$= \frac{9810*0.025*6.88}{.7}$

≈ 4 HP

Small Stands Existing Calculations:

$H_s = h_s + h_{fs} + h_{fl} + \frac{\overline{V_S}^2}{2g}$

$= 3 + \frac{flv^2}{2gd} + \frac{3^2}{2*9.81}$; neglecting losses due to fittings.

$= 3 + \frac{0.0863*3*3^2}{2*9.81*0.762} + \frac{3^2}{2*9.81}$

$= 3.613$ m

$H_d = h_d + h_{fd} + h_{fl} + \frac{\overline{V_S}^2}{2g}$; head imparted to delivery is zero as pipe in horizontal plane.

$= \frac{0.0863*3.4*5.5^2}{2*9.81*0.762} + \frac{5.5^2}{2*9.81}$

$= 2.131$ m

$H_m = H_s + H_d$

$= 3.613 + 2.131$

$= 5.744$ m

$HP = \frac{W[Q]H_m}{\eta_{overall}}$

$= \frac{9810*0.025*5.744}{.7}$

≈ 3 HP

Small Stands Proposed Calculations:

$H_s = h_s + h_{fs} + h_{fl} + \frac{\bar{V_S}^2}{2g}$

$= 3 + \frac{flv^2}{2gd} + \frac{3^2}{2*9.81}$; neglecting losses due to fittings.

$= 3 + \frac{0.0863*3*3^2}{2*9.81*0.762} + \frac{3^2}{2*9.81}$

= 3.613 m

$H_d = h_d + h_{fd} + h_{fl} + \frac{\bar{V_S}^2}{2g}$; head imparted to delivery is zero as pipe in horizontal plane.

$= \frac{0.0863*14.27*5.5^2}{2*9.81*0.762} + \frac{5.5^2}{2*9.81}$

= 4.03 m

$H_m = H_s + H_d$

= 3.613 + 4.03

= 7.643 m

$HP = \frac{W[Q]H_m}{\eta_{overall}}$

$= \frac{9810*0.025*7.643}{.7}$

≈ 4 HP

	Small stands			Big stands			
	HP	KWH	Cost/Day (Rs/day)	HP	KWH	Cost/Day (Rs/day)	Total cost/day (Rs/day)
Existing	3	26.856	188.26	4	53.712	376.52	564.78
Proposed	6	35.808	251.01	4	35.808	251.01	502.02
Savings/day (Rs/day)							**62.76**

Table 8: Summary of motor size requirements and overall cost saving achieved by cooling tank placement

Summary:

Monthly Savings = Savings/Day x Working Days

= 62.76 x 26

= Rs 1,631.76

Annual Savings = Monthly Savings x 12

= 1631.76 X 12

Annual Savings = Rs 19,581.12

3.2.5 Coal Handling:

As per the inference from the activity relationship chart we see that the distance between coal storage and the coal supply unit of the furnace is too far. This adds on to the time of supply of pulverized coal and also cost due to the manual handling by semi-skilled lab ours. This could be taken care by planning the layout in such a way that all the coal is stored near supply unit of the furnace and hence there is a reduction of time in the handling of powdered coal to the air injection system of the furnace.

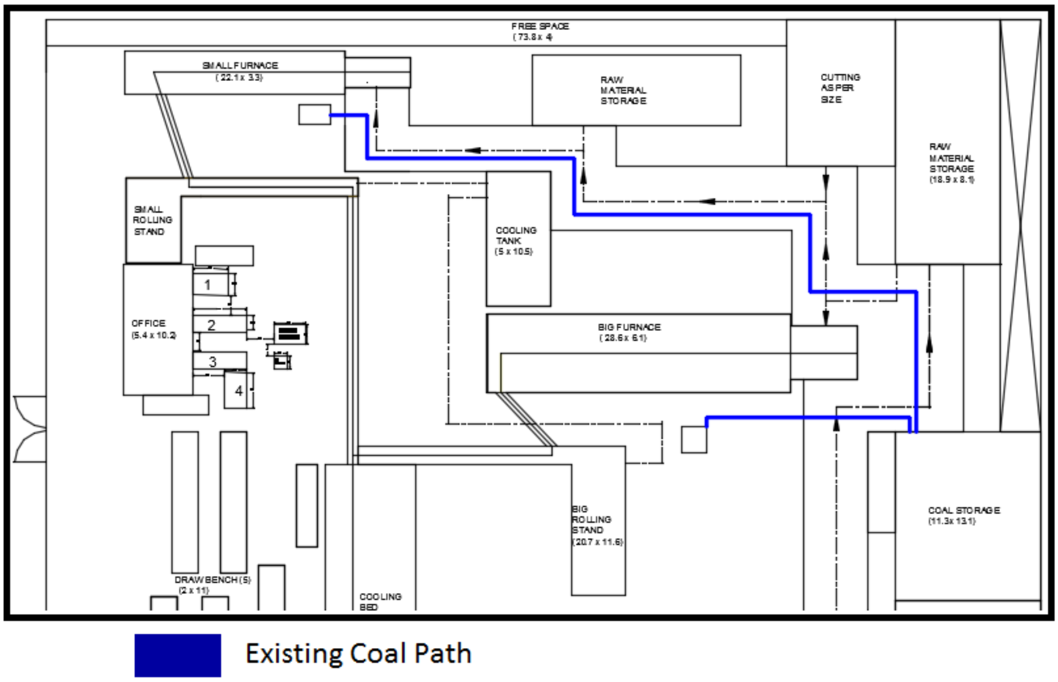

Figure 18: Existing Coal Handling Path

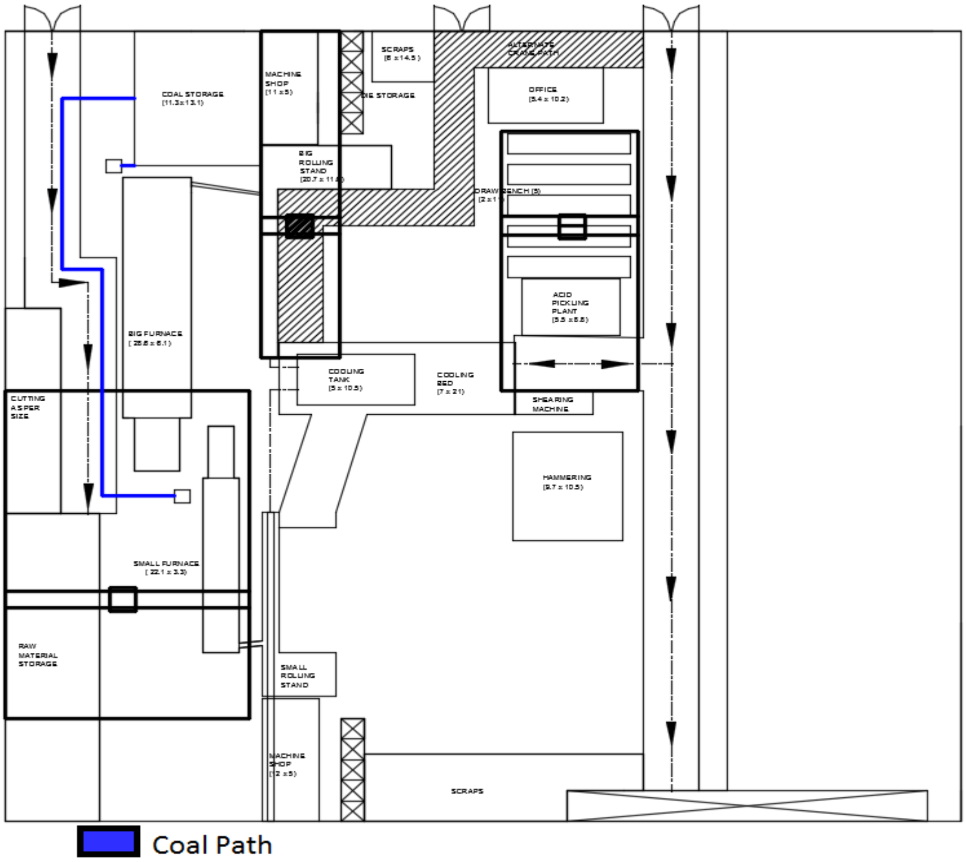

Figure 19: Proposed Coal Handling Path Showing a Decrement in Distance of Travel

Overall Time Saving calculations:

Total time required in existing plant for both Furnace =5.66+1.2 =6.86 min

Total time required in proposed plant for both Furnace =3.89+.091=3.981 min

Overall time saving (%) $= \frac{\text{Total time required in existing plant for both Furnace}}{\text{Total time required in proposed plant for both Furnace}} \times 100$

$$= \frac{6.86}{3.981} \times 100$$

$$= 58.03\ \%$$

Summary:

	Existing Path Distance		Proposed Path Distance	
	Distance (m)	Time Measured from Stopwatch (min)	Distance (m)	Time Calculated by Unitary Method (min)
Small Furnace	68.95	5.66	47.5	3.89
Big Furnace	14.61	1.2	1.12	0.091
Overall time saving (%) calculated on proposed plant timings				**58.03**

Table 9: Distance and time savings in Coal handling path in Proposed and existing layout

3.2.6 Finished Product Storage

At Pratap Re-Rollers maximum space is occupied by storing of finished and raw material. Approx. 539 sq. m. is used for storing finished products. This finished raw material is stacked in 2 levels which is very difficult to access. We shall incorporate Cantilever Racks from Cisco eagle which at a cost of 2200$ would store up to 27.5 tones in four arm levels in double sided arrangement. The cost of an adder would be 1250$. The cost is all inclusive of delivery and the installation could be done by a local civil contractor and mechanical foremen. The cost of installation could be negotiated and deducted from the final bill as the cost is also inclusive of installation. This would create an area of 539 sq. m. By just using 185 sq. m. Also eliminating all the scrap in the plant and having a dedicated storage for dies will create a lot of space for further expansion

.

Figure 20: Cantilever racks for proposed storage of finished Products

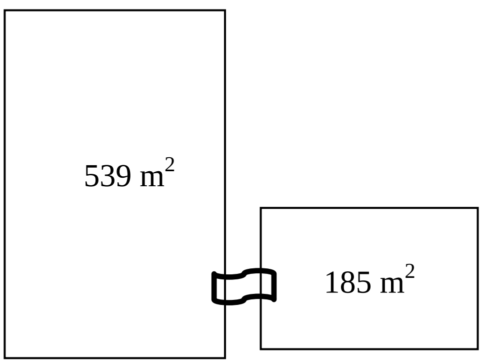

Figure 21: Block diagram showing reduction in area by usage of cantilever racks

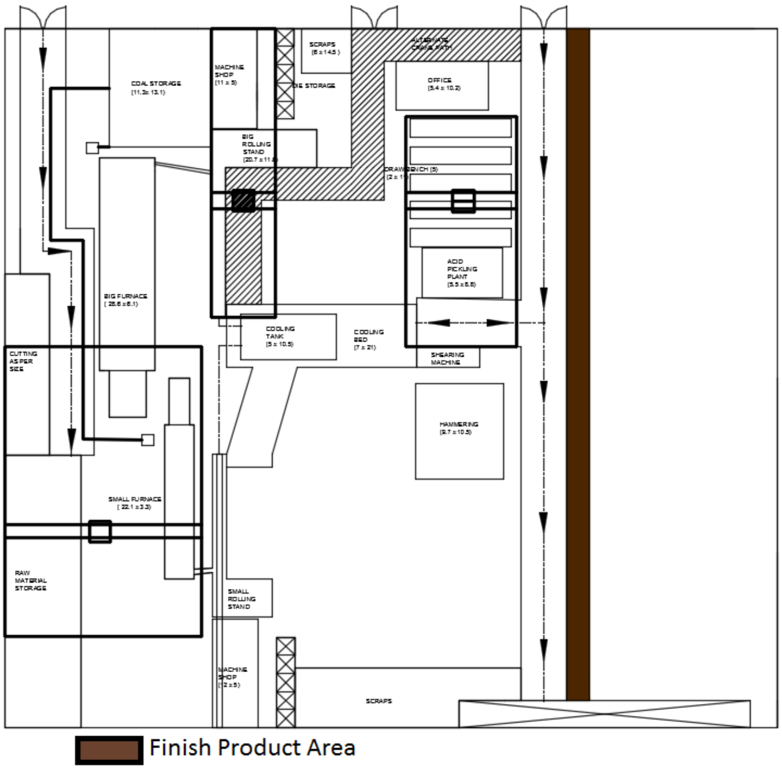

Figure 22: Proposed Layout Showing Finished Product Area

Hence, we have saved an area of 354 sq. mt. (i.e. 539-185=354 sq. mt.). By using cantilever rack arrangement.

3.2.7 Reduces Material Handling Time and Cost:

As per our new proposed layout the distance between the material storage area and furnace push table has decreased quite with a notable value. The table below shows a detailed report for it. Also as the distance travelled will decrease it's quite sure the travelling time will decrease and if the time decreases then cost shall also decrease.

Distance Efficiency Calculations:

Efficiency calculated on proposed plant layout values.

Big Furnace:

Efficiency $= \frac{Existing\ distance\ value}{Proposed\ distance\ value} \times 100$

=52.33%

Small Furnace:

Efficiency $= \frac{Existing\ distance\ value}{Proposed\ distance\ value} \times 100$

= 28.88%

Summary:

	Small Furnace	Big Furnace
Distance travelled for reach (Existing) in mtr.	45.7	12.42
Distance travelled for reach (Proposed) in mtr.	13.2	6.5
Distance Efficiency	28.88%	52.33%

Table 10: Distance travelled savings in existing and proposed layout in raw material entry

Chapter 4 - Results

4.1 Proposed Plant Layout:

Executive Summary/ Results:

It is very clear from the below diagrams that after the plant is laid down using the "Systematic Layout Planning" by Muthur an area saving of 1536 sq. mt. is achieved. This area can be effectively be used for future expansion, stocking of raw material and finished products in times of demand fluctuations or raw material cost decrement. This new proposed layout not only creates space but shows us the exact amount of land to be purchased as land is the heavy source of capital expenditure. Hence, we could save large sum of money if we purchase land in 10% range of the required land.

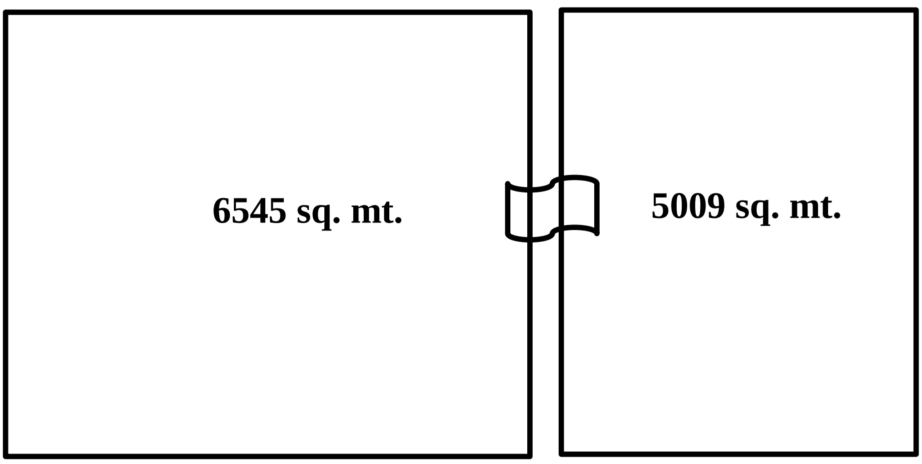

Figure 23: Block Diagram Showing Reduction in Area by Relocating Current Workstations and Spaces

Also having a plant laid down systematically has many benefits out of which some are enumerated below in context to the current plant.

1) Material Handling distance, time and hence cost reduces.
2) Efficient utilization of labour.
3) High Machine utilization.
4) Ensures Employee safety and health.
5) Efficient Utilization of area.

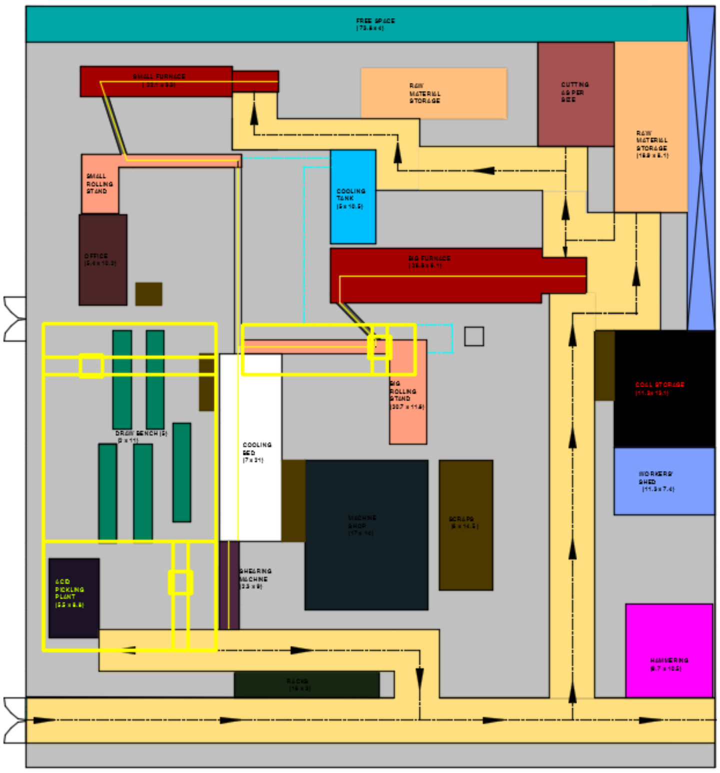

Figure 24: Existing Plant Layout at Pratap Re-Rollers Pvt. Ltd.

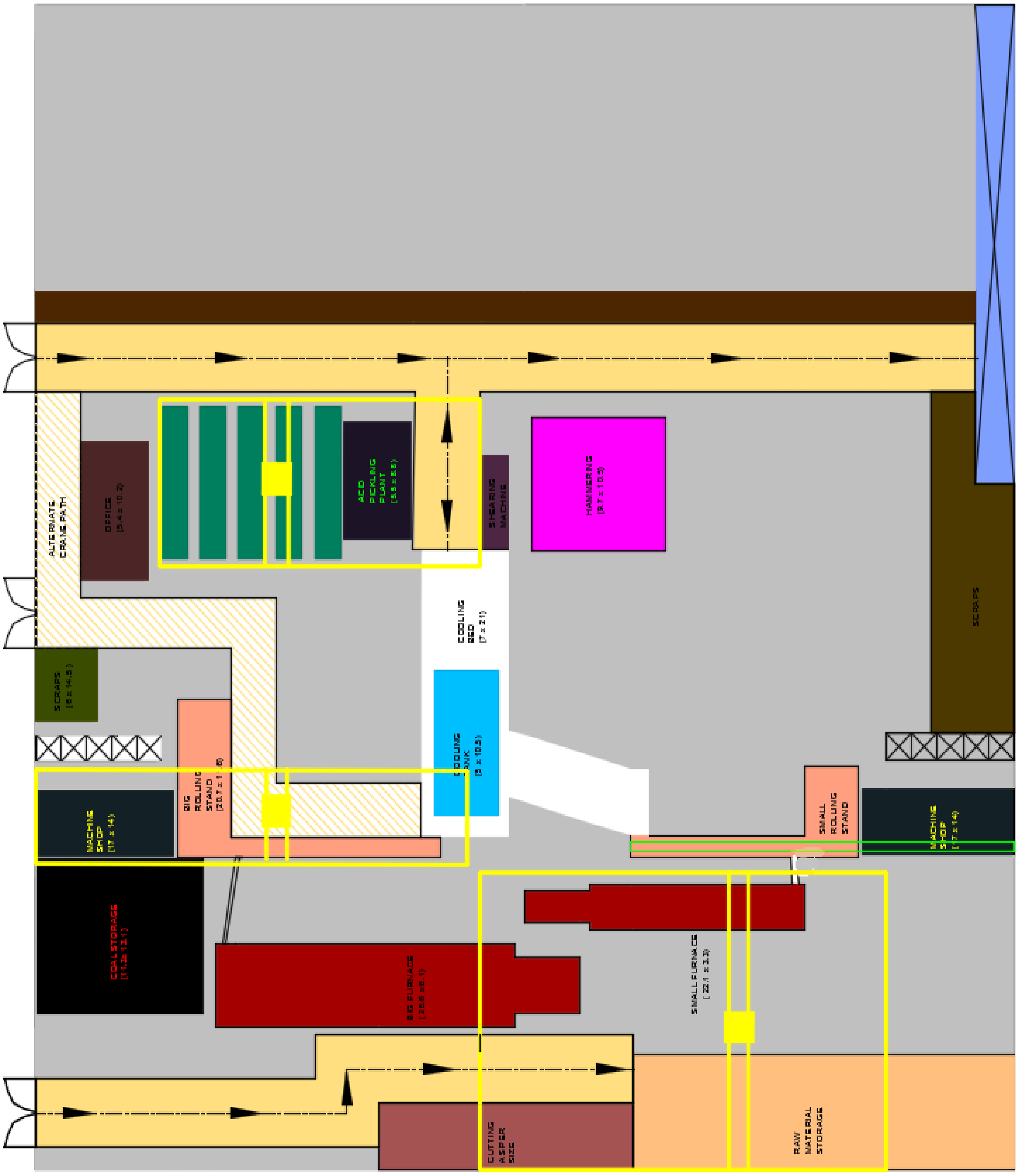

Figure 25: Proposed Plant Layout for Pratap Re-Rollers Pvt.Ltd.

Executive Summary:

Sr. No	Parameter	Existing Plant	Proposed Plant	Advantages Achieved
1.	Coal Handling	83.56m	48.62	1. Material Handling distance, time and hence cost reduces. 2. Efficient utilization of labour.
		58.03% Time Savings		
2.	Crane Path	1191.56m^2	678.4215m^2	1. Ensures Employee safety and health. 2. Efficient Utilization of area.
		513.1385m^2		
3.	EOT in Raw Material Side	14.34 min	0.985 min	1. Ensures work proceeds without delay. 2. Efficient utilization of labour. 3. Ensures Employee safety and health. 4. High Machine utilization.
		Rs. 6,00,000 saving/year.		
4.	Cooling Water	44.02m	17.67m	1. Cost decrease on handling. 2. Efficient Utilization of area.
		Rs.19,581 saving /year.		
5.	Die Storage and Retrieval	60 m^2	40 m^2	1. Decreases cost on Handling. 2. Efficient Utilization of area. 3. Efficient utilization of labour.
		Saving of 2 helpers a day (Approx. 2,88,000/year)		
6.	Cantilever Racks	539 m^2	185 m^2	1. Efficient Utilization of area.
7.	Raw Material Entry	58.12m	19.7m	1. Material Handling distance, time and hence cost reduces.
8.	Total Area Required	6545m^2	5009m^2	1. Efficient Utilization of area.

Table 11: Overall Summary achieved in plant due to Changes made

4.2 Workshop Shifting Plan First Proposal:

This plan had to be changed as a space reduction constraint was added up by the industry management after the proposal of this plan. These plans were made for the immediate shifting of the lathe workshop at the industry.

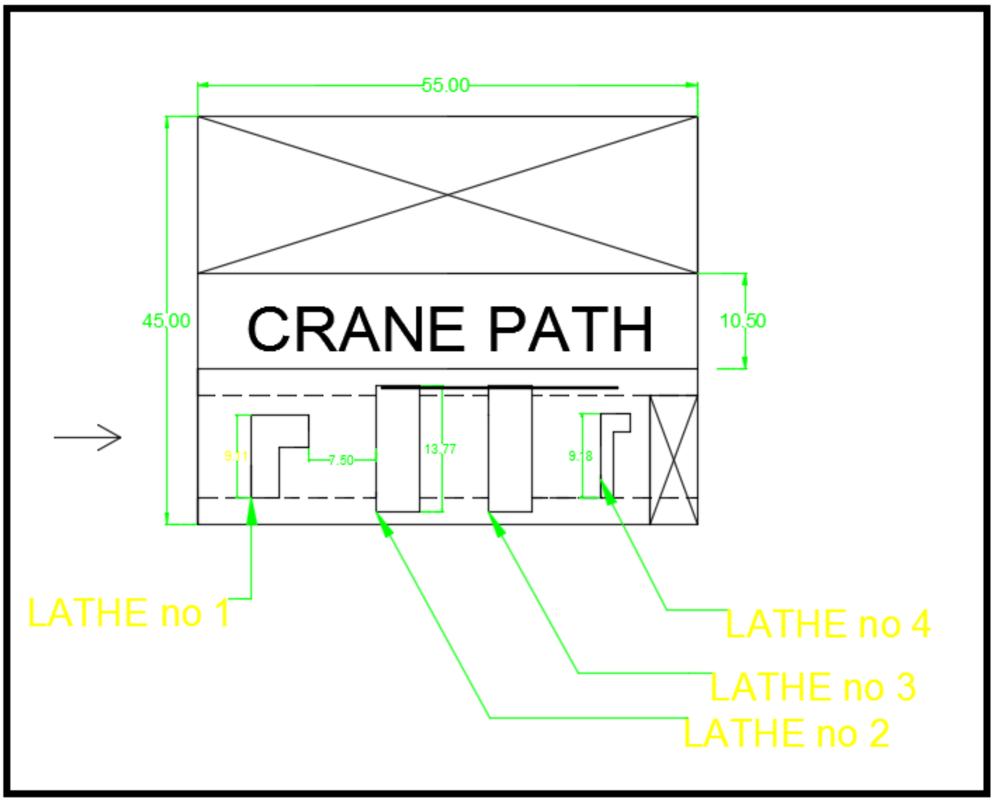

Figure 26: Proposed First Workshop Layout

4.3 Workshop shifting plan second proposal:

This plan was accepted by the management as all the space constraints were taken care off by us in the designing of this layout.

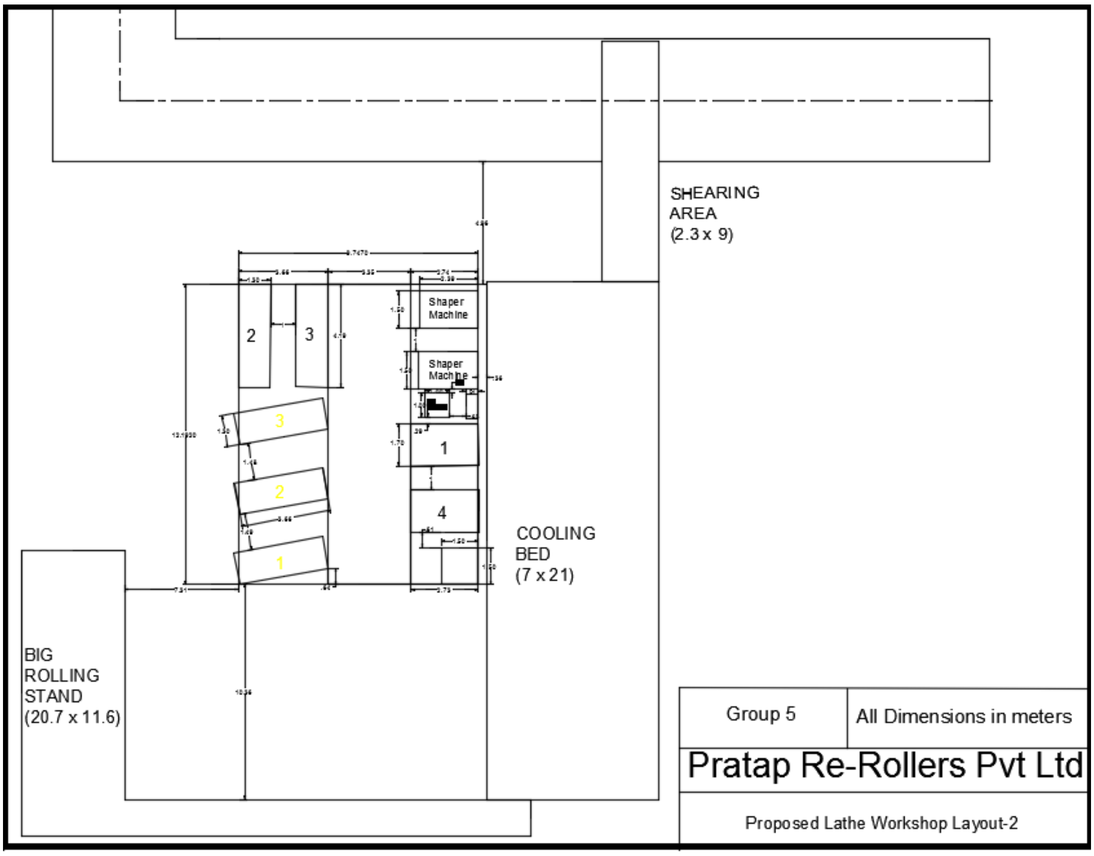

Figure 27: Proposed Second Workshop Layout

Chapter 5 - Conclusion

5.1 Conclusion

As per the summary in the results, a lot of saving on the material handling time and cost was achieved successfully by proposing a completely new layout. This is of extreme importance to the company as it would help them to achieve a competitive edge in market in terms of pricing as well as timely productions. Also, a lot of area was created which will help the plant to have scope for future expansion as well as stocking of raw materials and finished products to a larger extent. This was just achieved by changing the current layout and relocating workstations and spaces without outright purchase of any new machinery or equipment. Hence all of these advantages were just achieved with usage of the current machinery without levying heavy expenditure to the industry.

5.2 Future scope

5.2.1 Mill Stands:

Pratap Re-Rollers is a medium scale industry and a completely labour oriented one. About 3 workers are required at each mill stand to give the hot metal a pass. These workers can be reduced by placing each mill stands one after the other such that their axes coincide. This is an option which is always open to the industry management but will require purchase of new rails and mounting gear for the mill stands.

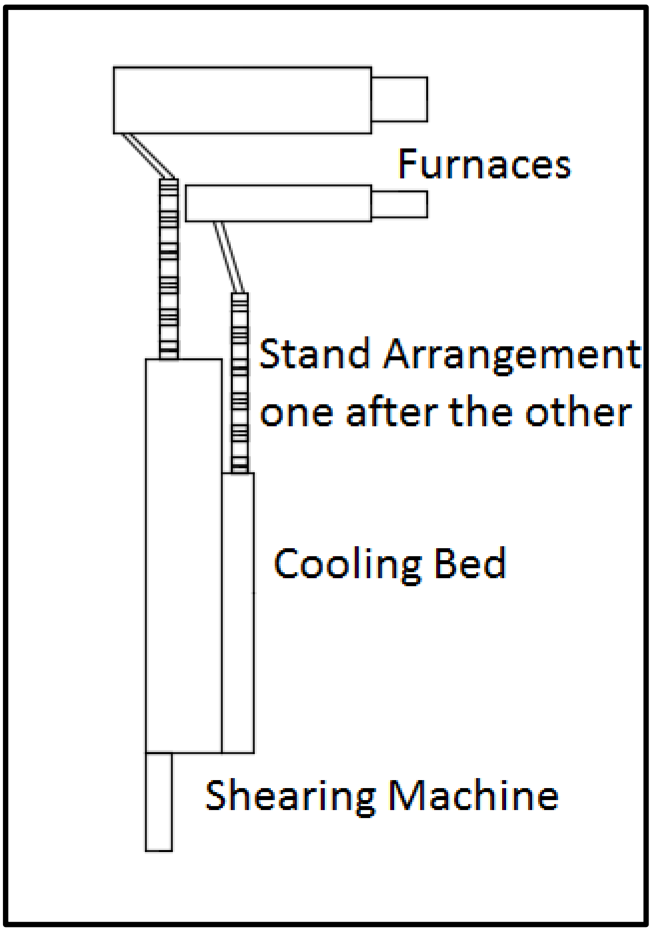

Figure 28: Proposed Future Scope for Mill Stands

5.2.2 Centralized Gas Cutting Plant:

It is also been seen that the plant uses LPG and Oxygen gas for the cutting process of raw material, cutting of ends on the production line, cutting of pointed ends of the steel bright plant, cutting parts for maintenance near the mill stands. These gases are supplied in cylinders weighing approximately 45 kg for commercial LPG cylinder and 30 kg for 1500 litres of oxygen cylinder. These cylinders are transported throughout the plant via manual handling this practice also shows sign of imperfect plant layout. This problem can be solved by having a gas distribution line thorough out the plant such that the pipes can be fitted on various positions where the cutting processes take place. This would reduce the handling of heavy cylinders in the plant by skilled labours.

We have proposed a centralized gas layout. This gas line will be laid down by a Central Gas cutting line Layout Company which will inspect the area and then quote the management respectively. This line shall be having outlets at many points which could be accessed throughout the plant. This central gas line will reduce the labour handling of gas cylinders efficiently and will also be safe in case of emergency.

Chapter 6 - Bibliography

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