A PROJECT REPORT
ON

"OPTIMIZATION OF PLANT LAYOUT & IMPLEMENTATION OF 5S"

Submitted by

PURKAR TALHA (15DME135)

MEMON SADDAM (15DME134)

MIRZA A. RAHIM (15DME150)

RAHEMAN ZIYAUR (15DME136)

In partial fulfilment for the award of the Degree
Of

BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING

UNDER THE GUIDANCE OF

Prof. RAHUL RAMESH THAVAI

DEPARTMENT OF MECHANICAL ENGINEERING
ANJUMAN-I-ISLAM'S
KALSEKAR TECHNICAL CAMPUS
SCHOOL OF ENGINEERING & TECHNOLOGY
NEW PANVEL, NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2017-2018

A PROJECT REPORT
ON

"OPTIMIZATION OF PLANT LAYOUT & IMPLEMENTATION OF 5S"

Submitted by

PURKAR TALHA (15DME135)

MEMON SADDAM (15DME134)

MIRZA A. RAHIM (15DME150)

RAHEMAN ZIYAUR (15DME136)

In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING

UNDER THE GUIDANCE OF

Prof. RAHUL RAMESH THAVAI

DEPARTMENT OF MECHANICAL ENGINEERING
ANJUMAN-I-ISLAM'S
KALSEKAR TECHNICAL CAMPUS
SCHOOL OF ENGINEERING & TECHNOLOGY
NEW PANVEL NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2017-2018

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS, NEW PANVEL

(Approved by AICTE, recognized by Maharashtra Govt. DTE)

Affiliated to Mumbai University

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI- 410206
Tel.: +91 22 27481247/48 * Website: www.aiktc.org

CERTIFICATE

This is to certify that the thesis entitled

"OPTIMAZATION OF PLANT LAYOUT & IMPLEMENTATION OF 5S"

Submitted by

PURKAR TALHA (15DME135)

MEMON SADDAM (15DME134)

MIRZA A. RAHIM (15DME150)

RAHEMAN ZIYAUR (15DME136)

To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by them under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

Internal Examiner
(Prof. Rahul Thavai)

External Examiner

Head of Department
(Prof. Zakir Ansari)

Principal
(Dr. Abdul Razzak Honnutagi)

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recognized by Maharashtra Govt. DTE)

Affiliated to Mumbai University

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI- 410206
Tel.: +91 22 27481247/48 * Website: www.aiktc.org

APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

"OPTIMAZATION OF PLANT LAYOUT & IMPLEMENTATION 5S"

Submitted by

PURKAR TALHA (15DME135)

MEMON SADDAM (15DME134)

MIRZA A. RAHIM (15DME150)

RAHEMAN ZIYAUR (15DME136)

In partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering, as prescribed by University of Mumbai approved.

(Internal Examiner) **(External Examiner)**

Date: __________

ACKNOWLEDGEMENT

After the completion of this work, we would like to give our sincere thanks to all those who helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound gratitude to our guide **Prof. Rahul Thavai** whose constant encouragement enabled us to work enthusiastically. Their perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

We take this opportunity to give sincere thanks to **Mr N. Jyoti kumar** Managing Director in *NEXA PVT.LTD, MUMBAI*, for all the help rendered during the course of this work and their support, motivation, guidance and appreciation.

We are thankful to **Dr. Abdul Razzak Honnutagi**, Kalsekar Technical Campus New Panvel, for providing an outstanding academic environment, also for providing the adequate facilities.

we would also like to thank all the staffs of Kalsekar Technical Campus (Mechanical Engineering Department) for their valuable guidance with their interest and valuable suggestions brightened us.

PURKAR TALHA (15DME135)
MEMON SADDAM (15DME134)
MIRZA A. RAHIM (15DME150)
RAHEMAN ZIYAUR (15DME136)

List of Figures

List of Tables

ABSRACT

The objective of this thesis is to improve the production floor layout of a manufacturing firm using systematic layout planning (SLP) and implement 5s. This project is conducted at NEXA PVT. LTD. MUMBAI various Aviation and Marine equipment's parts manufacturing company located in at New panvel. The major problem faced by the company is inventory control, store management, poor utilization of space, poor material handling and safety hazards. There is high flow intensity between departments which have high interrelationship. This leads to high travelling time and high travelling cost which in turns decreases overall productivity of the company. An alternative layout is proposed using the 11 steps in Systematic Layout Planning, which is a systematic way of generating layout alternatives. The proposed layout involves transferring the departments which have high interrelationship close to each other. The proposed alternative layout is evaluated later. The layout is chosen based on the performance measures which have the most significant improvement, which are total travel distance, total travel time, output, average resource utilization, total average WIP level, total average waiting time and total time spent in manufacturing certain product either job order or in batches.

Table of Contents

Chapter 1

Introduction

1.1 Background of Problem

In the 21st century business world, companies are exposed to continuous challenges. One of it is to equip organizations with the ability to compete in a global marketplace. Schonberg states that world class performance is dedicated to serving the customer. Thus, to keep track of performance, organizations must develop measures of performance. The current trend in the industry, which is experiencing very competitive era like many others is striving hard to reduce manufacturing costs, improve quality and customer satisfaction.

Materials handling equipment and the facilities it operates can contribute to as much as 70 percent of the total cost of the manufactured product. Facilities layout design is part of facilities planning. It is the arrangement of work space which, in general terms smoothest way to access facilities that have strong interactions. The main concern with the plant facility layout planning is to reduce the cost of materials handling as poor materials handling can generate business problems. The best material handling is no handling. Subsequently, a good layout will enable the manufacture of the product economically in the required volume and variety. Other objectives can be stated as effective utilization of manpower, space and infrastructure, as well as providing overall wellbeing and morale of the work.

Today s manufacturing industry is facing problems that have been growing and complexity over the last several years. As a result, there is an immediate need for procedures or techniques in solving various problems encountered in today's manufacturing arena without extended shutdown's or expensive modifications (Clark,1996). Based on the above facts, it is obvious that layout optimization & 5S is crucial to any facility planning. If not tackled in the early phases, it can generate logistics implications for the company involved.

1.2 Problem Statement

NEXA MUMBAI various Aviation and Marine Equipment Company located in at New panvel. The products are manufactured by going through various processes. The plant suffers from poor utilization of workspace, poor material handling and safety hazards. Also, placement of raw materials hinders manufacturing process. Processes which have high interdependency are not located close to each other. This causes high travelling time for the operator.

Fig. 1.1 Poor Utilization of Space

Fig 1.2 Poor Placement of in-process Inventory

1.3 Proposed System

In response to the above problems, the need for facilities layout optimization is essential to achieve the manufacturing goals of the company. This thesis proposes to use Systematic Layout Planning (SLP) as the infrastructure for layout optimization & Implementation of 5S for better production. The factory performance improvements are in terms of cycle time reduction, productivity increase, reduction in travelling cost and reduction in travelling distance.

1.4 Objective

- ❖ To study the current flow pattern and relation of overall plant layout.
- ❖ To develop a new plant layout.
- ❖ To propose an appropriate material storage system.
- ❖ To study and identify problems at work area.
- ❖ To implement 5S practices among the employees.
- ❖ To measure the improvement after implementing 5S practices.

1.5 Scope

In this thesis, the case study is limited to production floor area of NEXA MUMBAI. This work focuses on improving the facilities design of the production floor. The layout of the production is process oriented layout. The Systematic Layout Planning (SLP) methodology will be utilized in this case study as part of the strategy to portrait the relationship between each department to generate improved layout alternatives.

1.6 Significance of Study

An approach from Muther (1973), Systematic Layout Planning (SLP) is used as the improvement method. It uses a graphical representation and builds up a proximity matrix which represents the closeness of each facility. Flowcharts can also be developed showing quantitative relationships. From the above proximity matrix, a trial and error process can be used to generate the layout.

This case study which focuses on manufacturing activities in the filter industry can also be easily applied with minimal modification in other types of facilities such as offices where workflow processes may be present. Thus, the model described possesses a general applicability in other domains that can be achieved through mapping of equivalent governing parameters to those that have been identified in the manufacturing sector.[1]

1.7 5S Strategy

5S is a strategy for attaining workplace organization and cleanliness, and it will improve quality, productivity and moral than any other lean manufacturing improvement. fishbone diagram shows various phases of 5S methodology. In each phases we have describe the problem by using this phases we have solved the store management problem.

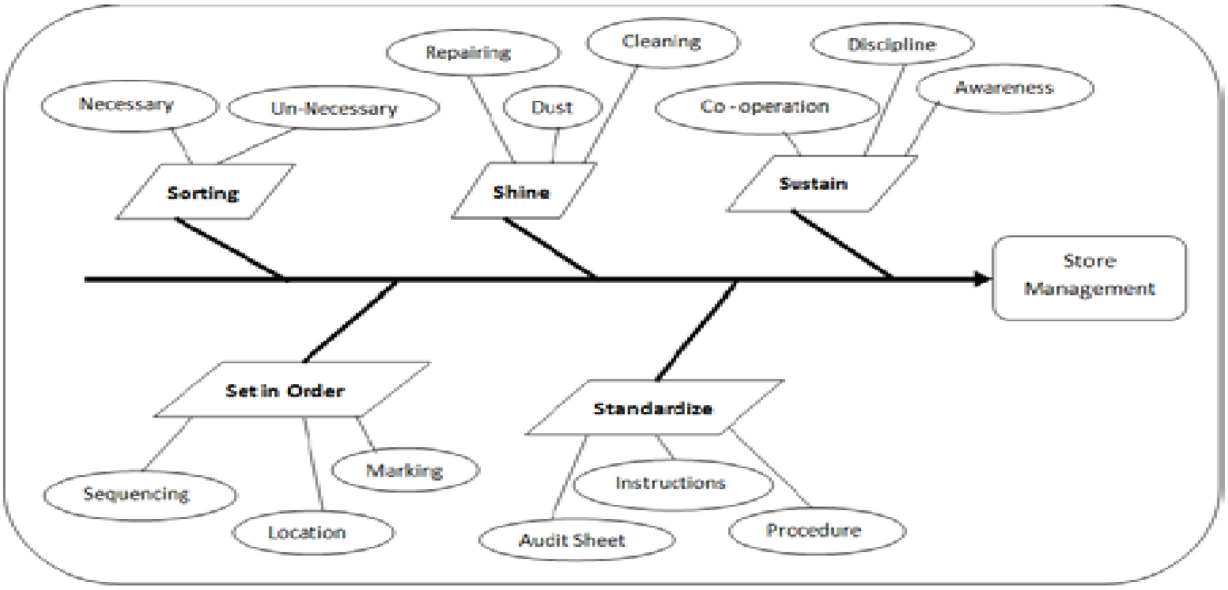

Fig. 1.3 Fishbone Diagram

1.8 Company Background

1.8.1 Introduction - NEXA MUMBAI

Established in the year 2004. NEXA MUMBAI various Aviation and Marine equipment company located in at New panvel. The products are manufactured by going through various processes. The highest qualities of raw material and cutting-edge techniques have been utilized in the manufacturing process to ensure the quality. Raw material has been procured from some of the genuine vendors of the market.

1.8.2 General Information

Having profound knowledge in the respective domain, they are occupied in providing superior quality assortment of products. Our prompt delivery, ethical business practices, customized solutions and competitive prices makes us highly esteemed business name in the industry. Moreover, to accomplish bulk orders of our customers, our dedicated professionals are working in sync with them. Some other factors of our firm are:

- Industrious professionals
- International quality standards
- Customer-oriented approach
- Industry leading prices
- Ethical business practices

1.8.3 Plant Layout of Company

The fig. shows the dimensional layout of the industry. In this the constraints areas are clearly mentioned.

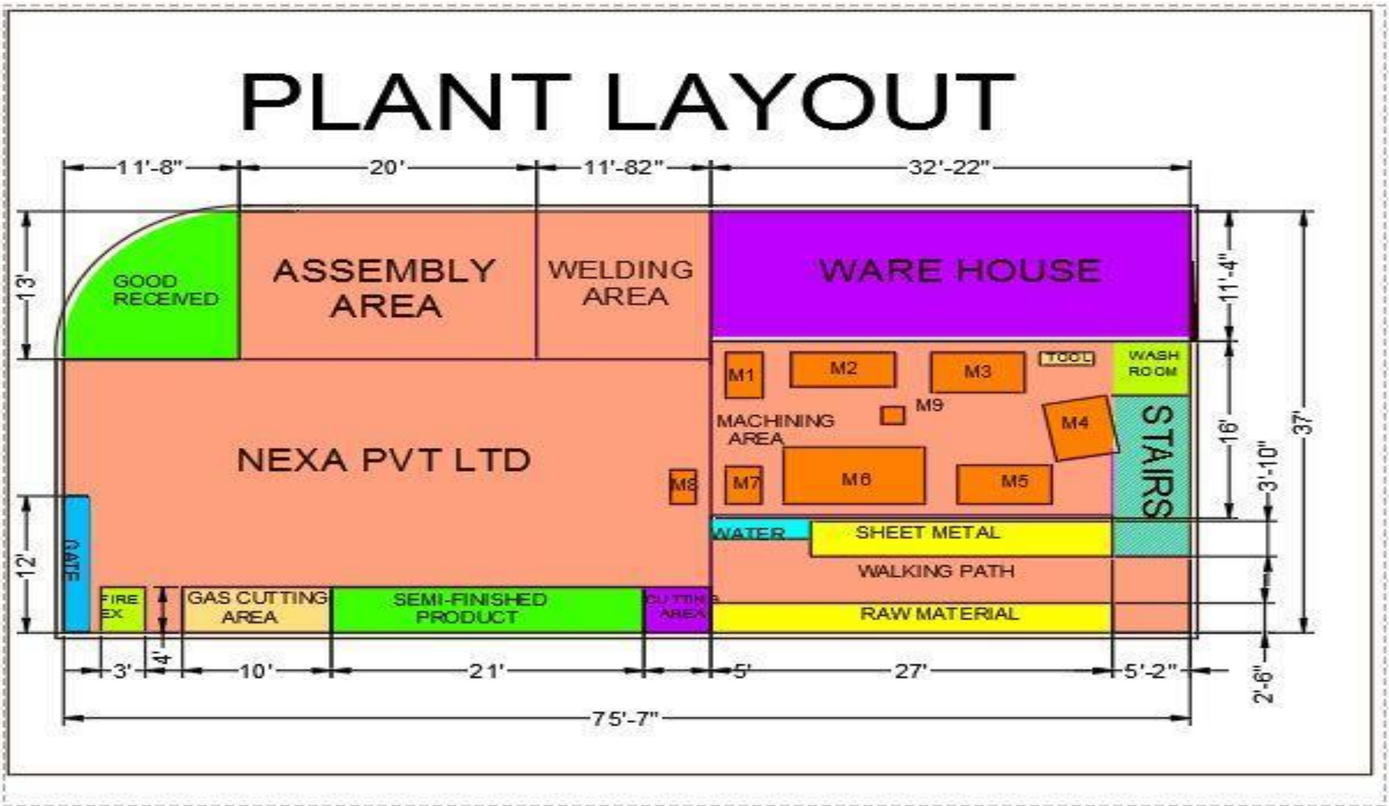

Fig. 1.4 Existing Layout of Company

1.9 Conclusion

In the beginning of this chapter, an overview of the facilities layout planning and its importance to existing companies is written to further enhance the importance for using it as the main principle for this project. The objectives are also defined to be linked to the deliverables in this case study. The boundary of this project is also defined based on the statement of problem. Some justifications of conducting this case study and its importance is also discussed.

Chapter 2

Literature Review

2.1 Summary of Literature:

Sr. No	Title and Author	Methodology	Finding
01	Layout design for Low capacity manufacturing Line - A case study Flippo De Carlo.	Empirical	In the present work, the results of a fashion manufacturing line relayout were compared by analysing the current situation with the solutions provided by a homemade company design, both through a systematic layout planning approach and a lean reengineering activity.
02	A Heuristic procedure for the integrated facility layout design and flow assignment problem Ali Taghavi.	Proposed a novel integrated heuristic procedure based on a perturbation algorithm and sequential location heuristic.	Performed the experimental study to assess the performance of the proposed procedure .The experimental results demonstrate that proposed heuristic procedure is both efficient and effective in identifying quality solutions.
03	A genetic algorithm with the heuristic procedure to solve the multi-line layout Problem Amir Sadrzadeh.	The paper presents a Genetic Algorithm-based meta heuristic to solve FLP.	The efficiency of the proposed method has been proved through solving examples and comparing results with other genetic & craft algorithm.
04	Using Simulation for Facility Design: A Case Study (Greasley,2008).	A discrete event simulation model was developed and used to estimate the storage area required for a proposed overseas textile manufacturing facility.	It was found that the simulation was able to achieve this because of its ability to both store attribute values and to show queuing levels at an individual product level.
05	A methodology for solving the unequal area facility layout problem using distance and shape based measures R. Logendran.	A mixed binary nonlinear programming model is formulated	In addition to the distance measure, the impact of geometry or the shape of the departments is quantified in the formulation of the model. A higher level heuristic solution algorithm, based on a concept of " Tabu search" is proposed and the results are compared with the published alternatives in the problem area and has demonstrated the effectiveness of the proposed method.

06	An alternative multiple attribute decision making methodology for solving optimal facility layout design selection problems K.D.Maniya.	The proposed methodology is based on Preference selection index (PSI).	In the proposed methodology appropriate facility design is selected for a given application. Two different types of facility layout design selection problems are examined to demonstrate, validate and to check the reliability of proposed methodology. It is concluded that FLP design selection methodology based on PSI method is simple, logical and more appropriate.
07	An Empirical Comparison of Tabu Search, Simulated Annealing, and Genetic Algorithms for Facilities Location Problems. (Arostegui ,2006).	Compare the relative performance of Tabu Search (TS), Simulated Annealing (SA), and Genetic Algorithms (GA) on various Facilities Location Problems (FLP).	The results indicate that TS shows very good performance in most cases. The performance of SA and GA are more partial to problem type and the criterion used. Thus, in general it may conclude that TS should be tried first to the extent that it always yields as good or better results and is easy to develop and implement.
08	Genetic Algorithms for Integrating Cell Formation with Machine Layout and Scheduling.(Xiaodan, 2007).	Proposed a new approach to concurrently make the cell formation (CF), group layout (GL) and group scheduling (GS) decisions for a successful Cellular manufacturing (CM). A conceptual framework and mathematical model, which integrates these decisions, are proposed.	The result of this study indicate that: (1) The concurrent approach often found better solutions than the sequential one. (2) With the proposed heuristic operators, the hierarchical genetic algorithm (HGA) procedure performed better than without them. A hierarchical genetic algorithm (HGA) is developed to solve the integrated cell design problem. Two heuristic operators are proposed to enhance its computational performance.
09	A Study on Facility Planning in Manufacturing Process Using Witness. (Roslin,2008).	Comparing two alternative design of layout : U-shape and S-shape.The study is conducted in Dinamika Pelumas Sdn. Bhd. Simulation tool using Witness software.	This paper found that U-shape flow pattern design has increase the efficiency utilization of labour, equipment, space and reduces idle time.

10	Metaheuristic methods for a class of the facility Layout problem. (Alvarenga, 2000).	Comparison of simulated annealing (SA) and Tabu Search (TS).	Both methods produced the known optimal solution for a facility layout problem set with high frequency and low computation time.
11	Solving the failure-to-fit problem for plant layout by changing department shapes and sizes. (Lin 1996).	Apply Artificial intelligence (AI) to FLP	Artificial intelligence could solve the scenario of failure-to-fit solutions, when no feasible layouts are generated.
12	Simulation Model for Production Line Layout. (Zuhdy 2008)	Existing layout is evaluated by Using Pro model software by Integrating Process layout, constant period scheduling and Short Processing time.	This paper proved that the simulation model is capable to predict the capacity of initial system and test the proposed design.
13	Design and Analysis of a Virtual Factory Layout. (Iqbal and Hashmi,2001).	All production machines created in AutoCAD and imported to 3D Studio Max software. Layout problem was visualized and modified by applying Facility Layout Problem (FLP) solving techniques.	Virtual factory layout helps in evaluating plant layout before actually building them and assists in avoiding the cost involved in doing physical re-layout. By virtual factory layout, a designer can have feel of the actual setting of the factory, easy to visualize, understand and evaluate. Re-location of the machine can be done such that the material handling cost reduced as well
14	Layout Design in Group Technology Manufacturing (Hassan, 1994).	Literature review	A review and consolidation of the emerging literature in the GT layout and a suggestion framework of analysis for developing the GT layout.
15	Advances in Discrete Material Handling System Design. (Rajagopalan and Heragu, 1997).	Literature review	This paper presents an outline of trends seen in layout and material handling flow path design research. The current trends are to integrate the different aspects of the manufacturing system design problem. Also present an idea for solving P/D (Pick-up/Drop off) point location and material handling flow path problem.
16	A Classification of Different Type of Facility Layout Design. (Taha ,2008).	Literature review	This paper discusses on the objectives of facility layout design, flow pattern and material Handling systems and finally discusses the different type of layout.

17	Multiple objective facility layout: a heuristic to generate efficient alternatives.(Malakooti, 1989).	Using Heuristic and metaheuristic methods to solve FLP.	Both methods find sub optimal or near optimal solution have been successful on some problems but not on a universal level. However, it is depend on decision assumption made by problem solver and the time required to compute solution is lengthy.
18	FACOPT : A user friendly Facility Layout optimization System. (Balakhrishnan,2003).	Comparison of genetic algorithm (GA) and simulated annealing (SA).	The genetic algorithm model performed better than the simulated annealing model in terms of time required to compute solution.

2.2 Review of Literature Survey

2.2.1 Improvement in plant layout using systematic layout planning (SLP) for increased productivity. (Pramod P. Shewal, Manmath S. Shete, Prof. DR. S. M. Sane)

The objective of this research is to study plant layout of compressor manufacturing based on the systematic layout planning pattern theory (SLP) for increased productivity. In this case study, amount of equipment and tools in compressor production are studied. The detailed study of the plant layout such as operation process chart, flow of material and activity relationship chart has been investigated. The new plant layout has been designed and compared with the present plant layout. The SLP method showed that new plant layout significantly decrease the distance of material flow from stores until dispatch.

According to the analysis of the workflow, it was found that the distance from the moving out of the stores to machining, assembly and to keeping at dispatch was 320 m., reduced to 143 m or reduced by 176 m. As for the c-shaft in the new plant layout, the distance for moving materials is 82 m, reduced from 106 m. or reduced by 24 m. As for the flywheel in the new plant layout, the distance for moving materials is 67 m, reduced from 172 m. or reduced by 105 m. Finally, rearrange layout decreased flow of material, resulting in reduction in waste and increased production.[2]

2.2.2 Improvement in Layout Design using SLP of a small size manufacturing unit: A case study (Chandra Shekhar Tak, Mr.Lalit Yadav)

The paper presents an application of the SLP (System Layout Planning) method for establishing, in an efficient manner, the layout of a productive enterprise. A case study is described in the paper, referring to a factory designated for manufacturing steel almirah. The phases of the SLP method application are described in the paper together with the presentation of one particular product given as example. The optimal solution of the productive system's layout is selected by analysing three possible identified alternatives.

The paper presents an application of the SLP (System Layout Planning) method for establishing, in an efficient manner, the layout of a productive enterprise. A case study is described in the paper, referring to a factory designated for manufacturing steel almirah. The phases of the SLP method application are described in the paper, together with the presentation of one particular products given as example. The optimal solution of the productive system's layout is selected by analysing three possible identified alternatives. The case study of SLP at this company illustrate that small and medium firms can successfully layout and re-layout their facilities with this easy to use technique. The results arrived from SLP does not completely satisfy all but it clearly shows why decisions are made. This study shows that SLP process was as valuable as the final layout.[6]

2.2.3 Optimization of Plant Layout Using SLP Method (Shubham Barnwal, Prasad Dharmadhikari)

In this paper, ongoing engine reconditioning process layout of an automobile industry are studied and a new layout is developed based on the systematic layout planning pattern theory to reduce engine reconditioning cost and increase productivity Since it is an automobile assembly plant, the company has both processes as well as product layouts. The number of equipment and travelling area of material in engine reconditioning have been analysed. The detailed study of the plant layout such as operation process chart, activity relationship chart and the relationship between equipment and area has been investigated. The new plant layout has been designed and compared with existing plant layout. The new plant layout shows that the distance and overall cost of material flow from stores to dispatch area are significantly decreased. The implementation of proposed model will help in the overall improvement of production performance of the engine reconditioning unit of the corporation.

The proposed model based on SLP is found to be effective in solving the above- mentioned problems. The production rate increased by 28%, the production time per bus came down by 3.34% and total distance travelled by material came down by 14%. In this paper per unit cost and distance are considered to improve existing layout but there are many other parameters to analyse the layout that may be worker number, the area required, equipment required. Due to Lack of opportunity and practical limitations above two parameters are used in our calculation. The problem of existing layout is the large comparative distance between several departments that's forced to travel a long distance and impedes the smooth material flow and leads to higher cost. In our proposed layout, the position of various departments is altered with various others based on activity relationship chart. It is expected that this proposed model will mostly be preferable while setting up a new plant implementation and will help in the overall improvement of production performance of the engine reconditioning unit of MSRTC.[3]

2.2.4 Facility Planning for a Gas Manufacturing Plant (Chui Wing Cheong & Chu Lap Keung)

This case study is regarding facilities planning carried out in a manufacturing plant, named Hong Kong Oxygen. Oxygen supply in tanks is the main products of this company. Plant relocation is needed due to new town planning scheme, by the Hong Kong government. The new town ship will be a residential area replacing the area of this plant. Some of the objectives of this relocation are also better safety could be achieved in the new plant; considerable profit could be derived by re-developing the existing piece of land into a residential and commercial area. There are 3 locations whereby the company needs to select the lowest transportation cost among 3 locations to minimize delivery cost. After the selection of the strategic location, Systematic Layout Planning is used to develop block plans based on the data input, activity relationship diagrams, activity relationships charts. The best solution is this case study utilized computer aided planning (CORELAP), which is a construction type of layout program, to generate layout alternatives, to generate a new layout from the activity relationship diagram, space requirements and shape. The best layout is selected based on the most favourable compromise among a list of competing criteria. The layout alternative which has the highest score of competing criteria is selected. Results are relocation of new plant to new location, Tseung Kwan, which has minimum transportation cost. The best layout selected has the most compromising among the competing criteria in terms of economy of material handling, safety, ease of supervision, room for expansion, flow of material and convenience. The limitations however, are it did not publish the quantitative improvements as it only uses the ratings. No actual data of performance measures indicators. The reader will not have a clear idea on the improvements before and after re-layout.

2.3 Conclusions

In this chapter, the literature review of facilities planning and types of layout is discussed. Apart from that, some review on previous trends of layout improvement methodology is reported, followed by systematic planning layout (SLP) methodology. From the review of the literature indicated in the above section, it can be concluded that there have been numerous research activities in the area of layout design. There also have been a number of algorithms developed. Existing literature for a layout design problem often fall unto two major categories as algorithmic and procedural approaches Algorithmic approaches usually simplify both design constraints and objectives in order to reach a surrogate objective function which solution can then be obtained (Peters and Yang 1997; Cardarelli and Pelagagge,1995; Geiger et al,1997). These approaches usually involve quantitative input data. Their design solutions are easier to be evaluated by comparing their objectives functions.

The output from algorithmic approaches often need further modifications in order to satisfy detailed design requirements such as departmental shapes, utilities supply, material handling system, ergonomics concerns, work in process storage, space utilization, etc. Advance training in mathematical modelling techniques are often pre-requisites for a designer to use algorithmic approaches. Accordingly, many companies hesitate to adopt algorithmic approaches as their design methodologies.

Procedural approaches can incorporate both qualitative and quantitative objectives in the design process (Padilli et al,1997; Apple ,1997; Muther 1973) For these approaches, the design process is divided into several steps that are then solved sequentially. The success of a procedural approach implementation is dependent on the generation of quality design alternatives that are often from the output of an experienced designer.

Systematic Layout Planning (SLP) is a procedural layout design approach. The process involved in performing SLP is relatively straight forward; however, it is a proven tool in providing layout design guidelines in practice in the past few decades. This case study proposes to use Muther‟s systematic layout planning (SLP) (Muther 1973) as the infrastructure to solve an electronic layout problem.

Chapter 3

Problem Identification

3.1 Introduction

This chapter discusses about the identification of area where facilities layout planning is to be implemented. Process flow diagram and from-to-chart will be used to determine relations between various departments.

3.2 Flow of material

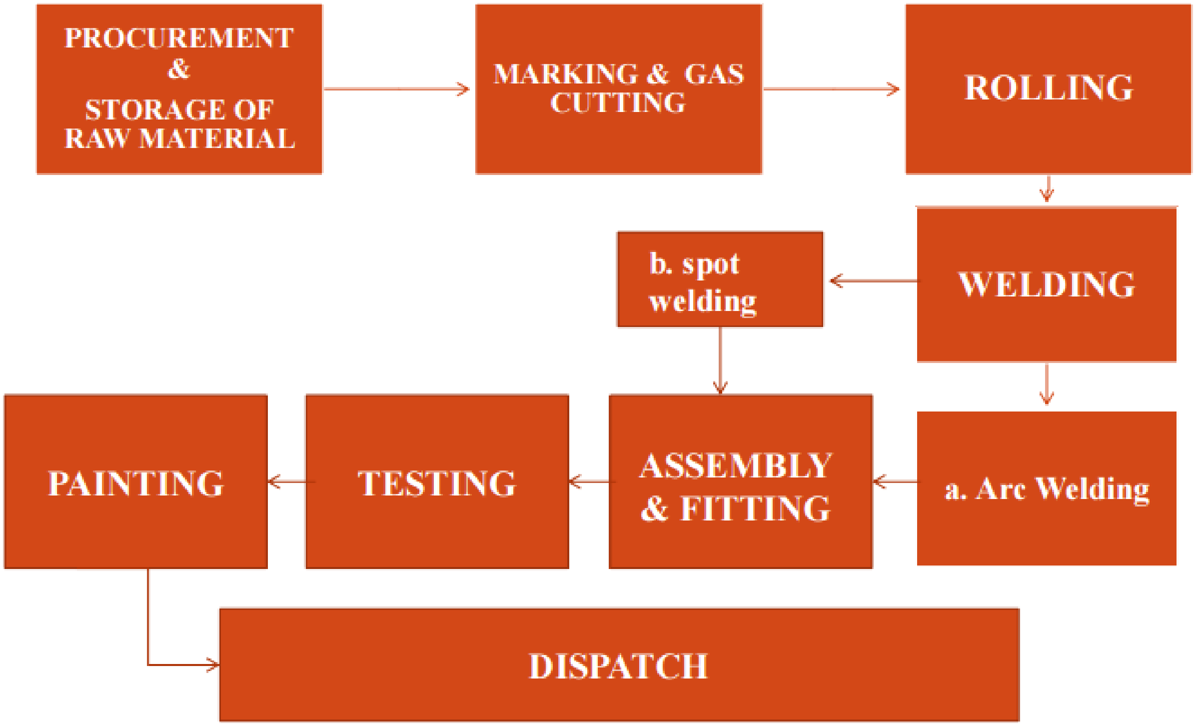

Fig. 3.1. Flow of Material

3.3 From-To-Chart

The From-To-Chart is a popular tool for material flow analysis. It represents the flow intensity between each process. The more the flow intensity, the more important the relationship between each process. From the chart, we can see that cutting, fabrication and assembly have the highest flow intensity due to both products also shares the same process as shown in the chart. Painting and testing has lesser flow intensity as there is only one product for each of the process.

Table 3.1 FROM-TO-CHART

Dept.	Storage	Machining	Rolling	Fabricate	Fitting	W.I.P.	Testing	Painting	Dispatch	Office	Inventory	Scrap
Storage		A	O	U	U	U	U	U	U	U	U	X
Machining			I	A	U	U	U	U	X	U	I	I
Rolling				I	U	U	U	U	U	----	----	U
Fabricate					I	I	U	I	U	X	I	U
Fitting						A	A	O	U	U	E	U
W.I.P.							A	I	U	U	U	U
Testing								I	U	X	O	U
Painting									A	X	E	U
Dispatch										U	U	U
Office											----	X
Inventory												U
Scrap												

Based on the rule of thumb for closeness ratings, „A" represents absolutely necessary relationship and cannot be more than 5 % of the relationships. „E" represents especially important relationship and cannot be more than 10% of the relationships. „I" represents important relationship and cannot be more than 15% of the relationships. „O" represents ordinary relationship and cannot be more than 20% of the relationships. „U" represents unimportant relationship and consists about 50% of the relationships. Lastly, „X" represents undesirable relationship and consists of not more than 5% of the relationships.

3.4 Conclusions

From the analysis, From-To-Chart, it is obvious that the layout of the products is a major contribution to the high cost and the high cross-over quantity. This is further justified by the from-to- chart where significant flow intensity occurs within processes which are currently located far apart.

We conclude the following problems in the company:

- ❖ Improper utilization of workspace area.
- ❖ Poor placement of machining equipment.
- ❖ Problem in material handling causing unnecessary increase production time.
- ❖ Several injuries of labours due to improper precautionary measures.

Therefore, in the following chapter, systematic layout planning will be used as a methodology to define, analyse and synthesize the current problem faced by the company.

Chapter 4

Methodology

4.1 Introduction

In this chapter, the Systematic Layout Planning methodology is analysed in detail for different layout alternatives generations. Basically, the SLP methodology literature has a total of 11 steps. First is input data, followed by flow of materials, activity relationships, relationship diagram, space requirements, space available, space relationship diagram, modifying constraints, practical limitation, developing layout alternatives and lastly evaluation.

4.2 Systematic Layout Planning

In 1973, Richard Muther proposed the Systematic Layout Planning (SLP) method that formalizes the whole layout process as a pattern of procedures through which each layout project passes. The design of process is being treated stepwise starting from the generation of alternatives, evaluation, selection and implementation. It has been widely used since its introduction which has proven to work well in many situations. Overall there are 11 stages required to complete an SLP.[4]

1. Gather input data
2. Identify flow of material/information
3. Identify relationships between activities and resources.
4. Create a string diagram.
5. Determine space requirements
6. Quantify space availability
7. Create a space relationship diagram
8. Identify modifying considerations
9. Apply practical limitation
10. Developing layout alternatives
11. Evaluation of final design

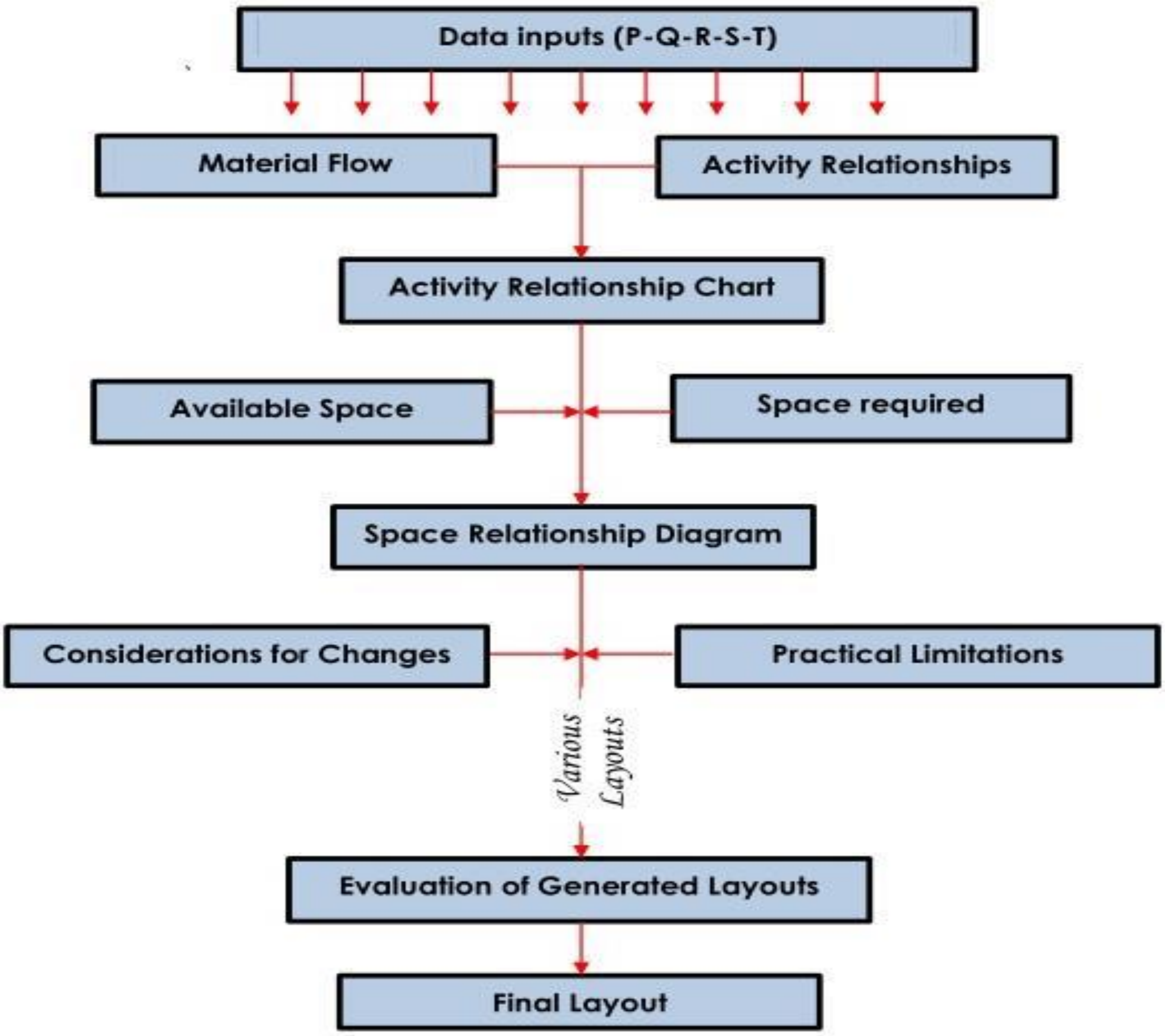

Fig. 4.1 Procedure of Systematic Layout Planning

4.3 Steps To Solve The Problem

Optimisation of Plant Layout:

The methodology is summarized in graph format in which is created originally from Richard Muther and simplified by the following researchers such as Gómez. The overall procedures are consisted by three parts which are analysis, search and selection.

The first phase of the SLP method involves using a from – to matrix to describe an interdepartmental material flow. In order to do this, a unit of measurement about material handling must have been decided firstly. So the products with different characteristics can be homogenized and comparisons are feasible. Then the REL chart which means the relationship diagram should be made. This chart collects the qualitative information of proximity ratios" which consist of a set of letters (A, E, I, O, U, X). They reflect how necessary is for every two work units to be adjacent in the final layout (ranging from A which means absolutely necessary" through to X which shows „not desirable.

The following step is space analysis which includes availability and requirements. Space availability consists about the actual facility layout where the different work units should be placed. Space requirements are focus on the necessary production parameters such as staff, equipment's and others from a theoretical analysis. Comparison and combination of space availability and requirements will provide the actual area to be assigned to each work unit. As a result of analysis process, the space relationship diagram is emerged based on the above space analysis.

After the space relationship diagram is built up, the designers have to remodel or modify the previous design to a greater or lesser extent. Therefore, certain factors which might affect the following implementation of the layout should be taken into account. These factors include various aspects like natural light in the facility, roof heights, the position of electricity points and doors, and the inclusion of aisles for staff, material and equipment movements and so on. Additionally, the practical limitations and modifications which are researched in step 7 and 8 are highly dependent on the empirical skill knowledge and the subjectivity of the person who is responsible for the layout. In the final analysis, again it is dependent on the design person's experience and opinions to determine how the new information or sources affect the modified layout of the different sections.

Step 1: Input Data and Activities:

The input variables for every SLP and P, Q, R, S and T. P (Product), material or service that will be processed. Q (Quantity), is the volume each item to be processed. R (Routing), is the path an item travels to be processed. S (Services), refers to services required to complete this processing and T (Time), refers to the overall time required to complete processing should be scrutinized in order to assure the validness of the input data at the design stage.

Step 2: Flow of Materials Analysis:

All material flows from the whole production line are aggregated into a from to-chart that represents the flow intensity among different departments. The analysis of material flow involved determining the most effective sequence of work and material. An effective flow means that the materials move progressively through the process and should always advance without excessive detours. In traditional manufacturing applications, the flow is determined from either the product or the process.

Fig 4.2 Flow of Material

Step 3: Activity Relationship Diagram:

The step of activity relationships performs qualitative analysis towards the closeness relationship decision between activities and resources. The results will be displayed into an activity relationship chart. The relationship chart displays which entities are related to others and it also rates the importance of the closeness between them. These ratings make the relationship chart one of the most effective tools for layout planning and are the best way of planning the arrangement of facilities. The activity relationship chart itself is a record keeping tool to organize data into a usable form. With this data and Activity Relationship Diagram was generated where proximity and relationship are visually evident.

The relationship is defined by a closeness rating system: A meaning that it is absolutely necessary that the activities be next to each other, B meaning it can be or it can not be next to each other, X meaning it can not be next to each other, O meaning blank.

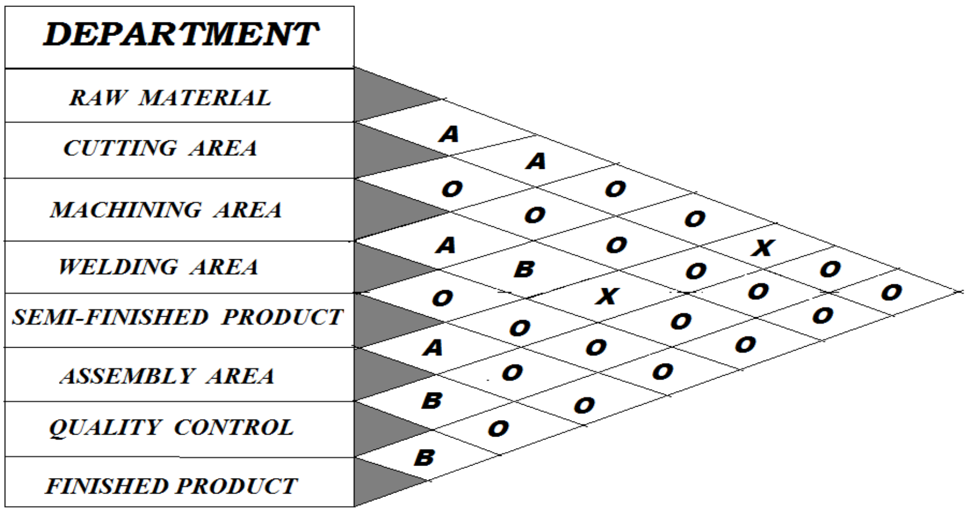

Fig 4.3 Relationship Diagram

Step 4: Create Existing Layout:

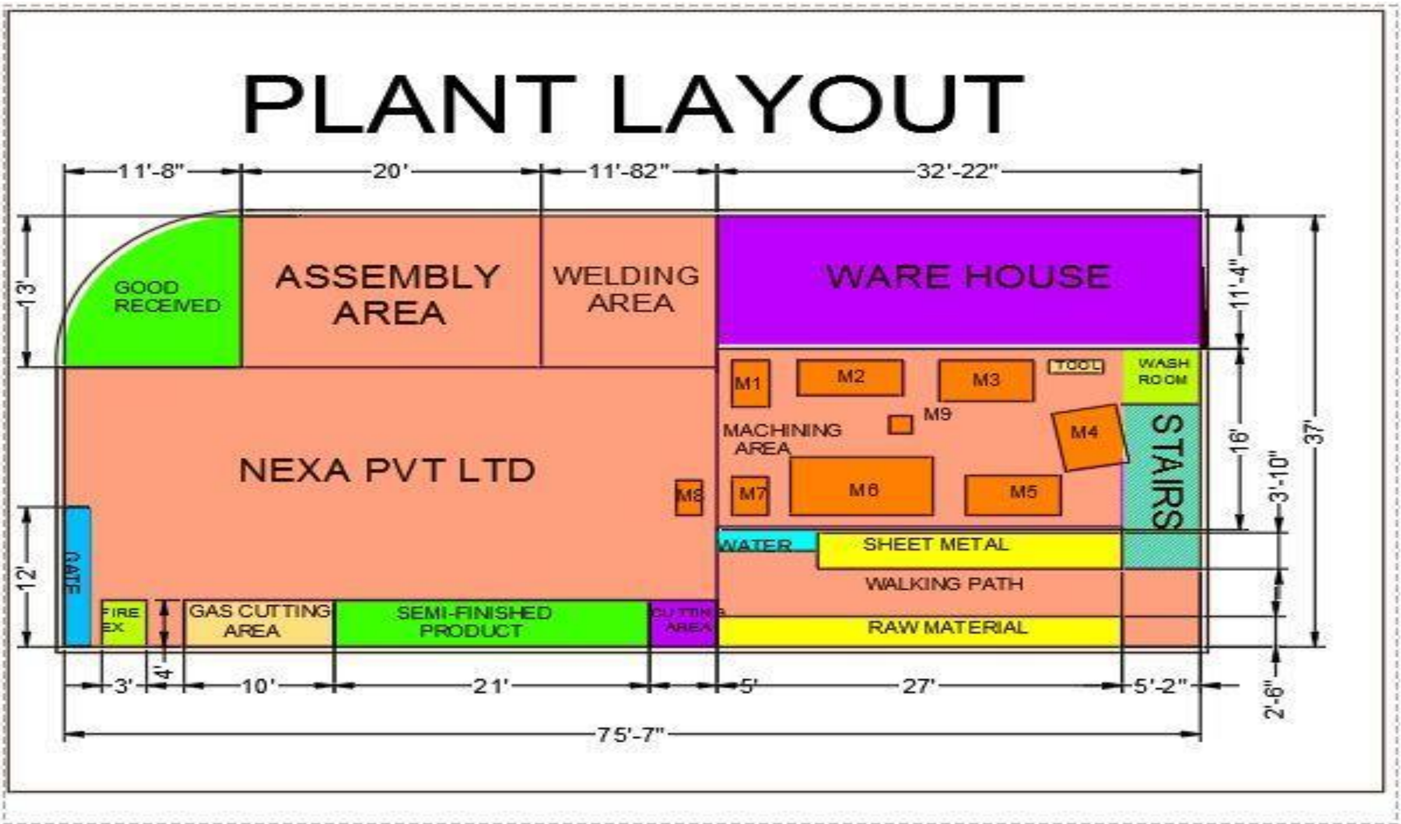

Fig 4.4 Existing Layout

Step 5: Space Requirements:

Now that relationships have been identified, special requirements must be analysed and then applied to a spatial relationship diagram. The information to be included in terms of amount of space, equipment and operational improvements for each activity has to be determined.

- Raw Material = 154 ft^2
- Cutting Area = 40 ft^2
- Machining Area = 432 ft^2
- Welding Area = 153 ft^2
- Semi Finished Area = 84 ft^2
- Assembly Area = 260 ft^2
- Quality Control Area = 367 ft^2
- Finished Product Area = 118 ft^2

Step 6: Space Available:

During this step, a square footage is assigned to each activity. The space assigned to each activity is predicated previously in the space requirements step. The total available space at the plant is reviewed. The area is divided at first approach to estimate the space required for each department. When performing the detailed layout, it is required to have more accurate shapes adjusted to the reality. The total available area of the company is 2800 ft^2.

Step 7: Space Relationship Diagram:

Adds departmental size information into the relationship diagram from step 4. At this point, the space requirements are applied to the space available. The purpose of the space relationship diagram is to combine established spatial constraints with the activity relationship.

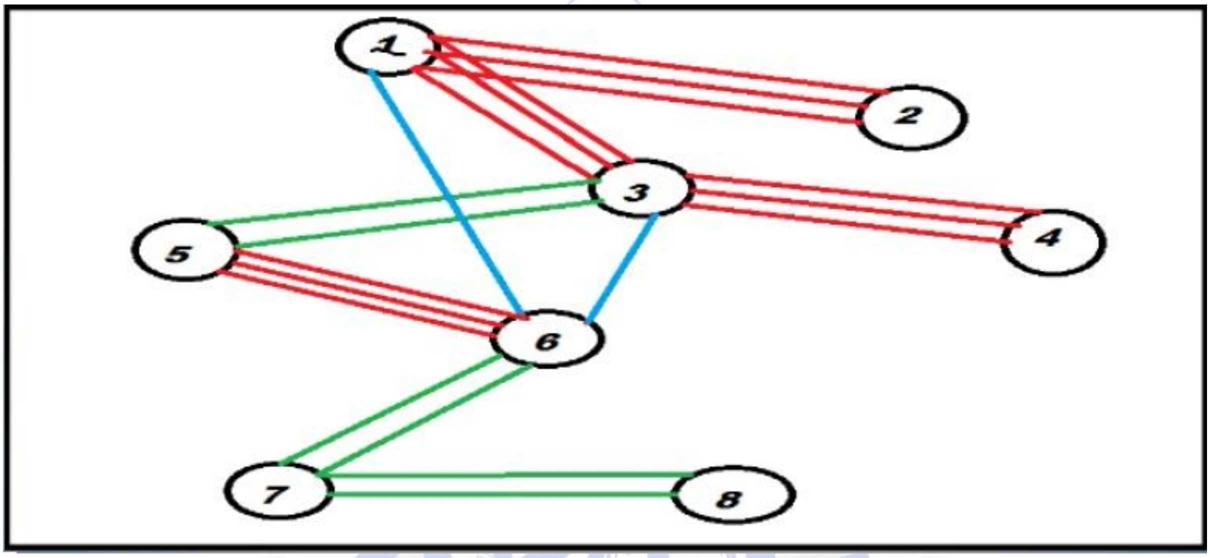

Fig. 4.5 Space Relation Diagram

Step 8: Modifying Constraints:

These are additional constraints for the department during the initial stages of the new layout design. It is in terms of space requirement or department personnel needs.

Step 9: Practical Limitations:

Practical limitations can be in terms of budget or space.

Step 10: Develop Layout Alternatives:

This step involves development of layout alternatives as design candidates. These initial designs were created using the requirements and constraints described before. This is a layout of facility using blocks of space, no details. The block plan is developed y using the space available information and the relationship chart that 38 have been previously developed. With this information, blocks of space are developed and positioned according to their relationships defined in the relationship chart. The pros and cons of each layout are compared as each layout had good traits that are combined into a final block plan layout. Usually these designs are brought to the management for further inputs and comments.

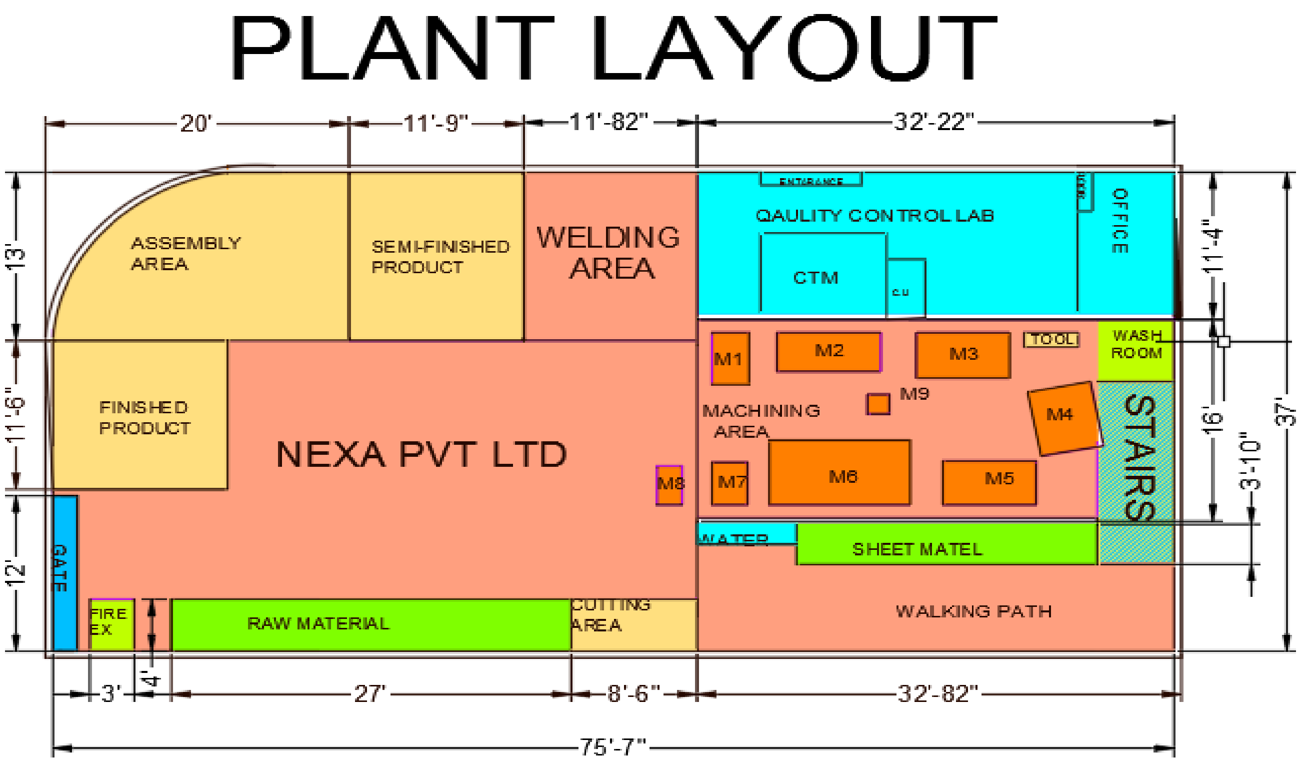

Fig.4.6 Develop Plant Layout

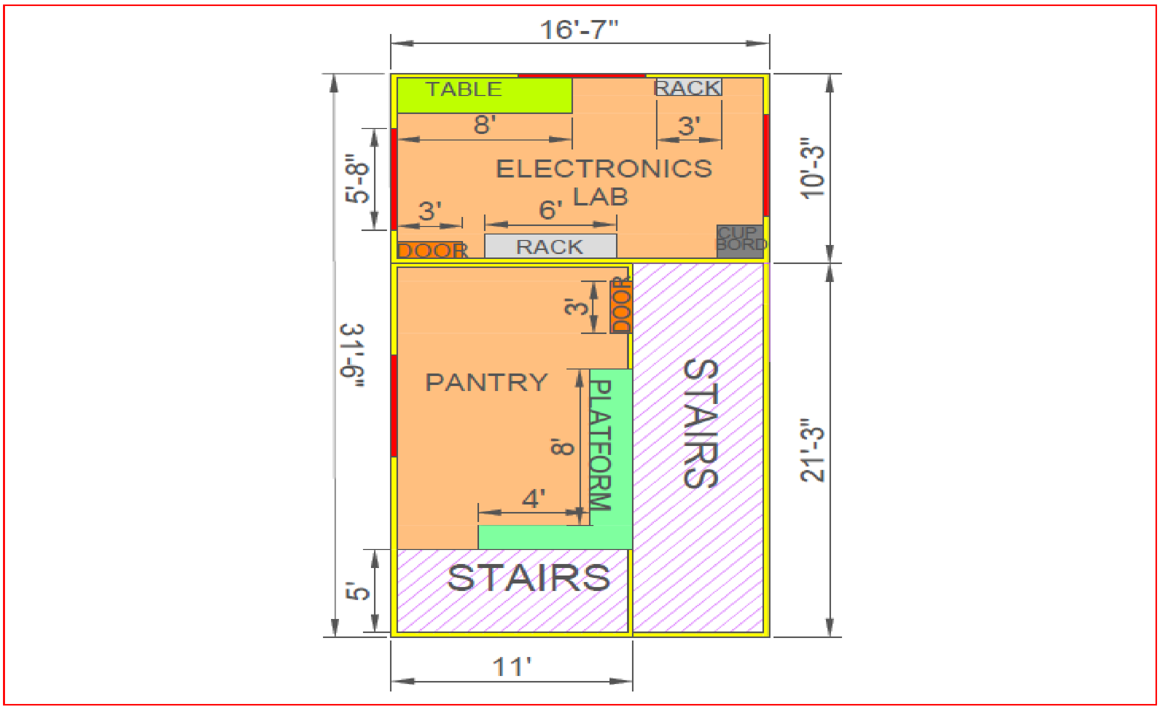

Fig.4.7 3rd Floor Layout

Step 11: Evaluation:

Chooses the final design from the design candidates. Once a final block plan layout has been selected, the equipment layout can then be developed. Equipment and machinery layout within each department is presented in the detailed layout

4.4 Implementation of 5S :

The name 5s refers to a set of five terms borrowed from Japanese, all beginning with the letter “S” when transliterated. The equivalent terms in English also begin with an S. In essence, these five terms represent the five steps toward operational and process excellence:[8]

Fig 4.8 5S Chart

- **Sort:** Separate required tools, materials, and instructions from those that are not needed. Remove everything that is not necessary from the work area.
- **Store:** Sort and organize all tools, equipment, files, data, material, and resources for quick, easy location, and use. Label all storage locations, tools, and equipment .
- **Shine:** Set new standards for cleanliness. Clean and remove all trash, grease, and dirt. Everything must be clean, tidy, and neatly put in its appropriate place. Cleanliness provides a safe workplace and makes potential problems noticeable, e.g., equipment leaks, loose parts, missing guards, loose paperwork, or materials.
- **Standardize:** Engage the workforce to systematically perform steps 1, 2, and 3 above daily, to maintain the workplace in perfect condition as a standard process. Establish schedules and set expectations for adherence.
- **Sustain:** Make 5S part of your culture, and incorporate it into the corporate philosophy.

Chapter 5
Systematic Layout Planning

5.1 Introduction

In this chapter, an overview of Facilities Layout Planning, types of layout, Systematic Planning methodology and simulation will be discussed. This will give a brief overview on the tools and techniques used for this case study.

5.2 Plant Layout

Plant layout planning includes decisions regarding the physical allocation of the economic activity centres in a facility. An economic activity centre is any entity occupying space. The plant layout process starts at an aggregate level, taking into account the different departments. As soon as the details are analysed, different issues arise and the original configuration maybe changed through a feedback 13 process. Most layouts are designed properly for the initial conditions of the business, although as long as the company grows and has adapted to internal and external changes, a re-layout is necessary. Symptoms that allow us to detect the need for a relayout.[5]

- Congestion and bad utilization of space.
- Excessive stock in process at the facility
- Long distances in the work flow process
- Simultaneous bottle necks and workstations with idle time
- Qualified workers carrying out too many simple operations
- Labour anxiety and discomfort.
- Accidents at the facility.
- Difficulty in controlling operations and personnel.

5.3 Facility Layout Planning

A facility layout is an arrangement of everything needed for production of goods or delivery of services. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work centre, a manufacturing cell, a machine shop, a department, a warehouse, etc. (Heragu,1997). It means planning for the locations of all machines, utilities, employee workstations, customer service areas, material storage area, aisles, restrooms, lunchrooms, internal walls, offices and computer rooms. This is for the flow patterns of materials and people around, into and within buildings. The layout design generally depends on the products variety and the production volumes. Four types of organization are referred to, namely fixed product layout, process layout, product layout and cellular layout (Dilworth,1996)[5]

5.3.1 Objectives of Facility Layout Planning

The main objective consists of organizing equipment and working areas in the most efficient way, and at the same time satisfactory and safe for the personnel doing the work.

- ❖ Product design and Volume (Product strategy)
- ❖ Process equipment and capacity (process strategy)
- ❖ Quality of work life (human resource strategy)
- ❖ Building and site constraints (location strategy)

These main objectives are reached through the attainment of the following facts:

- ❖ Congestion reduction.
- ❖ Elimination of unnecessary occupied areas.
- ❖ Reduction of administrative and indirect work.
- ❖ Improvement on control and supervision.
- ❖ Better adjustment to changing conditions.
- ❖ Better utilization of the workforce, equipment and services.
- ❖ Reduction of material handling activities and stock in process.
- ❖ Reduction on health risks and increase on worker safety.
- ❖ Moral and worker satisfaction increase.
- ❖ Reduction on delays and manufacturing time, as well as increase in production capacity.

All these factors will not be reached simultaneously, so the best solution will be a balance among them.[6]

5.3.2 Factor Affecting Facilities Layout Planning

The final solution for a Plant Layout has to take into account a balance among the characteristics and considerations of all factors affecting plant layout, in order to get the maximum advantages.

The factors affecting plant layout can be grouped into 5 main categories:

- ❖ Materials
- ❖ Machinery
- ❖ Labour
- ❖ Material Handling
- ❖ Waiting Time

5.3.2.1 Material

The layout of the productive equipment will depend on the characteristics of the product to be managed at the facility, as well as the different parts and materials to work on. Main factors to be considered: size, shape, volume, weight, and the physical-chemical characteristics, since they influence the manufacturing methods and storage and material handling processes. The sequence and order of the operations will affect plant layout as well, taking into account the variety and quantity to produce.

5.3.2.2 Machinery

Having information about the processes, machinery, tools and necessary equipment, as well as their use and requirements is essential to design a correct layout. The methods and time studies to improve the processes are closely linked to 16 the plant layout. Regarding machinery, the type, total available for each type, as well as type and quantity of tools and equipment has to be considered. It is essential as well to know about space required, shape, height, weight, quantity and type of workers required, risks for the personnel, requirements of auxiliary services, etc.

5.3.2.3 Labour

Labour has to be organized in the production process (direct labour, supervision and auxiliary services). Environment considerations: employee's safety, light conditions,ventilation, temperature, noise, etc. Process considerations: personnel qualifications, flexibility, number of workers required at a given time as well as the type of work to be performed by them.

5.3.2.4 Material Handling

Material handling does not add value to the product; it is just waste. Objective: Minimize material handling as well as combining with other operations when possible, eliminating unnecessary and costly movements.

5.3.2.5 Waiting Time

Objective: Continuous Material Flow through the facility, avoiding the cost of waiting time and demurrages that happen when the flow stops. On the other hand, the material waiting to flow through the facility not always represents a cost to avoid. As stock sometimes provides safety to protect production, improving customer service, allowing more economic batches, etc. It is necessary then to consider space for the required stock at the facility when designing the layout.

Resting time to cool down or heating up.

5.3.3 Importance of Plant Layout

Plant layout can be varied and can significantly impact the overall effectiveness of production systems. Since 1955, approximately 8 percent of the gross national product (GNP) has been spent annually on new facilities, and it is generally accepted that effective facilities planning can reduce material handling cost by at least 10 to 30 percent (Tompkins et al,1996). The magnitude of the investment in the new facilities each year renders the criticality to the plant layout generations function. The main objectives of the plant layout function are to enable the manufacture of the product economically in the required volume and variety. Other objectives can be stated as effective utilization of manpower, space and infrastructure, as well as providing for the overall wellbeing and morale of the worker.[6]

5.4 Traditional Types of Facilities Layout

Traditionally 4 types of layout are considered appropriate for a manufacturing facility:

- ❖ Process (Job Shop)
- ❖ Layout Product (Flow Shop)
- ❖ Layout Fixed Position
- ❖ Group technology Layout

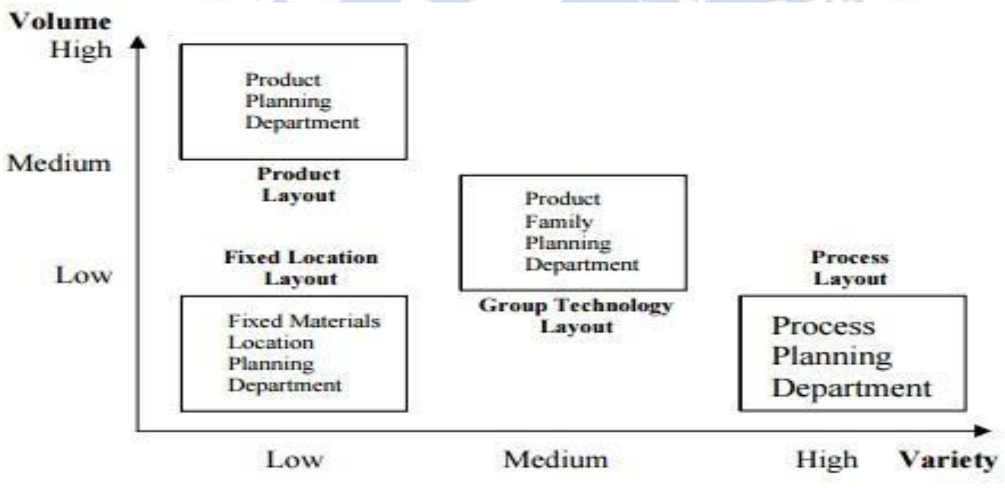

Fig. 5.1 Types of Layout

5.4.1 Process (Job Shop) Layout

In the job shop layout, machines are grouped according to function to machine centres. Orders for individual products are routed through the various machine centres to obtain the required processing. Designed to facilitate processing items or providing services that present a variety of processing requirements. The layout includes departments or other functional groupings in which similar kinds of activities are performed. This type of plant layout is useful when the production process is organized in batches. Personnel and equipment to perform the same function are allocated in the same area. The different items have to move from one area to another one, according to the sequence of operations previously established. The variety of products will lead to diversity of flows through the facility. Variations in the production volumes from one period to the next one (short period of time) may lead to modifications in the manufactured quantities as well as the types of products to be produced.[7]

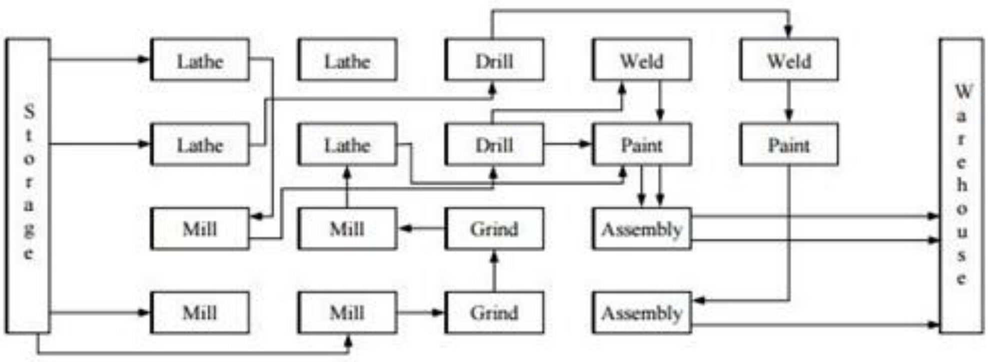

Fig. 5.2 Process Layout

5.4.1.1 Advantages of Process Layout

- ❖ A high degree of flexibility exists relative to equipment or manpower allocation for specific tasks.
- ❖ Smaller investment in equipment as duplication is not necessary unless volume is large.
- ❖ The diversity of tasks offers a more interesting and satisfying occupation for the operator.
- ❖ Supervisors for each department become highly, knowledgeable about their functions.

5.4.1.2 Disadvantages of Process Layout

- ❖ Lack of process efficiency as back tracking and long movements may occur in the handling of materials.
- ❖ Lack of efficiency in timing as workers must wait between tasks
- ❖ Complications of production planning and control
- ❖ Workers must have broad skills and must be paid higher wages than assembly line workers.

- ❖ Comparatively large amounts of in process inventory as space and capital are tied up by work in process.
- ❖ Lowered productivity as each job requires different setups and operator training.

5.4.2 Product (Flow Shop) Layout

Here the product (or products) follows a fixed path through the production resources. The resources are arranged to minimize the material movement. This type of plant layout is useful when the production process is organized in a continuous or repetitive way.

- ❖ Continuous flow: The correct operations flow is reached through the layout design and equipment and machinery specifications.
- ❖ Repetitive flow (assembly line): The correct operations flow will be based in a line balancing exercise, in order to avoid problems generated by bottle necks.

The plant layout will be based in allocating a machine as close as possible to the next one in line, in the correct sequence to manufacture the product. A job is divided into a series of standardized tasks, permitting specialization of both labour and equipment. Because of the high volume of production, the machines on the line can be designed with a high level of fixed automation, with very little manual labour. Operations are arranged in the sequence required to make the product.[7]

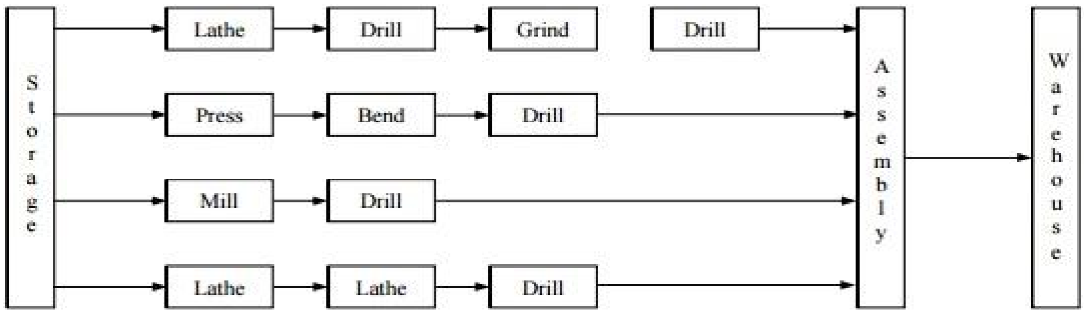

Fig. 5.3 Product Layout

5.4.2.1 Advantages of Product Layout

- ❖ Since the layout corresponds to the sequence of operations, smooth and logical flow lines result.
- ❖ Since the work from one process is fed directly into the next, small in-process inventories result.
- ❖ Total production time per unit is short.
- ❖ Since the machines are located so as to minimize distances between consecutive operations.

- ❖ Simple production planning control systems are possible.
- ❖ Less space is occupied by work in transit and for temporary storage

5.4.2.2 Disadvantages of Product Layout

- ❖ A breakdown of one machine or absence of enough operators to staff all work stations may stop the entire line.
- ❖ Lack of process flexibility, since the layout is determined by the product, a change in product design may require major alternations in the layout.
- ❖ Lack of flexibility in timing, as the product cannot flow through the line faster than the slowest task can be accomplished unless that task is performed at several stations.

5.4.3 Fixed Position Layout

For tasks on large objects such as the manufacture of an electrical generator, the construction of a building, or the repair of a large airplane, the machines implementing the operation must come to the product, rather than the product moving to the machine. In fixed position layouts, the item being worked on remains stationary and workers, materials and equipment are moved as needed. Fixed positions layouts are used in large construction projects (buildings, power plants and dams), shipbuilding and production of large aircraft and space mission rockets. Fixed position is widely used for farming, firefighting, road building, home building, remodelling and repair and drilling for oil.[7]

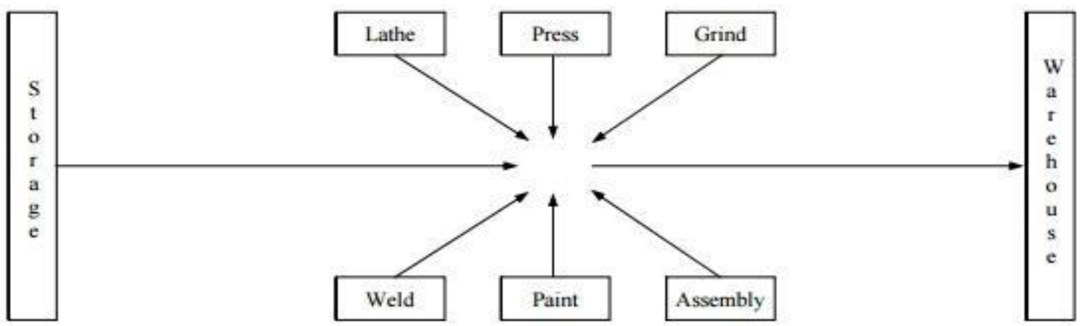

Fig. 5.4 Fixed Position Layout

5.4.3.1 Advantages of Fixed Position Layout

- ❖ Material movement is reduced, minimizes damage or cost of moving.
- ❖ Promotes job enlargement by allowing individuals or teams to perform the whole job.
- ❖ This reduces the problems of re-planning and instructing people each time a new type of activity is to begin.
- ❖ Highly flexible; can accommodate changes in product design, product mix, and product volume.

5.4.3.2 Disadvantages of Fixed Position Layout

- Increased movement of personnel and equipment may be expensive.
- The necessary combination of skills may be difficult to find and high pay levels may be necessary.
- Equipment duplication may occur. Higher skill requirements for personnel as they are involved in more operations.
- Cumbersome and costly positioning of material and machinery.

5.4.4 Group Technology Layout / Cellular Layout

Definition of Group Technology

Group technology us the technique of identifying and bringing together related or similar parts in a production process in order to utilize the inherent economy of flow production methods. V.B Solaja, 24 Institute of Machine Tools, Belgrade, Yugoslavia. Group technology is also called cellular layout. Cellular layout is a type of layout in which machines are grouped into what is referred to as a cell. Groupings are determined by the operations needed to perform work for a set of similar items or part families that require similar processing. It is the physical division of the manufacturing facilities into production cells. Each cell is designed to produce a part family. A part family is a set of parts that require similar machinery, tooling, machine operations and jig or fixtures. The parts within the family normally go from raw material to finished parts within a single cell.[7]

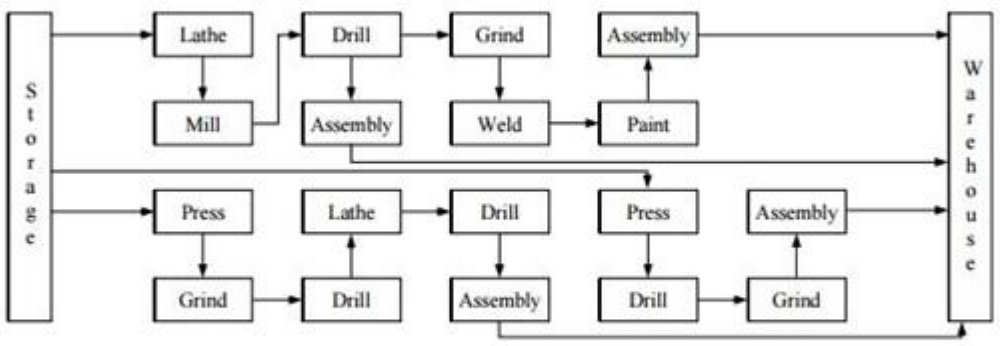

Fig. 5.5 Group Technology Layout

Chapter 6
5S Implementation

6.1 Introduction of 5S

5S initially based on the Japanese acronyms of seiri (organization), seiton (neatness), seiso (cleaning), seiketsu (standardization) and shitsuke (discipline), is used as a platform for developing an integrated management system by the parallel use of total productive maintenance (TPM) (Bamber et al., 2000). Osada (1991) refers to 5S as the five keys to a total quality environment. 5S is a system to reduce waste and optimize productivity and quality through maintaining an orderly workplace and using visual cues to achieve more consistent operational results. The practice of 5S aims to embed the values of organization, neatness, cleaning, standardization and discipline into the workplace basically in its existing configuration, and it is typically the first lean method implemented by firm.

Kobayashi et al. (2008) make a distinction between 5S as a philosophy or way and 5Sas a technique or tool by comparing the frameworks provided by Osada (1991) and Hirano (1995) respectively. From their study, they conclude that 5S tends to be recognized as a philosophy in Japan, but in the other hand it is likely to be considered as a technique or tool in the United Kingdom and United State of America. Osada (1991) views 5S as a strategy for organizational development, learning and change, whereas Hirano (1995) considers 5S to be an industrial formula that differentiates a company from its competitors.

A common definition of 5S in the West is housekeeping (Becker, 2001; Chin and Pun, 2002; Ahmed and Hassan, 2003; Eckhardt, 2001). In the West both 5S and TPM are sometimes 9 disregarded or at least underutilized (Douglas, 2002). A framework of applying 5S within a business (as appose to a personal philosophy of way of life) was first formalized in the early 1980s by Takashi Osada (Ho et al., 1995).

The practice of 5S aims to embed the values of organization, neatness, cleaning, standardization and discipline into the workplace (Osada, 1991). In Japan the 5S practice was initiated in the manufacturing sector and then extended to other industries and services sector. The Toyota Production System provides a well-known example of 5S principles in practice, the early versions were based on 3-S this, became 4-S (Ohno, 1988).

6.2 History of 5S

5S was developed in Japan. It was first heard of as one of the techniques that enabled what was then termed 'Just in Time Manufacturing'. The Massachusetts Institute of Technology's 45-year study into the future of the automobile in the late 1980s identified that the term was inappropriate since the Japanese success was built upon far more than components arriving only at the time of requirement. John Krafcik, a researcher on the project, ascribed Leanto the collective techniques being used in Japanese automobile manufacturing; it reflected the focus

10 on waste in all its forms that was central to the Japanese approach. Minimised inventory was only one aspect of performance levels in companies such as Toyota and in itself only arose from progress in fields such as quality assurance and Andonboards to highlight problems for immediate action.

5S was developed by Hiroyuki Hirano within his overall approach to production systems. Many Western managers coming across the approach for the first time found the experience one of enlightenment. They had perhaps always known the role of housekeeping within optimized manufacturing performance and had always known the elements of best practice. However, Hirano provided a structure for improvement programs. He pointed out a series of identifiable steps, each building on its predecessor. Western managers, for example, had always recognized the need to decide upon locations for materials and tools and upon flow of work through a work area; central to this (but perhaps implicit) is the principle that items not essential to the process should be removed – stored elsewhere or eliminated completely. By differentiating between Seiri and Seiton, Hirano made the distinction explicit. He taught his audience that any effort to consider layout and flow before the removal of the unnecessary items was likely to lead to a sub-optimal solution.

Equally the Seiso, or cleanliness, phase is a distinct element of the change program that can transform a process area. Hirano's view is that the definition of a cleaning methodology (Seiso) is a discrete activity, not to be confused with the organization of the workplace, and this helps to structure any improvement program. It has to be recognized, however, that there is inevitably an overlap between Seiton and Seiso. Western managers understood that the opportunities for various cleanliness methodologies vary with the layout and storage mechanisms adopted. However, breaking down the improvement activity in this way clarifies that the requirements for the cleanliness regime must be understood as a factor in the design aspect of Seiton. As noted by John Bicheno, Toyota's adoption of the Hirano approach is '4S'.

6.3 Philosophy of 5S

6.3.1 Introduction

5S is a manufacturing technique for work place organization and it is used to the implementation of lean conditions.5S is a reference to five Japanese works which described standardized method to improve the work in the organization.

6.3.2 SEIRI - Sorting Out

5S Seiri or Sort is the first step in 5S, it refers to the sorting of the clutter from the other items within the work area that are actually needed. This stage requires the team to remove all items that clearly do not belong in the working area and only leave those that are required for the processes in question. The necessary and unnecessary items available in the workplace should be sorted and classified. By sorting one can identify the materials, tools, equipment and necessary items for this. Frequently used items are placed near to reach while not frequently used items are placed after that. It helps to maintain the clean workplace and improves the efficiency of searching and receiving things, shortens the time of running the operation.

Rules of Performing Seiri:

- If there are any unnecessary things which are causing mixing of things should be cleared.
- Any unnecessary part of the item placed other side should be brought back to its original position.
- Tools of material which lie on production floor should be in the tool floor.
- Check weather all necessary things sorted to its own place.
- All tools are classified properly with the rule.
- After all these steps, we will use Red Label or Red Tag technique, this technique is applied to all the unnecessary items for its reorganization.

Fig. 6.1 Seiri

Benefits of Seiri:

- Improve the processing in the work place.
- Reduction in the cost.
- Solves the problem of Stock of item.
- Problem of losing tools eliminated.
- Better Work area.

6.3.3 SEITON - Set in Order

5S Seiton or Straighten is the process of taking the required items that are remaining after the removal of clutter and arranging them in an efficient manner through the use of ergonomic principles and ensuring that every item ―has a place and that everything is in its place. It means cleaning & organizing the necessary items neatly and systematically so that they can easily be taken and returned in the original place after use. By this we can increase the efficiency of production in the industry. The aim of this is to minimize the number of work that a worker has to perform during operation. Visualization of the workplace is also very important. Eg. painting the floor helps to identify the places of storage of each material or transport ways, drawing out the shapes of tools makes possible the quick putting aside them on the constant places, coloring labels permit to identify the material, spare parts or documents. Tools, equipment, and materials must be systematically arranged for the easiest and the most efficient access. There must be a place for everything, and everything must be in its place.

Fig 6.3: Seiton

Rules of Performing Seiton:

- Position of every place should be decided earlier where items supposed to be placed.
- All tools should be segregated on the basis of regular uses.
- Put all the important items in a accessible position where it can be brought easily.
- Small tools should be placed in a specific place or recognized place.

Benefits of Seiton:

- Increases the efficiency of the production.
- Effectiveness increases.
- Time required for seeking the items are reduced.
- Improves the safety.

6.3.4 SEISO – Shine 5S

Seiso or Sweep is the thorough cleaning of the area, tools, machines and other equipment to ensure that everything is returned to a ―nearly new status. This will ensure that any non- conformity stands out; such as an oil leak from a machine onto a bright, newly painted clean floor. For asthetic view, it is essential to create a clean and regular working and living environment in the workplace. This is because dust, dirt and wastes can stop the efficiency of workplace. Cleaning should become a daily activity. Work place should be cleaned at regular intervals for better production. Regular cleaning permits to identify and to eliminate sources of disorder and to maintain the clean workplaces. During cleaning it is checked the cleanness of every item in the workplace on the regular basis. A sheet of cleaning can also be made by operator to check cleanness in the workplace. By providing this sheet, we can enhance the maintenance of the work place.

Rules of Performing Seiso:

- Check roughly everything, and clear all major source of unnecessary things.
- Clean all the machines present in the work shop on daily basis.
- Check all the tools, equipments on weekly basis, and provide necessary cleaning.
- Clean the shop floor & work floor.

Benefits of Seiso:

- Cleans the workplace.
- Increases the efficiency of machines.
- Maintains the cleanness in the industry.
- Finds the errors in the workplace.

Fig: 6.4 Seiso

6.3.5 SEIKETSU – Standardize

5S three stages of 5S become standardized; that is we ensure that we have common standards and ways of working. Standard work is one of the most important principles of Lean manufacturing. It maintains the habit or standard of cleanness all time in the industry. It maintains good practices at the workplace. Standards should be very clear and easy to understand. There is a need after some period to choose the best ways to practice sort, set in order and cleaning. It is assumed that standards should not be implemented only in the processes such as production, maintenance, storing, but also in the administrative processes, for example: book-keeping, customer service etc.Seiketsu or standardize is the process of ensuring that what we have done within the first

Rules of Performing Seiketsu:

❖ Give strict instructions about cleanness to the whole staff.
❖ Maintain habit to check the progress in the cleanness.
❖ Make an audit sheet to ensure cleanness.

Benefits of Seiketsu:

❖ Increases the safety of industry.
❖ Reduction in the pollution created by industry.

Fig 6.5 Seiketsu

6.3.6 SHITSUKE – Sustain

The final stage is 5S Shitsuke or sustain, ensuring that the company continue to continually improve using the previous stages of 5S, maintain housekeeping, and conduct audits and so forth. 5S should become part of the culture of the business and the responsibility of everyone in the organization. It makes the habit for staffs of industry to learn all the above 4S.Trained skilled persons teaches the staff about the all 4S.The task here is undertaken by the leader directors. The directors should explain the importance of 5S to the personnel through various trainings. The knowledge of the personnel about 5S should be kept updated through the 5S boards to be formed at the workplace. To maintain the standards and keeping the technique in safe and efficient order. It is also important to understand the need of executing the 5S rule on a fixed interval. The learning of the 5S rule is executed once a month by chosen team.

Rules of Shitsuke:

Manager of the industry should take the responsibility to held a program for 5S rule. Staffs should also be eager to learn the technique.

Benefits of Shitsuke:

- Increases the awareness among the staffs.
- Reduces mistake resulting by staffs.
- Improves relations between the staffs.

Fig 6.6 Shitsuke

Chapter 7
Evaluation of Results

7.1 Evaluation of Results:-

❖ Current capacity for hydraulic jack product	=	03 Nos
❖ Total capacity with proposed layout	=	04 Nos
❖ Relative increase in productivity	=	(Increase in capacity ÷ current capacity) x 100
	=	1/3 x 100
	=	33.33%
❖ Mfg. time for a product	=	6 days
❖ Annual days	=	300 working days
❖ Increase in products	=	48 products p.a.
❖ Min. cost of product	=	25000 INR/product
❖ Expected Profit	=	12,00,000 INR

Conclusion and Future Scope

Conclusion

The optimized plant layout is obtained with the application of SLP technique and implementation of 5S, the report focuses on the optimization in 2 criteria which are capacity and productivity thus taking into consideration the sequence of the operation to be followed & space requirements, the capacity of plant is increased. Hence it has reduced the overall cycle time into half. Previously it was required to take 42 foot steps to complete a cycle, now in optimized layout it takes 22 foot steps to complete the cycle. Hence it reduces the unnecessary material travel and reduces the idol time.

Future work

The future development can be carried out by integrating CNC with process so that the efficiency of operation can be improved and the accuracy of product will get improved. Further improvement can be done by implementing new type storage system of raw materials like multi stage rack it will reduce the area required for storing raw material hence increasing the area of work.

References

[1] Vivekanand S Gogi, Rohith D , Shashi Kiran K , Suhail M Shaikh. "efficiency improvement of a plant layout". International Journal of Innovative Research in Science, Engineering and Technology - Vol. 3, Issue 4, April 2014

[2] Yosra Ojaghi , Alireza Khademi , Noordin Mohd Yusof, Nafiseh Ghorbani Renani ,Syed Ahmad Helmi bin Syed Hassan. "production layout optimization for small and medium scale food industry" ScienceDirect

[3] Bobby John, Jubin James, R. Mahesh Rengaraj. "analysis and optimization of plant layout using relative allocation of facilities technique". International Journal of Emerging Technology and Advanced Engineering - Volume 3, Issue 8, August 2013

[4] Shubham Barnwal, Prasad Dharmadhikari. "optimization of plant layout using slp method" International Journal of Innovative Research in Science, Engineering and Technology - Vol. 5, Issue 3, March 2016

[5] Pramod P. Shewale, Manmath S. Shete, Prof. DR. S. M. Sane. "Improvement in plant layout using systematic layout planning (slp) for increased productivity" International Journal of Advanced Engineering Research and Studies

[6] Sanjeev B. Naik. "a literature review on efficient plant layout design" International Journal of Industrial Engineering Research and Development (IJIERD) - Volume 7, Issue 2, May-August 2016

[7] Chandra Shekhar Tak, Mr.Lalit Yadav. "improvement in layout design using slp of a small size manufacturing unit: a case study" IOSR Journal of Engineering(IOSRJEN) - Volume 2, Issue 10 (October 2012)

[8] Bayo. A.M,,Pintado A.B., and Cerio J M.D " 5S use in manufacturing plants contextual factors and impact on operating performance", International Journal of Quality & Reliability Management, 27 (2), pp.217 – 230, 2010.

[9] Ho. S.K.M., "5S practice: a new tool for industrial management", Industrial Management & Data Systems, 98(2): p. 55-62, 1998.

[10] Ho. S.K., Cicmil. S, and Fung C.K., " The Japanese 5-S practice and TQM training". Training for Quality, 3(4), pp. 19-24, 1995.

[11] Moradi. M., Abdollahzadeh M., and Vakili. A., "Effects of implementing 5S on Total Productive Maintenance": A case in Iran. 2011: IEEE.