# FACILITY LAYOUT DESIGN IMPROVEMENT IN ABC INDUSTRY

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**ABSTRACT**

*The aim of the paper was to investigate, analyze and implement improvements of the facility layout design for plant layout. Facility planning is a major undertaking that requires substantial resources and careful planning. Literature review was done to point out current knowledge on facility layout design and investigate tools, methods and approaches that could be followed in this paper to improve the processes.*

*In layout optimization study of existing plant layout and design implementation new proposed plant layout. The optimized machine layout in magnetic particle inspection (MPI) station and offset grinding station has resulted in to straight line material flow, reduced operator fatigue and reduced operator motion loss. Also it reduces material flow in plant for coil spring 210 meters to 140 meters and stabilizer bar 290 meters to 160 meters respectively.*

***Keywords: Critical analysis, offset grinding workstation, Magnetic particle test machine, Plant layout***

## I. INTRODUCTION

### 1.1 Facility Planning and design

Facility layout dates back to ancient times where it became important for rulers and planners to locate the locations for market centres, sport arenas and most living quarters. In those days, time and cost considerations were not of great importance because of the abundance of labour and other resources. Facility planning has a long history in finding the optimal or suboptimal facility design. S. Kulturel-konak et.al [1] The unequal area facility layout problem is studied considering both production uncertainty and routing flexibility. Stochastic production quantities are introduced under the assumption of dependent demands and incorporated into the usual objective of material handling cost minimization. Concurrently, alternative routings are considered based on production quantity. An efficient simulation approach is used to estimate the resulting department pair wise flows, both their expected values and variances. Using these estimates, a tabu search heuristic procedure performs the layout design optimization. Chawalit Jeenanunta [2] The facility layout design determines the best location of the production areas, support areas and personnel areas within the building. The typical plant layout objectives are to minimize investment in equipment and material handling cost, to minimize overall production time, to minimize variation in types of material handling equipment, to meet the requirement of quality of work life and to meet the requirement of building and site constraints. The optimum plant layout was solved by using analytical approaches such as exact mathematical procedures, probabilistic model, graph theory, and heuristics methods. These procedures can be classified as construction method and improvement method. Construction methods develop a new layout from scratch whereas the improvement methods generate alternatives based on an initial layout.

N. R. Rajhans and Dr B. B. Ahuja [3] Plant layout decisions require strategic evaluations of the various important parameters specific to the manufacturing system of the industry concerned. As a consequence to this it is necessary to evaluate a number of alternative strategies each having characteristic criterion. Layout design is based on many factors such as flexibility in manufacturing, batch size, cost and accessibility to maintenance. These are the basic factors considered for the layout. Each factor can be further divided into sub factors and then a hierarchy of these can be found. It is not always necessary that all these factors be of equal importance while considering the redesigning. Analytical Hierarchy Process (AHP) calculates different weight ages to be given to each factor. Based on the selection criteria, different factors can be used with their weightages and a layout can be designed. Apple J.M. [4] Many heuristic methods for facility layout problems are developed by researchers over the last 20 years. A facility layout is an arrangement of everything needed for production of goods or delivery of service according to Moore[5] Facility planning has a significant impact upon manufacturing cost and an important effect on the performances and efficiency of a manufacturing system. A good placement of facilities contributes to the overall efficiency of operations and can reduce up to 50% of the total operating expenses. Muthur [6] considered facility layout as an industrial problem and the object is to minimize the cost of the materials that flow between workstations. Simulation studies are sometimes used to measure the benefits and performance of given layouts. Not all facility layouts are that simple, therefore research has been conducted through a number of decades to optimize and design complex layouts. In the early stage of a system design, it is important to strive for an optimal design and facility layout. It is expected that in the future, facility layout design will play a significant role for that extra space needed, for the growing demand of high quality products and a good performance system. A well known and popular layout planning method is the Systematic Layout Planning (SLP). This is a systematic approach that was developed by Muther. According to Muthur the following are common reasons for the redesigning of facilities:

- Material handling problems, bottlenecks and high costs that normally occur because of inefficient layouts.
- Safety hazards and possible occurring of accidents.
- Frequent changes in the design of the product or service.
- Introducing a new service.
- Changes in the volume or the mix of the output of products.
- Changes in methods, processes or equipment.
- Changes in legal requirements or environmental requirements.
- Morale problems (lack of face-to-face and teamwork).

There are ever increasing pressures on most manufacturing companies to be effective and efficient to stay competitive. The environment in which they operate are becoming more competitive with the increasing threat from international competition and customer demands for on-time delivery, consistent quality, low cost and customer specified product design and functionality. Today, algorithms and software tools are also used for these complex manufacturing environments to automate and optimize their facility layout designs. Facility layout problems or inefficient layouts can occur in many ways and can have significant effects on the overall effectiveness of the production system. According to Apple J. M. at least 10% to 30% of material handling costs can be reduced by an effective facility planning.

## II. BRIEF INTRODUCTION OF ABC INDUSTRY

ABC industry, was established in 1999 to design and manufacture of parts like Hot coil springs, Stabilizer bars, Torsion Bars and Strut bars for the automotive industry in line with customer expectations. The plant area is 35,600 m2 with a built up area of 5754 m2 . It is also supplying in OE spares market. The Major Strength of ABC industry is usage of special grade material locally developed for coil springs. The major advantage of this material is higher design stress leading to lesser weight & better fatigue life. ABC industry, has a concern about their plant because of excessive in process inventory, high material handling cost and excessive lead time. They suspect that an inefficient facility layout, process structure and material handling might be factors that contribute to the situation. According to their performance results they need to investigate these factors. An inefficient facility layout, process structure and material handling are possible reasons for the excessive inventory, high material handling cost and excessive lead time at the plant. The plant is lacking in performance and effectiveness.

## III. METHODOLOGY

The aim of this paper is to improvement in plant layout and work stations by implementing lean principles; therefore the output of this paper should be applicable in improving the current situation. To be able to accomplish this, first theories are studied, and then those theories are implemented at ABC. Critical analysis of processes that are of concern with the design or improvement at the Finishing Station should be done. This will allow for inspections of standards, the manner of how material is handled, tool equipment and working conditions and methods. This is an important step in the designing of a new facility or material handling for improving an existing operation or system. According to Niebel and Freivalds [7] method analysts use operation analysis to increase productivity per unit of time by means of studying all productive and non-productive fundamentals of an operation. The means of using the questioning approach on all facets of the facility, process and material handling should help to develop an efficient facility layout design. Table 1 shows a template of the critical analysis technique that uses the questioning approach to analyse operations to study these operations, and focusing on the items likely to provide improvements. This can also help to identify problem areas and evaluate alternative facility layouts.

Table 1 Critical analysis template

| CRITICAL ANALYSIS TECHNIQUE | | | |
|---|---|---|---|
| METHOD: | | | |
| PRESENT METHOD | | ALTERNATIVES | SELECTED ALTERNATIVE |
| Purpose: What is achieved? | Is it necessary? (Y/N) If Yes - Why? | What else could be done? | What is the purpose? |
| | | | |
| Means: How is it done? | Why that way? | How else could it be done? | How should it be done? |
| | | | |
| Place: Where is it done? | Why there? | Where else can it be done? | Where should it be done? |
| | | | |
| Sequence: When is it done? | Why then? | When else could it be done? | When should it be done? |
| | | | |
| Person: Who does it? | Why that person? | Who else could do it? | Who should do it? |

## IV. STUDY OF EXISTING PLANT LAYOUT

Present plant layout is process type layout. Present layout divided in three areas i.e. initial area, bending area, final area. In initial area raw material storage, cutting machines, end heating furnace, forging press, walking beam furnace, new continuous tempering furnace, muffle furnace, tool crib area, maintenance area are covered. In bending area CNC bending machine, correction presses, tempering furnace, pit furnace, offset grinding are covered. In final area shot peening, pretreatment tank, powder coating, final inspection and packing are covered. In present plant layout it was observed that work in process (WIP) between each station was excessive and improper material flow. The following table 2 shows list of machines and area covered by machines in plant and table 3 shows new machine which will be part of new product layout. After studying the present plant layout it is found that work in process (WIP) between station is excessive and lead time also excessive due to which plant utilization is not done properly for detail material flow of stabilizer bar and coil springs.

Table 2: List of machines in present plant

| Sr. No. | Name of Machine | Qty. | Size in M. | Area in Sq.M. | Total Area in Sq.m |
|---|---|---|---|---|---|
| 1 | Band Saw Cutting Machine | 1 | 9.5 X 1.2 | 11.4 | 11.4 |
| 2 | Abrasive Cutting Machine | 1 | 10 X 1.5 | 15 | 15 |
| 3 | Forging Press | 2 | 2.2 X 1.8 | 3.96 | 7.92 |
| 4 | End Heating Furnace | 2 | 2.3 X 1.2 | 2.76 | 5.52 |
| 5 | End Rolling Machine | 1 | 2.3 X 1.9 | 4.37 | 4.37 |
| 6 | Induction Heater | 1 | 6 x 1.2 | 7.2 | 7.2 |
| 7 | Walking Beam Furnace | 1 | 6 X 1.3 | 7.8 | 7.8 |
| 8 | Coiling Machine | 1 | 3.2 x 0.9 | 2.88 | 2.88 |
| 9 | Pig Tailing Machine | 1 | 3 X 0.8 | 2.4 | 2.4 |
| 10 | C.S. Quenching Tank | 1 | 7.8 X 1.5 | 11.7 | 11.7 |
| 11 | T.B. Quenching Tank | 1 | 2.6 x 2.6 | 6.76 | 6.76 |
| 12 | Upsetting machine | 2 | 2 X 0.65 | 1.3 | 2.6 |
| 13 | Continous Tempering Furnace | 2 | 15.5 x 4.5 | 69.75 | 139.5 |
| 14 | C.S. Hot Setting machine | 1 | 1.2 x 0.8 | 0.96 | 0.96 |
| 15 | Muffle Furnace | 2 | 3 x 2.5 | 7.5 | 15 |
| 16 | Bending Machine | 8 | 5 x 1.4 | 7 | 56 |
| 17 | Pit Tempering Furnace | 1 | Dia. 2.16 | 3.66 | 3.66 |
| 18 | 30 Ton Press with Power Pack | 11 | 1.7 x 1 | 1.7 | 18.7 |
| 19 | T.B.Hot Setting machine | 1 | 2.6 x 1 | 2.6 | 2.6 |
| 20 | Hardness Tester | 2 | 0.6 X 0.6 | 0.36 | 0.72 |
| 21 | C.S. Hot Setting machine | 1 | 1 x 0.8 | 0.8 | 0.8 |
| 22 | Drilling machine | 2 | 1.2 x 0.7 | 0.84 | 1.68 |
| 23 | C.S. Grinder | 1 | 2 X 1.8 | 3.6 | 3.6 |
| 24 | Stress Peening Fixture | 4 | 2 x 1.2 | 2.4 | 9.6 |
| 25 | Shot Peening Machine | 1 | 10 x 8 | 66.5 | 66.5 |
| 26 | M.P.I. machine | 2 | 4 x 4 | 16 | 32 |
| 27 | Pretreatement Tank Set up | 1 | 13.5 x 5.5 | 74.25 | 74.25 |
| 28 | Powder Coating Plant | 1 | 19 x 11 | 209 | 209 |
| 29 | Scragging machine | 1 | 4.25 x 0.7 | 2.98 | 2.975 |
| 30 | Crimping Machine | 2 | 3.2 x 0.5 | 1.6 | 3.2 |

Table 3: List of new machines for proposed plant

| Sr. No. | Name Of Machine | Qty. | Size in meters | Area in sq. meters |
|---|---|---|---|---|
| 1 | Shot peening machine | 1 | 10x8 | 80 |
| 2 | Resistance heating machine | 1 | 8X2.5 | 20 |
| 3 | Scragging machine | 1 | 4.25X0.7 | 2.98 |
| 4 | CNC Bending machines | 2 | 5X1.4 | 14 |

## V. ANALYSIS OF FACILITY LAYOUT DESIGN

In facility layout design new product type layout designed and phase wise implementation are to be carried out. machine layout improvement are carried out to reduce operator motion loss, fatigue and productivity improvements. Facility layout design involves the determination of the placement of the departments, work groups within the departments and workstations within production facility layouts.

The objective is to arrange these elements in a way that it will ensure a smooth work flow of material, machines and people. General inputs to a layout design are the space requirements for the elements in the layout and the flow of elements between operations. Effective flow planning in the various workstations is an important aspect of facility layout design. Investigation revealed that there were numerous pattern and flow problems such as magnetic particle inspection station, offset grinding station etc. In proposed plant layout consists of two separate production lines for two products i.e. coil spring and stabilizer bar for this design some new machines required for achieving production demand that also consider. New plant layout material flow from raw material storage to packing for coil springs and stabilizer bar is 140 meters and 160 meters. In present layout material flow from raw material storage to packing for coil springs and stabilizer bar is 210 meters and 290 meters.

### 5.1 Magnetic Particle Inspection (MPI) layout improvement

### 5.1.1 Present magnetic particle inspection layout

In present magnetic particle inspection layout charging station and inspection station is covered by 4 m X 4 m dark room. The present method is one operator is required to pick up coil spring from incoming trolley and give to the charging station operator then operator charge the coil spring and send to inspection table. In inspection table one operator is inspected coil spring in ultra violet light and send to outside of dark room. ( shown in the fig. 2)

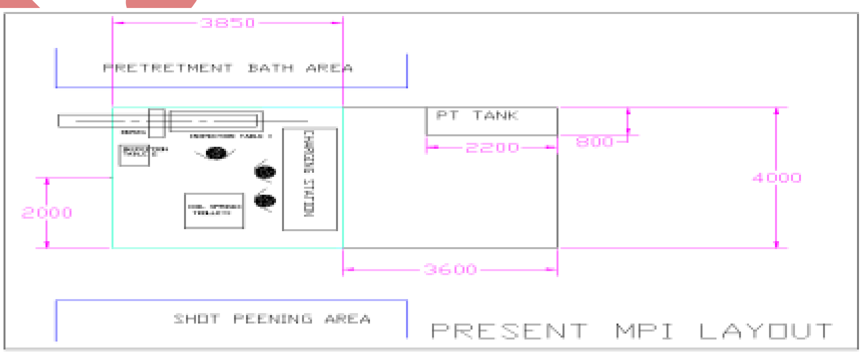


Fig. 2: Present magnetic particle inspection layout.

By first viewing the actual station, it does not look too bad but there is no chance to increase output with a second operator if the demand is increased. The improved process flow pattern as shown in the fig. 3 is a straight line shape, where two operators can work on single inspection table in both sides. It creates the potential to increase output with a second operator if needed. One of the several advantages of the straight line is better operator access. The straight line is also easier to balance and an extra operator can help to increase the output. Presently all process of MPI is under the close dark room. In new layout only inspection activity are carried out in dark room and magnetization is done outside the dark room. Following are advantages

- Work in process reduced between inspections and charging station.
- Two operators can work on single inspection table in both sides. It creates the potential to increase output with a second operator if needed.
- Straight line is better operator access. The straight line is also easier to balance and an extra operator can help to increase the output.

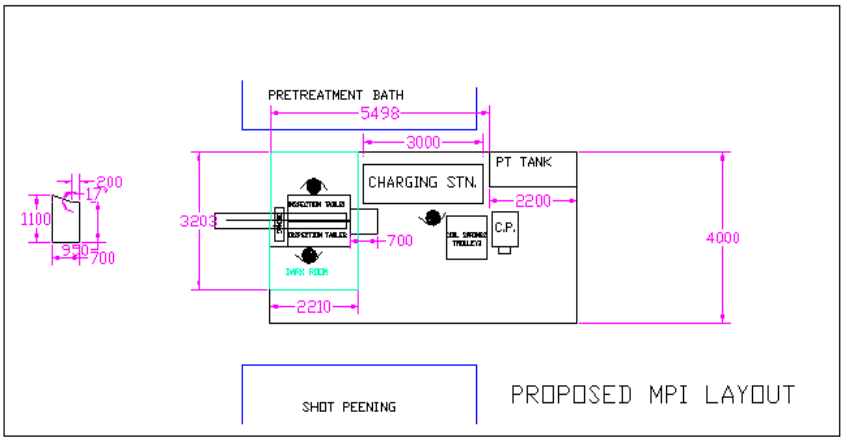


Fig. 3: New magnetic particle inspection layout.

## 5.2 Offset grinding layout improvement

### 5.2.1 Present offset grinding layout

Presently coil spring grinding coil spring trolleys are placed behind the surface grinder and one common outward trolley was placed in front of surface grinder. Due to this arrangement material flow are not in stream line, operator motion loss is more due to movement of operator and no proper handling of coil springs. Present layout is shown in fig. 4. In modified offset grinding layout shown in fig. 5 input material trolley and outward material trolley are placed both sides of surface grinder. Due to modified layout material flow is streamline with zero operator loss and operator fatigue reduced.

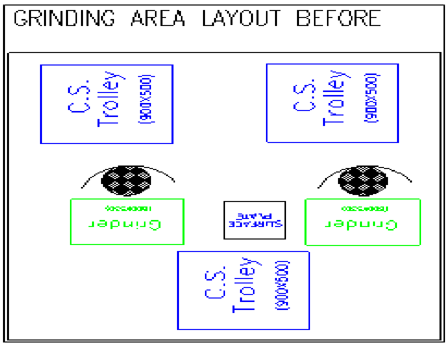


Fig. 4 Present offset grinding layout

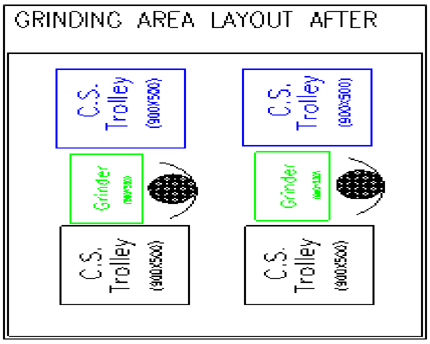


Fig. 5 Modified offset grinding layout

## VI. CONCLUSION

- Optimized machine layout in magnetic particle inspection (MPI) station and offset grinding station has resulted in to straight line material flow, reduced operator fatigue and reduced operator motion loss.
- By implementing the above changes it is observed that new product oriented plant layout reduced material flow from raw material to packing area of coil spring is 33% and stabilizer bar is 45%

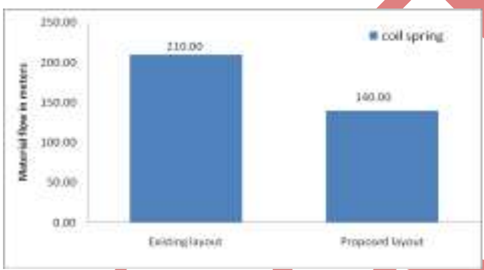


Fig. 6 Material flow of coil springs

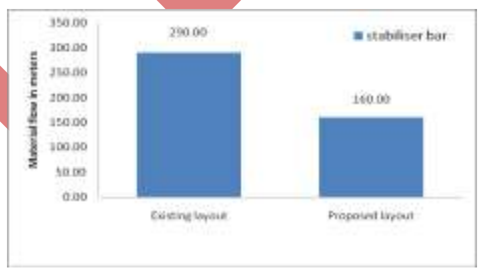


Fig. 7 Material flow of stabilizer bars

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