Evaluating the Role of Supply Chain over the Molds and Dies in the Production Process through Systematic Layout Planning

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ABSTRACT
The use of the molds and the dies play a very important role in the field of industrial revolution. The overall production chain mainly depends upon the implications and applications of use of the dies in the manufacturing process. Thus, the quantity of production awfully affects the components, their subassemblies and assemblies to a larger extent. The plant layout generation is challenging, especially for the process oriented layout. The systematic layout planning (SLP) proposes as the infrastructure to solve a layout design problem in engineering-to-order company. 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. The implementation of systematic layout planning tools in the industries reduces the overall cycle time for production, reduces the material handling cost and the distance travelled by the material during the production process. This gives the attempt for the makers to produce the new products with significant advances and practical applications in the fields, which would suggest the various ways and means to make the process more effective and efficient.

Keywords: *Molds and Dies, Plant Layout, Systematic Layout Planning(SLP).*

1. Introduction:

With the rapid increasing demand in production, industrial factories need to increase their potentials in production and effectiveness to compete against their market rivals. At the same time, the production process needs to be equipped with the ability to have lower cost with higher effectiveness. Therefore, the way to solve the problem about the production is very important. There are many ways i.e. quality control, total quality management, standard time, plant layout to solve the problems concerning productivity. The impact of improper plant layout on the manufacturing process for valve and metal parts production has been studied. The plant layout was changed to comply with the international standards through SLP method. The plant layout is one way to reduce the cost of manufacturing and increase the productivity. It also increases good workflow in production route. This research describes original plant layout, material flow analysis, which includes area and distance between operation A and B. From the experience in the factory, it was found that there was wasted time or delay in manufacturing, the movement of the material in long line and interrupted flow as well as useless area of the plant. The basic industrial layout planning applied to Systematic Layout Planning (SLP) method which shows step-by-step procedure of plant design from input data and activities to evaluation of plant layout. This method provides the new plant layout that improves the process flow through the plant, and help to increase space in industries. In solving facility layout or facility location design problem, it is important that general procedure advocated for solving design problems be used. Specially, the following steps are recommended:

1. Formulate the problem.
2. Analyze the problem.
3. Search for alternative solutions.
4. Evaluate the design alternatives.
5. Select the preferred design.

2. Systematic Layout Planning (SLP) Procedure:

Facilities design consists of the facility systems design, the layout design and the handling systems design. The layout design considers all equipment, machinery and support structure within the operational perimeter. Manufacturing factory layouts can be classified as: fixed position layout, process-oriented layout, group or cellular layout, product-oriented layout. The type of layout utilized will largely depend on the nature of the manufacturing activities, including the volume and variety of the products being produced. The plant layout generation is challenging, especially for the process-oriented layout. Many algorithmic approaches have been developed in the plant layout research include the systematic layout planning procedure, steepest descent search method by pair-wise exchange, graph-based construction method, genetic algorithms. Advanced training in mathematical modeling techniques is often prerequisites for a designer to use algorithmic approaches to solve a layout design problem. Procedural approaches can incorporate both qualitative and quantitative objectives in the design process for effective plant layout.

3. Objectıves of Process Planning:

An efficient factory layout is the one that can be instrumental in achieving the following objectives:

a) Proper and efficient utilization of available floor space.
b) To ensure that work proceeds from one point to another point without any delay.
c) Reduce material handling cost.
d) Utilize labour efficiently.
e) Increase employee morale.
f) Reduce accidents.
g) Provide for volume and product flexibility.
h) Provide ease of supervision and control.
i) Allow ease of maintenance.
j) Allow high machine or equipment utilization.
k) Improve productivity.

4. Functional Analysis of the Plant :

The required raw material was collected and stored in the "Raw Material Storage Section". From there it was travelled to the "Hopper" where addition of dies and other necessary materials are added and then it is melted. After the raw material was melted to the liquid state in the hopper at a high temperature (above melting temp) the liquid state of the material was supposed to be maintained. For that purpose the material passing section was covered with heating coil or preheated to maintain the temp.. The liquefied and hot raw material is then passed to the Injection Molding Die. The process is primarily used for simple shapes with some basic coring possible. Further the shaped pieces are passed to the next section "Runner Cutter". Here the outer non-required part of the material is cutoff and the workpiece is prepared to be machined and sent to the next section "Machining Section". The scrape of the pieces can be reused and therefore they are sent back to the hopper.

In Machining Section the workpiece is machined and imparted with prpoer finishing. In this plant the Plastic injection molding parts are produced. After the proper finishing is provided to the plastic parts they are sent in "Quality Inspection Section" where these jobs are checked whether they are ready and appropriate to be supplied to the client. All the correct pieces are sent to be labelled and packaged to the labelling section. Further the workpieces are kept in the warehouse section before being sent out to the client or to the market as per the required number of pieces. The dimensionally wrong workpieces which are collected from the "Qulaity Inspection Section" are then sent back to the "hopper" to be recycled or used again as a raw material. Hence, the flow of process can be drawn as given below:

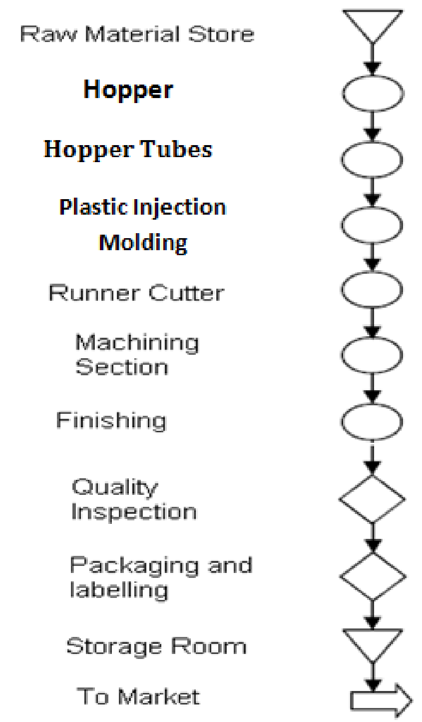

Figure No. 1 Flow of theProcess.

5. Current Layout:

In the current layout material flows from raw material to finished product and its transportation distance should be calculated by mid points of units of layout from raw material storage to finished products. The dotted line in this layout represents relation between Melting furnace, Quality inspection, Runner cutting. The relation between Quality inspection & Melting furnace is to send the defective pieces back to the melting furnace. The details of material transportation is shown in figure and the distance travelled by the raw materials within the plant (in meters)is as given below:

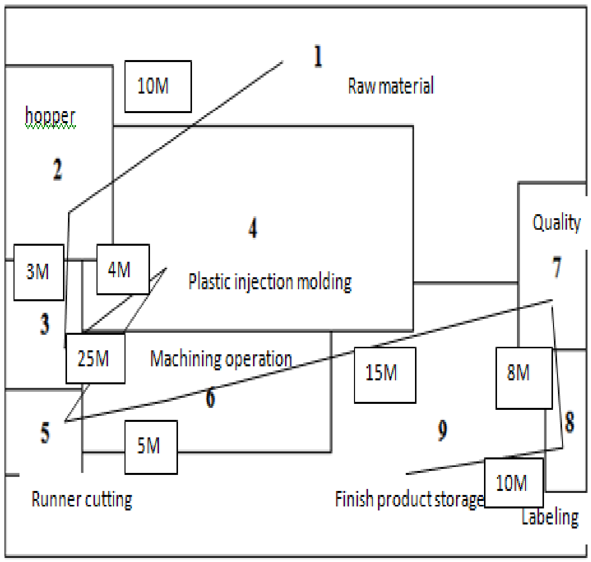

Figure No. 2 Material Transportation in Various Units in Factory in Current Layout.

Details	**Distance(m)**
Raw Material Store Room	-
Metal was taken to the melting in hopper	10
Passing the molten material through preheating coils	3
Plastic Injection moulding	4
Sending out the work piece to runner cutter machines	25
Scrape (runner) send to hopper	15
Send out the work pieces to the machining section	5
Machining the work pieces	-
Imparting finishing to the machined work piece	-
Sending out the finished product to the quality inspection	15
Quality inspection	-
Sending the Defective pieces back to the melting furnace	35
Labelling and packaging the products	8
Sending to the Final Product Storage Room	10
Total Distance	**130 m**

Table No. 1 Distances Travelled by the material during the production process.

6. Implemented layout:

The production management studied the proposed Layout and they could find out the nearest possible layout they could implement. The changes in the equipments and machines were also made as the material flow through the plant was going to be increased. No of runner cutters was increased, so as the machines in the machining sections were also increased. Entire numerical details are as shown in the charts. Number of holding furnace lines were increased from 3 to 6 which caused the later proceedings to be taken place at a high speed. Hence number of machines was increased in each further section. This all adds to increase the production rate. In addition the distances between required sections were reduced. Hence all the possible hurdles in the way of production are removed by applying Systematic Layout Planning (SLP).

6.1 Material Transportation in Implemented layout:

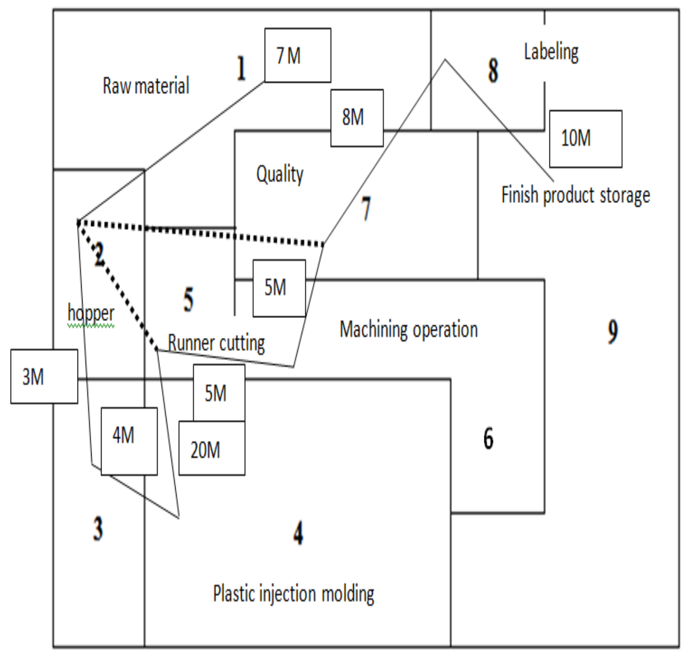

Figure No. 3 Material Transportation in Various Units in Factory in Implemented Layout

In Implemented layout material flows as raw materials to finished product and its transportation distance should be calculated by mid points of units of layouts from raw material storage to finished products. The dotted line in this layout represents relation between hoppers, Quality inspection, Runner cutting. The relation between quality inspection &hopper isforsendingthe defective pieces back to the melting furnace. The details of transportation flow is as shown in fig. as well as tabular form is given below:

Details	**Distance(m)**
Raw Material Store Room	-
Raw material was taken to the hopper	7
Passing the melt material through hopper tube	3
Plastic Injection moulding machine	4
Sending out the work piece to runner cutter machines	20
Scrape (runner) send to melting hopper	12
Send out the workspieces to the machining section	5
Machining the work pieces	-
Imparting finishing to the machined work piece	-
Sending out the finished product to the quality inspection	5
Quality inspection	-
Sending the Defective pieces back to the melting furnace	15
Labelling and packaging the products	8
Sending to the Final Product Storage Room	10
Total Distance	**89 m**

Table No.2 Distance Travelled by the material during the production process.

Department	Equipment Type	Number of Equipment	Equivalent area or working Area(m^2)	Total Working Area(m^2)
hopper	Addition of dies and other chemicals	1	16	16
hopper	Melting	6	19	19
moulding	Plastic injection moulding machine	20	49	49
Runner Cutting	Runner Cutter	02	11	11
Machining	Finishing Machines	15	28	28
Quality Inspection	Quality test machinery	2	22	22

Table No.3 Details of Equipments and Area utilized in the Implemented Layout.

7. Data Analysis:

7.1. Anova Analysis:

Response parameter: Time required for transportation per day:

Input Parameter: Total distance travelled per day:

Distance travelled (m)	time required (min)
130	8.86
130	8.4
130	8.1
115	6.2
115	5.8
115	5.5
89	4.9
89	4.7
89	4.4

Table No. 4 Data Analysis chart

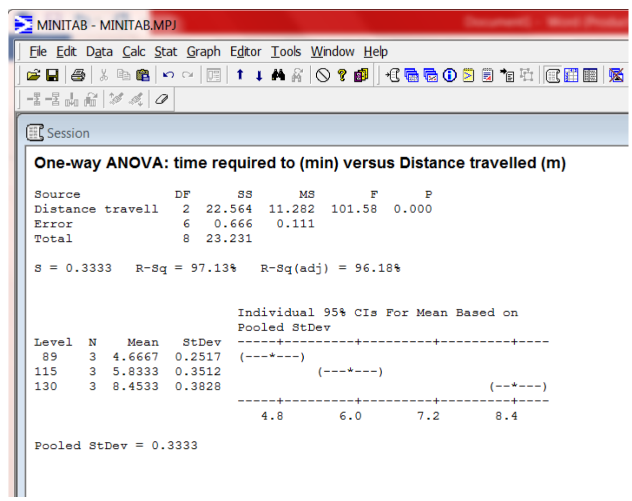

Figure No. 4 Screen Chart of Result.

In the above data, the R – square and R- square adjusted are showing excellent %, which means the input data and output values are very closely correlated. Usually, these values are expected to be above 85% or more. In our case it is above 95%, which is very good.

Distance travelled (m)	time required (min)	RESI1
130	8.86	0.40667
130	8.4	-0.05333
130	8.1	-0.35333
115	6.2	0.36667
115	5.8	-0.03333
115	5.5	-0.33333
89	4.9	0.23333

89	4.7	0.03333
89	4.4	-0.26667

Table No. 5 Details of Residual Values.

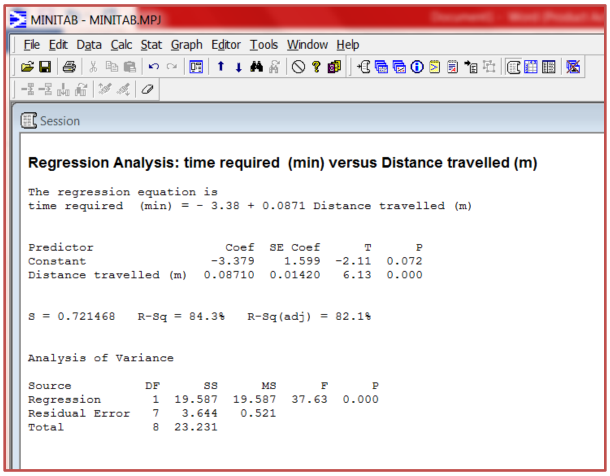

Figure No. 5 Screen Chart of Result.

The above regression equation is a general guideline to estimate the time required for a particular distance travelled by the part. This is a tactical equation, which means that there are assumptions and deviations, so this equation can be used a thumb rule for our given set up and cannot be applied universally for other set of data values.

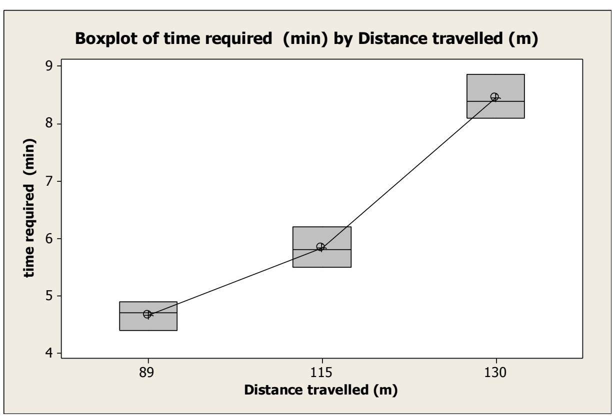

Figure No.6 Graph of Data Plotted.

The Box plot shows / depicts the following:

- There is a direct relationship between Distance and Time, as the distance increases, the time also increases.
- The slope of the curve from 89m to 115m is less steep than the slope between 115m to 130 m. This means for any delta increase in distance value between 89m to 115m will lead to smaller delta increase in time when compared to 115m to 130m.
- This also reveals that, if the location of the parts can be re-arranged in such a distance which is between 89m to 115m, then the overall time taken to move the parts will be less when compared to 115m to 130m range. By re-arranging the parts to such a fashion that may lead to additional locations but it is worth giving a try to see, if really some time can be saved in the overall exercise or not.

8. Results and Conclusion:

According to the analysis of the workflow for the production of the parts it was found that the distance of moving the products from out of the warehouses to do intermediate processes and to keep them back at the warehouse was **89 m**., reduced from **130 m**. (or reduced by **41 m**). Finally, rearranged layout reduced the distances required for flow of materials, resulting in reduced time for transportation and the associated cost.

ANOVA- relevance:

ANOVA means Analysis of Variance. Anova is usually used to analyze the effect of one input parameter on the output parameter. In this case, input parameter is distance travelled and output response parameter is time taken. When there are multiple input parameters, then we use Taguchi method to carry out the analysis. Usually ANOVA exhibits better correlation with respect to output parameter because the entire influence of that single parameter is only acting on the output result.

Independence of variable:

In any equation, there would be dependent and independent variables. In this case, the dependent variable is 'Time' that is the output parameter and independent variable is 'Distance', that is the input parameter. In short, all input parameters are generally classified as independent variable. Also, the relevance the case study is, when there is a change in the value of independent variable, there should be a change in output variable too, only then the hypothesis is validated. For any change in input variable, if there is no effect on the output variable at all, then the equation is invalid. In the case discussed above the Input value of 130 m distance, the output value is around 8 minutes; when input is at 115m, the output value is around 6 minutes, etc. So there is a change in output value when input changed.

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