© 2016 IJEDR | Volume 4, Issue 3 | ISSN: 2321-9939

Automation of assembly unit in an alternator manufacturing industry

Vinish V, Dr Haris Naduuthody
M.Tech Student, Associate Professor
Dept. of Production Engineering, Manufacturing System engineering
GEC Thrissur, Kerala, India

***Abstract*— Facility planning is critical design of manufacturing facilities due to their role in achieving an efficient product flow. It is estimated that between 20%-50% of the total costs in manufacturing is related to material handling. This cost can be reduced until 30% through an effective facility planning. Proper analysis of facility layout design could improve the performance of production line such as bottleneck rate, minimize material handling cost, reduces idle time, and raises the efficiency and utilization of labor, equipment and space. Similarly automation of assembly could improve the production by improving productivity, accuracy and quality. Moreover it could reduce the effort of labor. This study aims at the optimization of manufacturing unit of KEL, by addressing layout with the help of a software solution implemented in MS Excel. Moreover an attempt is made to design an automated assembly system. Together they could improve productivity at KEL.**

***Index Terms*— Facility planning, Automation, Productivity, material handling, facility layout.**

I. Introduction

Assembly is a manufacturing process in which parts are added as the semi-finished assembly moves from workstation to workstation where the parts are added in sequence until the final assembly is produced. Most of the time it is called a progressive assembly and the parts are said to be interchangeable parts.

In order to improve the productivity as well as the ease of assembly process of alternator, an arrangement is to be proposed. This will be an automated arrangement, hence the assembly process can be said to be partially automated once this is implemented.

II. LITERATURE REVIEW

In early days, the manufacture of the parts and their fitting and assembly were carried out by craftsmen who learned thru trade as indentured apprentices. Each part would be tailored to fit its mating parts. Consequently, it was necessary for a craftsmen to be an expert in all the aspects of manufacturer and assembly, and training of a new craftsmen was a long and expensive task. The scale of production was often limited by the availability of trained craftsmen rather than by the demand of the product. This scenario had got drastic shift with the Second World War.

The principal contributor to the development of modern production and assembly methods was Henry Ford. He describe his principles of assembly in the following words: “First, place the tools and then the men in the sequence of the operations so that each part shall travel the least distance whilst in the process of finishing.”

“Second, use work slides or some other form of carrier so that when a work-man completes his operations he drops the part always in the same place which must always be the most convenient place to his hand and if possible have gravity carry the part to the next workmen.”

“THIRD, USE SLIDING ASSEMBLY LINES BY WHICH PARTS TO BE ASSEMBLED ARE DELIVERED AT CONVENIENT INTERVALS, SPACED TO MAKE IT EASIER TO WORK ON THEM.”

These principles were gradually applied in the production of the Model T Ford automobile. The modern assembly-line was first employed in the assembly of a flywheel magneto.[3] When considering the manufacture of a product, accompany must take into account of various factors like:

- Suitability of the product design
- Production rate required
- Availability of labor
- Market life of the product

If the product has not been designed with the automatic assembly in mind, manual assembly is the probably the only possibility. Similarly, automation will not be practical unless the anticipated production rate is high. If the labor is plentiful, the degree of automation desirable will depend on the anticipated reduction in cost of assembly and increase in the production rate. Following are some of the advantages of assembly process applied in appropriate circumstances:

- Increased productivity and reduction in costs.
- A more consistent productivity with higher reliability.
- Removal of operators from hazardous operations.
- The opportunity to reconsider the design of the product.

In the past, in the most manufacturing industries, ehwn a new product was considered, careful thought was given to how the product would function, to its appearances and sometimes, to its reliability. However, little thought was given to how easily the product could be assembled and how easily various parts could be manufactured. This philosophy was often termed as “over-the-wall” approach or “we-design it-you make it”. In other words an imaginary word was there between the design and manufacturing functions. From here an era of concurrent engineering developed. Concurrent engineering, also known as simultaneous engineering, is a method of designing and developing products, in which the different stages run simultaneously, rather than consecutively. It decreases product development time and also the time to market, leading to improved productivity and reduced cost.

In some situations, assembly by manual workers would be hazardous because of high temperature and the presence of toxic, or even explosive, substances under these circumstances, productivity and cost considerations are less important.

III. METHODOLOGY

Data was collected from the industry regarding the assembly process. There are thirteen processes or procedures followed in assembly process in the manufacturing of alternator. They are

I. Heating the roller bearing, bearing cover, spacers, end shield in an oil bath.
II. Select the rotor, clean using brush and apply air drying varnish.
III. Insert the spacer on non-drive end.
IV. Insert the inner bearing cover end on the non-drive end.
V. Insert the roller bearing.
VI. Insert the end shield.
VII. Insert outer bearing cover in the non-drive end.
VIII. Now insert the spacers, inner bearing cover on drive end.
IX. Insert the roller bearing.
X. Cool the rotor assembly and insert into the stator.
XI. Fasten the screws on the non-drive end shield.
XII. Provide drive end shield.
XIII. Provide lock washer and lock nut.

In the automation of an assembly process, it is important to construct a precedence diagram. In precedence diagram all the operations that can be carried out first are placed in column I. operations that can be perform only when at least one of the operations in column I are placed in column II. Lines are drawn from each operations column II to the preceding operations in column I. Similarly third stage operations are placed under column III with lines connecting preceding operations.

Assembly relations are mainly represented through precedence and sequence diagrams. The precedence diagrams represent the direct relations between assembly tasks that correspond to different components. The precedence diagram of assembly of alternator is shown below. The six boxes shows the six columns.

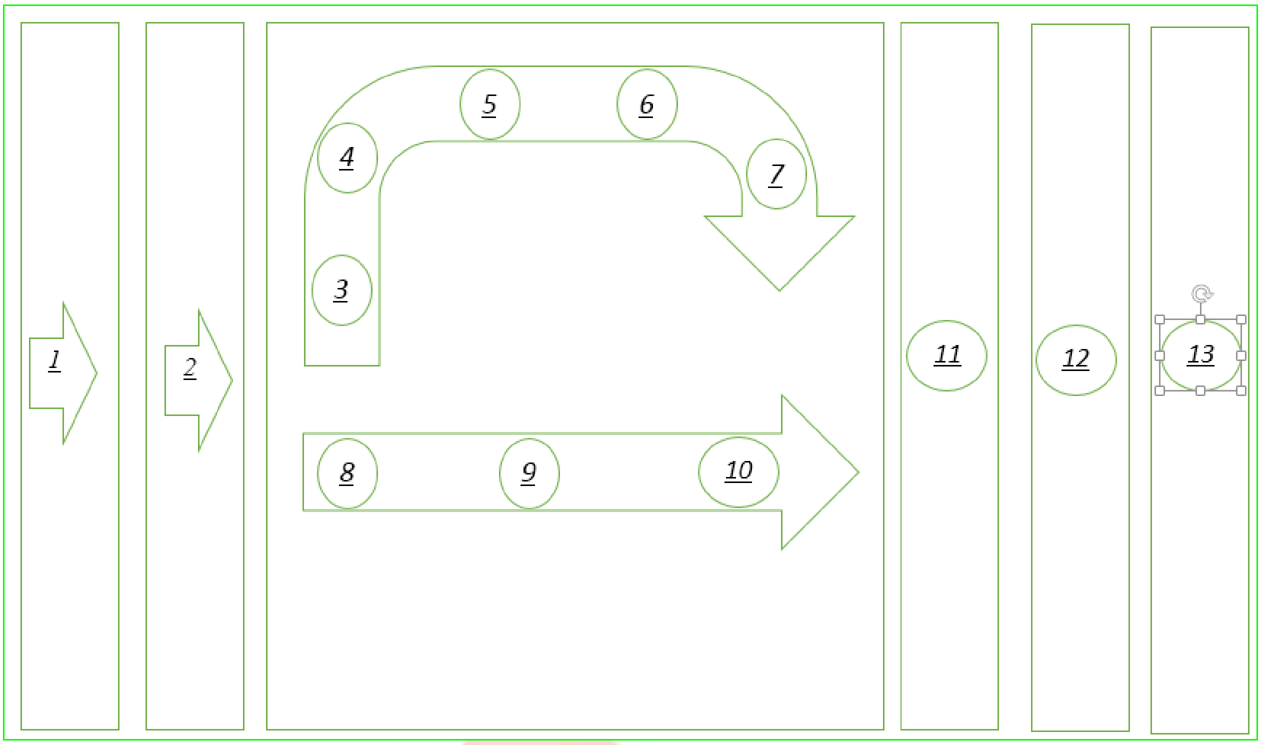

FIG 1 PRECEDENCE DIAGRAM OF ASSEMBLY OPERATIONS

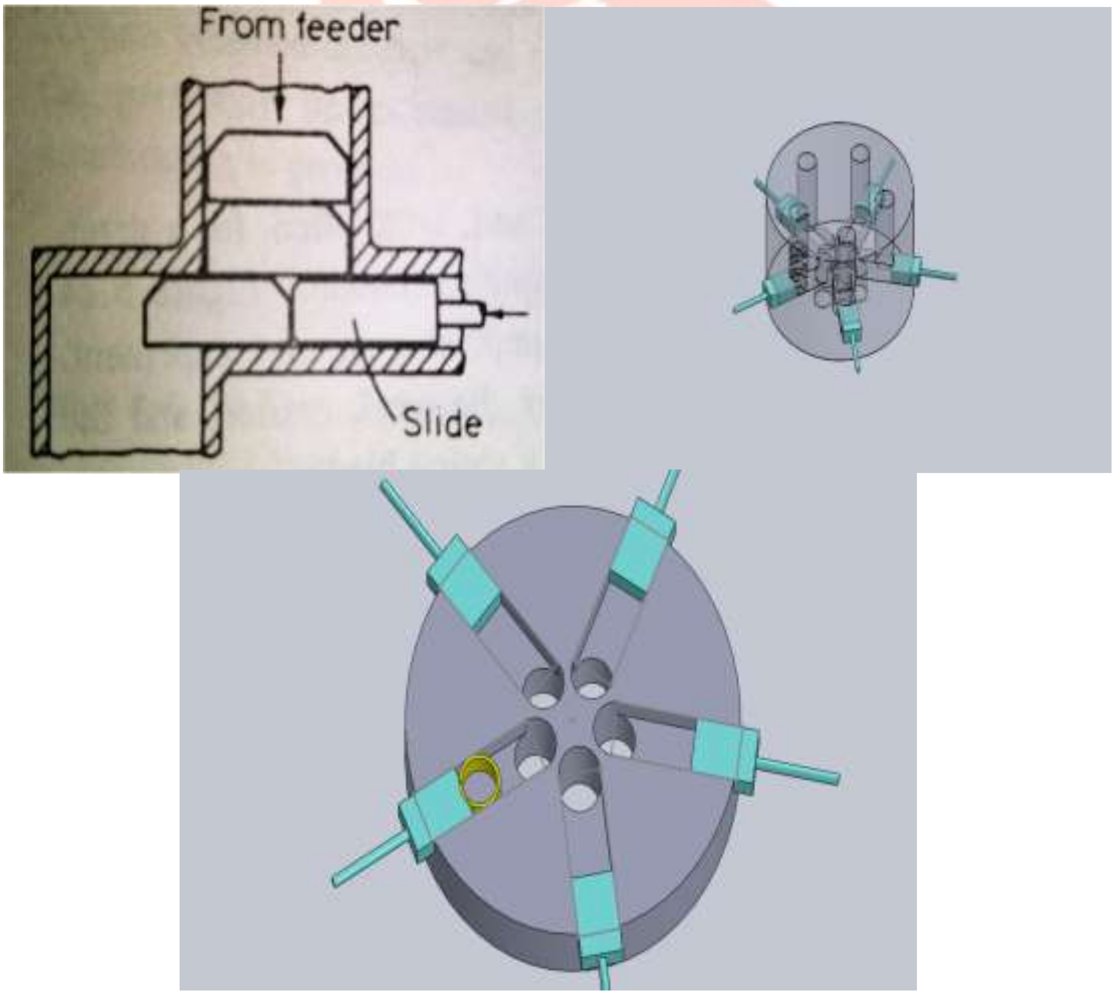

Fig 2. Feeding mechanism in different views.

For the automation, a simple mechanism has been adopted[4]. The mechanism that enables partial automatic assembly is being shown in the figure 2.The rotor is gripped manually such that rotor shaft comes under the cylindrical chute. The cylindrical head is actuated. The slider escapement 1 which is in an oriented position with the rotor will move. The cylinder pushes the spacer from the loaded chute into rotor oriented chute. By gravity, the spacer will slide smoothly over rotor shaft and settle at the edge of laminated sheets. Once the above mentioned spacer get actuated, after a certain amount of time (10seconds) the cylinder get rotated through a 72°. Now the second chute come in orientation. The assembling elements are pre-loaded after heating in each chutes, in the order, spacer, inner bearing cover, bearing, outer bearing cover and end shield. Once all these elements are assembled at one side, the rotor is reversed and all are assembled at other side except end shied. Assembly is inserted into stator. End shield, lock washer and nut re provided. Pulley is also been inserted.

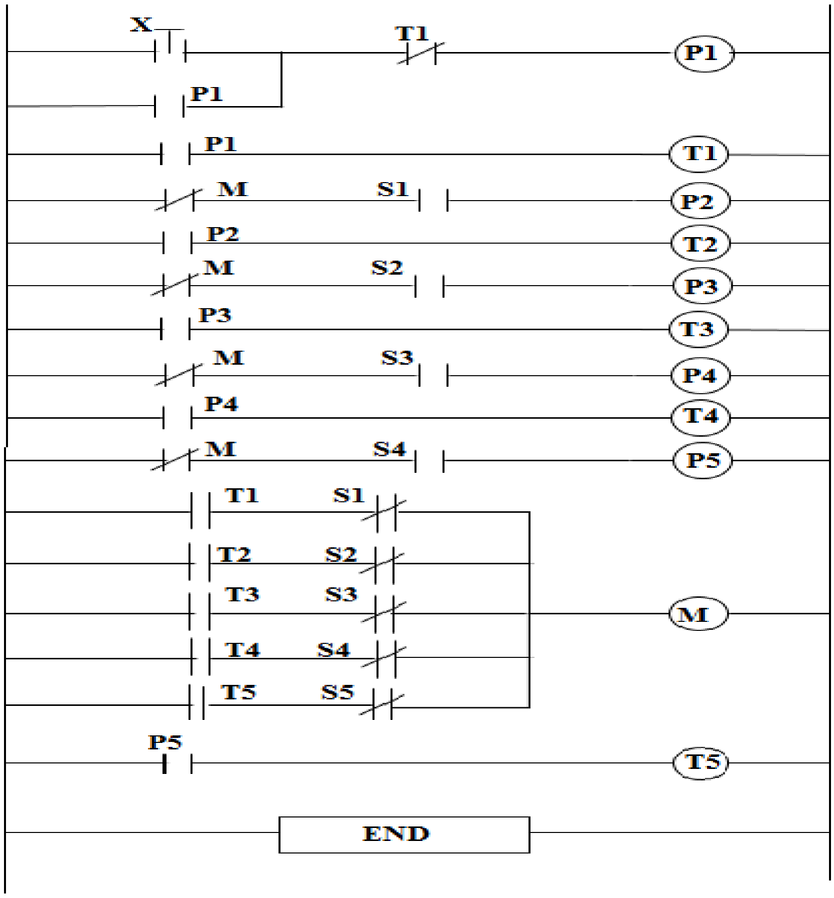

Fig 3. Ladder circuit for slider actuation

For the timed action a PLC circuit could be used. Hydraulic circuit is being used to actuate the slider. Once all the parts are assembled with end shield at the end. P1 actuates the solenoid of direction control valve in hydraulic circuit. Hence the first position is attained. This enables the movement of slider in right direction. Once the movement is at the extreme end, contact sensor will actuate and hence the second position will get actuated. This in turn causes the movement of cylinder in left direction. The end stage is shown in figure.

T timers are provided for providing a time gap for assembly. After the prescribed time M motor will rotate cylinder so that second cylinder will come above rotor. S are sensors that will ensure the rotation is completed before the slider actuation. A push button is provided at beginning to making the circuit ON.

.

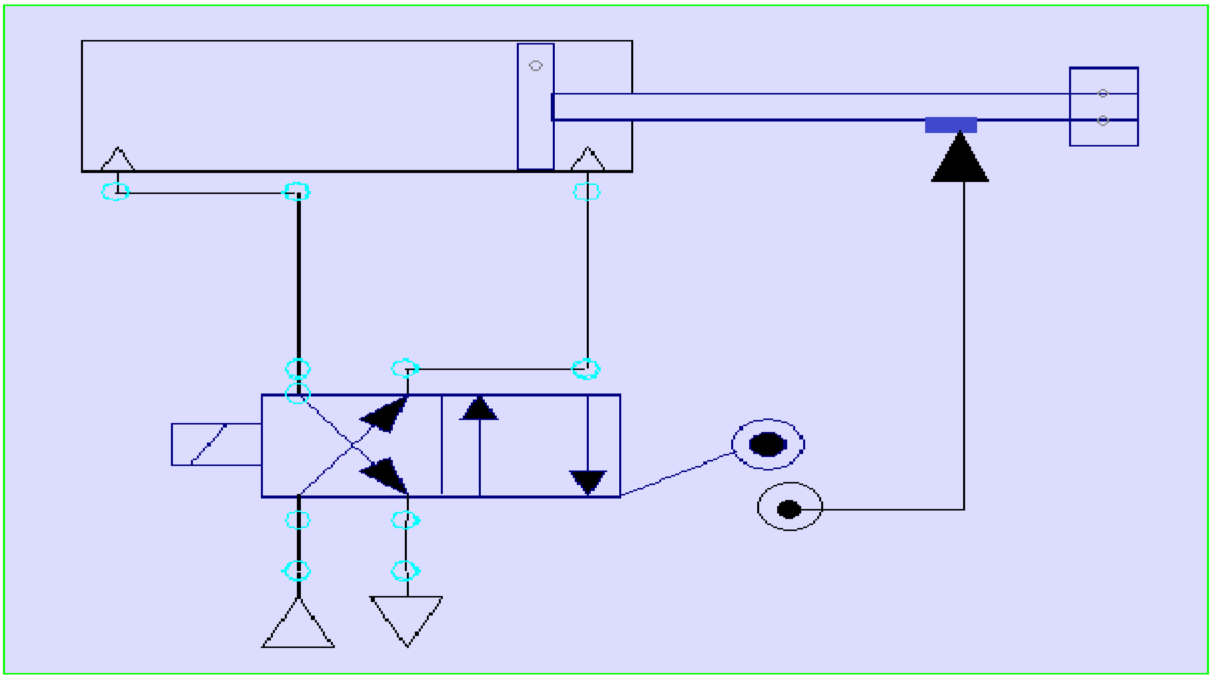

Fig 4. Hydraulic circuit for slider actuation

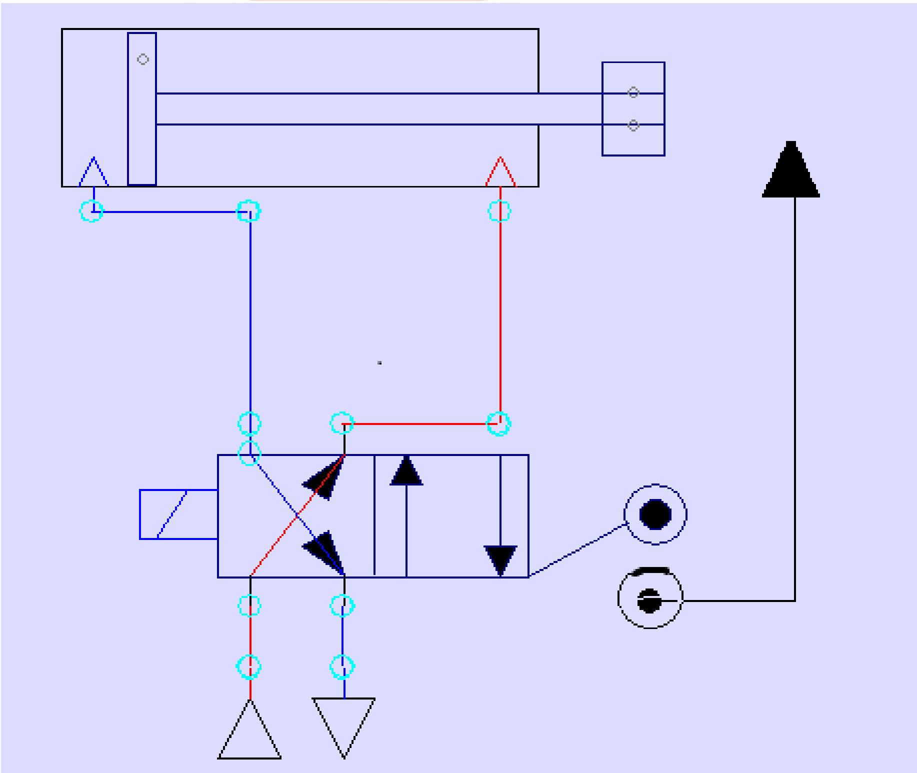

Fig 5. Hydraulic circuit for slider actuation in reverse direction

IV. CONCLUSION

Productivity is a relationship between the output of goods and services and one or more of the inputs-labor, capital, goods, and natural resources. Both output and input can be measured in different ways, none of them being satisfactory for all the purposes. The most common way of defining and measuring productivity is output per man-hour; usually referred to labor productivity. A more realistic way of defining productivity is the ratio of output divided by the total input, usually referred to as productivity.

Automation of assembly process is suggested with the eye on reducing the effort of labor. But at the same time looking on the productivity improvement terms, it is very clear that automation is economically beneficial. At the present scenario, three to four employees are involved in the assembly process of rotor and stator in KEL. With the suggested automation number of employees needed for taking care of the entire process can be reduced to one or maximum two. Hence two more labors are available for carrying out one more assembly. In other words the total productivity increases by twice, because, the total input is an aggregate of all the inputs including the number of labor hours.

Another merit of the suggested technique is that any change in the assembly process due to a design change could be easily incorporated here. As a PLC is used for controlling activities, which is being flexible, could be easily reprogrammed and used.

When an assembly operation calls for the insertion of a disk- shaped part into a hole or a disc with hole into a cylinder, jamming or hang up is a common problem. Special handling equipment are available which can be used to prevent the jamming, but simpler, less costly solution is to analyze carefully all part dimensions before production begins. The diameter of shaft is one unit, all other dimensions that are critical in reducing risk is relative to this unit and are dimensionless. The disk diameters 1+c where c is a dimensionless diametrical clearance between mating parts, P the rousting force in the assembly operation, and μ is coefficient of friction.

When a disc with no chamfer is inserted into a hole or to a shaft, the condition for free sliding is determined by

$$L^2 > \mu^2 + 2c - c^2 \qquad (1)$$

If c is so mall, then the equation becomes

$$L^2 > \mu + c/\mu \qquad (2)[5]$$

References

[1] L. Bainbridge , 'Ironies of automation' Automatica, vol:19 (6),1983 ,pp. 775–779

[2] Terborgh G., "The automation Hysteria" , Norton, Newyork,1965

[3] Seering W.P.,and Gordon , S. J., " Review of Literature on assembly", Dept of Mechanincal Engineering,MIT,Cambridge MA., Nov 1983

[4] Boothroyd,'Design for assembly—The key to design for manufacture' The International Journal of Advanced Manufacturing Technology, 1987 , vol:2 (3), pp. 3–11

[5] Boothroyd "Assembly Automation and Product design", First edition.