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# Improvement Plant Layout Using Systematic Layout Planning (SLP) for Increased Productivity

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***Abstract*—**The objective of this research is to study plant layout of iron manufacturing based on the systematic layout planning pattern theory (SLP) for increased productivity. In this case study, amount of equipments and tools in iron 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 billet cutting process until keeping in ware house.

***Keywords*—**Plant layout, Systematic Layout Planning, Flow analysis, Activity relationship chart

## I. INTRODUCTION

WITH rapid increasing of 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 (QC), total quality management (TQM), standard time, plant layout to solve the problems concerning productivity. For example, a case studies from the lamp industry [1]. The found problem was that the staff did not work in orderly manner, resulting in confusion and no standard time nor facilitating tool. The staff spent too much time on work. The way to solve these problems was to improve the steps in working and the area where they worked through observation and fieldwork as well as proposing tools to facilitate the work to set balance and find the standardized time. In additional Yookkasemwong *et al*. [2] studied the production process for Cable box to form metal. The problem was that the work could not be finished within 8 hours. The problem was then studied from data collection, the actual time load, improper plant layout, and the duration of the process. The principle of ECRS was adapted to reduce the waste and arrange the repeated steps, resulting in changes in plant layout and staff workload. 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 [3]. Sucharitkul *et al*. studied the possibility of plant layout and installing aluminum foundry [4]. As for the layout of plant, it was done in accordance with the steps in systematic plant layout design. Yujie *et al*. studied the general plane of long yards using SLP which the best layout showed the good workflow and practical significance [5].

According to the researches mentioned above, plant layout is one way to reduce the cost of manufacturing and increase the productivity. 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, through such a steel rod factory that was case study. From the experience in steel rod factory, it was found that there was wasted time or delay in manufacturing, that is to say, the movement of the material in long line and interrupted flow as well as useless area of the plant. According to these problems, the researchers would like to analyze the way to solve such problems and find the way to improve the plant layout. The basic industrial layout planning is applied to systematic layout planning (SLP) method in which showed step-by-step 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.

## II. PROCEDURE FOR PLANT LAYOUT PLANTING

The data were collected and the number of tools/ equipment for manufacturing was counted in terms of the direction for raw materials and product. The operation process chart, flow of material and activity relationship chart have been used in analysis. The problem of the plant was determined and analyzed through SLP method to plan the relationship between the equipments and the area. The framework of SLP is shown in Fig. 1. Based on the data such as product, quantity, route, support, time and relationships between material flow from –to chart and activity relation chart are

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displayed. From the material flow and relationship activity in foundry production, the relation between each operation unit can be observed. Then the results were drawn through the comparison between the existing manufacturing process and the proposed way.

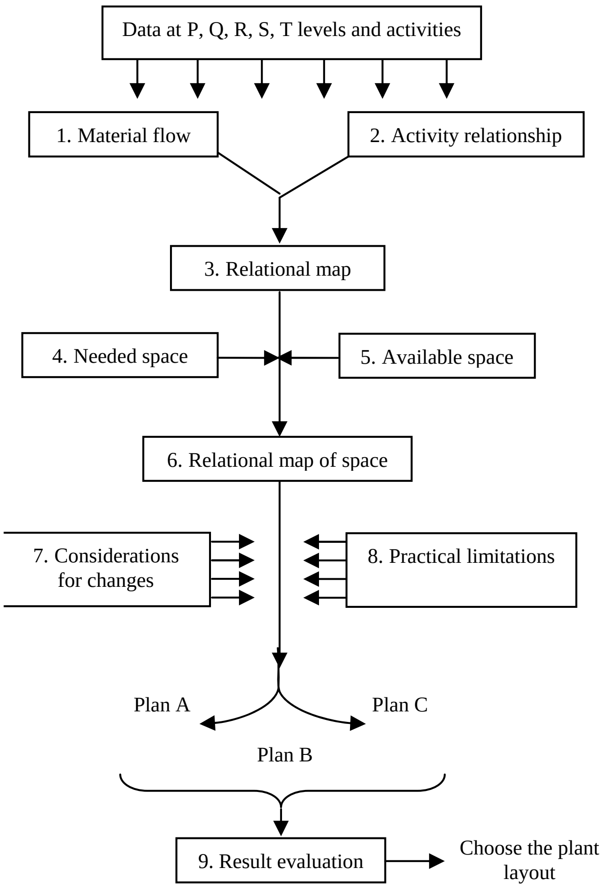


Fig. 1 Systematic Layout Planning Method [3]

## III. Analysis of Original Plant Layout

In this study, the steel rod as production was mostly made to customer's order. The manufacturing process was shown in Fig. 2 along with the flow of the operation process. The size of the equipment was relational to the area as shown in Table 1 and 2. The foundry would produce rod steel with sizes 10, 16 and 20 mm.

According to the original plant layout, the flow of the material, the utility of the area in the plant and material handling equipment could be discussed as follows:

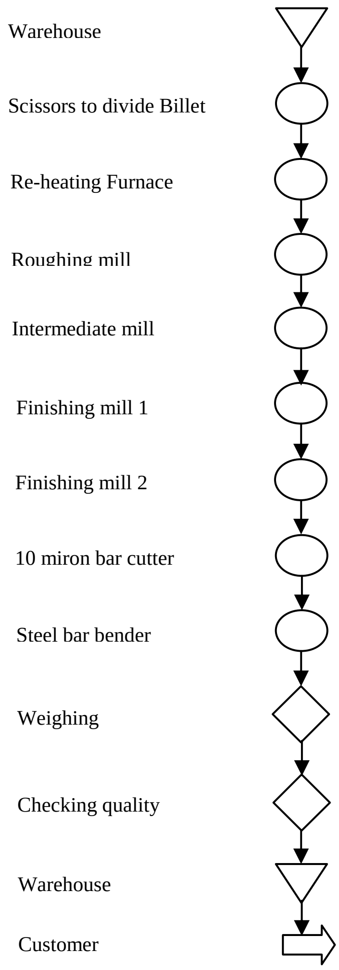


Fig. 2 Flow of the operation for billet

TABLE I
RELATIONSHIP BETWEEN EQUIPMENT SIZE AND AREA

| Department | Equipment type | Number of equipment | Equipment area/Working area (m2) | Total working area(m2 |
|---|---|---|---|---|
| Cutting iron | Dividing scissors | 1 | 21 | 21 |
| Re-heating | Re-heating Furnace | 1 | 134 | 134 |
| Roughing | Roughing stand | 6 | 620 | 646 |
| Intermediate process | Intermediate stand | 4 | 13 | 14 |
| Finishing process 1 | Finishing stand 1 | 6 | 15 | 17 |
| Finishing process 2 | Finishing stand 2 | 2 | 16.5 | 18 |
| Cutting 10 micron | 10 micron bar cutter | 1 | 3.3 | 4 |
| Bending billet | Billet bender | 2 | 109 | 426 |

TABLE II
THE AMOUNT AND SEQUENCE FOR MANUFACTURING THE BILLET WITH SIZE A=12 MM AND B=16-20 MM

| Details | A: Distance (m.) | B: Distance (m.) |
|---|---|---|
| 1. Ware house | - | - |
| 2. Billet was taken to cutting scissors | 30 | 30 |
| 3. Cutting Billet | - | - |
| 4. Putting Billet into furnace | 19.26 | 19.26 |
| 5. Reheating Billet | - | - |
| 6. Entering the process of Roughing stand R1-R6 | 9.78 | 9.78 |
| 7. Crossing the Roughing stand R1-R6 | 20.26 | 20.26 |
| 8. Taken to Intermediate step | 10.43 | 10.43 |
| 9. Milling at Intermediate M1-M8 | 8.46 | 8.46 |
| 10. Entering finish 1 process | 22.21 | 22.21 |
| 11. Milling at finish 1 F1-F6 | 13.89 | 13.89 |
| 12. Entering finish 2 process | 8.3 | - |
| 13. Milling the sign at finish2 F7-F8 | 8.08 | - |
| 14. Attending 10 m | 9.38 | 9.38 |
| 15. Entering the process for cutting 10 m. | 7.84 | 7.84 |
| 16. Dividing 10 m iron bar | - | - |
| 17. Entering the bending | 4.94 | 4.94 |
| 18. Bending 10 m iron bar | - | - |
| 19. Taken to be weighed | 4.25 | 4.25 |
| 20. Weighing | - | - |
| 21. The metal was randomly picked up for checking quality | 37.13 | 37.13 |
| 22. Checking quality | - | - |
| 23. Being stored at Ware house | 13.40 | 13.40 |
| 24. Keeping at Ware house | - | - |
| Total | 227.61 | 211.23 |

*A. The Flow of Materials*

Raw materials were carried with long distance and that means a waste in time and energy, resulting in high cost as shown in Table 1, 2 such as moving the steel bar from warehouse to scissors to divide billet for 30 meters, resulting wasted time and more energy.

*B. Utility of the Area*

The area was not used to the full potential because old machine and remaining materials were still there in the working area, resulting in useless area of the plant.

The department of maintenance was still spacious and adjacent to the area where the raw materials were kept, resulting in limited area for storing raw materials

The area to store raw materials before moving to the process of dividing billet was limited so the area could contain only 600 billets per day. The plant needed to move the raw materials inside regularly until there were 60 billets per day. Thus, this affected the cost of energy.

*C. Material handling equipment*

The material handling equipment of the raw materials was not good enough, that is to say, fork lift was used to move in one direction and the pathway was not flexible enough due to untidy arrangement of the things. This was the reason why the raw materials were to be carried for a long distance.

*D. Storage area of billet*

Actually warehouse for billet or the raw materials was 1,020 square meters. One pile of billet took up 36 $m^2$ so the plant could contain billet for 9,310 tons per month. The plant at the present time could contain only 8,000 tons per month. After the improvement, it had more space to contain billet or raw materials.

## IV. ANALYSIS PLANT LAYOUT BASED ON SLP

According to the study of the manufacturing process, it was found that the long distance could be reduced for moving raw materials and the problem about useless area could be solved. The way to improve the plant was to apply SLP method to make the work flow continually by arranging the important sequence of the manufacturing. Then the relationship of each activity in closeness area was considered to make the relationship of each activity in the graph from – to – chart as shown in Fig 3 , and the closeness value are defined as A = absolutely, E = especially important, I = important, O= ordinary closeness, U= unimportant. The details for each activity were described in Table 3, as follows:

A: Billet warehouse
B: Scissors to divide Billet
C: Re-heating Furnace
D: Roughing mill
E: Intermediate mill
F: Finishing mill 1
G: Finishing mill 2
H: 10 m. iron bar cutter
I: Steel bar bender
J: Weighing
K: Checking quality

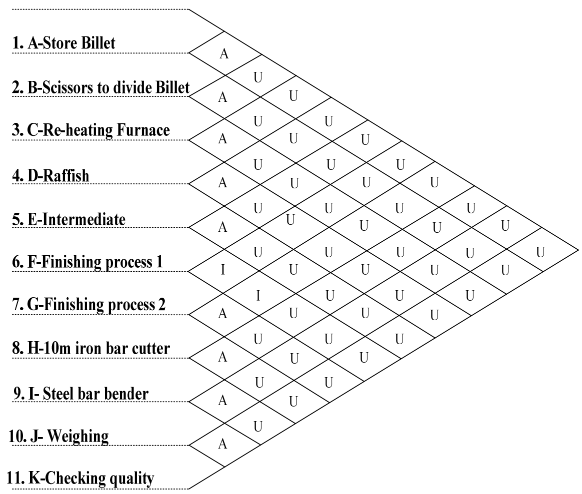


Fig. 3 Relational graph of each activity

TABLE III
SHOWS THE WORKFLOW OF THE MANUFACTURING PROCESS IN DOUBLE STAGE

| Product | (Per month) | Routing |
|---|---|---|
| Billet with the size of A mm | 3,000 | A-B-C-D-E-F-G-H-I-J-K |
| Billet with the size of B mm | 1,500 | A-B-C-D-E-F-H-I-J-K |
| Billet with the size of C mm | 1,000 | A-B-C-D-E-F-H-I-J-K |

The important sequence of each activity was rearranged from the most important one to the least important one as shown in Fig 4. The intensities of flow from each activity to another were developed in Fig 5.

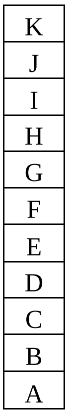


Fig. 4 The sequence of activities in the manufacturing process

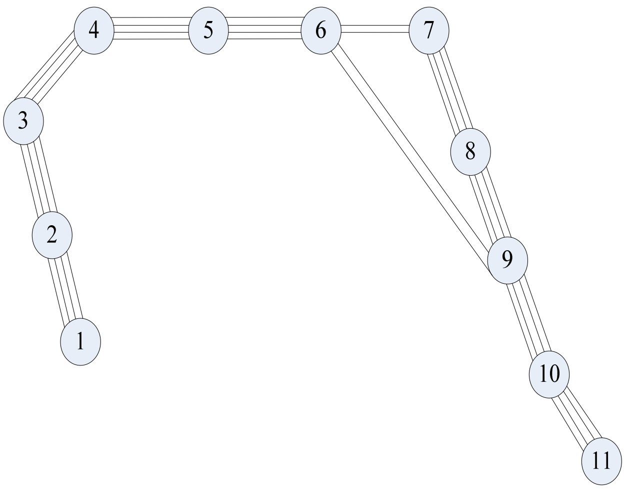


Fig. 5 The intensities of flow in the manufacturing process

Based on modifying plant layout and practical limitations, a number of layouts were developed. There were 2 choices to improve the plant layout as shown in Fig 6. The original plant layout represents A, while modified plant layout represents B and C.

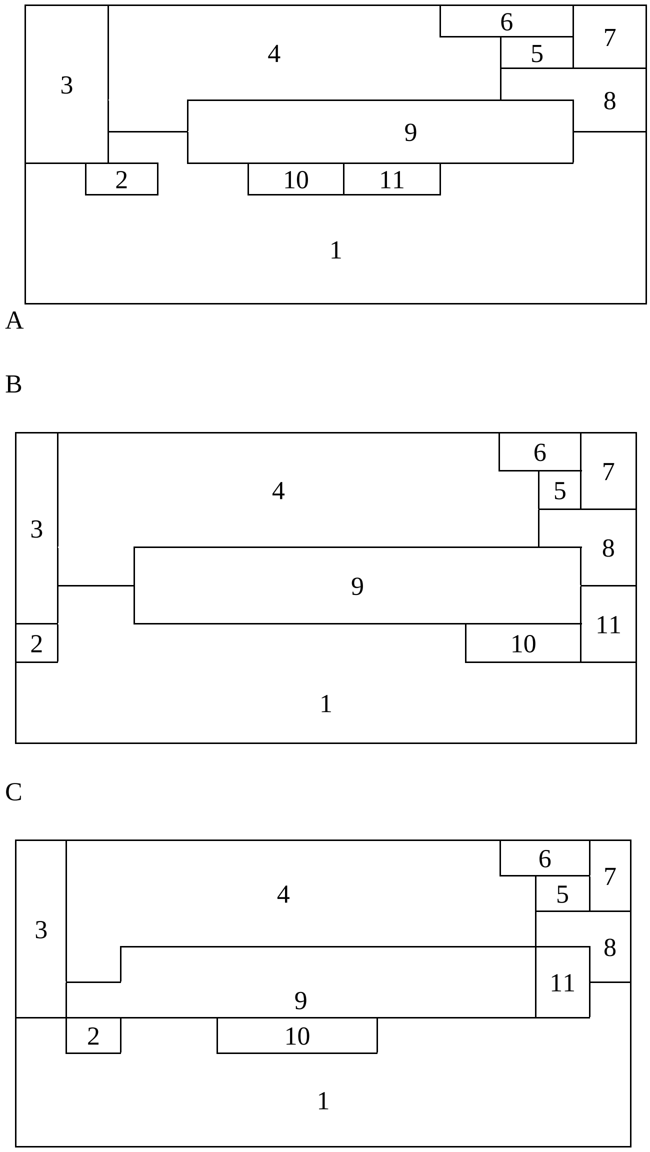


Fig. 6 Plant layout between origin and improvement

According to the analysis of the workflow for the billet with the size of 10 mm (Table 4), it was found that the distance from the moving out of the warehouse to dividing the billet and to keeping at warehouse was 190.08 m., reduced from 227.61 m. or reduced by 37.53 m. As for the billet with sizes 16, 20 mm in the new plant layout, the distance for moving materials was 187.80 m, reduced from 211.23 m. or reduced by 23.43 m. Finally, rearrange layout decreased flow of material, resulting in increased production.

TABLE IV
WORKFLOW OF THE MANUFACTURING PROCESS FOR BILLET WITH THE SIZE OF A MM IN THE DOUBLE STAGE PLANT (NEW LAYOUT)

| Details | Distance (meters) |
|---|---|
| 1. Ware house | - |
| 2. Billet was taken to cutting scissors | 16 |
| 3. Cutting Billet | - |
| 4. Putting Billet into furnace | 19.26 |
| 5. Reheating Billet | - |
| 6. Entering the process of Roughing stand R1-R6 | 9.78 |
| 7. Crossing the Roughing stand R1-R6 | 20.26 |
| 8. Taken to Intermediate step | 10.43 |
| 9. Milling at Intermediate M1-M8 | 8.46 |
| 10. Entering finish 1 process | 22.21 |
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| 15. Entering the process for cutting 10 m. | 7.84 |
| 16. Dividing 10 m iron bar | - |
| 17. Entering the bending | 4.94 |
| 18. Bending 10 m iron bar | - |
| 19. Taken to be weighed | 4.25 |
| 20. Weighing | - |
| 21. The metal was randomly picked up for checking quality | 17 |
| 22. Checking quality | - |
| 23. Being stored at Ware house | 10 |
| 24. Keeping at Ware house | - |
| Total | 190.08 |

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