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Adopting the Lean Methodology by Improving the Plant Layout in the Foundries

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ABSTRACT: *To reduce the production cost and improve the quality of the product, suitable methodology is to be adopted. This involve is to study the various steps of casting process at the micro level. In the foundry industry most important step is the pouring of the molten metal in the mould, therefore the most sensitive parameter is the pouring time. Pouring time is mainly depending on the plant layout. Study of the industrial layout of the of the casting area is one of the most important task to reduce the pouring time and thus reduce the ultimate production time of the job . Other important parameters are also deeply studied such as balancing of workload, queuing during the processes , ability of the workers, cooling of the casting, shake out the casting, job handling facilities available ,cleaning processes and cut burr processes. Expected outcome of the research to focus on the plant layout which involve the process of pouring metal inside the mould, cooling of the casting, shakeout, and transport to the cleaning and cut burr processes. At the foundry industry the scenarios simulated to increase the potential of production capacity explore all possible alternatives to reduce the pouring times through an improvement in industrial lay out and workload balancing including the worker's ability is to be improved by proper training. These procedures can lead to reduce the waste of time and thus reduce the waiting time inside the processes, an essential requirement of the lean manufacturing technology.*
Keywords: *plant layout, Pouring time, workload, waiting time*

I. Introduction

Lean manufacturing is one of the initiatives that many major businesses in the United States have been trying to adopt in order to remain competitive in an increasingly global market. The focus of the approach is on cost reduction by eliminating non-value added activities. Originating from the Toyota Production System, many of the tools and techniques of lean manufacturing (e.g., just-in-time (JIT), cellular manufacturing, total productive maintenance, single-minute exchange of dies, production smoothing) have been widely used in discrete manufacturing. Applications have spanned many sectors including automotive, electronics, white goods, and consumer products manufacturing. On the other hand, applications of lean manufacturing in the continuous process sector have been far fewer. It has sometimes been argued that in part, this is because such industries are inherently more efficient and have a relatively less urgent need for major improvement activities. Managers have also been hesitant to adopt lean manufacturing tools and techniques to the continuous sector because of other characteristics that are typical in this sector. These include large, inflexible machines, long setup times, and the general difficulty in producing in small batches.

While some lean manufacturing tools might indeed be difficult to adapt to the continuous sector, this does not mean that the approach is completely inapplicable. Abdullah et al. (2002) and Abdelmalek et al. (2006) examine aspects of continuous production that are amenable to lean techniques and present a classification scheme to guide lean implementation in this sector. The objective of this paper is to use a case-based approach to demonstrate how lean manufacturing tools when used appropriately, can help the process industry eliminate waste, maintain better inventory control, improve product quality, and obtain better overall financial and operational control. A large integrated steel mill is used to illustrate the approach followed.

II. Concept

Lean Thinking starts with the customer and the definition of value. Therefore, as a manufacturing process is a vehicle to deliver value (a product) to a customer, the principles of lean thinking should be applicable to the Process Industries and the specific manufacturing processes within that industry. We can remove waste from many steps of our manufacturing processes, from how we develop the initial product and process design, how we assure compliance, to how we design to operate a completed facility. However, to be truly lean we have to link all these elements within a robust supply chain—we need to ensure the flow of value. This leads to what many are calling a 'lean enterprise' (LERC, 2004).

The Lean Enterprise Research Centre (LERC, 2004) at Cardiff Business School highlighted that for most production operations:

- 5% of activities add value;
- 35% are necessary non-value activities;
- 60% add no value at all.

Therefore, there is no doubt that the elimination of waste represents a huge potential in terms of manufacturing improvements—the key is to:

- identify both waste and value;
- develop our knowledge management base;
- Realize that sustainable improvement requires the buy in of the people operating the processes and managing the business, and therefore a culture of continuous improvement.

III. Objective

The main objective of this paper to reducing the production cost of the castings by improving the plant layout and applying the principles of lean manufacturing .The lean manufacturing will help reducing the waste, waiting time and balancing the production line. The major benefit is high productivity which is the need of the hour.. Lean Manufacturing is one such area having great potential to obtain higher productivity especially in foundry practice.

IV. Methodology

Collection of data through literature survey, interviews, group discussions, questionnaires, databases, seminars, conferences etc. Data analysis by using various tools like hypothesis testing, qualitative analysis, using relevant statistical software Mat Lab ,ANSYS etc.

John S. W. Fargher [2] suggested a method in his case study as follows:-

- The first step is to group products into families of similar production processes.
- The second step is to establish the Takt time. The Takt time is the demand rate and consequently the time between completion of each product off of the production line. It is first necessary to find the available capacity of the production line:

Available Capacity = Time Available x PFS x Utilization

Where:
Time Available = Hours / Time Period x Number of Employees
Personal, Fatigue, and Safety (PFS) = Standard Hours Produced / Hours Worked
Utilization = (Hours Available - Downtime) / Hours Available

- The third step is to review the work sequence by:
  i. Observing the sequence of tasks each worker performs,
  ii. Break operations into observable elements,
  iii. Identify value added versus non value added elements and minimize or eliminate non value added
  operations, and Study machine capacity, cycle times and change over times
  iv. In IE words, conduct methods and standards studies.
- The fourth step is to balance the line using the calculated Takt times found in step two.
- Step five is to design and construct the cell to:

Implement a “U” shaped line to assure one way flow and maximize visibility,
Provide a flexible layout to account for all members of the production family,
Decrease distance between operations and integrating process operations wherever possible for simplicity, minimizing both transportation and production lot sizes, integrate in point of use storage next to each assembly operation.
Minimize material handling by concentrating on value added motion
Establish replenishment procedures for point of use storage using the A-B-C rule

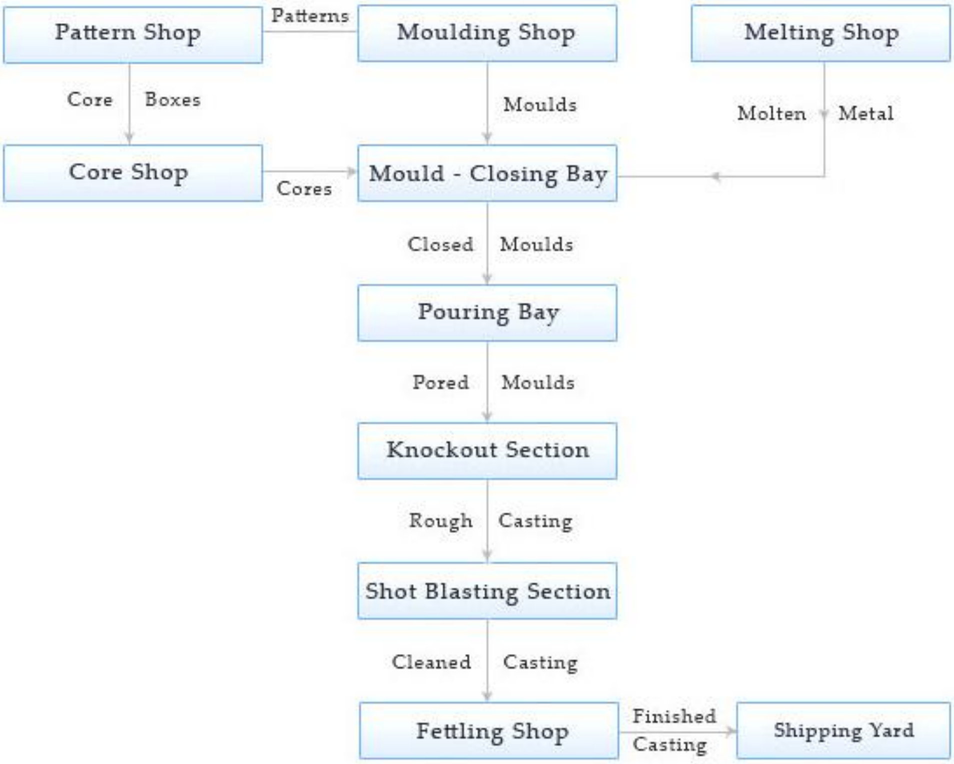


Fig. No. – 1: Flow chart of Foundry Practice

To carry out the proposed research work through data collection, small and medium sized foundries to be visited. Complexity of casting process and parameters need to be studied.

There are other lean practices to implement. If production flows perfectly, there is no inventory waiting to be worked on. Metal casters have helped minimize work-in-process by installing conveyor lines to keep castings moving right through to finished goods storage. This eliminated putting the castings in totes and the added handling. One low to medium volume gray/ductile iron jobbing foundry (casting weights under 50 pounds) we know now ships 30% of its production the same day and believes they can achieve 70% same day shipment. These standards aren't just for the high volume or dedicated metal casting companies any more.

"Autonomation" or "smart automation" is a part of lean manufacturing as well. Autonomation refers to automating the process so humans can focus o n what humans do best. The objective here is to design the machine so it knows when it is working abnormally and alerts a human. The human no longer has to monitor normal production but can focus on abnormal or fault conditions. Removing routine and repetitive activity reduces the chance for error.

V. Case Study

A Case study on application of Lean Manufacturing to Higher Productivity in a rolling coil steel industry -- Bhushan Steels Ltd. (NCRM Division) Khopoli, Mumbai has been done and plant layout is improved to increase the productivity, following outcomes have been observed :

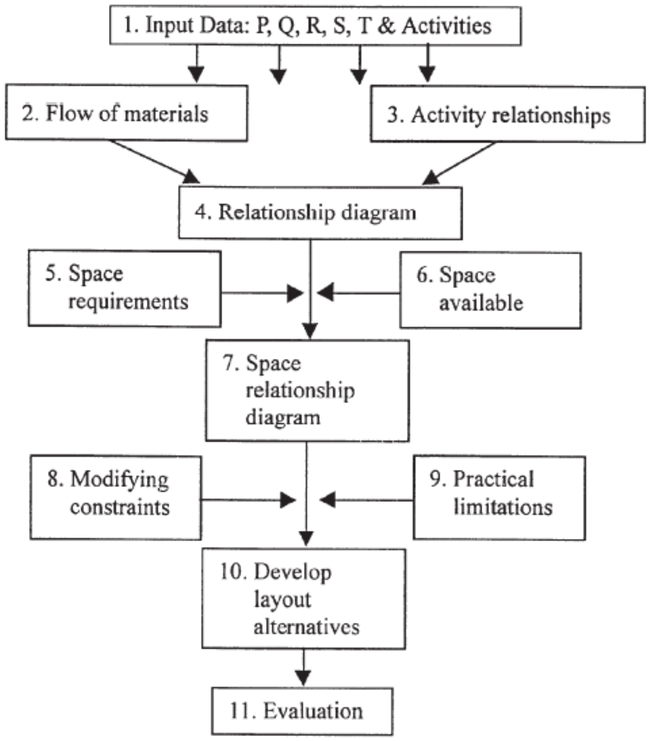
5.1 Introduction

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 rolling coil steel industry that was case study.

5.2 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 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.



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 rolling coil from warehouse to Pickling 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. 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, Cranes and trolley was used to move the coils 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 Coils

Actually warehouse for Rolling coils or the raw materials was 1500 square meters. One Rolling coil took up 3 m2 so the plant could contain rolling coil for 5000 tons per month on ground and same amount of coil could arrange on these coils. 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.

VI. Conclusion

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.

References

[1]. S. Tenwong et al.,“ Productivity improvement for the lamp manufacturing, a dissertation for Master’s degree in Manufacturing Systems Engineering, School of Engineering,” King Mongkut’s University of Technology Thonburi, 1991.
[2]. S. Yookkasemwong, S. Pitchaya-anankul and Areerat Bussarakamwadee, “Process Improvement for increasing efficiency of Cable BoxProcess, a project for Bachelor’s degree in Industrial Engineering, School of Engineering,” King Mongkut’s University of Technology Thonburi, 2005.
[3]. M. Khansuwan and C. Poowarat, “A Study on Plant Layout Improvement”: A Case Study at Kritchai Mechanical Company Ltd., a project for Bachelor’s degree in Industrial Engineering, Faculty of Engineering, Thammasat University, 1999.
[4]. T. Sucharitkul et al., “The feasibility study and alumsinium foundry plant layout design : a case study : Sathien Plastic and Fibre,” a dissertation for Master’s degree in Manufacturing Systems Engineering, School of Engineering, King Mongkut’s University of Technology Thonburi, 1999.
[5]. Y. Zhu, and F. Wang, , “Study on the General Plane of Log Yards Based on Systematic Layout Planning,” IEEE. Computer Society, vol. 4, pp. 92–95, 2009.
[6]. M. Mahajan “Industrial Engineering and Production Management” Published by Dhanpat Rai & Co(P) LTD.
[7]. Bhushan Steels LTD. Savroli. Khopoli. Mumbai, Maharashtra
[8]. Aza Badurdeen, Lean Manufacturing Basics, 2007
[9]. Taichi Ohno, Toyota Production System, Productivity Press, pp. 6, 8, 29, 58, 70, 126 (1988)
[10]. Seiichi Nakajima, "Introduction to TPM", 1989
[11]. Anwar Ali, “Key Practice Areas of Lean Manufacturing”, International Association of Computer Science and Information Technology – Spring Conference, 2009.