Lean Manufacturing for Plant Design

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Lean manufacturing is used to add value and eliminate waste. The physical capability to add value in a manufacturing plant is done by facility planning. Facilities are expensive, have a long lifetime, and take years to commission. Manufacturing plants can create a competitive advantage by designing appropriate facilities for their products and manufacturing processes. Therefore, designing a lean facility is important to running a successful manufacturing plant.

**Introduction**

Facilities for manufacturing operations should have a properly designed layout to create a competitive advantage in a market sector. The facility should operate at low cost, operate efficiently, be flexible for new parts or products, produce many different products at high or low volume, and provide unique services. The first step in operation is often overlooked. Wickham Skinner, also known as the father of Manufacturing Strategy, suggests deciding key manufacturing tasks is the most important step in facility planning. This is done by focusing on factors such as process technology, market demand, product volume, quality levels, and manufacturing tasks. Without looking at these factors, factories do not maintain competitive advantage due inconsistent policies or mission creep, for example.

Plant design can be broken down into multiple levels. The first decision that must be made is the plant location. The plant must be located in such a way that freight cost and labor cost are at appropriate levels, labor skill availability is sufficient, and the site accommodates the volume of products and manufacturing machines. The second level is developing a master site plan which includes number, size, and location of buildings as well as infrastructure. The master site plan must accommodate strategic business units to separate manufacturing processes. The next level is the building layout which focuses on departments within the company. Positioning of tasks within the building in a sequential fashion is important here. The work cell or department level is next level. The design must compromise between requirements and technical limitations to maximize the efficiency of each department equally. Considerations here are based on grouping of products together or even having pre-assembled pieces to increase productivity. This is known as cellular manufacturing and it is important for minimizing time to find products and accomplish repetitive tasks. Having bins of parts makes it easier for workers to find parts especially when the bins are grouped appropriately. Part bins are grouped in accordance to relation so screws would be near washers and nuts of the same size. The fifth level is workstation design and is concerned with ergonomic considerations. Tasks must optimize the relationship between workers and equipment. Equipment must also be arranged to parallel tasks in order to decrease time between manufacturing steps. This should be considered as the final level.

A plant layout has four elements. They are space planning units, affinities, space, and constraints. A space planning unit is like a department such as shipping and receiving and each unit has a role in the manufacturing process. Affinities are important to relationships between space planning units and therefore help positioning the space planning units in the plant. Space must be appropriate for the task completed and therefore ranges in size. Constraints limit the plant layout and space may be a constraint so that the layout fits into the space provided.

Traditionally plant work centers were grouped for functional flow layout by departments with similar processes and machines. To implement lean methods, work centers should be grouped by product families or by products that share similar processing methods. An important consideration is to separate people from products. Products can easily adapt to changes in manufacturing however, people are often resistant to change. If workers do not have the tools or knowledge to follow lean manufacturing methods, the methods become detrimental to production. Workers will complain rather than solve problems, procedures will not last, and continuous improvement will not happen. To avoid this, all workers involved should be trained in lean manufacturing methods being implemented. A common example is standardization of work. This allows for preassembled parts, repetition of tasks, and a common understanding of the tasks for all workers. When all workers are well educated and comfortable with lean manufacturing methods, time to complete tasks is minimized and tasks produce parts of similar quality.

Finally, the facility should be structured following a few guidelines. As stated above, work cells should be product focused. Material handling and storage should also be minimized where possible. Raw materials should be directly delivered to the plant as well. A last point is to use Kanban Stock Points. This is a scheduling system for lean manufacturing and JIT manufacturing. Using this involved measuring lead and cycle times in full manufacturing processes and well as steps. Following this prevents the overflow of inventory for the manufacturing process which therefore minimizes material storage.

**Business in Plant Design**

Plant design is a determinant of entry into a market sector. The minimum standard for admission into a market is called a qualifier. Meeting all qualifying standards means all businesses are held equal without a competitive advantage. Deciders are what give certain businesses more orders and give competitive advantage to certain businesses. Price and delivery are often deciders. Those with the fastest and most reliable delivery often receive the most orders. Products are very similar and therefore business considerations are critical to gaining a competitive advantage in the market.

As stated earlier, freight cost is a high level focus during plant design steps. Such a business consideration must be made before anything else. If a plant is located far from distributors or customers, freight cost will be high and reliability of transportation will decrease. However, it is wrongly assumed that customers consider all factors of a product. Some may consider price, others quality, and sometimes multiple product factors. In order to attract a customer, facilities must adjust to each market sector individually. For example, if a customer only cares about quality and price, then plant location will not be as important as lean manufacturing and efficient methods of production. Therefore, when designing a plant, the location, equipment, workers, and many other considerations must meet the demands of the specific market the product is placed in.

**Relevance for Beginning and Experienced Engineer**

The significance of the topic for a beginning engineer is to understand various aspects that go into workplace design and how the design affects the flow of production and cost. The significance of the topic for an experienced engineer is to aid implementation of facility layout or processes to create a lean manufacturing process that is followed, accepted, and understood by all workers.

**Learning**

From the book I learned the various considerations that go into not only implementing lean manufacturing into an existing plant, but also the considerations when opening a new plant in a specific market. From the course, I knew that implementing lean manufacturing methods must be done in such a way to accommodate the products and the people not just the products. I learned the various factors to consider when designing a plant setup and how lean manufacturing considerations are implemented from the first step of facility design and constantly are implemented. I realized why at work that lean manufacturing methods are implemented sequentially in order to allow workers to adjust to change over time rather than be flustered by change all at once. Much of this topic has been helpful to me since it aligns with the course material and because I am able to relate plant design such as standardization and cellular manufacturing to the plant layout where I work.

**Resources**

[1] Lee, Quarterman, et al. *Facilities and Workplace Design: An Illustrated Guide*. Engineering & Management Press, 1997.