Chapter 24
Lean Thinking Based Investment Planning at Design Stage of Cellular/Hybrid Manufacturing Systems

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ABSTRACT

This chapter focuses on providing a methodology for lean thinking based investment planning from the perspective of cellular or hybrid manufacturing systems. The chapter has been divided into three parts. First part provides a general explanation of why lean thinking is so beneficial for managing manufacturing processes and obtaining sustained improvement. This part then moves to the aim of cell formation, and then uses value stream mapping to map current state for visualizing material-information flow and to design a desired future state for examining economic aspects of new machine investment decisions aligned with lean manufacturing principles. The purpose of second part is to explore axiomatic design approach; it provides an overall view of what to do. The third part presents the actual use of the methodology with implementation of hybrid system at a furniture factory; it helps to see application results of this methodology as part of a lean manufacturing program.

INTRODUCTION

Traditional manufacturing systems are built on a functional layout or an assembly line with the principle of economies of scale. This point of view causes much capital investments in high-volume operations and large work-in-process inventories. As an alternative to traditional manufacturing, the principles of the Toyota Production System (TPS) have been widely adopted in recent years. Application of TPS principles have led to lean manufacturing (Sullivan *et al.*, 2002). Womack & Jones (1996) used the term lean thinking as the thinking process of Taiichi Ohno and the set of

methods describing the Toyota Production System (Womack & Jones, 1996; Monden, 1993). Lean manufacturing emerged as a global approach that uses different tools to focus on waste elimination and to manufacture products that meet customer's needs (Hines & Taylor, 2000). Lean manufacturing has been increasingly adopted as a potential solution for many organizations, particularly within the automotive industries (Womack, *et al.*, 1990; Day, 1998; Jones, 1999) and aerospace industries (Abbett *et al.*, 1999; Womack & Fitzpatrick, 1999).

Lean production requires the analysis of the "value stream". A value stream is defined as all the value-added and non-value-added operations required manufacturing specific products and services to a customer (Womack & Jones, 1996; Rother & Shook, 1998). Value Stream Map is an enterprise improvement technique to visualize entire production process, representing information and material flows, to improve the production process by identifying waste and its sources (Rother & Shook, 1998).

Lean manufacturing focuses on the waste elimination and produces products that meet customer expectations. Lean production uses production and assembly cells consisting of product focused resources. The aims of the cell formation are smoothing work flow with flexible operation across a wide variety of low cost and high quality products by means of waste elimination. Economic benefits of lean manufacturing include smaller floor space requirements, lower work-in process, reduced lead-times and higher throughput (Sullivan, *et al.*, 2002). Lean production focuses on value pulled from the next upstream activity as customer. As value is specified, value streams are identified eliminating steps that do not create value, so the product will flow smoothly toward the customer. A value stream mapping is an enterprise improvement technique to visualize an entire production process by identifying waste (Braglia *et al.*, 2006).

Cellular manufacturing is an important technique in the planning and controlling of manufacturing system. Cellular manufacturing offers three groups of benefits. These benefits are: human related factors facilitated by empowerment in smaller cells; improved flow and supervisory control in cells to deal with smaller number of parts and facilities; improved operational efficiency, obtainable due to similarity; setup reduction; batch size reduction; improvement in performance related to productivity, quality and agility (Babu *et al.*, 2000). In practice, it is usually hard to partition all machines into independent cells. So, a functional layout generally becomes necessary. Because of this fact, hybrid cellular manufacturing systems (HMS) are required (Suresh 1991).

Hybrid manufacturing system (HMS) is the system where manufacturing cells and functional layout coexist (Shambu & Suresh, 2000), and also it has an advantage of more product flexibility (Satoglu *et al.,* 2009) and less capital investment for machines. Utilization of alternative machines in the HMS reduces additional machine purchasing requirements, and therefore it is beneficial (Satoglu *et al.,* 2009). Empirical evidences also show that hybrid manufacturing system is common for practice (Marsh *et al.,* 1999).

Lean manufacturing tools and techniques provide economical basis to managers for investment planning decisions. Value stream mapping creates a common language about a production process, enabling more purposeful decisions to improve the production system. Value stream map of the system should be taken into account for the design of future state to examine the economic aspects of new machine investment decisions (Sullivan, *et al.*, 2002). This chapter attempts to provide insight as to the choice and use of appropriate tools for designing a successful lean manufacturing system. Although it does not cover every lean manufacturing aspect, it does offer a road map that can guide a company for effective new machine investment decisions toward the development of a lean manufacturing environment.

Investment planning is the determination of suitable machines for manufacturing of part

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