

ESD.83 Book Review by Randy Urbance

**The Machine that Changed the World**

by James Womack, Daniel Jones, and Daniel Roos

The Machine that Changed the World, published in 1991, has been critically and popularly hailed as the definitive source on Japanese manufacturing methods commonly called lean production. James Womack, Daniel Jones and Daniel Roos demystified the Japanese techniques in this book as the culmination of several years of study in the field automotive manufacture. Their research was sponsored by the International Motor Vehicle Program (IMVP) as a part of a worldwide auto manufacturing benchmarking study. Womack, Jones and Roos opened a window into a new way of organizing the production of goods that departed greatly from the traditional American method of mass production. They revealed that a new method of optimizing a whole production system, from suppliers to sales, could offer great advantages over mass production techniques.

In order to establish a context for discussing lean production, the authors first discussed the details of the two main non-systems techniques of manufacturing, craft production and mass production. This story starts with old world craft production, which established its dominance in Europe in the years preceding the industrial revolution. In that time, finely skilled craftsmen with general tools made products to exact customer standards. Standardized parts were not available in large quantities to enable large or efficient production runs. Products, especially complex ones like automobiles, required much customization and fitting by craftsman in order to maintain function and quality. As a result craft production was had very low efficiencies and resulted in only small numbers of consumer products entering the upper classes.

Henry Ford's assembly line methodology revolutionized production in the early 20<sup>th</sup> century by introducing mass production to the manufacturing world. Unskilled workers assembled large numbers of standardized parts into automobiles in a series of short tasks.

Productivity under Ford's mass production increased substantially beyond what was obtainable through craft techniques. Ford's methods quickly overwhelmed craft producers because unit costs fell rapidly with the increased productivity. As costs fell craft producers could no longer compete.

One of the most important aspects of Ford's ideology was the high level of division of labor. Workers performed assembly, while industrial engineers and management personnel handled line organization and optimization. Diversification and division of labor went beyond the assembly plant as well. Internal to the automotive firm, separate departments designed vehicles, engineered parts and created marketing strategies. Many times these separate entities had conflicting goals leading to corporate infighting. Similar conditions prevailed externally as well, division of labor resulted in very independent supplier firms, manufacturing sites and dealerships. Each of these players had separate goals with respect to the flow of parts, vehicles and customers through the supply chain. Again, this created adversarial conditions similar to the political infighting witnessed within the auto manufacturer. Ford's contemporary, Alfred Sloan at General Motors, created management structures to handle the diverse interests within a large manufacturing company. Each division of the automotive chain, including engineering, components, assembly and sales, was managed in such a way to provide an optimal level of performance for the whole company.

Managing the large manufacturing operations associated with automobiles remained complicated despite the management techniques suggested by Sloan. Often times, there was little or no communication between divisions, departments and even between workers. Each division, group or worker concentrated on producing their parts to the required productivity and quality with little regard to the interests of their surrounding divisions. There were several problems with this lack of coordination and communication. Large buffer inventories were required between manufacturing operations (and between suppliers and the assembler and even engineering departments) due to differing running rates. These buffers were needed in

order to maintain manufacturing flow. Quality problems hidden in these buffers were often discovered at the end of the assembly line requiring large amounts of rework. On the engineering side, product design decisions were made with little regard to manufacturing. Design changes often resulted in products that were very difficult to build. Communication between sales and manufacturing was also disconnected. Assembly of vehicles was not coordinated with sales resulting in large inventories of vehicles on dealer lots that customers did not want. These problems of communication were of little concern however, because all producers in the United States worked with similar practices. Mass production was the standard and it had been successful despite its shortcomings. Therefore there was little reason to change.

The threat to mass production came from an unlikely source, a small Japanese manufacturer, Toyota. Eiji Toyoda came to the US to learn mass production from Henry Ford in 1950 in order to better implement auto manufacturing in Japan. Despite all that he was taught, Toyoda saw through to many of mass production's shortcomings. This coupled with the constraint of limited capital, strong labor laws and lack of space prompted Toyoda and his production chief Taiichi Ohno to create an alternative ideology to mass production, called the Toyota Production System (TPS), the forbearer of lean production.

Taiichi found that a total systems view of the manufacturing process was key to maintaining efficiency, quality and flow through the system. As a result waste, in terms of cost, time and effort, was attacked relentlessly by Toyota's core of semi-skilled manufacturing workers. One of the best examples of waste elimination was the reduction of change over time for stamping dies. To reduce down time Ohno invented flexible tooling systems that reduced die changes from one day to three minutes. This enabled Toyota to make small batches of parts as needed and eliminated large stocks of identical parts generated by long stamping runs.

Toyota workers were also empowered by the system to make changes and improve the system as problems arose. All inventory buffers between processes and the suppliers were

reduced or eliminated to promote a continuous, but very fragile, manufacturing flow. This technique was termed as Just-In-Time delivery. Because of the fragility of Just-In-Time processes, manufacturing problems were quickly addressed rather than leaving them until the end of the line. As a result quality of finished products was nearly perfect, with no required rework. Through waste reduction and continuous improvement, efficiencies and quality of Toyota manufacturing plants became standard of the world.

Communication was vital to maintaining the lean production system. Information about manufacturing flowed easily from manufacturing to engineering departments. This allowed engineers to understand how their decisions would greatly impact the manufacturing process. More informed engineers were then less likely to introduce un-manufacturable designs into plants. Continuous design improvements enabled Toyota to improve product quality even further.

Supplier and vehicle sales communication was also very cooperative due to the fact the breakdowns at either end could lead to wild swings in part availability or factory orders. Stable supply and demand was necessary to keep the lean manufacturing system running without inventory buffers. Cooperative relationships with suppliers allowed lean manufacturing lessons and best practices to pass freely along the supply chain. Cost pressures and quality issues were by addressed by Toyota and the suppliers jointly in the interest of maintaining the integrity of the whole system. On the sales end, Toyota instituted a very proactive sales force that built strong contacts with customers. These contacts were built into family-like relationships that reinforced sales by brand loyalty. In periods of lower demand, line workers were even injected into the sales force to help market vehicles. Toyota used ideas of customer focus and labor flexibility to ensure the long-term integrity of the whole manufacturing system.

Lean production has been applied worldwide by Japanese and non-Japanese firms with much success. This systems view of managing manufacturing systems is based on several strong concepts. Waste elimination should be a vital goal of all manufacturing operations.

Continuous improvement techniques employed by skilled and empowered employees ensures high productivity and quality of product. If carried out to the end, continuous improvement can attain perfect first run quality. Above all maintaining strong lines of communication is vital to keeping the system working. Lines between suppliers and the automakers, between engineers and manufacturing workers, between retailers and automakers, between customers and designers must be utilized efficiently.

Utilizing the inherent efficiency and quality benefits of lean production, Japanese firms like Honda, Nissan and Toyota have gained noticeable market share in the US. After sensing the threat from lean producers, US automakers resisted Japanese entrance into the American market. However, the domestic automakers have had little success keeping Japanese vehicles out and are having trouble competing with the high levels of Japanese quality. As a result American auto manufactures have begun to adopt some of the techniques of lean production. Progress until this point has been slow. While recent troubles in the Asian economies have cast a shadow on Japanese business practices, the most adept lean automobile producers, Honda and Toyota, continue to have success and have been able to adapt their practices during periods of economic hardship. The systems level outlook of lean production appears to have real benefits over traditional American mass production techniques. Womack, Jones and Roos exposed the fact that much of lean production has wide applicability, even outside the Japanese business environment. They suggest that it would likely benefit all manufacturing firms to employ the lessons taught by lean production.