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The Automotive Industry Supply Chain: The Evolution Of Quality And Supplier Relationships

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Quality and supplier relationships in the automotive industry have seen significant evolution since its inception just over 120 years ago. While vast improvements were offered by Henry Ford's introduction of the moving assembly line in 1913, only one other period has seen substantial change with a resulting increase in production efficiency and quality – the implementation of Toyota's lean production-based Toyota Production System (TPS). Through decades of research and development, production methods which improved both efficiency of the supply chain (SC) and product quality were developed, tested, and introduced. These successful methods of production have become a standard for the industry. Companies that have not adopted these approaches have fallen behind with significant losses in market share and sales revenues. With environmental issues at the top of virtually all agendas today, the next phase in automotive production improvement will require new innovations in green methods and ideologies, with further improvements in efficiency, quality, and customer satisfaction.

Keywords: Automotive Manufacturing, Toyota Production System (TPS), Lean Production, Modular Production, Environment, Recycling.

1. Introduction

The automotive industry has seen great strides in the past 20-25 years in its quality, engineering, efficiency, and customer satisfaction. A significant percentage of this can be attributed to Toyota and its TPS business model. Toyota's TPS concepts created drastic improvements not only to the automotive production world, but to the entire industrial world. However, the TPS system was not invented overnight, but evolved after nearly two decades of detailed observation, data collection, analysis, and experiments (Womack, et al, 2007).

2. Quality Improvement Through Production Methods

The TPS model is generally believed to have been in full effect somewhere around the early to mid 1980's. At this time, the American "Big Three" manufacturers were enjoying a commanding possession of the domestic and world automotive market, and did not see any foreign car manufacturers as a significant competitor.

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They were inefficiently producing poorly engineered, low quality vehicles, and were fully able to "get away with it," as in their eyes, there was no better made product available. This attitude started not only at the factory (along with the design and engineering of these vehicles) but followed the SC all the way down to the dealership and end consumer level. Little to no concern was ever given to customer grievances, preferences, or satisfaction, which generally created a demoralized consumer mentality to simply "take what they could get." The domestic manufacturers also continually told themselves (and everyone else) that there was little to no room for improvement, and that they were at the forefront of the technology of the day.

In one instance in 1986, managers from GM's Framingham, Massachusetts plant who had recently visited Toyota's new state-of-the-art Fremont, California NUMMI plant went so far as to say that Toyota had "secret repair areas" and "secret inventories" somewhere (which was absolutely not true), and that the level of quality and efficiency at NUMMI was impossible to achieve by any tangible means (Womack, et al, 2007). This type of reaction to the constant evolutionary challenges faced in the automotive industry has brought GM, along with Chrysler and Ford, to their precarious situation today; and while they have made great strides to improve quality and production efficiency, they still bring continual excuses of why they do not need to (or cannot) restructure and become leaner, more advanced automobile production companies (Koudal, et al, 2003).

Meanwhile, with their TPS production methods perfected, Toyota (and other Japanese manufacturers with similar philosophies) continued on, producing vehicles that continually raised the industry bar for all aspects of automobile production. Great strides were made in engineering, quality, efficiency, emissions reduction, technological breakthroughs, and even customer satisfaction (Ehrlich, 1991).

The automotive pinnacle of complete Supply Chain Management (SCM) came with Toyota's introduction of their covertly developed Lexus marquee, which quickly overtook the luxury automotive market by storm (as well as the entire automotive industry for that matter), and set benchmarks for quality and engineering that were previously thought to be unattainable. The Lexus program was a meticulously designed and managed SC model, with quality management being of the utmost in importance: From product inception, to their ultimate, unprecedented after-sale customer service and support (Mahler, 2004).

3. Proper Supplier Relations

An item that is absolutely critical to effective SCM in the automotive industry is forming efficient relationships with suppliers - especially at the first tier (or tier-1) level. Again,

using the domestic automobile manufacturers as an example, their view was that their suppliers were simply pawns that filled a need, and nothing more. According to an industrial fastener supplier to Ford, GM, Chrysler, and Honda, "…[American] automakers have us work on drawings, ask other suppliers to bid on them, and give the job to the lowest bidder…" This sheer abuse is the complete opposite of the TPS theory of keiretsu, which specifies a very tightly related network of vendors that use each others' experiences and knowledge to increase all partners' efficiency, quality, profits, etc. (Liker and Choi, 2004). Additionally, long-term relationships are not only encouraged, but are the ultimate goal, with rewards of increased business for better performance. In some instances, Toyota has taken this one step further by actually taking financial or managerial interest in some of its suppliers.

Once a keiretsu relationship is initiated, virtually all company information and knowledge is shared (sans proprietary or sensitive information), so both parties can have a full understanding of what is necessary to get the job done, and what the exact costs and benefits are. With mutual interests at stake, this results in a very efficient, and oftentimes innovative and technologically groundbreaking relationship, along with commensurate improvements in quality and profitability (Liker and Choi, 2004).

4. Long Term Importance Of Supplier Relationships

At the heart of the TPS is a production system that has become known as Just-In-Time (JIT). The JIT method states that instead of inefficiently carrying large amounts of inventory, a manufacturer relies on their SC to have the proper components available for production at the right time, at the right place, and of course in the right quantity and at the right quality (Drake, 2006). This heavy reliance upon suppliers is what makes the TPS work, but definitely requires a secure and trusting relationship with suppliers in the SC, and the suppliers' suppliers as well.

The TPS JIT theory (or lean production theory as it is now called) relies on a pull-type production system, where only the parts that are needed are present, (plus a minimal number of additional units for the approaching work in progress). As previously mentioned, this type of lean production absolutely relies on suppliers to have the right part at the right place at the right time (Wisner, et al, 2009). Hyundai Motor Manufacturing's Montgomery, Alabama plant (HMMA) is an excellent example of this reliance. Completed in 2005, it is designed with a campus-type layout, rather than consolidation of all departments under one roof. With this layout, additional dock doors were placed on the exterior of the main factory building (130 total), allowing for more efficient receipt and processing of deliveries (from the surrounding departments, as well as the suppliers). These dock doors along the perimeter of the building allow deliveries to be as physically close to the point of installation as possible, significantly increasing efficiency by reducing handling time - sometimes down to only a matter of seconds before the part is installed on a vehicle. During normal production, one trailer arrives to the facility on the average of every 60 seconds, and virtually all processing and

unloading duties are automated and sequenced. With this operation, lead time for orders placed to the local departments or suppliers is approximately two hours, at which time all relevant product details, options, and specifications are provided, including delivery time and location (Kalson, 2008).

For a supplier to provide this level of performance, efficiency, and quality, it obviously requires a serious commitment from the automobile manufacturer. If this trust did not exist, it would be virtually impossible to expect the level of performance that these suppliers demonstrate day in and day out. The resources and financial obligations necessary to operate in this manner require suppliers to genuinely commit themselves to these relationships, with the trust that the manufacturer will do the same. It is this mutual commitment that creates the synergy required to form and maintain the bonds necessary to produce a reliable long-term relationship and the constant push for improved quality (Rice, 2005).

5. Supplier Benefits - Opportunities And Quality Improvement

From the automotive manufacturer's point of view, its reliance on suppliers is absolutely critical to keep production moving, so a great deal of trust is instilled in their suppliers. While this trust is of utmost importance for efficient production, it can also ease development for future projects and opportunities. For the supplier, good performance usually results in increased sales volumes and the potential for additional future partnerships (Bagchi, et al, 2009).

For example, in 1988, after successfully purchasing Johnson Control seats for a number of years for its U.S.-based production, Toyota asked Johnson Controls to participate in a seat production venture for its Kentucky production facility, instead of turning it to a larger supplier. Toyota proposed for Johnson Controls to partner up with Japan-based seat manufacturer, Araco, (another Toyota seat supplier), to form a new seat company called Trim Masters. Ownership of this new company, Trim Masters, was split between the three companies (40% Araco, 40% Johnson Controls, 20% Toyota). Established as a completely separate entity from Johnson Controls, Trim Masters proved to be highly successful, and ultimately allowed Johnson Controls to significantly increase their market share and profits (Liker and Choi, 2004).

Improving quality is never an easy feat, but lowering production costs at the same time (and subsequently increasing profits) is even more difficult to accomplish. Normally, significant resources are required to research and develop new methods to improve production efficiency in this manner. Oftentimes smaller companies do not have these resources available, and hence cannot evolve to any appreciable level beyond their existing capabilities. The TPS keiretsu system allows for sharing of methodologies, and the opportunity for mutual development of innovative methods and procedures that benefit both the larger manufacturer and its smaller suppliers. This pooling of knowledge and its resulting ideas and solutions would only be possible with such close-

knit relationships and long-term commitments. This creates a truly unique win-win-win situation, where the benefits of improved efficiency and quality are realized by not only the manufacturer and supplier, but by the end customer as well.

6. Manufacturer Benefits – Customer Satisfaction And Marketing

Obviously, a quality product results in a satisfied customer, although the parameters used to measure customer satisfaction can vary from survey to survey, or by type of survey. Some additional factors that can significantly affect customer satisfaction could be product packaging or presentation, transaction experience, logistical issues, price, ergonomics or ease of use, and after-sale support (just to name a few). However, the bottom-line for customer satisfaction oftentimes comes down to one thing - the quality of the product. By employing keiretsu methodologies with suppliers, constant improvements in product quality are realized - moving products closer and closer to the holy grail of zero defects, and improving customer satisfaction along the way.

Perception of quality (either positive or negative) is also a very important factor for any company in the marketplace, and in many cases, can trump all other marketing efforts no matter how much time, effort, and money are invested. Audi's sudden acceleration issues in the 1980's are a good example of this. Although no proof was ever given for these problems, the Audi brand nonetheless became synonymous with defective vehicles and sudden, uncontrolled acceleration problems – something no amount of marketing or public relations work could overcome. If customers perceive a product or service to be poor, no matter what the source - hearsay, advertising, consumer reporting agencies, internet forums, etc. - it can have significantly adverse effects on the product. At the same time, perceived good quality is a priceless asset, which is always difficult at best to ingrain in customers' minds. By producing a product that is consistently high in quality - and perhaps even the benchmark of the industry – with proper marketing and advertising, increased sales and profits can be achieved.

7. Future Visions – Modular Vehicles For Quality Improvement

A further iteration of the JIT or modular concept could be implemented, with only certain modules or sections of vehicles shipped from the factory (rather than completed vehicles) to regional assembly facilities - or for the ultimate efficiency in Supply Chain, a complete elimination of the main assembly factory, with modular subassemblies being shipped from first tier suppliers directly to regional assembly facilities, or sub-factories. These sub-factories would then perform the final mating together of the components (which would be produced and delivered with the various customer-chosen options) - similar to the way that Dell computers are optioned and assembled (Gunasekaran and Ngai, 2005). This way, a further reduction of dealer inventory could be achieved, and

the lead time could be reduced (from months) to a matter of days for a custom ordered and optioned vehicle. This approach also results in increasing customer satisfaction by providing more agile production capabilities (Christopher and Towill, 2000). An accompanying increase in quality level would be also obtained, due to easier testing and quality monitoring of the subassemblies by each vendor. In addition, troubleshooting during or after assembly would be much easier – worst case scenarios would simply have complete modules removed and replaced, and the defective part returned to the vendor on their departing supply delivery truck. This would bring the automotive industry much closer to a pure pull-type system, and could substantially reduce transportation and holding costs, thereby significantly increasing profits and efficiency.

For example, when a vehicle is currently shipped from the factory, it must be loaded onto a special vehicle carrier, and great care must be taken to avoid (or at least minimize) any damage. This is in many ways inefficient and expensive, and still requires after-transport damage repairs on a certain percentage of vehicles. By default, vehicles are shipped to regional staging or pre-delivery preparation facilities (located in various areas around the country) before they are sent to dealerships, so they are transported a minimum of two times from the factory. These preparation facilities could be converted to handle both staging and preparation (their current function), and sub-factory duties.

If certain modular pieces of the vehicles or certain subassemblies could be palletized and stacked safely, it would result in significantly more efficient use of transport space, and virtually eliminate any damages during transport that would require repair or touch-up. Cosmetic external or fragile pieces could be sourced locally to each sub-factory, or safely packed and shipped in bulk in a manner that would still be considerably more efficient than shipping one complete assembled vehicle. These space-efficient transportation methods would substantially lower costs for both movement and holding.

Reaching to this level of efficiency requires a vehicle to be designed in such a manner that it could be modularly assembled, which need a top-to-bottom change in current design and engineering methods. Favorably, however, the move toward modular bus-type data control systems in today's vehicles (CAN-bus and MOST-bus systems, for example) makes them very conducive to modular design and assembly - even more so if they were battery- or electric-powered.

A significant benefit would be that the modular pieces could be assembled with less machinery or specialized equipment than current factories require, and would reduce the space and cost necessary for assembly. The major shift with this process would obviously be to have more dependence on the SC's first tier suppliers, as they would be doing a larger part of the production of the vehicle, rather than simply supplying parts or minor subassemblies as they do now. An evolution such as this would bring the world of automotive production to the next level of lean production, and JIT inventory.

An additional byproduct of a vehicle produced in this way would be easier repair in the case of damage or collision, as each section of the vehicle could be replaced if necessary, with no trace of the previous damage. This is oftentimes not possible with the current unibody-type construction that most vehicles currently employ. Lower labor costs would result due to quicker repair times, and a sizable credit could be issued to the customer for portions of the exchanged modular section that are not damaged, or are reusable or recyclable (as detailed in the following section). This could significantly lower repair costs, resulting in a further increase in customer satisfaction.

8. “Green” Environmental Bonuses

By utilizing these modular subassemblies and parts (or portions of parts) that have the ability to be reused or recycled, a significant improvement in the automotive industry’s attempts at being environmentally friendly could be achieved. In the event that a vehicle is damaged and determined to be un-repairable, a credit could be issued to the customer based upon the value of remaining reusable or recyclable parts. Depending on the subassembly or part, it could be refurbished and recertified for sub-factory use in the construction of a new vehicle, sent back to one of the first tier suppliers for reuse, (picked up at the same time that modular assemblies are being delivered, for the ultimate in transport efficiency), or packaged for resale as a service part for the dealership.

This recycling operation could be implemented at the same grounds as the sub-factory, further reducing lead time for processing and reuse of the parts. The vehicles destined for recycling could also be transported from the dealerships to the sub-factory/recycling facilities on the return trip from delivery of new vehicles, resulting in little to no transportation and handling cost.

9. Conclusion

A forward-thinking manufacturer, if able to capitalize on this modular concept, could achieve a significant first-to-market advantage, not only in marketing, but with initiating new recycling credit programs or more stringent environmental programs with the government, thereby raising standards for all to follow. Environmental sensitivity is an important factor for any industry today, especially when looking towards the future. This modular concept, with its complete business process reengineering, substantial gains in environmentally friendly production over current levels, along with its significant improvements in efficiency and quality, would truly begin the next generation of automotive production methods (Muthu, et al, 1999).

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