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EXTENDED VALUE STREAM MAPPING APPLIED IN AUTOMOBILE INDUSTRY TO DESIGN A LEAN SUPPLY CHAIN

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Abstract. *Lean manufacturing, the concept pionereed by Toyota, has been widely applied in the manufacturing industry. Value stream mapping become a popular tool and it is driving the dock-to-dock improvement efforts in many plants. The lean roadmap shows that the next logical step is to integrate the members of the supply chain in the quest for maximizing value. This paper aims at studying how the extended value mapping can support collaborative lean supply chain design. The literature about extended value stream mapping and supplier-buyer relationship in auto industry are initially reviewed and they are followed by the establishment of a framework for applying mapping tool. A real application of the framework is shown. It presents a case of cooperation among a first tier supplier and its major local subcontractor and objectifies to cut waste and noise in the supplying process. Thus, the framework is tested and it is concluded that is provides a quick and low cost approach that allows understand and improve the whole supply chain.*

Keywords*: Supply Chain Design, Lean Thinking, Value Stream Mapping*

1. Introduction

In a little more than a century of history the automobile industry not only transformed the world, but changed itself many times. From the crafted vehicles to an up-to-date model, some questions about designing the supply chain remain challenges waiting for answers to come. Along the mass production golden years the industry was transformed from a vertical integrated chain to an arm's length relationship. On the other hand, especially at Toyota, the relations among the members of automakers' supply chain moved to a collaborative approach directly related with the Toyota Production System, also known as lean thinking.

Fine (1998) proclaimed supply chain design as the meta-core competence for organization and goes further suggesting that supply chain, manufacturing system and product development should be performed concurrently, in what he calls three dimensional concurrent engineering.

In spite of being recognized as essential discipline, Croom et al. (2000) and Tan (2001) point out a lack of knowledge on effective supply chain design. They had noticed that current principles are nothing more than a cherry picking from other areas as logistics, purchasing, operations research or manufacturing. The application of this sort of tools and techniques guides to local improvements, but it will not be able to assure a superior overall efficiency, adding more value to the end-customer point of view (Holweg and Pil, 2004 ; Jones and Womack, 2001).

The high performance of Toyota is not a surprise. Fujimoto (1999) remembers that the company has never recorded an operating loss since 1963, when they started to measure it. The most important business magazines in the world just reinforced the same results when they stamped on their pages reports as "Can anything stop Toyota?" (Business Week, 2003) or "The car company in front" (The Economist, 2005).

Taking a closer look at how Toyota manages its supply chain many particularities may be found. Dyer and Hatch (2004) had shown how the collaborative design of the supply chain at Toyota has been providing and sustaining competitive advantage to the company. Favaro (2002) explains that the company created routines that the knowledge sharing increases the trust among the members of the supply chain. Concurrently it allows reducing transaction costs and improving both, quality and productivity. Thus, the overall cost of the product drops down.

The present paper aims at providing a lean supply chain design roadmap to be executed in collaboration with the suppliers. Based on the lean thinking philosophy and on the extended value stream mapping tool, the work is organized as follows. A literature review about the evolution customer-suppliers relationship and also about extended value stream mapping is shown in the second part. The framework to support the supply chain design is purposed in the section three.

The real application of the framework is described in the fourth part. Finally, the conclusions are summarized in the section five.

2. Custumer-Supplier Relationship in the Automotive Supply Chain

As highlighted in the introduction, the characteristics of the relations among automakers and its suppliers changed since the beginning of this industry. In the era of craft production there was a strong technical cooperation. The advent of mass production turn this relation up side down and now, the advance of lean thinking is bringing back the some of the concepts that were found in craft production era.

Merli (1991), Lamming (1993) and Hines (1994) presented some aspects about the evolution of relationships in the supply chain. The authors identified some different stages that can be titled as follows:

- Traditional approach;
- Lean approach with operational integration;
- Lean approach with operational and product development;

The traditional model also called arm's length, keeps it focus on pricing reduction and large scales. It is the model directed related with the practices of mass production. A competition is established by attracting many bidders and the scale economics improve the bargain power. Buyers usually push orders based on a forecast, trying not to carrying inventory. In order to sustain their delivery performance the suppliers hold safety stocks. The paradox consists that in spite of both companies in the supply chain carrying large amounts of inventory, the service level used to be low and the response time high.

Womack (2002) noted the lack of process thinking in the traditional approach, who wrongly assumes that "market will assure the lower costs and the highest efficiency". The consequences of traditional model are the margin squeezing and crisis in both, quality and delivery, increasing the total cost of the supplying process.

The Lean model first purposes the operational integration. The concepts of Total Quality Control and Lean Thinking start to be introduced in the value chain. There is a tendency of reducing the total numbers of suppliers and establish long term contracts. Toyota invested hardly in its supplying base after the oil shock in the seventies and in the middle eighties it dealt with about 200 suppliers, while General Motors had about 5500 and Ford 2500 (Takeishi, 1990).

By reducing the total of suppliers it becomes possible to support development activities in order to improve quality, delivery and costs. The objective is to understand and discuss the total cost and collaboratively design a new operational procedure to reduce the cost, not the price.

Because of its strong focus on the margin, the traditional approach tends to put the supplying basis in a financial crisis. The Lean vision differs from it by putting efforts on reducing the cost, in order to assure financial health for all the members of its supply chain. Figure 1 compares the Traditional and the Lean Models view of price, cost and margin.

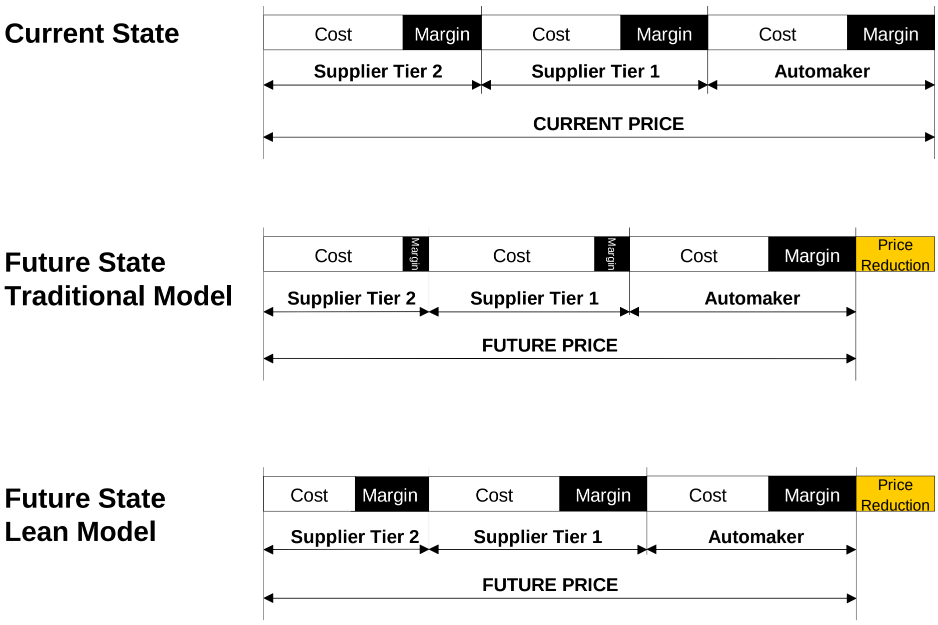

Figure 1: Comparison of Traditional and Lean Approaches to Price Reduction (adapted from Favaro, 2005)

The third stage in the integration of the suppliers in the product development. This model includes the participation of the supplier in the process of research and development of new products, including mutual investments of customer and supplier. The focus of this paper is in the operation of the supply chain and the more details about this model are found in Clark & Fujimoto (1991), Nobeoka (1993) and Takeishi (1998).

The following topic will show a collaborative methodology to implement the operational migration from the traditional model to the lean model.

3. Extended Value Stream Mapping and the Lean Supply Chain Design

Every value stream passes through many information processing points and facilities owned by many different companies. In order to create a future state map for a complex situation like this, extended value stream mapping was developed and improved by many authors, including Jones & Womack (2002) and Hines et al. (2001).

The extended map is drawn observing and summarizing each step of the information and materials flow of a product family. A cross-company team should conduct the whole process together, starting for a group of products that shares the same process. The leader of the team should be the value stream manager of the company that is closer to the end-customer.

The first step is to define a current state map as shown at fig. 2. A typical value stream map of each plant must be drawn individually. All the members of the team should be present, understanding each single unit of their value stream. The big picture, considering all the maps summarizes information like the total number of physical steps, the total lead time and the traveled distance. It is important to note that all the steps related with the information flow do not add value at the end-customer point-of-view.

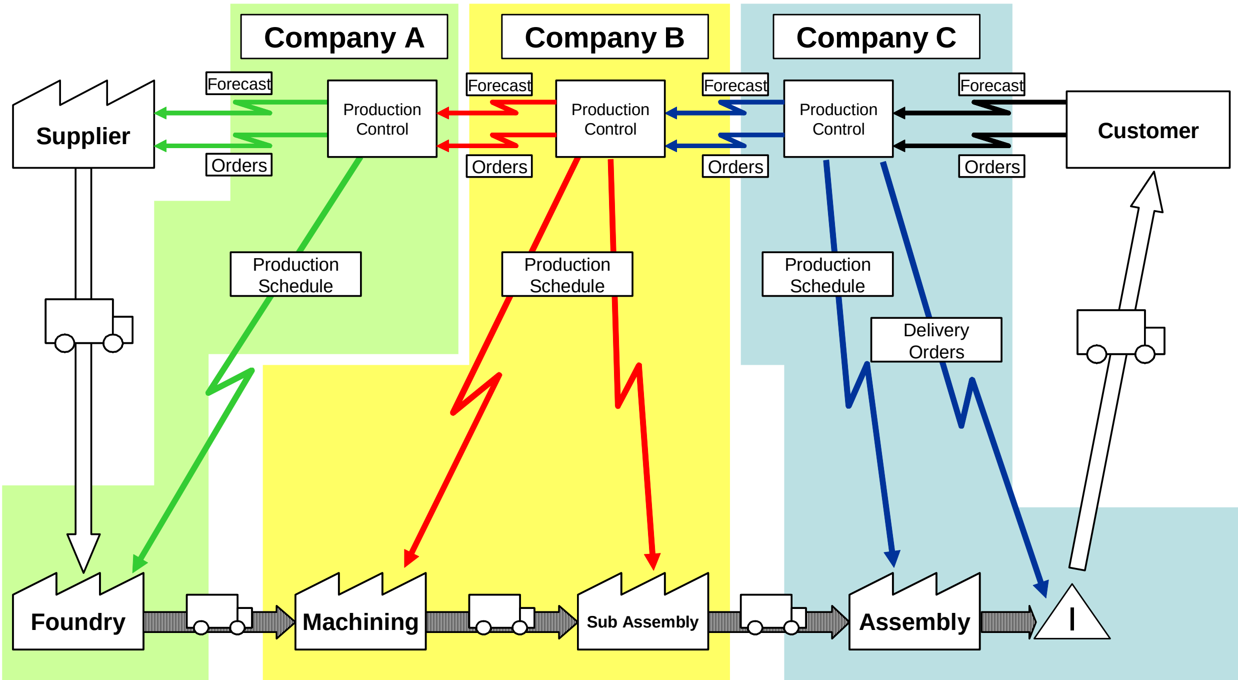

Figure 2: Current State Extended Value Stream Map

Jones and Womack (2002) suggest that a lean supply chain accomplish:

- All the member focusing on the end customer demand;
- Low level of inventory, quality assured and on time delivery;
- Elimination of transport connections;
- A demand signal free of noise;
- Short response time and quick response to the customer;
- Low cost improvements.

The Future State Map I has the same aspect of the current state, but many non-value added steps are eliminated. Pull and flow are introduced in each facility. There is almost no reduction in the noise on the demand transferred among plants.

The Future State Map II shows some additional improvements that covers the relationship among plants. It includes a leveled pull system between plants and a lot size reduction at the same time when increase the deliveries. It is achieved by the application of an electronic kanban system and a milk-run transportation. Figure 3 represents this Future State.

The second future state allows reducing many non-value added steps. Thus, the overall thought put time decreases. There is also reduction on the amplification of the demand and on the level of defects, because the time between a mistake occurs and be detected falls. The costs of the logistics system tend to increase a little, but the total cost decreases hardly.

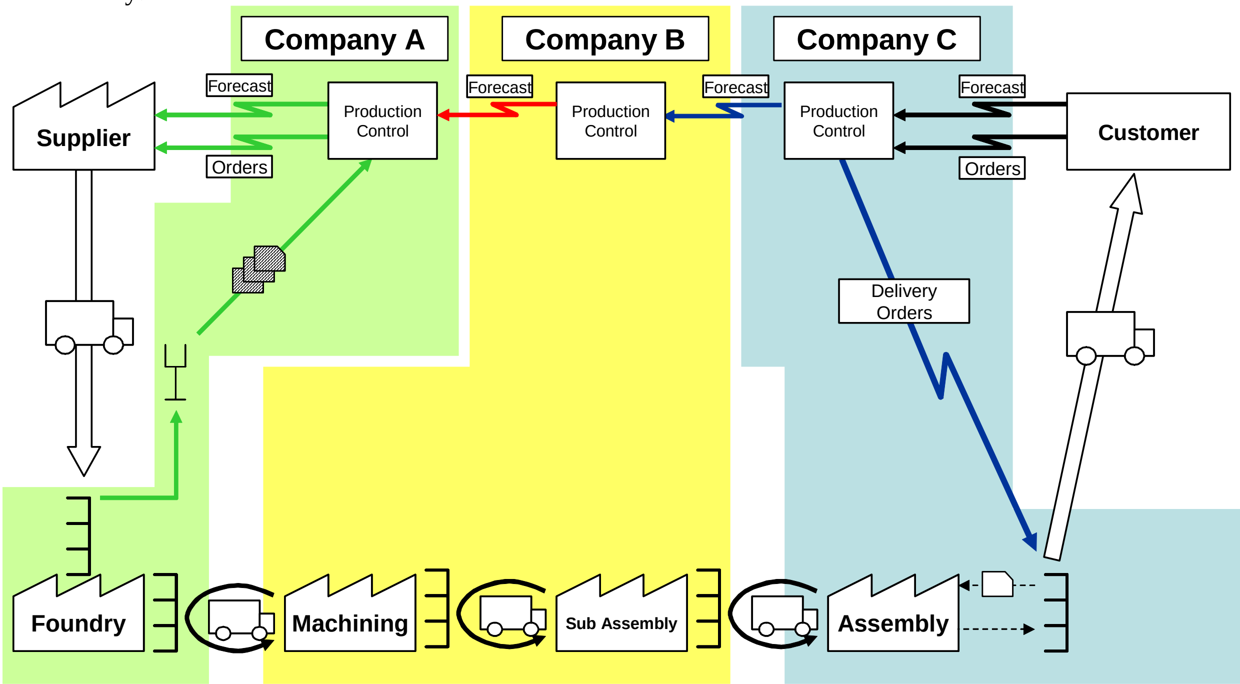

Figure 3: Future State II – Pulling and Leveling Among Plants

At last, a third Future State is presented in the fig. 4. In this stage the logistics complexity is reduced by bringing some members of the supply chain together in an industrial park. The distance is strongly reduced and the demand is transferred to upstream member is real time cutting the noise and delays in the information system. The logistics and connectivity costs also are reduced to a minimum level.

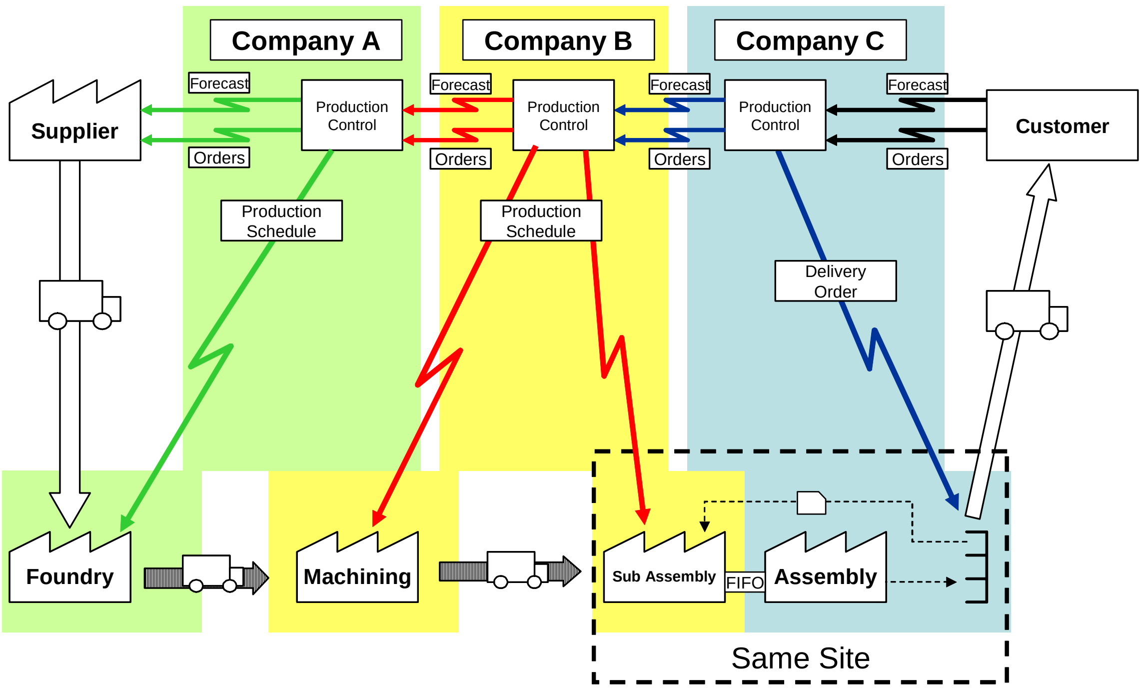

Figure 4: Future State III – Industrial Parks

The steps briefly described are summed up in the steps shown in the fig. 5, called Lean Supply Chain Design.

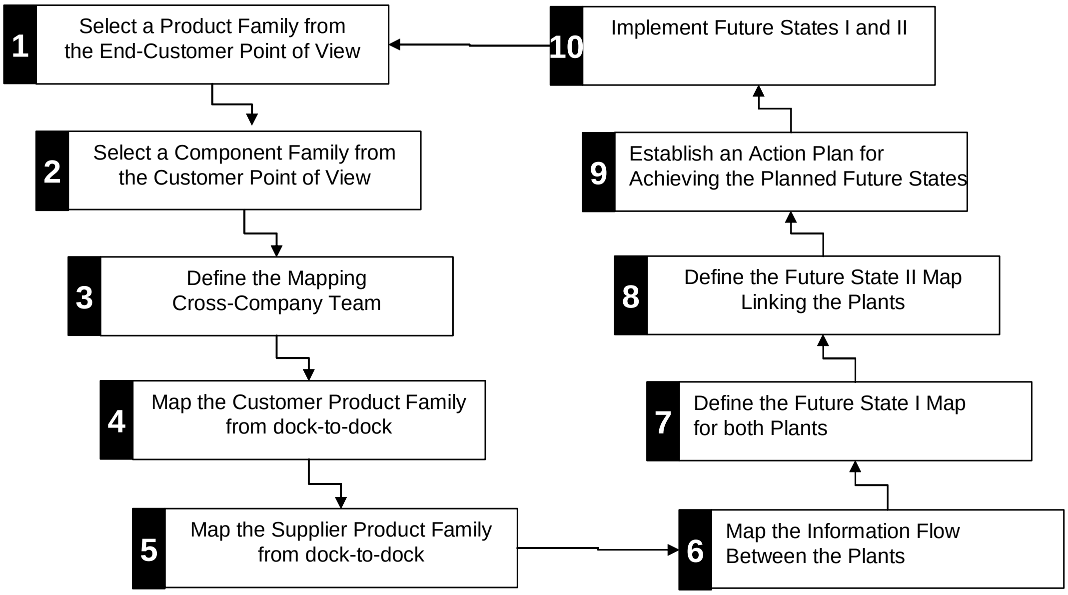

Figure 5: The Ten Steps to Lean Supply Chain Design

4. A Practical Application of LSCD

This section presents a practical application of the ten steps described in the fig. 5. It embraces the value stream of two different companies (tier 1 and 2) who provide a component that is used in diesel engines. The tiers 1 and 2 are located in the same city and the distance between them is not more than 5km.

In 2003 three the tier 1 stated to implement lean in one of his product lines. This product family includes 316 finished goods and a long value stream with a total of 53 value added steps. At the right side of fig. 6, this value stream is shown at a macro level. It includes basically soft machining, heat treatment, hard machining and a final assembly.

In the beginning of 2004 the tier 1 observed that his delivery performance was affected hardly by the performance of its main supplier. Thus, it was decided to draw a map of the whole value stream and improve the overall efficiency of the supply chain.

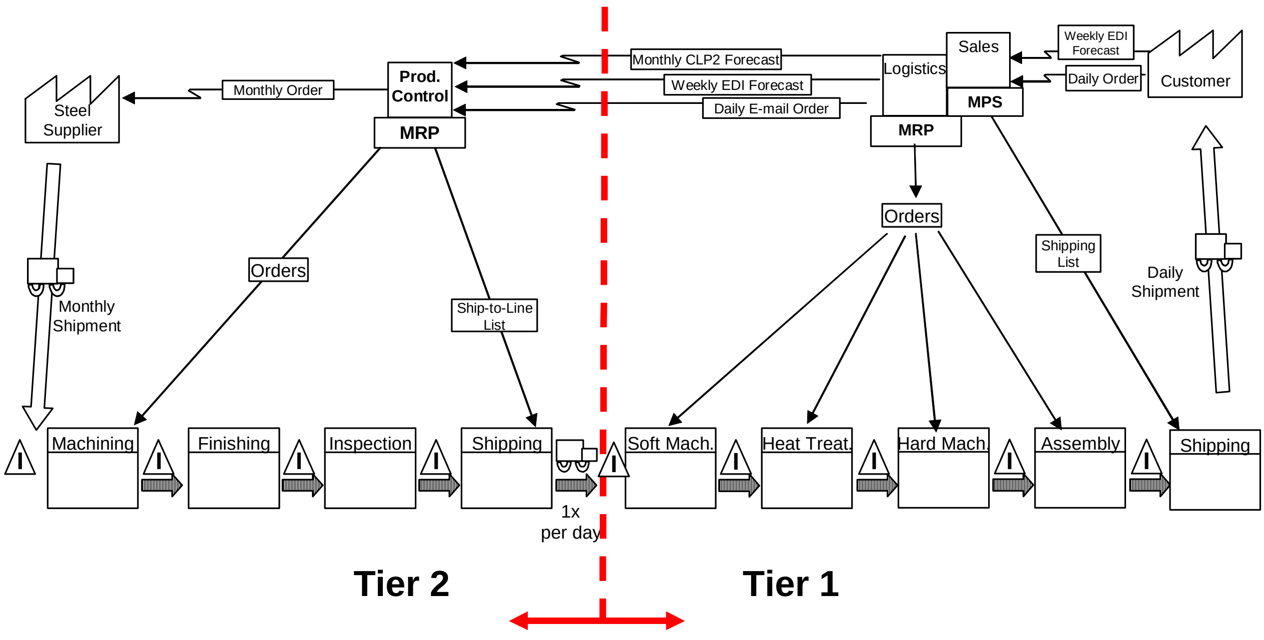

Figure 6: Extended Value Stream Map – Current State (December, 2003).

A cross-functional team led by the logistics department of the tier 1 had drawn a detailed map that was summarized in the fig. 6. The value stream of the tier 2 is shorter, being compose of only 3 value added steps. It starts with steel that is turned, grinded, inspected. The deliveries were made daily.
The information flow in both plant are based on forecasts and the scheduling is a typical push system supported by an ERP. The forecast is updated weekly and excel sheets dictated the volume and mix of the daily deliveries. Many rework was found in the management of the information flow.

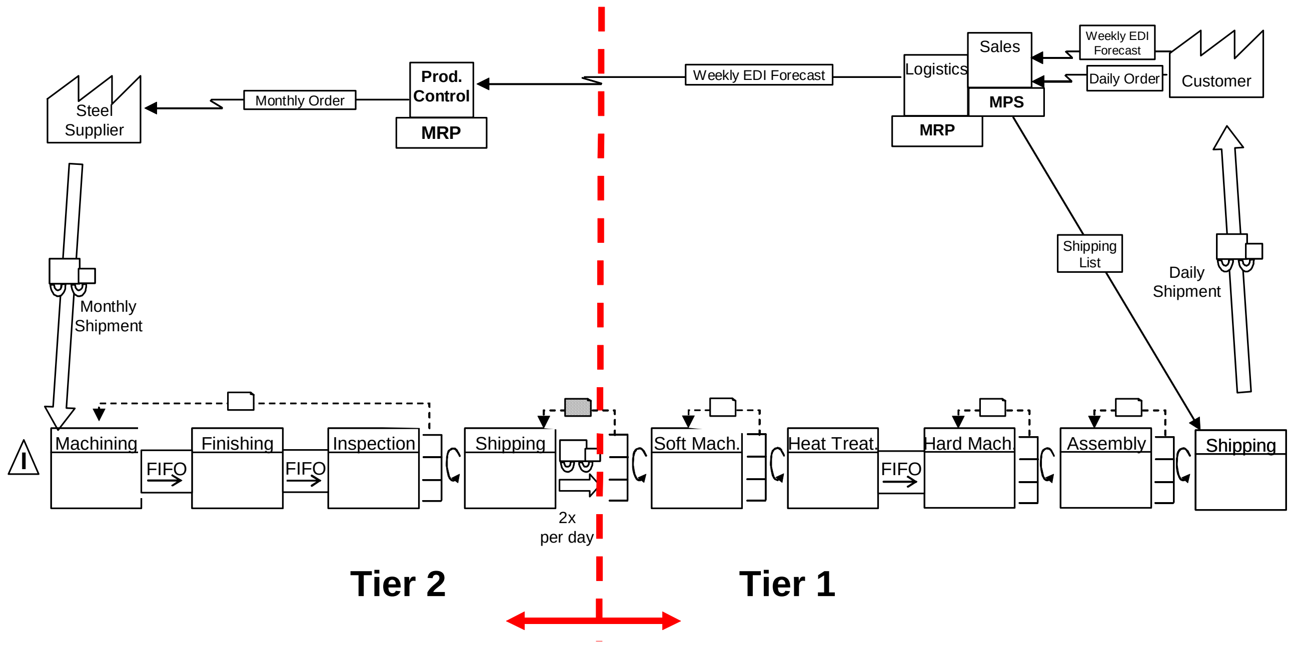

Figure 7: Extended Value Stream Map – Future State (January, 2005).

After the recognition of the current state map the team had drawn the future state map for each plant (Figure 7). The actions included the improvement of the material flow through the establishment of production cells and also the implementation of a production pull in both plants. The layouts were changed and the supermarkets were sized based on a capacity analysis of each plant as purposed by Tardin (2001). The linkage between the plants was also defined. The cost of increasing the delivery frequency was checked and the team decided that because of the physical proximity of the plants 2 deliveries per day are allowable. The withdrawal pull system between tier 1 and 2 was calculated as purposed by Favaro (2003) and Lima and Favaro (2003).

The implementation at the tier 2 took 3 months and at the tier 1 almost 16 months. It can be explained because of the complexity of the tier 1 process.

The results for the value stream of the application of the Lean Supply Chain Design are:

- Reduction in the lead time of tier 1 in 25% and tier 2 in 50%;
- Stable delivery performance in 100%;
- Increase of productivity in the tier 1 in more than 20%
- Self-managed pull system cut the rework in daily scheduling to zero.

The major obstacle found by the team was that the total volume of the part mapped increased in 25% during the project, delaying the formation of the supermarkets, especially in the tier 1.

The tier 2 provides more that 20 component families to the tier 1 and the results from the pilot project lead it to spread the concept to other components.

5. Conclusions

The present paper purposed a roadmap to establish a collaborative design of the supply chain supported by the extended value stream mapping. A practical application is developed embracing two member of automotive supply chain. The first step is defined a multi-functional e cross companies team to draw the current state map and then to design the future state map.

The work concludes that extended value stream mapping could help lean supply chain design because it is a low cost and easy learning method that could be replicated. It allows to have a quick diagnostic of the relationship not only among functions, but also among companies trying to improve their value streams, changing the focal plane from the traditional cost bidding to dialogue oriented by the creation of value and the elimination of waste.

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