A TRANSPARENT AND VISUAL AUTOMOTIVE VALUE CHAIN BY ICT-SUPPORT

Jan Ola Strandhagen, *Dr. Ing., Logistics Manager, Raufoss Technology*
Geir Ole Sletten, *Research Engineer, SINTEF Industrial Management*

Abstract

The absolute requirements of quality, cost and delivery (speed and precision) in the automotive business are well known. Raufoss Chassis Technology AS (RCT) manufactures wheel suspension parts in aluminium for cars. The manufacturing unit has been built and implemented based on Lean Manufacturing and Extended Enterprise Principles. The need to establish basic principles prior to the development of solutions for logistics is important. The need for a common visual description of the value chain is vital. The Extended Enterprise models, along with other tools and methods, have proven useful, but not complete in this respect. The strive for Lean ICT solutions must continue, where the systems and the use of them can be upsized or downsized in fluctuation with the product range, product complexity, demand fluctuations and emerging markets. Indicators of performance and status of the value chain flows are important. The RCT case is an example of how theory, models and concept can directly be applied to support industrial development. And the case feeds back updated needs for further research and development on Extended Enterprise and Supply Chain Management.

Keywords: Supply Chain Management, Extended Enterprise, Lean Production, Automotive Value Chain, Logistic model, Transparency, Visualisation

Introduction

The absolute requirements of quality, cost and delivery (speed and precision) in the automotive business are well known. The Original Equipment Manufacturers (OEMs) have standardised processes for information and goods flow from suppliers. But company-individual needs and solutions from suppliers like RCT can improve overall Value Chain Performance. How can these effects be achieved? The same challenges are applicable in the other end of the Value Chain for a 1st Tier supplier. Suppliers with varying standards and solutions regarding processes and information system must be integrated into RCT`s unified processes. RCT is working to develop its` supply chain to be able to meet these challenges.

RCT is developing and manufacturing chassis components for the Automotive industry. RCT has more than 20 years experience in this market segment. Due to a larger contract with General Motors (GM) for the Epsilon platform (Opel Vectra, SAAB 93 etc.), RCT has built a new plant at Raufoss in Norway to serve the European plants of GM. A duplication plant is built near Montreal in Canada to serve US clients. The manufacturing in each plant is organised in two fully automated manufacturing lines where all handling of the parts is automated trough robots and conveyors.

Extruded aluminium profiles and rods are delivered from two different suppliers. Suppliers are located in Europe and USA. Some of the suppliers have very long lead times: up to 10 weeks. Even though there is one GM contract, there are call-offs from 7 GM plants in Europe, and a similar number of plants in USA. Logistically this acts as different customers.

Theoretical Background

To meet the challenges of RCT, it was decided to base the development of the Value Chain and Logistic System on well know and approved theory, and develop solutions based on these. A thorough process was established, and a study of theory was performed. For sake of completeness the most important theoretical background for the project are given here. Supply Chain Management concept and principles are in the backbone of this theory, and numbers of references can be found like (Christopher, 1998).

Forrester effect, Transparency and Real-time information flow

A typical effect on less integrated supply chains, is how small changes in downstream demand are dramatically amplified upstream. This is known as the Forrester effect or Bullwhip effect. This has been discussed by among others Simsci-Levi et. al. (2000) and McCullen and Saw, (2001). There are many causes to these effects: uncertain forecast, long lead times, large batch sizes, price variations and hamstring. In a supply chain, information sharing in real-time is pointed to as one major implementation to avoid these effects.

Towill and McCullen (1999) have presented four material flow control principles, and have demonstrated their successful application by means of an industrial case study. McCullen and Saw (2001) further discuss this. A central point in this study was how to avoid the Forrester effect. The four principles are Control System, Time Compression, Information Transparency and Echelon Elimination.

ERP-systems in Manufacturing

Traditionally an enterprise had many different computer systems and databases to support its various functions. An ERP-system is a standard application program, which support execution of business processes throughout the whole company. The ERP-system has functionality that makes the company able to replace many of their applications with a single seamless system with one common database. The use of the ERP-systems are in the core still based on MRP planning principles.

Looking outside the factory walls, the Distribution Resource Planning (DRP) systems can support the material logistics planning between actors in the network if the units are using the same ERP-system and database. The last 2-4 years the ERP vendors have introduced their SCM solutions, which promise e.g. multi-enterprise visibility, collaboration, and intelligent decision support and execution capability for the value chain.

Lean Production

The ERP based approach follows a traditional mass production strategy, and are seldom sufficient to handle the low volumes and demand variety that characterise current markets. An alternative approach is *lean production*. During the last decades, several enterprises have achieved flexibility and increased competitiveness by implementing the “lean” or “just-in-time” principles developed at Toyota (Womack & Jones 1996). The basic purpose of lean production is to increase profits by reducing costs through completely eliminating waste such as excessive stocks or work force. To achieve cost reduction, production must promptly and flexibly adapt to changes in market demand without having wasteful slack time. Such an ideal is accomplished by the concept of JIT: producing the necessary items in the necessary time (Monden 1998).

Lean/JIT manufacturing is based on simplified, fast flows that are co-ordinated by shop floor people to meet real demand. Supply on real demand requires that work-in-progress and throughput times are minimised to ensure responsiveness. In lean production, teams are tightly linked in customer-supplier connections. These can typically interact with each other in a predictable sequential manner. The focus is turned towards process improvement. Activities, connections, and production flows are standardised and rigidly specified to provide the necessary performance and flexibility to supply a wide range of standardised products at low costs.

Extended Enterprise

According to Browne, Hunt and Zang (1998) new approaches have emerged in Manufacturing, including Agile Manufacturing, Extended Enterprise and Virtual Enterprise.

Figure 1 presents a generic model of the Extended Enterprise from Browne, Hunt and Zang (1998). This generic model is based on the understanding of the Extended Enterprise in terms of business processes. The model identifies the main building blocks for assembling an Extended Enterprise environment. The models show a systematic approach to integration and co-ordination across the various players. Each of these blocks can be further divided into several detailed building blocks. This generic model represents a functional view of a manufacturing enterprise. The business model is composed of a vertical and a horizontal axis. The vertical axis, is composed of design, manufacturing and control issues, therefore representing the traditional, functional view of a manufacturing system.

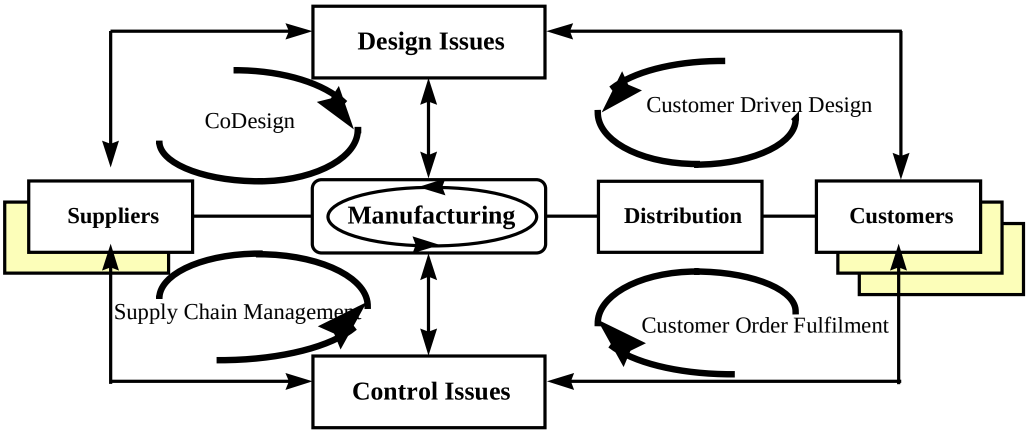

Figure 1. Generic model for the Extended Enterprise Browne, Hunt and Zang (1998)

The vertical axis also represents the flow of information between the various functions and manufacturing. The horizontal axis represents the integration of the supplier, distributor and customer with the manufacturing system in an Extended Enterprise. The horizontal axis also represents the flow of materials/products from the supplier, through to the customer.

According to Browne, Hunt and Zang (1998) the model also identifies five high-level macro business processes. Each of these macro business processes can be decomposed further to show in greater detail the sequence of activities within the process. The macro processes identified are directly related to the operational activities of the manufacturing enterprise. The five macro business processes, and their associated definitions, identified using the business model shown above are as follows, (Bradley, 1996):

- The **Customer Order Fulfilment** process includes all of the activities directly involved with the planning, control and co-ordination of customer requirements with the manufacturing process and the delivery of the product to the customer.
- The **Supply Chain Management** process includes all of the activities directly involved in the co-ordination of supplier capabilities, the planning of supplies requirements and the delivery of these requirements to the manufacturing process.
- The **Manufacturing** process contains all of the activities directly involved in the physical production of the product.
- The **Customer Driven Design** process includes all of the activities directly involved in the design and development of a product (and its associated manufacturing process) subject to customer requirements and its release to manufacturing.
- The **Co-engineering** and **Co-Design** process includes all of the activities directly involved with the co-ordination of supplier capabilities into the product design process.

Jagdev and Thoben (2001) points out that today's supply chains in reality are enterprise networks, and has collected and developed a set of characteristics (an anatomy) of bilateral relationships. This anatomy can be used two ways. To determine the nature of the relationships, and to give advice on focus area of development for establishing the relations.

The RCT Supply Chain Challenges

The customer requirements

As something between a 1st and 2nd Tier supplier to automotive industry, RCT is facing extreme demands from the customer. Zero defects and 100% precision of delivery are obligatory. Continuous improvement is a must since prices are decreased by contract every year. The combination of these demands, the high volumes of identical parts, and the fully automated manufacturing, makes RCT very vulnerable to any kind of disturbances. From the Operations perspective of the company the overall competitiveness is dependent on the ability to fulfil these requirements, and at the same time minimise total costs.

Supply chain integration with a transparent information flow is one of the key parameters to achieve this. The concept of transparent information flow applies to RCT internally as well as the whole supply chain.

The RCT internal challenges

As mentioned in earlier sections the logistic complexity of our parts and manufacturing processes are extremely low:

- The speed of the production rate is constant (run by a certain speed or stand still)
- The number of levels in our Bill Of Material is 2
- The customers are defined through life-time contracts
- GM standards for supply specifies much of the logistics processes between the companies

From a logistics point of view the main challenges resulting from our customers and our own requirements are

- No defects or deviations are allowed in the logistics process (quantity, delivery time windows, labelling, etc)
- The extreme speed of production and delivery, combined with limited space and equipment for storage allows no stop of flow to make corrections
- Variations in information-process and -quality between the receiving plants of GM
    - Format and technical means (fax, e-mail and EDI)
    - Frequency (weekly, biweekly, daily as well as extraordinary)
    - Time horizon (20 weeks, ten weeks, fortnightly)
    - Accuracy (varies more than 100% on weekly basis)

The RCT solution

In order to meet these challenges a thorough development process of the entire logistics and information systems of RCT were needed. The key elements in the changes were:

- Redefine control principles of the entire Value Chain, abandoning the MRP/ERP principles where not applicable
- Implement new, flexible ICT solutions integrated with existing ERP-system
- Establish new types of relations with all suppliers
- Internal organisational changes regarding responsibility, tasks and reporting routines

The development process was performed through a number of steps. The steps are designed based on the Control Model Methodology (Strandhagen and Alfnes, 2000).

The RCT Extended Enterprise concept, control principles and Logistics Model

Based on the concept of the Extended Enterprise we defined our Value Chain model. This model was used to communicate and create understanding about the relations between all development and operational process; how they were linked, and how they influenced each other.

The Logistic Model was extremely important in this process, and created the common platform for the decisions that were made. It was also the basis for the decision to organise all logistics processes into one organisational unit; the Supply Chain Management Centre.

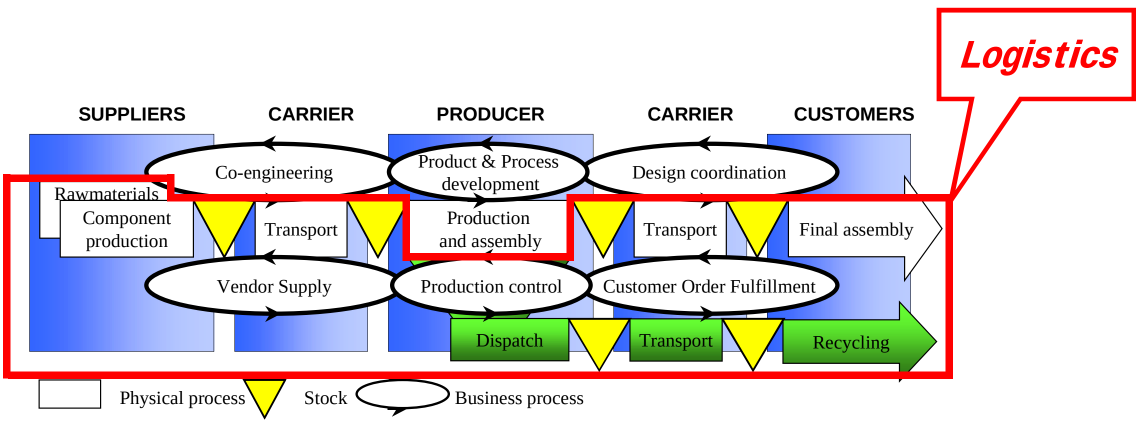

Figure 2. The RCT Extended Enterprise Model

Visualisation and Key Performance Indicators

Similarly to the transparency in the supply chain, RCT has implemented visualisation of material flow and manufacturing process status for manufacturing operators. In addition to ensure fast response to changes, this supports the team-based organisation and a highly motivated work force. Maintenance, tool changes etc. are easier to synchronise to the manufacturing rate.

Internally, information on changing demands etc. should be passed on to shop floor operators, maintenance etc. This makes the RCT manufacturing system able to respond to the changes, make fast alternation in plans, etc. The co-ordination of maintenance and manufacturing is a typical area where fast ant transparent information flow is beneficial. Each operator will have a special designed “control panel” where all the vital information is visual at any time, if not the operator choose to go into details on the data, which is available trough the Intranet panel.

A similar dashboard has been developed for the Supply Chain Parameters. In addition to the standard parameters on delivery precision, PPMs, lead time etc, the following parameters have been established

- Key parameters to display the change coefficients for value stream throughput. These coefficients are aggregate measures to display the changes in past and future, making it possible to extract tactical information from the exact operative information along the value chain
- Key parameter for plan stability and quality. These parameters are displaying the frequency and the level of change of the volumes of the plans.

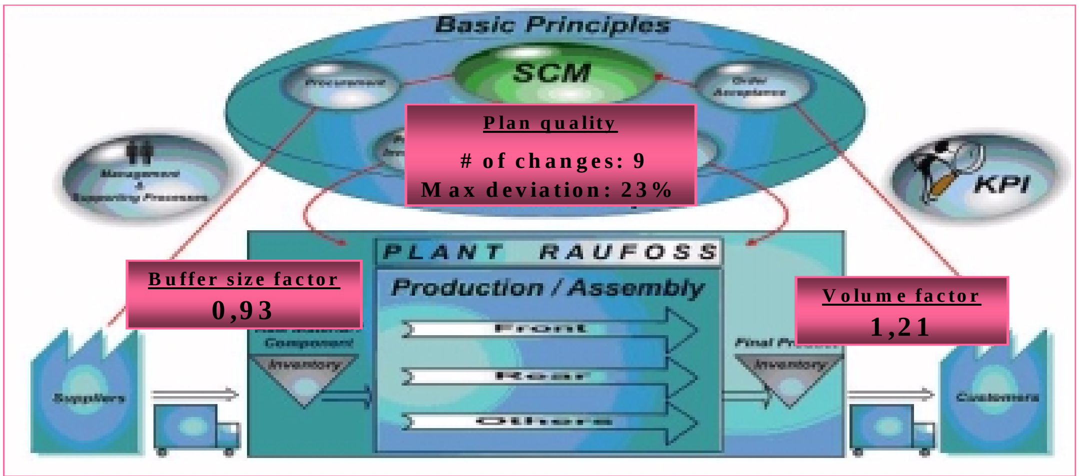

Figure 3 Example of Dashboard for the Supply Chain

The Supply Chain dashboard is shown in Figure 3. The buffer factor indicates the changes in the buffers sizes over the last 4 weeks period. A similar factor not shown in the figure displays to which degree that the stock size is "harmonising" with the needs in the production. The volume factor indicates the volume of goods delivered for the last period compared to the previous period. Another factor not shown in Figure displays the actual delivered volume compared to the forecasted volume four weeks earlier. The first plan quality indicator shows number of changes done in the production plan the last four weeks. The second factor shows the difference between the highest and lowest planned volumes for the current week that has occurred in the plans over the last twenty weeks.

Conclusions

Through this project both the researchers from NTNU and SINTEF, as well as the RCT personnel has gained considerable new experience and insight. Of general interest the following should be mentioned

- The concept of Extended Enterprise is directly applicable, and provides a platform for understanding, discussion and decision

- The need to establish basic principles prior to the development of solutions is important. There is still a strong tendency in industry to believe that technology and solutions can be purchased and implemented as black boxes without any impact to how the company will be organised and operated. To establish principles, and support them by technology and solution is therefore important
- The need for a common visual description of the value chain is vital. Showing the value chain, its partners and material flow, the information flow, the processes etc. The Extended Enterprise model along with other tools and methods have proven useful, but far from complete. Future development of models, methods and tools are required. Tools that that link to information systems for automated extraction and modelbuilding.
- As a consequence the strive for Lean ICT solutions must continue, where the systems and the use of them can be upsized or downsized in fluctuation with the product range, product complexity, demand fluctuations and emerging markets.
- The need to establish indicators that describes the past, the present and the future status of the value chain, and the quality of our control of it is vital.

The RCT case is an example of how theory, models and concept can directly be applied to support industrial development. And the case feeds back updated needs for further research and development on Extended Enterprise and Supply Chain Management.

References

- Alfnes, E., Strandhagen J. O. (2000), "Enterprise Design for Mass Customisation", *International journal of logistics*, Volume 3, #2, July
- Boyson, S., Corsi, T. M., Dresner, M. E. and Harrington, L.H (1999), *Logistics and the Extended Enterprise Benchmarks and Best Practices for the Manufacturing Professional*, John Wiley & Sons, inc., New York
- Browne, J., Sackett, P. J. and Wortmann, J. C. (1995), "Future manufacturing systems - towards the extended enterprise", *Computers in Industry*, Volume 25, pp. 235-54
- Christopher, M. (1998), *Logistics and Supply Chain Management: Strategies for reducing costs and improving service*, Pitman Publishing, London
- Jagdev, H.S., Thoben, K-D (2001), "Anatomy of enterprise collaborations", *Production Planning and Control,* Vol 12, No 5.
- McCullen, P., Saw, R. (2001), "Designing the Agile Supply Chain", p. 129 – 136, *Proc. of The International Symposium on Logistics,* Salzburg Austria
- Monden, Yasuhiro (1998), *Toyota Production System – An Integrated Approach to Just-In-Time*, Engineering & Management Press, Norcross, Georgia,
- Towill, D.R, McCullen, P.L. (1999), "The Impact of Agile Manufacturing on Supply Chain Dynamics", *The international Journal of Logistics Management*, 10(1) 83-96