THE TRANSPARENT AND VISUAL AUTOMOTIVE SUPPLY CHAIN

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1 ABSTRACT

This paper describes the implementation of a transparent and visual supply chain at Raufoss Technology AS (RCT). Large volumes of identical parts, fully automated production lines combined with the extreme demands on speed, precision and quality, makes fast response to changing demands important for the overall competitiveness for RCT. Supply chain integration, information transparency and visualization were understood as vital to achieve this. Transparent information flow implies immediate flow of correct information needed for controlling the processes, and secures fast responsiveness. The paper focuses on how transparent information flow is implemented, and how information is visualized. A Supply Chain Coordination Centre coordinates all information flow in the Supply Chain ensuring fast, reliable and transparent information flow.

2 INTRODUCTION

The requirements on quality, cost and delivery speed and precision in the automotive business are well known. Raufoss Technology AS (RCT) is working to develop its supply chain to be able to meet these requirements. Raufoss Technology (RCT) is a part of the Raufoss group, and is developing and manufacturing aluminium alloy chassis components for automotive industry. Due to a larger contract with General Motors (GM), RCT has built a new plant at RCT and are building a similar plant in Canada. Start Of Production was January 2002 at the Raufoss plant, and is scheduled to be June 2003 at the Canada plant. RCT manufactures front and rear wheel suspension as shown in Figure 1.

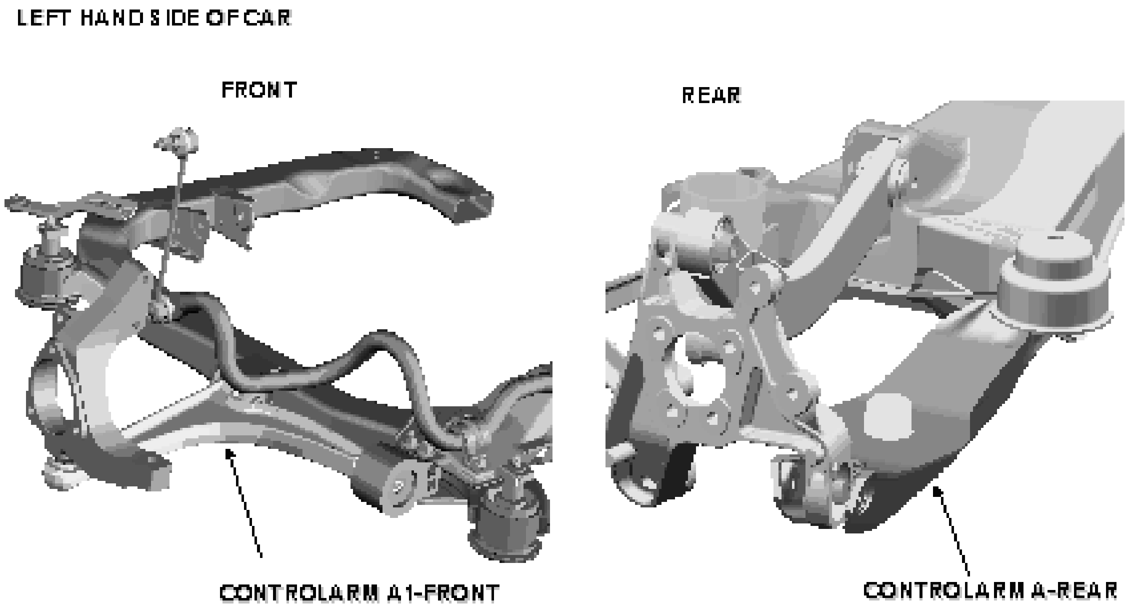

Figure 1. RCT products on GM cars

The plants are each designed to a meet a capacity level of 1,4 mill. front and 1,4 mill rear control arms. The manufacturing in the two plants is organized in two fully automated manufacturing lines: one for front control arm, and one for rear. The main manufacturing processes are Forging, Heat treatment, Machining and Assembly. There are 14 different assembled parts from 7 different suppliers in addition to the aluminium part. Extruded aluminium profiles are delivered from two different suppliers. Suppliers are located in Europe and USA. Even though there is only one customer, there are call offs from 7 GM plants in Europe, and a similar number of plants in USA. Logistically this acts as different customers.

2.1 Supply Chain Management (SCM)

SCM can be defined as (Christopher, 1998): “The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the chain as a whole”. SCM deals with the full scope of supply activities; production, procurement and distribution (Houlihan 1986). Throughout the 1980's and 1990's the concepts of customer and supplier integrative relationships gained renewed attention. (Bowersox et al., 1999, Browne et al., 1995). The driver behind such collaboration was the desire to extend the control and coordination of operations across the entire supply process. (Schary and Skjøtt-Larsen, 2001). The concepts of SCM and Extended Enterprise (Browne, Hunt and Zang, 1997) are contributions to reach these ideas. The goal with these concepts is to get everyone in the supply chain onto a common platform of logistics transactions and information systems for greater interorganizational “seamlessness” or transparency resulting in faster system response times (Boyson et al., 1999).

2.2 Forrester effect

A typical effect in a less integrated supply chain 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: Lee et al (1997a), Lee et al (1997b), Metters (1997), Alfnes and Strandhagen

(2000), Simsci-Levi et. al (2000) and McCullen and Saw, (2001). Forrester (1958) and Burbidge (1987) has called this the "Law of Industrial Dynamics": *If demand for products is transmitted along a series of inventories using stock control ordering, the demand variation will increase with each transfer"*. Information sharing in real-time is pointed to as one major implementation to avoid it and can been seen upon as the foundation of supply chain integration (Lee and Whang, 2001). Lee and Whang (2001) propose four critical dimensions for supply chain integration:

1) Information integration – sharing of information (real time) among the members of the supply chain
2) Planning synchronization – the joint design and execution of plans for product introduction, forecasting and replenishment between the actors in the supply chain
3) Workflow coordination – the streamlined and automated workflow activities between supply chain partners
4) New business models – allows partners to redefine logistics flow so to improve overall supply chain efficiency

3 TRANSPARENCY AND REAL-TIME INFORMATION FLOW

Towill and McCullen (1999) has presented four material flow control principles, and have demonstrated their successful application by means of an industrial case study. This is further discussed by McCullen and Saw (2001). 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. Any design or redesign of a supply chain would address more or less all these principles. The principles are complementary and have mutual effect on each other. Information transparency, for example, can be one of the principles applied in order to gain Time Compression and Echelon Elimination. To implement Information Transparency, on the other hand, a well-designed Control System is needed. In recent literature such as Womack and Jones 1996, the Principles of Time Compression and Echelon Elimination have had much focus. In this paper we focus on how Raufoss has implemented the Transparency principle.

3.1 Transparency benefits

Transparent information flow implies, immediate flow of correct information needed for controlling the processes. Our suppliers can "see trough" the supply chain upstream and knowing the forecasts and call offs from our customer and vice versa. The conventional information flow is usually in steps from plant to plant within the supply chain. Information such as year plans, forecasts and call offs are sent from OEM to 1st Tiers. There is usually a delay before the data is processed by 1st Tier and a delay before forecasts and call offs are sent to 2nd Tier suppliers, and similar upstream the Supply chain. The forecasts passed on upstream might be significantly distorted from the theoretically forecasts derived from the OEM forecasts. Moreover, internally in each company, there might be no direct logic connection between the customer forecasts and call offs and the forecasts and call offs sent to suppliers. Typically there are different departments dealing with deliveries, production and purchase, with a lack of integration between these departments, as illustrated by Figure 2. The result is delays and distortions trough each node. The concept of transparency will avoid losses from the delays and distortion mentioned above. Transparent information flow implies, immediate flow of correct information needed for controlling the processes. Figure 3 illustrated the difference in information flow.

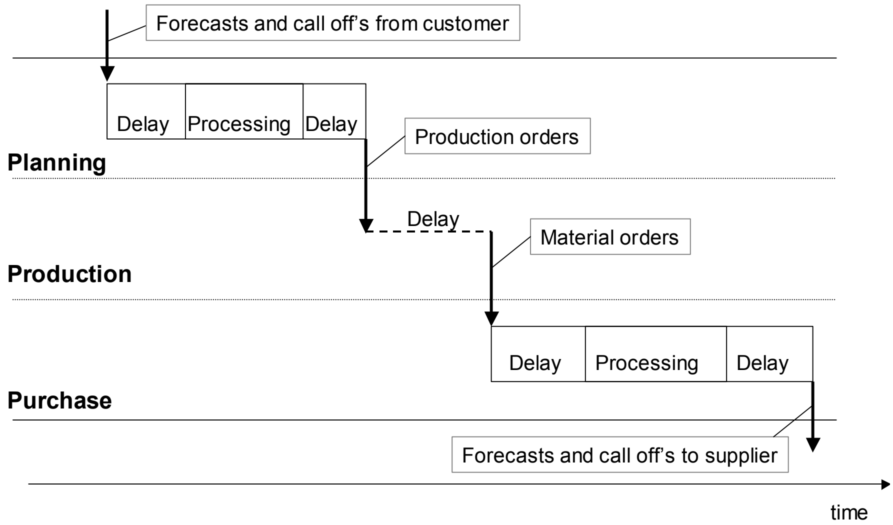

Figure 2. Typical less integrated internal Information flow

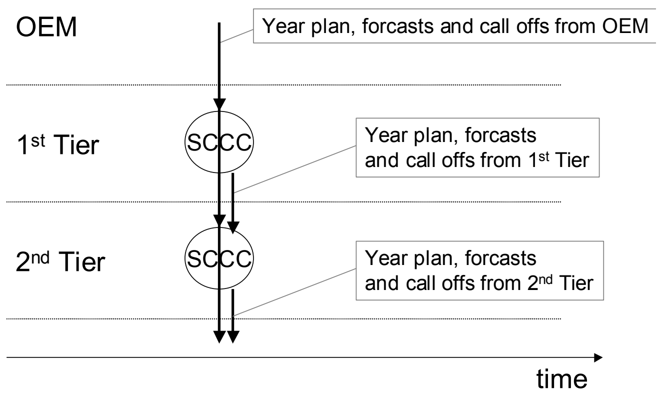

Figure 3. Transparent upstream information flow.

SCCC = Supply Chain Coordination Centre

4 RCT IMPLEMENTATION

As 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 improvements are 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. The overall competitiveness is dependent on the ability to meet the following:

- Minimization total costs
- Precision of delivery without building unnecessary large inventory
- Zero defects
- Fast responses to changes
- Correct and speedy information flow

Given the mentions demands from the customer and fact that there are a small number of suppliers and very few components, the focus on time is emphasized. Supply chain integration with a transparent information flow is one of the key parameters to achieve this.

4.1 Supply Chain Coordination Centre

Several changes were needed in the process of establishing a transparent supply chain:

- Redefine control principles of the entire Supply chain
- Implement new ICT solutions integrated with existing ERP-system
- Establish new types of relations with all suppliers
- Internal organizational changes regarding responsibility, tasks and reporting routines
- Establishing a Supply Chain Coordination Centre (SCCC)

All supply chain processes are performed in the SCCC with a dedicated group of people each having a complete and shared responsibility for all Supply Chain processes related to information flow and material flow. This centre coordinates all transactions regarding our node in the supply chain. That is: receiving year plans, forecast and call offs from GM, Issue production orders at RCT, Send year plan, forecasts and call offs to suppliers, monitoring of stock levels, etc. Figure 4 shows the SCCC Process as a 1st Tier Supplier.

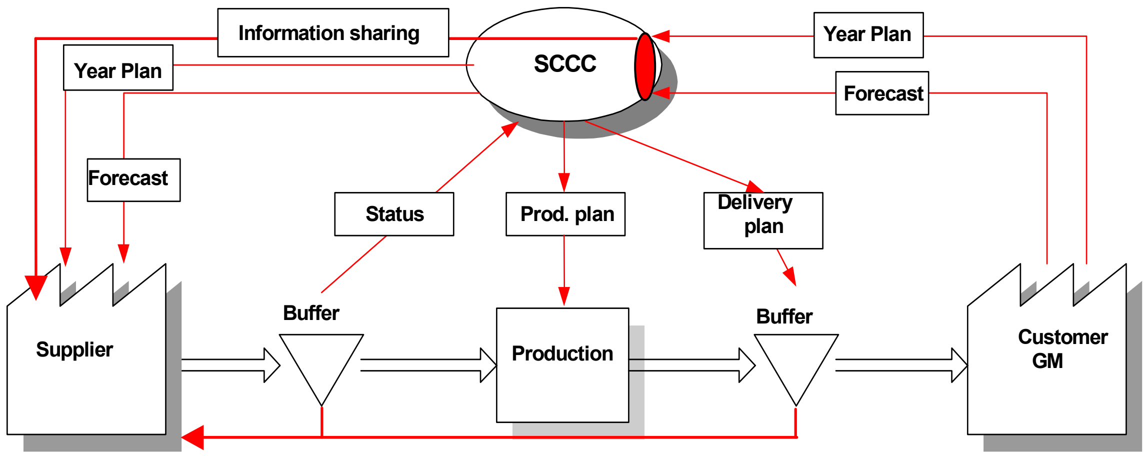

Figure 4. SCCC process

To develop the SCCC, RCT first trained the SCCC team leader on how to perform in the role as coach, supporter and coordinator. Through this training the team leader become more visual as a leader as a defined part of the team. Then the SCCC team developed a team contract. The purpose of the team contract is to develop a mutual understanding of team targets, roles, procedures and interpersonal relations through a common discussion in the team. Roles are typically related to who is doing what, who is responsible for what, and how to secure multifunctional training in terms of rotation within the team. Interpersonal relations are related to conflicts within the team. Conflicts in the teams are likely to occur especially since the role of the team leader is new, and no longer have the same control over information, recourses and task performance. The basic idea with the contract is however to avoid this. Targets, roles, procedures, and interpersonal relations are closely linked and sequential. This means that if there are conflicts in the team this can be caused by unclear or different interpretations of procedures, roles or targets, in this order. In case of conflict, the team is forced to increase the level of mutual understanding of the contract through new team discussions. In this sense the teams are, not only caused by potential conflicts, but by the contract it self, guided into becoming a learning organization.

4.2 Information Visualization

An equally important part of the supply chain is the internal operations organization at RCT. To respond to costumer demands, the RCT organization is dependent on knowledgeable operators working in teams, controlling resources and tasks based on real time information. Material flow and manufacturing process status data are visualized at computer workstations on shop floor trough intranet. In addition to enable fast response to changes, this supports the team based organization and a highly motivated work force. Maintenance, tool changes etc. are easier to synchronize to the manufacturing rate. The production status data are collected by Siemens WinCC production data collection system and both visualized on the shop floor as well as communicated to the ERP system and the SCCC team. Figure 5 Shows the visualization ”Control Panel” on shop floor workstations. The panel contains a simplified layout of the manufacturing line with red, yellow or green lights on different stations along the line. Green light is an ”OK” signal. A red light means the actual station is in alarm status, and has stopped. Yellow light means the station is unstable, with process parameters outside control limits but not outside tolerance limits. This is similar to the Toyota Production System ANDON principle (Monden, 1998).

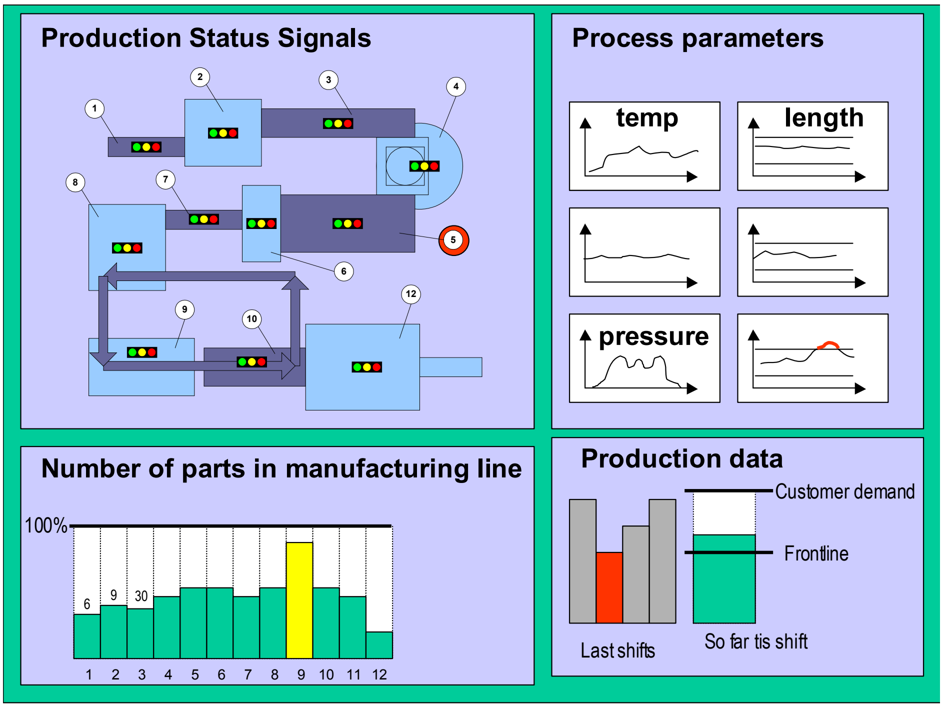

Figure 5. Shop floor control panel

4.3 Basic principles applied

Given the mentions demands from the customer and fact that there are a small number of suppliers and very few components, the focus on time is emphasized. Supply chain integration with a transparent information flow is one of the key parameters to achieve this. A set of basic principles where decided to rule the game of development and operations of the Supply Chain. These principles, based on the theoretical background and RCT challenges are:

- *Time focus*: The need to be precise and speedy in all our processes
- *Lean manufacturing*: Value adding processes only. The manufacturing unit has been implemented based on Lean Manufacturing Principles
- *One-way flow and tasks done once*: Focus on streamlining the flow of goods and information, all tasks done at once, and only once.

- *Real-time information*: All decisions and actions must be taken based on real-time information access
- *Transparent Supply chain:* Information sharing throughout the supply chain. Information from customers, our own company, as well as suppliers should be transparent through the whole supply chain.
- *Integrated processes:* Seek to integrated processes, both within the company as well as with our partners. Integration of processes by ICT
- *Visual and Simple:* Keep everything as simple and visual as possible
- *Logistics*: Synchronized logistics, Order controlled manufacturing, process responsibilities, control and backup solutions, Reliable ICT systems, Effective and environment friendly recycling systems

5 CONCLUSIONS

This paper has discussed the concept of information transparency and how Raufoss Technology (RCT) has implemented this concept in order to meet the demands as an automotive 1st Tier suppler. RCT has implemented a Supply Chain Coordination Centre (SCCC) that coordinates all Supply Chain information flow. To succeed in the implementation, a mutual understanding of team targets, roles and procedures was achieved trough discussions and the formation of a team contract. Time focus, Lean manufacturing, Real-time information, information sharing, process integration and synchronized logistics are the basic principles applied in the design of the SCCC.

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