Evaluation of Supply Chain Management Systems Regarding Discrete Manufacturing Applications

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Summary

The contribution will discuss findings of an industrial research project and concentrates on the evaluation of systems and approaches for supply chain management (SCM) with the background of typical discrete manufacturing applications. As strong competitive pressures are forcing a re-shaping of the value chains of many parts and components producers in discrete manufacturing, a study was carried out to evaluate effects on the supply chains and the relevant system architectures. Deliverables include statistic on the use and the estimated benefits of the SCM systems and approaches, discussion of typical supply chain architectures, features and elements, and some of the main weaknesses found.

1. Designing Efficient Supply Chains: A Challenge

Achieving world-class delivery precision is one of the most demanding and challenging goals of customer-oriented end producers and their suppliers. Designing and operating efficient supply chains is a major requirement for delivery precision. Common wisdom holds that the markets will force companies to build and operate highly efficient supply chains, but the whole supply chain is relevant – not just one company. With $1.1 trillion in inventory required to support $3.2 trillion in retail sales, a year 2000 Benchmarking Partner Projection based on U.S. Commerce Department Sales and Inventory Reports, estimated the economical resources and the price of inventories and stocks just within U.S. supply chains and supply networks. Is this the price to be paid to assure precise and time-accurate deliveries from several industries into a large set of end customer markets, taking into consideration uncertainty in all levels of the supply chains? There is much evidence that the economical values stocked between the supply chains as a result of uncertainty are very high – sometimes too high.

2. An Early Experiment on Complex Systems

When Mark Gardner and Ross Ashby simulated the dynamic behavior, stability, and reliability of complex systems in 1970, they presumably did not focus on supply chain control, nor on supply chain uncertainty or complexity. Years later, the late Jack Burbidge and Denis Towill from the Logistic System Dynamic Group rediscovered Gardner and Ashby's valuable work. Why are these early experiments so fundamentally relevant for the design, control, and management of today's supply chains?

Gardner and Ashby's 1970 simulation experiments revealed that a complex system basically performs unreliably – that means explicitly unstable and unpredictable – if:

- The number of nodes that might be interconnected within the network is increased above a switching line that specifically determines the beginning of chaotic behavior

- The system connections between the nodes measured by random traffic is leveled above a certain tolerance border

When you apply uncertainty to supply chain management, the importance of their work becomes clear. The Gardner and Ashby effect – unreliability – affects real-world supply chains. There is much evidence that uncertainty resulting from supply chain complexity is the major distortion factor that makes it difficult or even impossible to control and manage supply chains from the demand or the supply side.

Some of the basic uncertainty factors that affect real-world supply chains are changed and postponed, delayed, missing and wrong information, materials, deliveries, quantities, stock levels, production capacities and demand. The resulting effects have been studied and described by several authors and are known as the "Bull-Whip" and "Forrester"-effect (Stadtler, H.; Kilger, C. (2000); Simchi-Levi, D.; Kaminsky, P.; Simchi-Levi, E. (1999)) ; (**figure 1**).

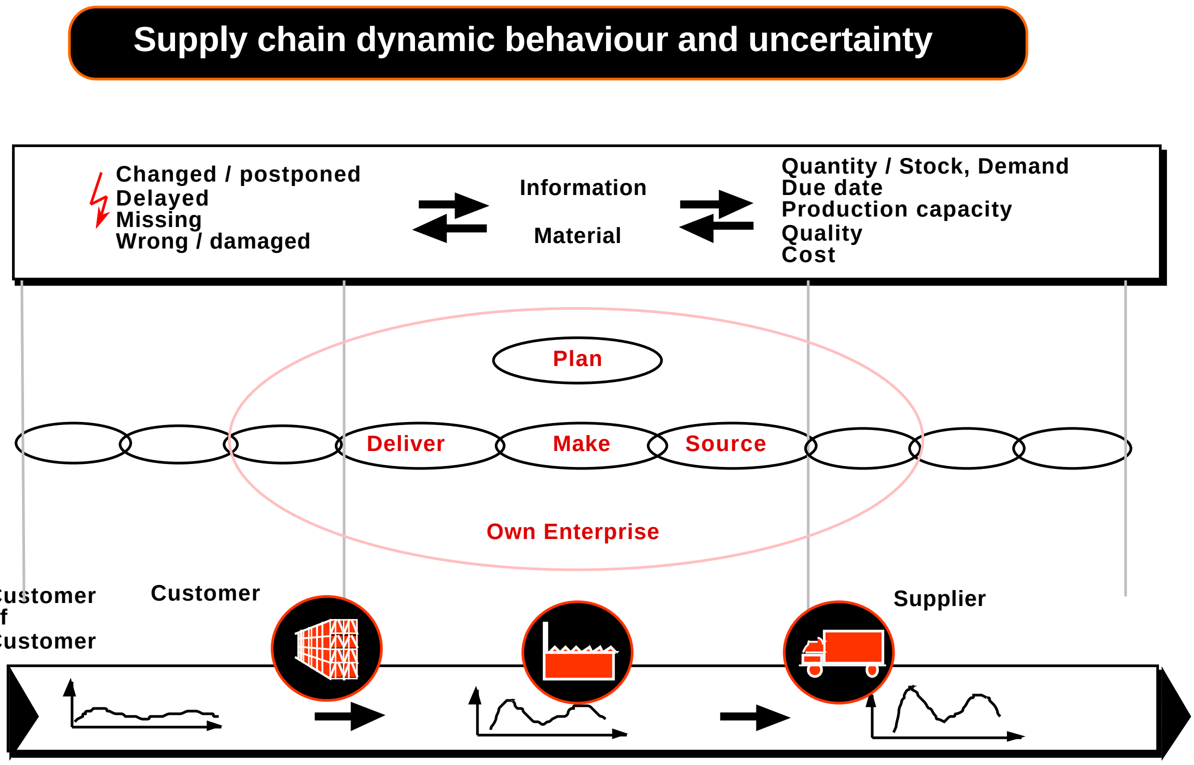

Figure 1: Basic uncertainty factors causing "bull-whip" and "Forrester"-effects

Because precices deliveries require a set of performance measures in a process within given time and quantities, the aspect of time considers possible differences between actual and promised deliveries. Too many actors – or nodes in a supply chain – will certainly disturb proper timely behaviour and synchronization. In the same way, the aspect of quantities of delivered and received goods that differ during time is seen. The third aspect considers the delivery quality, the share of deliveries without failures. Its known from experience that any supplier with decreasing quality performance will cause an increasing information flow on returns and safety stocks – thus traffic – in the supply chain in order to assure the customer's delivery goal.

Designing and keeping the supply chains simple, lean, and manageable to avoid too many interconnected nodes and traffic is the important message of Gardner and Ashby's experiments.

3. An Analysis of Supply Chain Uncertainty Factors in an Automotive Case Example

In an industrial research project between a German truck manufacturer and four major system and module suppliers, accompanied by the author, one of the basic questions were (Thaler2001):

- which kind of "bull-whip" and "Forrester"-effect occur, and
- which uncertainty factors in the supply chain could be identified as relevant.

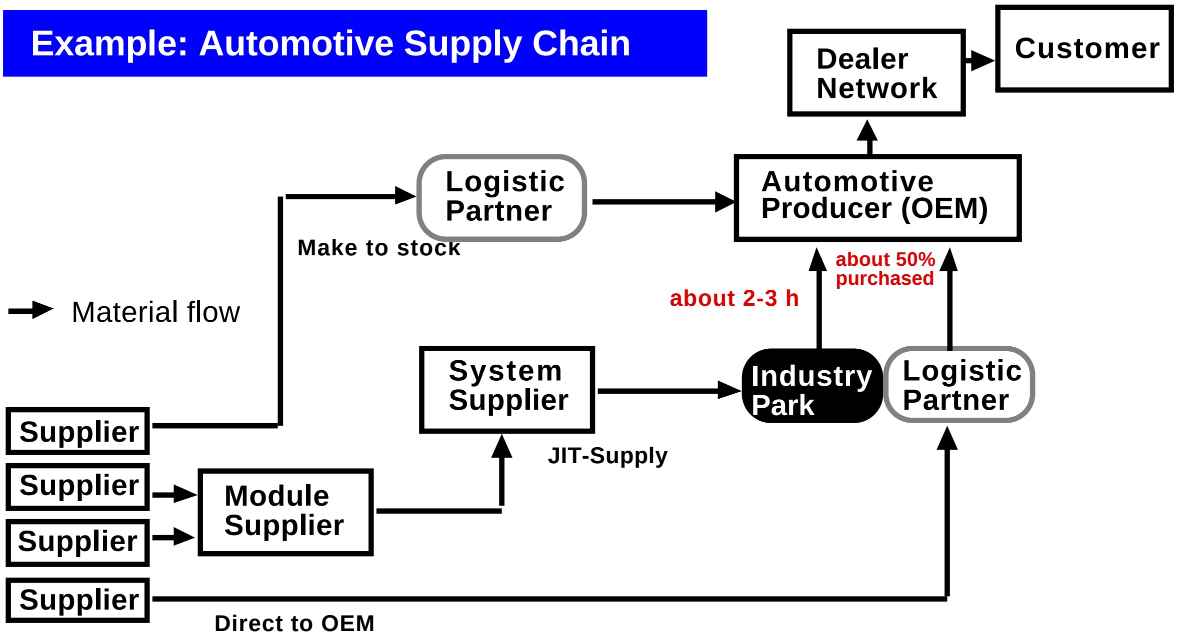

Figure 2: Automotive Supply Chain (Thaler 2001)

The overall supply chain investigated is shown in **figure 2**. In the final assembly system of the truck manufacturer, about 22.000 part positions have to be ordered each month, mainly with low quantities. This is mainly caused by a large variant basis with about 2000 basic models (variants) and 50.000 customer options. The customer has the possibility to change the ordered positions up to 35 days before final assembly is set.

The required schedules of the system supplier is based to 60 % on a material requirement calculation, where usually a supply stock of two work days is achieved. About 40% of the schedules are dynamically calculated on the basis of cumulates and directly send out to the supplier via electronic data exchange (EDI).

Demand data for the truck types and variants are planned on longterm from the sales department. However, on a short term basis, actual customer order have to be included into the production schedule. The sales department is thus responsible for a production programm covering one or serveral years, that is in principle broken down on years and month and that is updated frequently.

With an EDI based short term call, the supplier receives a forecast on the expected monthly quantities (planned quantities) for the next half year.

For the first 8 weeks of the forecast, the supplier receives a quantity broken down per day. For the following periods, this is processed per week. The planning cycle is weekly, whereas tolerances of +/- 20 % of quantity changes are possible. With a short term call, the actual quantities within 14 days are determined on a daily basis. Because this is still planned quantities, tolerances of +/-5 % of quantity changes are possible here. The sequence call finally determines the real order, that means the ordered components are immediately transported to the final truck assemly.

The basic findings of the analysis of the supply chain were effects on the demand side caused by:

- the proportion of deliveries not on time,
- too early,
- delayed,
- incorrect,
- damaged, parts,
- or deliveries with incorrect quantities.

On the supply side, the supplier received on reverse too many short term quantity changes by so called "imediate calls", that were processed additionally and that caused additional handling effort.

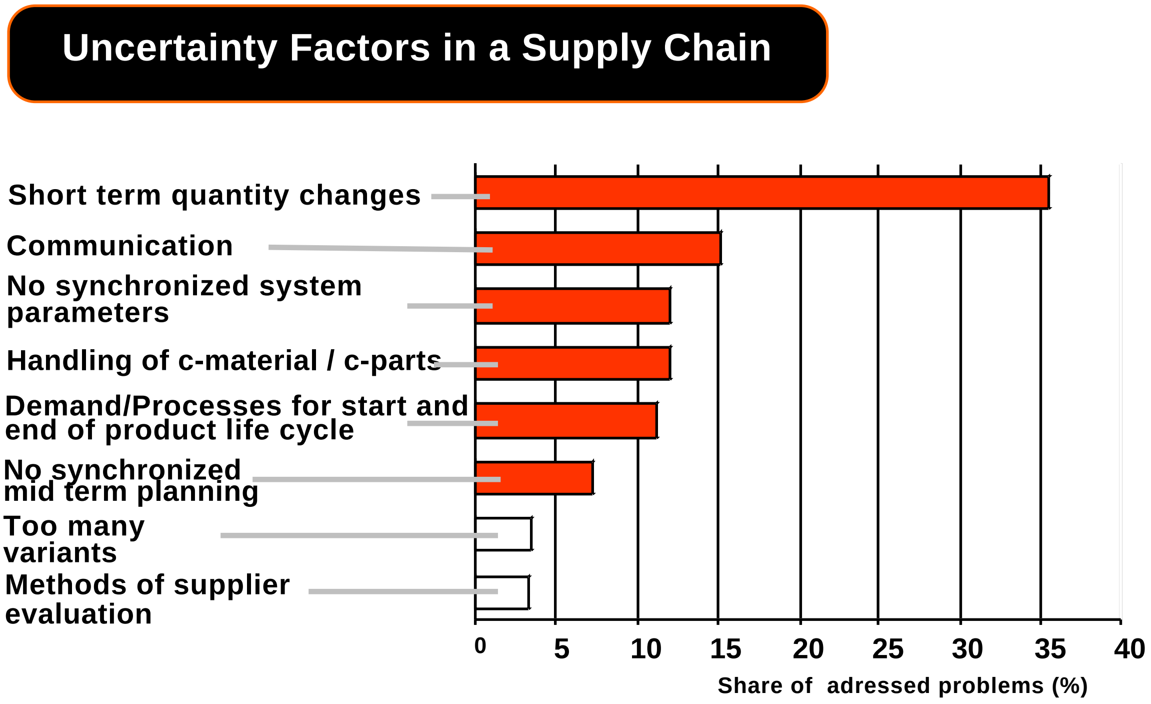

Figure 3: Analysis of uncertainty factors (Thaler 2001)

Figure 3 shows that more than 35 % of the adressed problem cases - that were investigated logistical transaction between manufacturer and supplier - were categorized as "short term" quantity changes. About 15 % of the problems were categorized to missing/misleading communication on forecast and actual demand, 13% on non adequate MRP system schedules. Furtheron, within 13% of the cases, the handling of C-material was considered critical. Especially the start and end of the production series caused further effect on demand variation (12% of cases investigated).

The lack of mid term planning data on the long term production programme was finally found as problematic in 7% of the cases.

Generally, the basic factors affecting uncertainty and thus increasing the complexity of the supply chain were identified as non transparent stock quantities, low robustness of the supply chain (internal and external processes depending on automotive-specific requirements), low organizational flexibility of the supplier to react on demand changes and unforeseen events, and low quality of delivery demand data processed by the end manufacturer.

4. The Survey on SCM Applications

Within the research conducted, an additional survey of German managers on supply chain management issues showed that nearly 40% of the 100 surveyed companies were currently preparing to implement supply chain management (SCM) tools and technology. But fewer than 10% of them had actually implemented SCM and had productive solutions in place (**figure 4**).

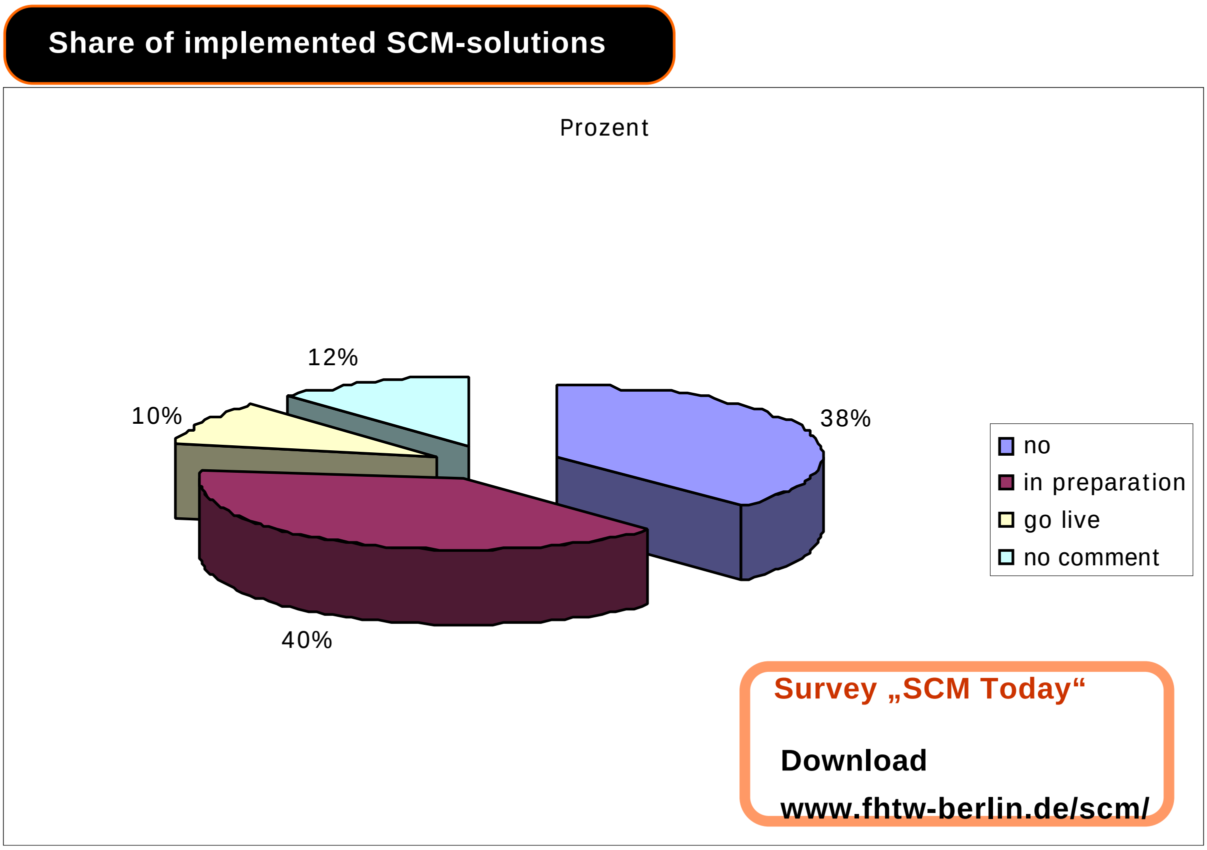

Figure 4: Survey results on implemented SCM solutions

A further investigation was adressed to the question which key processes were considered as relevant for specific SCM application and SCM projects. The basis szenarios that were found are the demand side (distribution to customer), the order acquisition, the production planning in collaboration with customers, the production planning of plants, the supply side with procurement, and finally recycling and product development.

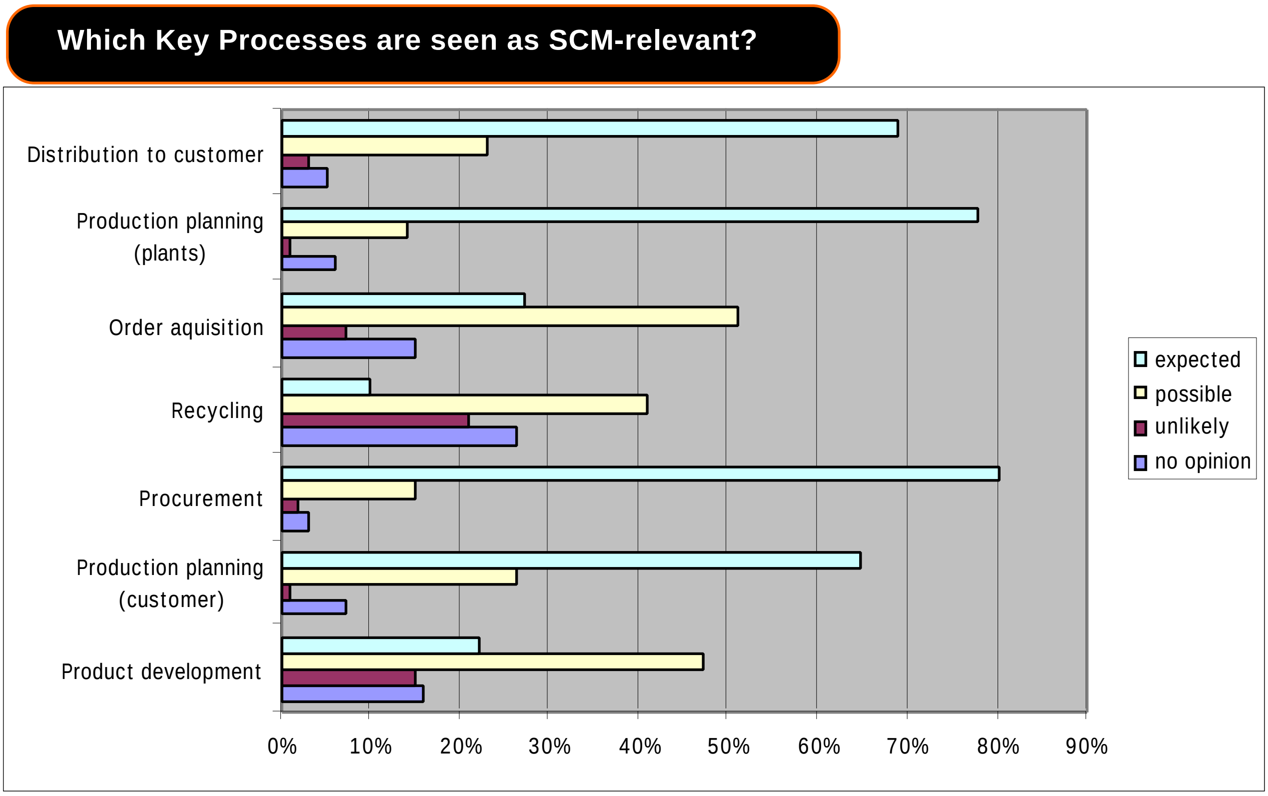

Figure 5: Survey results on SCM key processes

Figure 5 shows that the main focus is set on the procurement process (80%), followed by overall production planning of plants (78%), distribution to customers (69%) and collaborative planning of forecast with customers (54%). Less interest could be revealed within product development and recycling (22% and 10%).

The survey results also indicated that one of the basic success factors for SCM is to concentrate on specific key business processes and to develop an appropriate set of key performance indicators (KPIs) for the specific business application to control and manage internal and external activities. For example, it has become clear that the intention to control and manage distribution processes for key customers and to receive actual demand data from the markets is very strong in the whole automotive industry.

Acknowledgements
Support for the research was gratefully received from DaimlerChrysler, the FHTW Berlin and the University of Mannheim, Germany.

References

Stadtler, H.; Kilger, C. (2000): Supply Chain Management and Advanced Planning. Concepts, Models, Software and Case Studies. Springer, Heidelberg, 2000

Simchi-Levi, D.; Kaminsky, P.; Simchi-Levi, E. (1999): Designing and Managing the Supply Chain: Concepts, Strategies, and Cases. McGraw-Hill 1999

Thaler, K. (2001). Supply Chain Management - Prozessoptimierung in der logistischen Kette (in German) Fortis Verlag FH, Köln, 3rd Ed. 2001.