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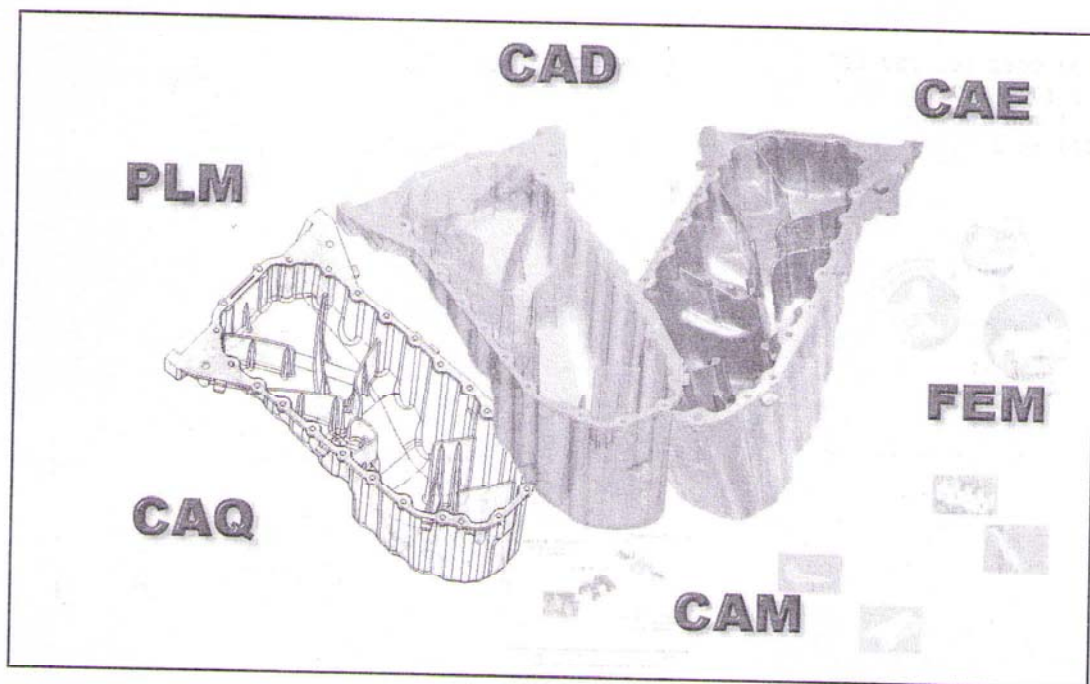


PROCEEDINGS

INTERNATIONAL CONFERENCE ON COMPETITIVE MANUFACTURING

COMA '07

The Challenge of Digital Manufacturing



31 JANUARY - 2 FEBRUARY 2007
STELLENBOSCH, SOUTH AFRICA

Organised by
Departments of Industrial Engineering &
Mechanical Engineering



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International Academy of Production
Engineering

PROCEEDINGS

International Conference on Competitive Manufacturing



31 January – 2 February 2007

Organised by

**Departments of
Industrial Engineering and Mechanical Engineering**

**Editor:
Dimitri Dimitrov**

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About CIRP

CIRP was founded in 1951 with the aim to address scientifically, through international co-operation, issues related to modern production science and technology. The **International Academy of Production Engineering** takes its abbreviated name from the French acronym of **College International pour la Recherche en Productique (CIRP)** and includes ca. 500 members from 46 countries. The number of members is intentionally kept limited, so as to facilitate informal scientific information exchange and personal contacts. In a recent development, there is work under way to establish a **CIRP Network** of young scientists active in manufacturing research.

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Foreword

Welcome to this third in South Africa International Conference on Competitive Manufacturing hosted by the University of Stellenbosch and organised jointly by the Departments of Industrial Engineering and Mechanical Engineering.

In a small world where global trade is the new driving force conquering countries and continents alike, international competitiveness is becoming the ultimate challenge of the new millennium. It requires high quality products manufactured with state-of-the-art technologies at low cost under the assumption of highly efficient operations management as well as clear corporate goals and strategy. This in turn is facilitated by and dependent on improved engineering training, education, and relevant applied research, fueled by active interaction between academia and industry.

The main objective of the International Conference on **Competitive Manufacturing** (COMA '07) is to present recent developments, research results and industrial experience accelerating improvement of competitiveness in the field of manufacturing. The 70 papers selected to be delivered at the Conference deal with wide aspects related to rapid product development, agile manufacturing, operations management as well as enterprise design and integration. The worldwide participation and range of topics covered indicate that the Conference became truly a significant meeting of people striving similar aims. The event is an additional opportunity for communication between paper authors and attendees, which undoubtedly will serve as a further step towards exciting developments in the future. It also provides ample opportunities to further exploit international collaboration.

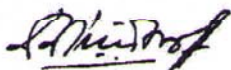
The Chairman and the Organising Committee express heartfelt thanks and gratitude to the Members of the International Programme Committee, who have given their help and expertise in refereeing the papers and will chair the technical sessions during the Conference, as well as to the authors for participating and ensuring that the high standards required on an International Conference were maintained. These thanks and gratitude is extended to our highly regarded keynote speakers.

The Chairman conveys sincere thanks to the conference sponsors for their generous support, which made this event possible, as well as to our exhibitors.

The International Academy of Production Engineering (CIRP) and the South African Institution of Mechanical Engineering are gratefully acknowledged for the scientific sponsorship given to the Conference.

Finally, the tremendous effort of the Organising Committee is appreciated. Grateful thanks are due particularly to the Conference Secretariat for ensuring the success of COMA '07.

We hope that you will find the Conference interesting and stimulating!



Prof. DM Dimitrov
Conference Chairman

ACKNOWLEDGEMENTS

Sincere thanks to our distinguished sponsors, whose generous support has contributed to success of the Conference



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Surveys on Production and Collaboration Aspects in the Automotive Supply Chain

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Abstract

Based on desk research and interviews with decision makers of car manufacturers, suppliers and service providers in Europe several studies were worked out. The studies examine the development of the automotive industry in general and the impact of investments in new production facilities in Eastern Europe. The paper summarizes the key findings of the studies and shows that collaboration between OEM and suppliers as well as between suppliers and logistics service providers will change in the future.

Keywords

Supply Chain, Automotive, Survey, collaboration, supply chain management, production and logistics network

1 INTRODUCTION

It is apparent that the business model currently employed by the automotive industry of mass-producing identical products, is flawed and becoming dysfunctional. The industry suffers from global over-capacity and rising stock levels and exhibits inherently low profitability. Vehicle manufacturers have attempted to meet the challenges through a series of global mergers and acquisitions, hoping for better economies of scale through platform and component sharing. At the same time, previous core competencies, such as component or module assembly, are being outsourced to large first tier suppliers, some of which have overtaken their customers in terms of turnover and size by now [1].

The question is, how will this industry develop in the future, how can OEM, logistics service providers or suppliers react to cope with future demands, how will the supply chain look like in the future? In order to predict the future of car manufacturing and in its supply chain, the Fraunhofer Gesellschaft in collaboration with other institutions like Mercer Management Consulting and the Technical University of Vienna made a couple of studies.

Aim of this paper is to summarize the key findings related to the supply chain and the collaboration between all stakeholders.

2 STUDY 1 FAST: FUTURE AUTOMOTIVE INDUSTRY STRUCTURE 2015

The first study, done by several Fraunhofer-Institutes and Mercer Management Consulting was called FAST: Future Automotive Industry Structure 2015. It examines the value creation system of car industry and predicts the global development in this industry. It is based on a research how automotive

brands developed in the last decades and the market perception of the brand by the customer. To be competitive in today's hypercompetitive market, unique characteristics of the brand must be emphasized and used as a differentiation from competitors. Core questions from a brand perspective are [2]:

- What brand profile is being sought? What should the brand stand for in the future?
- Which brand differentiation will create an edge over the competition?
- How does the customer perceive the brand?
- How can the brand promise be kept? What is the contribution of the 'auto' product (besides services, processes, etc.)?
- Which functions and value creation features will serve the core of the brand?
- What competencies and resources are therefore mandatory in-house, and where is there room to manoeuvre?
- What are the resultant consequences and possibilities for the value creation structure?

The actual and future market position of the brand will highly influence the company's decision on its own core competencies and therefore the share of work, done by the supplier network. This development is affected by the technological development in the product and the introduction of innovations as well as by the strategy and the behavior of all players in the supply chain. Last but not least, all activities will follow basically the economic rule of a positive value contribution. This leads to a logical proceeding (see Figure 1) how the structural change in the automotive industry will happen in the future – starting from the customers.

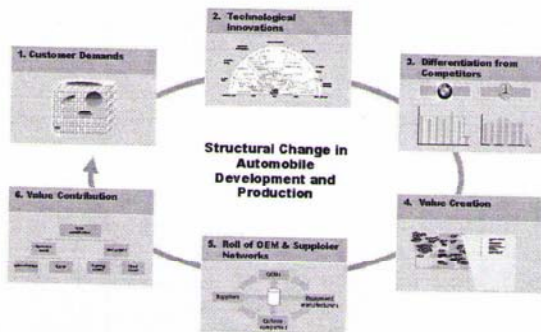


Figure 1 - Logic of structural change in Automotive Industry [2]

With this model it was possible to forecast the development of each brand, the performance of the vehicle modules in the car and the distribution of work between OEM and supplier network. This was done for several regions and together with market and macro-economic prognosis it was possible to predict production quantities for the vehicle series, investment needs and other indicators of the value creation system in the Automotive Industry. This model, the resulting business system and the roles of the several groups were validated in 60 interviews with key decision-makers (board members, CEOs, strategy planners ...) in the automotive industry (OEMs, suppliers, engineering service providers, etc.).

The FAST-Study then identifies several fields of action, where the Auto-industry as a whole or several players (OEM, suppliers etc.) can increase the profitability of the car manufacturing business and gives some recommendations for practical lines of action. The several working steps are shown in Figure 2.

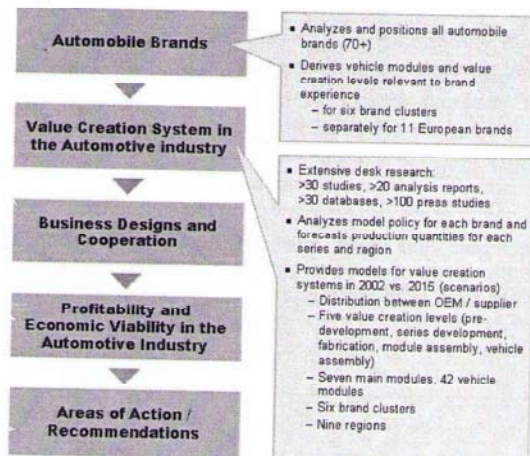


Figure 2 - Proceeding in the FAST Study [2]

2.1 Key Findings of the FAST-Study

Some Key findings of the study are [2]:

- The automotive industry will grow on average 2.6% annually to the year 2015
- Value creation from automotive development and production alone (without sales or after-sales) will grow from EUR 645 billion in 2002 to EUR 903 billion in 2015.
- Of the top decision-makers polled for the "FAST 2015" study, 80 percent expect that OEMs will consistently align their development and production competencies (and resources) on the (planned) positioning of their brands and will focus accordingly on areas that affect the brand experience (modules, value creation levels).
- The six brand clusters differ significantly in their value creation strategies and the amount of self-produced contents they retain. Although some premium brands (e.g. BMW, Mercedes-Benz and Audi) will increase their amount of self-production in absolute terms, they will lower it as a percentage of total output. The ones most strongly affected, however, will be mass-market brands, which will significantly lower their self-production in both relative and absolute terms.
- The amount of self-produced content among OEMs will thus drop from today's EUR 228 billion (35%) to EUR 203 billion (23%) by 2015. For some brands this will double the volume of outsourced value creation. Today's competencies and capacities must be reduced, especially in the areas of car body, sheet steel, paint and chassis. Along the value chain, OEMs will continue to withdraw especially from module fabrication and assembly (EUR - 57 billion), with development remaining constant at roughly EUR 30 billion.
- Value creation in the automotive industry will explode by some EUR 280 billion to EUR 700 billion by 2015, with the supplier sector growing by 68 %. Automotive suppliers and service providers will thus offer huge growth potential in all the main modules, but especially in body, sheet steel, paint and powertrain. The greatest amount of growth will be found in electrical systems and electronics, where auto makers and suppliers alike will be involved. An additional 3.3 million jobs will thus emerge in the supplier sector, which will become the 'engine of growth and employment.'
- The process of concentration in the automotive supplier industry will continue unabated. By 2015 it is expected that the number of suppliers will be halved to roughly 2,800. The reasons for this are the ongoing cost pressure in practically all major vehicle modules, the expansion of the range of competencies (e.g. in electronics), the rising pressure of innovation among suppliers

and the growing need for investment, and hence capital (e.g. for new production plants).

- Automotive suppliers will become indispensable partners of auto makers for the implementation of the impending growth and the planned model policy. New business designs and a "new quality" of cooperation will be required in order to cope with the structural change. Cooperation ventures will be characterized by transparency, trust, partnership, and the sharing of opportunities and risks, among other things. New forms of cooperation will evolve to handle operational implementation.

3 STUDY 2 AREE: AUTOMOTIVE REGION EASTERN EUROPE

In a second study, Fraunhofer and the Vienna Technical University focused the examination of the Automotive Supply Chain on the development of the Automotive Region Eastern Europe (AREE). This area comprises the new member states of the European Union Hungary, Czech Republic, Poland and Slovenia and the EU candidate Romania (see map Figure 3). These countries had very high investments from the automotive industry in the last years. 7 Billion Euro were spent until 2006 to build new car production facilities or to increase existing car plants. In a radius of 300 Kilometres 11 car plants are currently in operation. Until 2008 5% of the total world car production (more than 3 million cars) will come from the AREE-countries. [3]

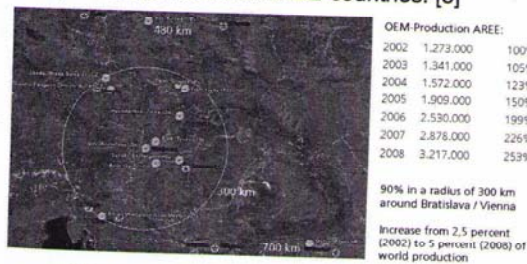


Figure 3 - Car Production in AREE [3]

The reasons for these immense foreign direct investments of the OEM were originally the low labour costs in AREE (only 17% of the average EU cost level) and very attractive conditions for investors (investment grants). This locational advantage was and is supported by extremely low tax rates for companies in comparison to the old EU-member states. [4]

The new car production facilities in Eastern Europe changed the structure of the whole supply chain. While bigger suppliers were able to follow quickly the OEM to the sites in Eastern Europe, the majority of companies especially small and medium sized enterprises (SME) did not move from their original location. This was due to low investment capabilities of the SME or a lack of experience building up new plants in a foreign country.

In the first step, this development resulted in an increase of logistics cost for the OEM. Only a few of the typically 400 to 600 suppliers from an automotive plant were locally present and parts from the rest of the suppliers had to be transported long distances. The study examined for example that 75% of parts of Volkswagen Bratislava in the Slovak Republic are transported from abroad. Only 16% of the parts are sourced locally. The logistics costs are 300 to 350 % of a comparable plant in South or West Europe. [5]

This led on one side to a sustained process of consolidation in the supplier sector. Bigger suppliers who had the ability to be locally present had an advantage against SME and were able to replace them. This development is emphasized by the tendency of the OEM to reduce their share of value creation and to outsource what is not necessary for to core differentiation of the brand. The outsourcing ratio is extremely high for most of the brands manufactured in AREE countries (see Figure 4) [2].

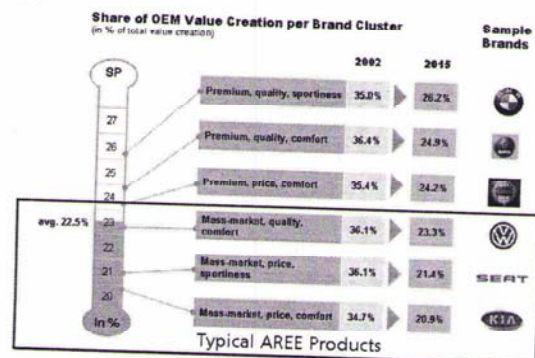
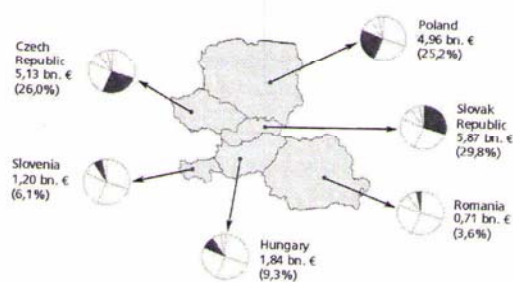


Figure 4 - OEM value creation in different brand clusters [2], [3]

On the other side, there is still an enormous opportunity for suppliers who are locally present because all OEMs would like to reduce logistics costs and source locally. The AREE study calculated a purchasing volume of 20 Billion Euro in 2008 from the different AREE countries (see Figure 5). [3]



Prognosis for 2008 for countries in AREE: 20 Billion Euro

Figure 5 - Purchasing volume from AREE countries [3]

While SMEs hesitate to transfer value adding to East Europe due to capital restrictions or risk considerations, OEM already act: in surveys done by the Fraunhofer Project Group for Production Management and Logistics, several small and medium sized enterprises reported an increasing pressure from purchasing agents of the OEM to open up subsidiaries in East European countries. [6]

3.1 Key Findings of the AREE-Study

For the suppliers from original locations such as Germany the question arises how to react. The first option, to supply the OEM factories in AREE from existing locations has the risk, that sooner or later they will be substituted by local companies due to cost (labour and logistics costs) disadvantages. This can be a strategy for companies with specialized products and / or a unique position in the market. [7]

The second option is to build a separate plant close to the customers. Here is the risk, that the diversification of sites (in the extreme 11 sites at 11 OEM plants) will increase overhead costs enormously and that the investments in land, buildings, equipment and machinery will not pay off since a contract with an OEM is never longer than the production lifetime of a car (between 5 to 7 years – in comparison to a period of depreciation of 15 or more years for most investments). In addition high start-up costs such as employee trainings, contingency costs and high expenditure on supervision, coordination and control have increased the risk especially for SMEs who are not experienced with production in foreign countries. This option was already chosen by large, international acting companies with the financial power, the experience to build up plants abroad and a critical volume of added value to have a 'healthy' ratio between overhead costs and product value. [7]

So for the majority of companies and especially the small and medium sized companies, the only option is to rent a turnkey factory in a supplier park to avoid investments. This is already offered by some OEM owned parks in AREE e.g. in Lozorno (VW) or Trnava (PSA) but focused on Tier-1 suppliers with products of high variance and/or high volume. [8]

The study therefore comes to a conclusion, that Multi Customer Supplier Parks (MCSP) will be built which allow SMEs to rent production and logistics facilities in short distance to several OEM plants [3]. This park concept is already successfully realized in South Africa [8] and the geographical situation in AREE (11 OEM plants in a 300 km circle) offers also this opportunity. MCSPs have the advantage that it reduces start-up and operating costs, SMEs can rent a turnkey factory within a park, and thus avoid high investment costs. Moreover the MCSP provides an environment for suppliers that need a highly fixed capacity for the economical operations because of increasing numbers of clients. [3], [7]

4 SUMMARY

Both studies show, that the automotive supply chain will change dramatically. The shift of value adding between OEM and supplier will lead to different forms of cooperation and a new understanding of the roles of OEMs and suppliers.

Structural change driven by the growth of the suppliers will lead to a sustained process of consolidation in the supplier sector. Balanced market relations between OEM and suppliers can be expected (Mega-Suppliers), the apportionment of services and the demands of OEMs will change, with overall packages and modules going to suppliers and a new 'quality' will be demanded from suppliers:

- Expanded range of products and services
- New areas of competence
- Additional resources
- Inter-regional business relations

This development is accelerated by creation and transfer of production facilities to East European countries (or other low cost countries). The emerging opportunities can not be realized by small and medium enterprises so big international suppliers will double profit – from the replacement of SMEs due to their weaknesses on one side and from OEM reduction of value adding on the other.

The only way to survive for SMEs is the development of unique competencies or the cooperation with other suppliers or logistics service providers to share risk and investments. Supplier parks are means to support this cooperation. The unique situation in AREE with its high density of OEM plants is suited to expand the supplier park idea to the Multi Customer Supplier Park where even more synergy and cost sharing effects can be realized.

5 REFERENCES

- [1] Sihn, W.; Bischoff, J.; Eszterhazy, M., 2005: Intelligent Logistics for Innovative Product Technologies within the EU 5-Day Car initiative; CIRP-38th International Seminar for Manufacturing Engineering; Florianopolis, Brazil.
- [2] Mercer Management Consulting / Fraunhofer-Institut IML and IPA, 2004: Fast Automotive Industry Structure (FAST) 2015 – die neue Arbeitsteilung in der Automobilindustrie, VDA-Verlag, Frankfurt am Main.
- [3] Sihn, W.; Palm, D.; Matyas, K.; Kuhlmann, P., 2006: Studie, Automotive Region Eastern Europe - Chancen und Potenziale des „Detroit des Ostens“ für Automobilzulieferer, Fraunhofer-Projektgruppe für Produktionsmanagement und Logistik, Wien.
- [4] EUROSTAT: <http://epp.eurostat.cec.eu.int>, December 2005
- [5] Wilhelm, K.-P., 2003: Die Strategie von VOLKSWAGEN SLOVAKIA für ihre Zulieferer, 5. Internationales Automobilforum Graz, Graz.
- [6] Sihn, W., 2005: „Da wird oft blind verlagert“; Automobil Produktion, Dezember 2005, S. 22 – 24.
- [7] Schmitz, K.; Sihn, W., 2006: Potentials and Challenges in Supply Industry in Eastern Europe AREE, MITIP 2006, Budapest.
- [8] Westkämper, E.; Freese, J.; Bischoff, J.; Barthel, H.; Lehnert, O., 2005: Nutzen und Potenziale von integrierten Versorgungsstrukturen wie Lieferantenparks, Industrieparks, Versorgungszentren und ähnlichen Ausprägungsformen für die beteiligten Unternehmen, Fraunhofer-Institut für Produktionstechnik und Automatisierung, Stuttgart.

6 BIOGRAPHY



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