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# SUCCESS FACTORS IN COLLABORATION MANAGEMENT IN INDUSTRIAL PRODUCT DEVELOPMENT

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## Abstract

The main objective of the presented work is the identification of success factors critical for the management of collaborations in a product development department in automotive industry. These collaborations take place between original equipment manufacturers (OEM) and system suppliers (suppliers who deliver complex systems directly to the OEM) as well as component suppliers (suppliers who deliver indirectly to the OEM). Due to rising product complexity, the need for collaboration in the product development of car components is still increasing. For instance, in the design of an automotive seating system for a certain model more than a hundred industrial designers, design engineers, project managers, accountants, and prototype experts need to collaborate effectively and efficiently in order to achieve the technical and economic objectives. Recent publications even highlight that the ability to collaborate with innovative supplier companies represents a distinctive quality of premium car companies [1]. Extensive work has already covered this area [2 ,3 ,4, 5, 6, 7], especially in the field of collaboration in industrial production (supply/value chain management). However, in daily practice many problems on a technical, personal, and organisational level still hinder efficient collaboration. This paper presents a collection of success factors identified in exemplary product development processes. In these processes the success factors were found to support the collaboration processes in a pragmatic manner.

*Keywords: distributed product development, design management*

## 1. Method

The presented findings are based on a reflection of two project managers [8] working on the product development of a car component (the seating system), as well as on a long term research project concerning the co-ordination and controlling of distributed product development processes [9]. In this project, data were collected using semi-structured interviews and participant observation. The insights were gathered and clarified following a model of the product development process valid for the development of seating systems for cars in the premium segment. This process serves as a basis for project planning and is then adapted to each individual project.

The process model consists of the main stages:

- “vehicle package specification”,
- “rough concept seat assembly”,
- “definition seating concept”,
- “production development”,
- “industrialisation”, and
- “production and use”.

In the "*vehicle package specification*" phase the vehicle concept is defined. The most important information of this first phase for the seating system are the H-point fields (areas which the pivotal hip-point of the driver and passengers (H-point) can reach when the seat is adjusted – this point is important e.g., for determining view possibilities of the driver) and the first package drawing. The resulting documentation is the global project specification.

In the next phase a *rough concept* of the *seat assembly* is generated, still in close cooperation with the Vehicle Package Department. General functions, such as adjustment possibilities or integrated safety systems, and general dimensions, such as comfort dimensions or seat movement fields, are defined. A specification of the seat concept is the output of this phase.

Starting from this result, the seating concept is being developed. Concept samples are being build, the variant tree, i.e., a hierarchical representation of the possible product variants, is generated, safety issues are being addressed, and the controlling of quality, weight, and cost is being started. The result of the "*definition seating concept*"-phase is a complete preliminary definition of all product parts.

In the next phase, the product is further developed, using CAX, simulation tools, and extensive testing in order to arrive with a complete product description as well as a sign-off for the procurement of the serial tools. The goal of the "*industrialisation*"-phase is to "ripen" the product so that it can be produced with as little expense as possible with high quality in high production numbers. This phase culminates in the final sign-off of the product (Baumusterfreigabe).

In the last phase, the "*production and use*"-phase, the production ramp-up is being carried out and a continuous optimisation of the production processes is started. Last but not least, a surveillance of the product in the hands of the users takes place and leads to additional improvement cycles.

The phases of the process model for the product development of seating systems are shown in Figure 1.

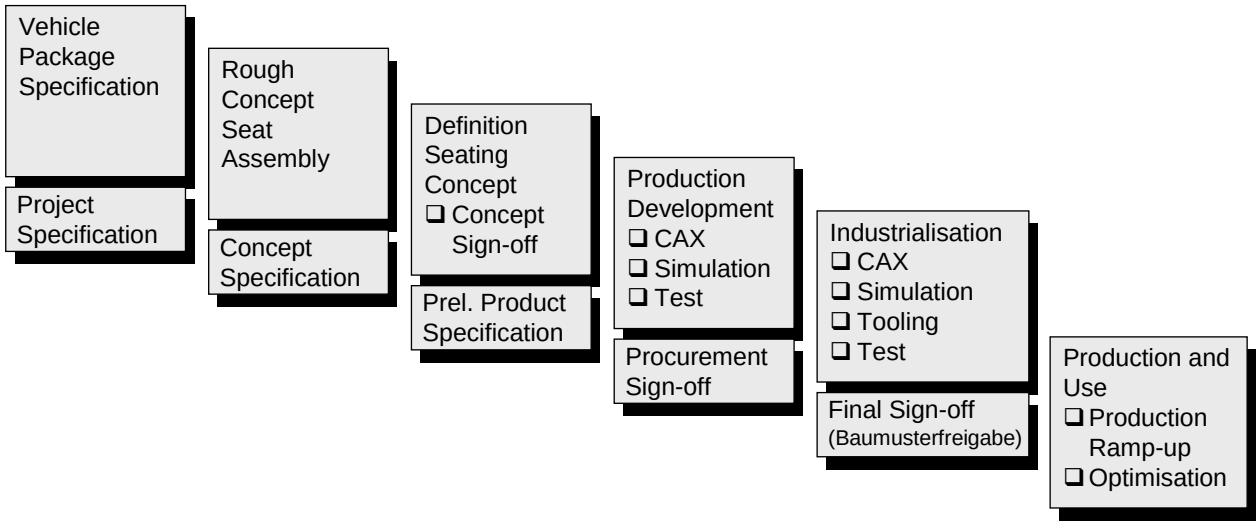



Figure 1. Process model for the product development of seating systems

In a first step all the phases of the process model for the product development of seating systems were analysed in detail, difficult and decisive situations (difficult and decisive for the

collaboration) were scrutinised and on this basis major problems and weaknesses within these phases were identified. These problems and weaknesses which are described in section 2 are the main insight of the focused analysis. In a second step already existing approaches to deal with these problems and weaknesses were formalised and additional approaches were sought and successfully applied. These approaches, the success factors in collaboration management, are summarized in section 3.

# 2. Insights

In this section the insights of the presented work – weaknesses and problems of the analysed processes and specific requirements of these processes in the different project phases – are presented according to the process model for the product development of seating systems. In this section only the problems and weaknesses are described, the measures to overcome these problems and weaknesses – the success factors – are described in section 3.

## 2.1 Vehicle Package Specification

In many of the analysed processes the role of suppliers in the very first phases of the product development of a new vehicle was very small. Obviously, in this phase confidentiality issues are very important, because that phase is carried out usually more that four years before the respective car will be produced. However, as a result of the demand for strongly diversified products, it is more and more important to incorporate specific features, such as multifunction seating systems or head-up displays, very early into the vehicle concept. Very often such fundamental innovations are not generated by the OEM but by leading system suppliers [1]. Frequently such innovations are integrated into the concept of the car later in the product development. However, in later phases many aspects of the car are already defined and the integration of fundamental innovations is less than perfect. Figure 2 shows a summary of the problems that arise from the non-existing participation of leading suppliers in the phase "*vehicle package specification*".

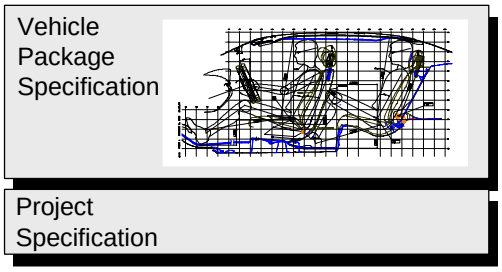



Figure 2. weaknesses / problems in the phase "vehicle package specification"

## 2.2 Rough Concept Seat Assembly

The rough concept of the seat assembly is usually defined within the OEM. In this phase usually a system supplier for the seating system in not yet defined. However, three to four system suppliers already propose seating systems. Most system suppliers produce certain components by their selves. In order to maximize their share of the chain of added value they try to use as many components out of their own production as possible. Frequently this leads to problems, because these components are not always the best components on the market or

are sometimes not appropriate for the requirements of the specific product program. The main problem in the phase "*rough concept seat assembly*" – the exclusive contact of the OEM with large system suppliers – and its consequences are summarized in Figure 3.

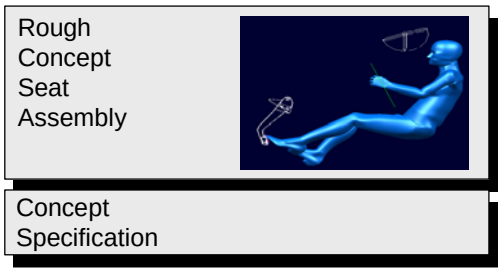



Figure 3. weaknesses / problems in the phase "rough concept seat assembly"

## 2.3 Definition Seating Concept

Since recent years, design engineers in automotive industry are faced by a new challenge, arising as a consequence of the introduction of platform systems. These systems aim to reduce production costs by re-using components and parts in different car models and even in different car brands. For example, in the Volkswagen Group, a product family of seat frames is used in Audi, Seat, Skoda, and VW cars. The components and parts of this product family are produced and developed by a number of different supplier companies. The engineering change management in such product families is one of the main challenges in the concerned product development processes. The mutual interdependencies are so numerous that the product development departments of the OEM are not longer able to handle this complexity on their own. In the analysed processes frequently changes resulted in subsequent changes that were not anticipated, because, for instance, it was not even known that the same component was used for a different purpose. Many examples clearly show that an inadequate change management resulted in high costs of subsequent changes, in high production costs, and even in functional problems. The main problem in the phase "*definition seating concept*" and its consequences are shown in Figure 4.

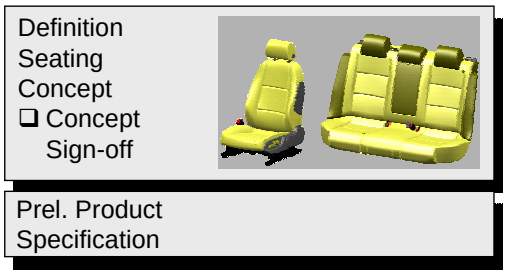
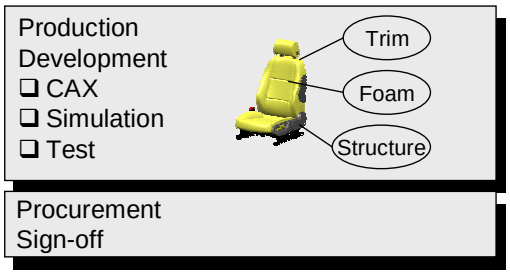



Figure 4. weaknesses / problems in the phase "definition seating concept"

## 2.4 Production Development

Suppliers in automotive industry nowadays are, mainly due to concentration processes, usually excellent experts in terms of the product development and the production of their components. In the analysed processes many problems, especially in the phase "*production development*", were not caused by technical difficulties, but by the missing capability of the suppliers to understand product development and decision processes within the OEM. An OEM, especially in the premium segment, disposes of elaborate procedures to ensure the functionality and product quality of the whole car. Furthermore, the product development and production of such a complex system as a car requires a large organisation with many hierarchy levels. Suppliers in the analysed processes frequently were not willing or able to deal with this organisational complexity within an OEM. The consequence was that valuable time was lost, because decision processes were not adequately prepared and dead ends were followed for a long time, because hierarchy levels responsible for certain decisions were not involved. Figure 5 shows a summary of the problems the phase "*production development*".




inadequate understanding by suppliers of the elaborate procedures and large organisation of an OEM:

→ inadequate decision preparation

→ inadequate involvement of responsible hierarchy levels

Figure 5. weaknesses / problems in the phase "production development"

## 2.5 Industrialisation

The industrialisation is one of the most challenging phases in a product development process. Every potential problem that has not been solved in the earlier phases becomes obvious in this phase and has to be addressed immediately. In the analysed processes, very often valuable time was lost, because the managers of the system suppliers and the managers of the OEM were not in direct contact. As a consequence, it was frequently not possible to come to a necessary decision or, even worse, opposed decisions were made by managers of the suppliers and managers of the OEM. Similar problems could also be found between the product development engineers of the supplier and the product development engineers of the OEM. A lot of confusion was caused by the fact that the product development engineers of a supplier reported different statements to their superiors than the product development engineers of the OEM to their superiors. Mostly these differences were not caused by bad faith but by different view-points. Still, these differences provided a lot of confusion and remarkably slowed down the processes. The main problems in the phase "*industrialisation*" – inadequate contact between managers of the supplier and managers of the OEM and inadequate contact between engineers of the supplier and engineers of the OEM – and their main consequences are summarized in Figure 6.


Figure 6. weaknesses / problems in the phase "industrialisation"

## 2.6 Production and Use

The product life cycles in automotive industry have decreased dramatically. One could even say: *after the SOP (start of production) is before the SOP*. This expression illustrates that soon after the start of production in a certain project the next product (maybe a product variant) will arrive in the same project phase. Frequently, the product development teams are dissolved shortly after the SOP and each member of the team is sent to a new, urgent project. Quite often, no review of the experience is made. During the project, a lot was learned with regard to the components, the overall function, and the ramp-up of the production. However, if there is no formalisation and no joint review, the only part that remains is a personal experience for every member of the project team. A further problem, observed during the analysis of the product development system, is that frequently product development engineers never hear anything about the experience of the end user with the product they have designed. Usually product development engineers of an OEM get a quite good feed-back from the end-user, because they have to deal with complaints and are informed about press reactions. Product development engineers of system suppliers sometimes also get this information. Especially product development engineers of component supplier nearly never get a direct feed-back from the end-user. Figure 7 gives an overview of the problems in the phase "*production and use*".


Figure 7. weaknesses / problems in the phase "production and use"

# 3. Success Factors

In this section, on the basis of the identified problems and weaknesses in the different phases of the product development process, the main findings of this work, the success factors in collaboration management, are presented in the respective phases of the process model for the product development of seating systems. These success factors were on the one hand already existing approaches to deal with the identified problems and weaknesses which could be

identified and on the other hand additional approaches that were generated by the project managers together with the researches from academia and were successfully applied.

## 3.1 Vehicle Package Specification

The main problem during the specification of the vehicle package is the non-existing participation of system suppliers. The lack of the participation often leads to an inadequate consideration of innovations generated by suppliers. A functioning collaboration with system suppliers is required, especially if innovations on the component level arise in areas not considered core competencies of the original equipment manufacturer (OEM) but nevertheless influencing the rough concept of the car. Multifunctional seating systems, such as length-adjustable back seats, have to be considered in the very early phases of a vehicle package. The collaboration in this phase has to be bi-directional for two reasons. On the one hand, the car manufacturer has to convey the ideas of the concept team to system suppliers in order to ascertain feasibility and to clarify the consequences of the vehicle concept, and, on the other hand, leading suppliers need to make the OEM aware of technological innovations which might be used in future cars. Therefore, in this phase strategic alliances between the OEM and system suppliers are needed, especially in areas that are not considered core competency of the OEM. Figure 8 shows an overview of the main success factor – a strategic alliance – in this early phase of the product development of a seating system.

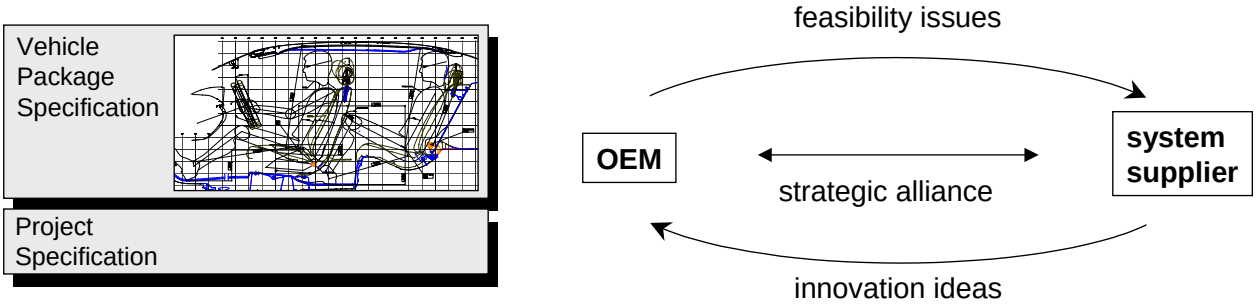



Figure 8. Success factors in the phase "vehicle package specification"

The strategic alliance between OEM and a leading system supplier is necessary because of confidentiality issues. Only on the basis of a deep reliance will a car manufacturer allow a system supplier to participate in the fundamental stages of a car development and to integrate their innovation ideas. This form of collaboration can be of further benefit, because the OEM is able to get answers for feasibility issues on system and component level (i.e., statements if innovation ideas of the OEM can be realized in serial production).

## 3.2 Rough Concept Seat Assembly

In the phase "*rough concept seat assembly*" it is mandatory to consider the best and cheapest standard components in order to save investment for serial tools and product development. Most system suppliers produce certain components by their selves. It is therefore inevitable for the OEM to contact component suppliers directly in order to allow an open competition for the different components of the system. In this phase, the system suppliers are in the difficult situation that they, on the one hand, need to concentrate a large share of the value chain in their own company but, on the other hand, need to make sure that products are specified meeting the demands of the OEM and being economic in production. It is one of the

main success factors in collaboration management that the OEM has enough own competence in order to be able to define a sensible concept and to control the choice of the right components especially in this phase (Figure 9).

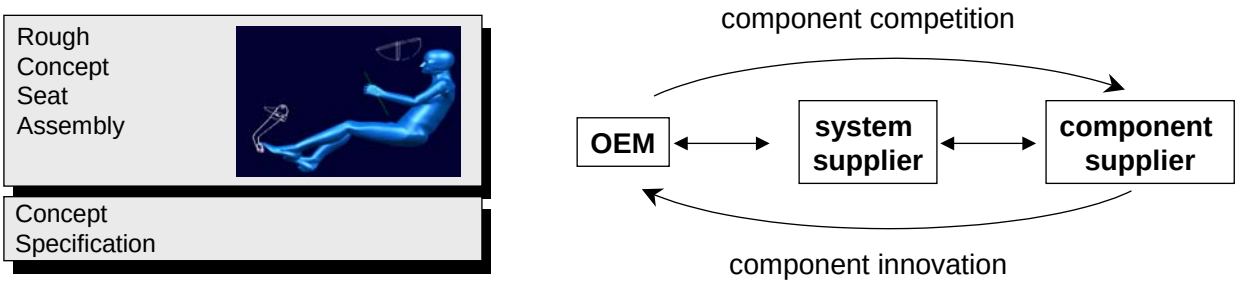



Figure 9. Success factors in the phase "rough concept seat assembly"

A component competition between different component suppliers enhances the chance that the best component on the market (in a functional and economical sense) and the component which is best suited to the specific project is chosen. Such a component competition has to be carried out by the OEM itself, because system suppliers will never have an unbiased position, since they usually produce components by their selves. A direct contact between component supplier and OEM also allows a direct transfer of component innovation without the (strategic) filter of a system supplier.

## 3.3 Definition Seating Concept

In the definition of the seating concept all components to be used are defined. The mutual interdependencies between all components of product platforms are so numerous that the development departments of the OEM are not longer able to handle this complexity on their own. It is therefore a main success factor that the system suppliers as well as the component suppliers are involved in every step of the engineering change management processes throughout the product platform. Lean but effective processes and a conscious interface management are mandatory to meet this challenge. The main success factor in the phase "*definition seating concept*" – a change management in a product platform - is shown in Figure 10.

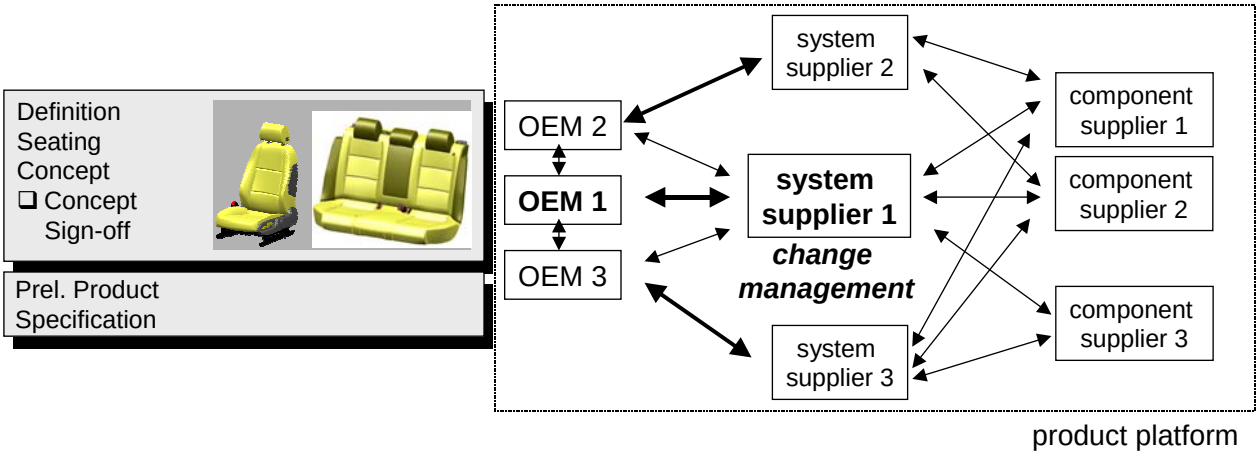



Figure 10. Success factors in the phase "definition seating concept"

In the collaboration system shown in Figure 10 a system supplier who is responsible for a certain project is in charge of the change management. This extremely important task can only be performed by a system supplier, because only the system supplier has an overview of all different components and their application in the different projects. In a sense, the system supplier has a central role in the phase “definition seating concept”. It is a major success factor that the system suppliers has the ability and the resources to handle the complex change management of a seating system with all its components.

In related work [10] information management was found to be extremely important for this and later phases. Two pragmatic tools were developed to support information management – the "Project Monitor" which contains all the relevant information for a technical controlling and for management, i. e., the project status and the technical maturity of the product – and the "Information Platform" – within which a current project status in form of the set of spreadsheets is made available to different participants of the product development process. The use of these or similar tools which support a conscious, efficient information management is also a major success factor for collaboration management.

## 3.4 Production Development

As a consequence of the still increasing number of models and the still decreasing development time-span, a new capability of the supplier is one of the key success factors in collaboration: an in-depth knowledge of the product development and decision processes of the automotive company. Suppliers need to understand these processes in order to be able to deliver the right information and hardware at the right time in the required quality in order not to slow down the internal processes. The success factors in this phase emphasising on detail design and the preparation of the decision to start procurement of serial tools are shown in Figure 11.

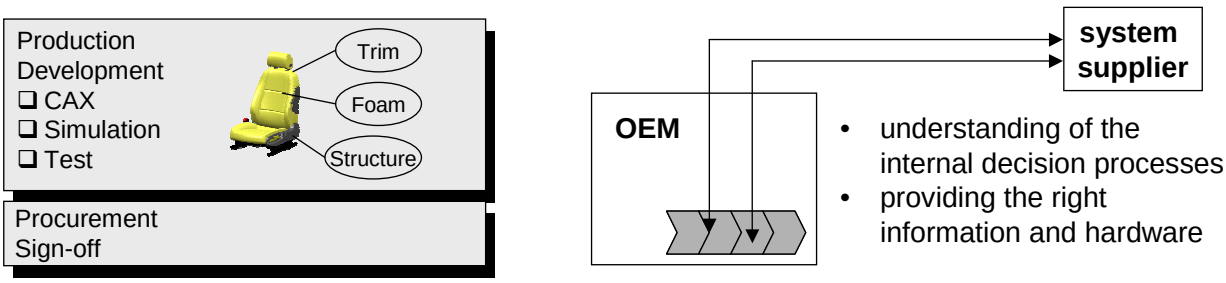



Figure 11. Success factors in the phase "production development"

As sketched in Figure 11, the responsible system supplier needs a in-depth knowledge of the internal processes and responsibilities within the OEM. It is mandatory for quick, efficient processes that the system supplier has a fundamental understanding of the internal decision process of the OEM and is therefore capable to provide the right information and hardware for decision preparation at the right time.

## 3.5 Industrialisation

In the "*industrialisation*" phase the main challenge are quick reaction times. It is mandatory in this phase that problems identified in this late phase are addressed immediately. How can that be achieved? One main factor is decisive. The project teams of the OEM and the system supplier need a joint committee of decision makers of the OEM and the system supplier, which they report to. This shared committee needs the capability and competence to decide whatever action is necessary. Furthermore, contradictory reports to superiors, which were a main problem identified in the analysis of the processes, can be avoided if a joint project team consisting of the members of the project team of the OEM and the members of the project team of the supplier is formed. This joint project team reports together to the joint decision committee. This constellation is shown in Figure 12.

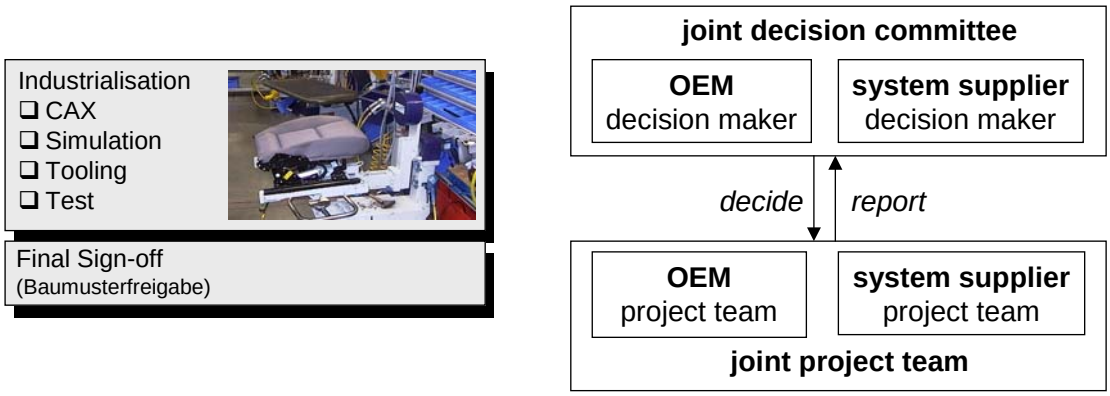



Figure 12. Success factors in the phase "industrialisation"

The important advantage of the constellation shown in Figure 12 is the conscious reduction of communication channels. If there should be a problem identified in the industrialisation phase, it is reported by a joint project team to a joint decision committee. This procedure has two main advantages:

- on the one hand, lengthy discussions who is responsible for the problem can be delayed to a point in time, when the problem is already solved, and
- on the other hand, by forming a joint decision committee the situation is avoided that managers of the OEM and managers of the supplier make different decisions.

Therefore this constellation is a key success factor for collaboration management since it helps to avoid time-consuming loops in the most time-critical phase of the product development process.

## 3.6 Production and Use

The experience made in the ramp-up of the production and the initial use by customers can only be used, if it is fed back immediately into the subsequent processes. Furthermore, system suppliers need to develop an understanding of the wishes and demands of the end user in order to be able to cope with the rising demands. It is necessary that the feedback is also made available to the component suppliers, in order to enable an improvement of the standard components which is oriented on actual user needs. The success factors for collaboration in the final phase are shown in Figure 13.

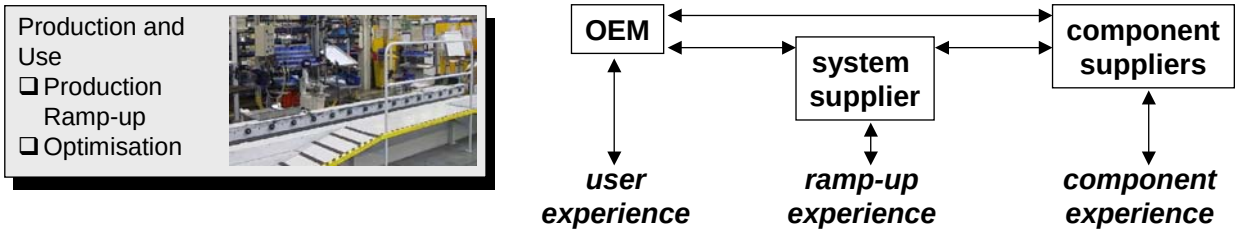



Figure 13. Success factors in the phase "production and use"

By means of field teams and interrogations of customers, leading OEMs gain an in-depth knowledge about the actual experiences of users with the product. On the long run, it is a main success factor that this information is also conveyed to system suppliers and component suppliers, as indicated by the arrows in Figure 13. Additionally, it is a key success factor that shortly after the start of production all the experience made during the product development and during the initial production is collected in reviews and is formalised and made available to all partner in the collaboration in order to achieve a reflection and, by this, an improvement cycle.

# 4. Conclusions

This paper describes a research project of the collaboration management in product development processes in automotive industry. A detailed analysis resulted in a list of problem and weaknesses in different phases of the product development process. Based on this list several major success factors for collaboration management in automotive industry were identified. The success factors presented in this paper share one main emphasis: the original equipment manufacturer (OEM) needs to be able to concentrate on the core processes in order to be able to keep up with the competition in a field of ever more complex and diversified end-user products. In recent years, leading system suppliers have developed the capability to cooperate with the OEM during all phases of the product development process and to take responsibility not only for the product but also the process. On this basis current collaboration forms emphasize on strategic considerations.

The success factors for collaboration management in product development processes in automotive industry presented in this paper are intended to serve as a basis for a critical review for design engineers and project managers working on product development processes ranging over company borders. Obviously, the findings are based on a very small sample size. However, in frequent discussions with several product development managers, it became clear that many similarities can be observed even in other industries. Therefore, we conclude that the presented success factors can be helpful for project managers in many disciplines of the ever more challenging endeavour of engineering design. Obviously such findings which are only based on a small sample size have to be critically reviewed before each application, if the surroundings as well as the background and motives of the participating persons are similar. Further research is needed to support and to clarify the effects of the strategies and tools for collaboration management that were summarized in the success factors.

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