Goals and challenges of future chassis developments – solving a multidimensional optimization problem

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1 Abstract

Designing a good chassis is never a trivial task. The problems already start with the fundamental question: What makes a good chassis in first place? In fact, the engineering goals keep changing as more and more influencing factors come in and have to be considered. In the early years the main focus was on the primary function of a chassis, which is to offer the best possible ride and handling performance. The reason for this narrow view was that neither ride nor handling scored very high and therefore a good chassis meant a significant advantage in the marketplace. For upper market vehicles or for performance cars the chassis is still a differentiator, but in general the technical progress has led to performance levels that exceed the expectations of many customers.

On the other hand we have new criteria that play an ever increasing role in the design of a chassis. Legislation is imposing high safety standards and we have to meet tough emissions targets. Complex infotainment systems and other attributes impose an ever increasing cost pressure on the overall program. To meet these cost targets we need to leverage volumes and sell the cars across the globe, which imposes the problem to find global solutions while we still need to meet regional expectations.

In this paper we are trying to give a position fix. We will frame this contribution by describing the task as what it is: We have to solve a multi-dimensional optimization problem in the presence of severe constraints. In other words, we need to select architectures, components and other design factors such that the resulting chassis meets all legal and market specific requirements and otherwise maximizes the perceived value of the total vehicle, exceeding customer expectations.

Meeting the constraints. The upcoming legislation about the CO2-emissions and the general need to reduce the fuel consumption of the vehicles has a very high influence on the design of the components. The chassis does have a significant effect on the mass, the overall friction, the rolling resistance, the aerodynamic drag and to some degree even on the electric loads. The potential penalties that are imposed by the new laws in the various regions leave little room for compromises.

Maximizing the customer value. In general the customers are not very interested in technology, but they evaluate a vehicle en bloc by its attributes, features, appearance and overall performance. That implies that the goal is not to design a ‘good chassis’, but to find a solution that makes the total vehicle more attractive. It can be shown that the chassis influences about half of the purchasing criteria of a typical customer. This half can be split again in direct chassis criteria like ride comfort, handling performance or stopping distance and another set of indirect criteria, like maximizing the trunk space or the seating comfort. The relative importance of these criteria vary across different regions, which imposes additional challenges to the chassis engineers.

Finding the optimum solution. This assessment of the overall situation has several implications. The first conclusion is that fundamentals matter and cannot be compromised. To reduce the aerodynamic drag on the vehicle the roof lines need to be lowered, which implies that the chassis components must be designed to enable a low H-point. The rear axle has to be placed and designed to accommodate different fuel systems and all moving parts must minimize the internal friction. It is also paramount that the mass distribution must be fully optimized.

In order to meet the specific requirements across the regions we will need to create scalable technical solutions and architectures that can be reconfigured easily. We will also need solutions to resolve the ever increasing conflict between the pressure to create high volumes by sharing parts across architectures while we still need to support technical deviations that may be required in specific markets.

While the above mentioned implications relate to the general design of the chassis systems, there are additional aspects when it comes to the practical execution of any specific carline. Because a good chassis competes for example with good seats or a sophisticated infotainment system for the same budget it is necessary to thoroughly balance the requirements across the vehicle. It is therefore very important to take a holistic view that is based on a good understanding of the real preferences of the customers. The chassis must be evaluated in context, never by itself.

There is no silver bullet that fixes all these problems at once. The challenge will be to take our chassis architectures, the design of the components, the processes to select the right systems to the next level and integrate them into a sophisticated managerial process.

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