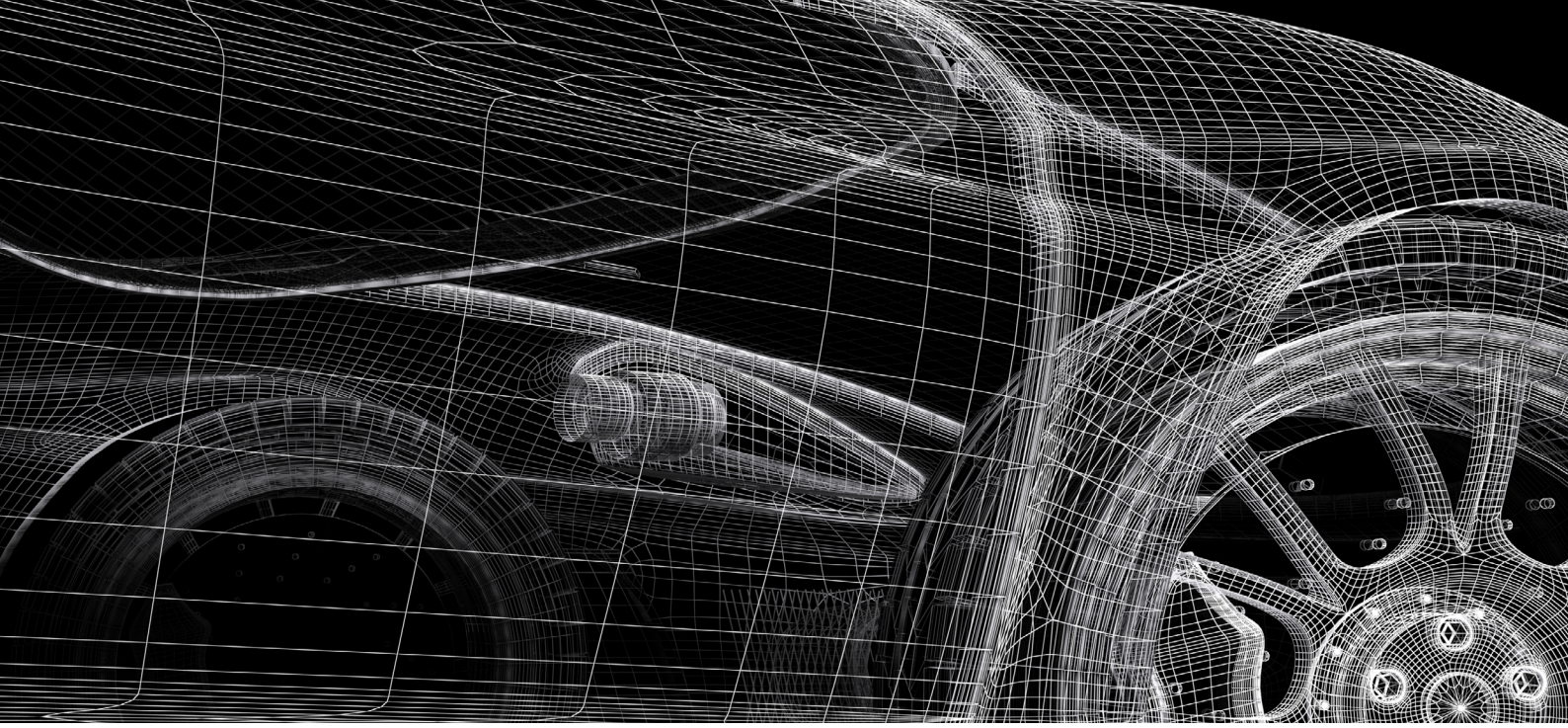
Mobility in transition – Seating in the future

Whitepaper on opportunities and challenges of digitalization in seat development

Wölfel

Preview

In this white paper, we first highlight the upcoming paradigm shift in the design and use of vehicle interiors. We then go into what this means for the development of seats and show, using specific examples, how OEMs and suppliers can optimally respond to the changes in the context of seat development.



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Who is Wölfel?

The Wölfel Group has been on the market for more than 50 years and, with more than 120 employees, offers cross-industry engineering and system solutions around our central areas of expertise: vibrations, structural mechanics, acoustics and immission control. In the simulation of seating comfort, Wölfel supports suppliers and OEMs in the automotive industry with the CASIMIR/Automotive software and matching seat test benches.

›› learn more

Mobility in Transition – Seating in the Future

The buzzwords e-mobility and autonomous driving are currently present in all media. The possibilities resulting from these technologies make it clear that mobility is undergoing change and is entering a new stage of development.

In tomorrow's mobility, the use of assistance systems will mean that the occupant will be less and less concerned with actually controlling the vehicle. In addition, control elements such as the steering wheel, accelerator and brake pedal can be eliminated through the use of voice control. Best examples from everyday life in the home and communications sector are Alexa (Amazon) and Siri (Apple).
As a consequence, a driver with all his tasks as today will probably no longer exist in 20 years. These changes offer new design possibilities in the interior, which occupants expect to be individual and comfortable.

In addition, perception and attention will also change. Information and stimuli from outside will have a much smaller impact on occupants. Examples here include the lower noise level of electric vehicles or the number of traffic signs, which could be eliminated due to automatic guidance systems.

Instead, other effects are likely to play a bigger role. If the elements for controlling the vehicle are neglected, the seat will be the central component in the vehicle interior in the future. It is through the seat that passengers are connected to the vehicle. If you look at the requirement profiles of current designs, they still represent a compromise between the decisive factors. **These are safety, ergonomics, comfort and acoustics.**

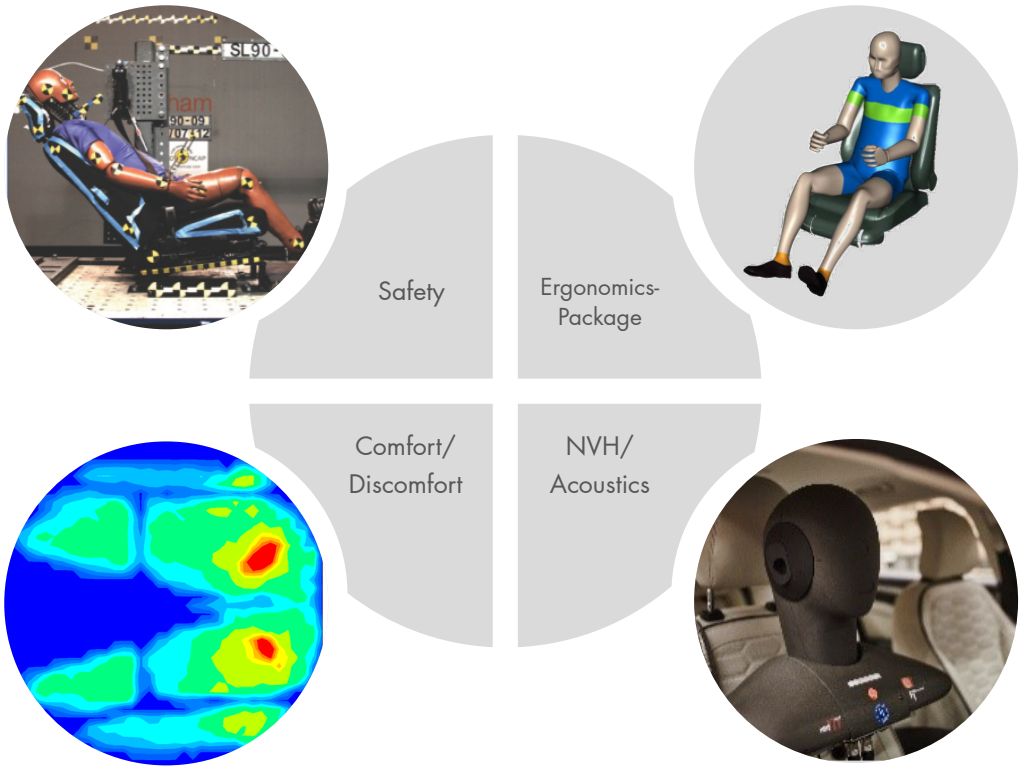
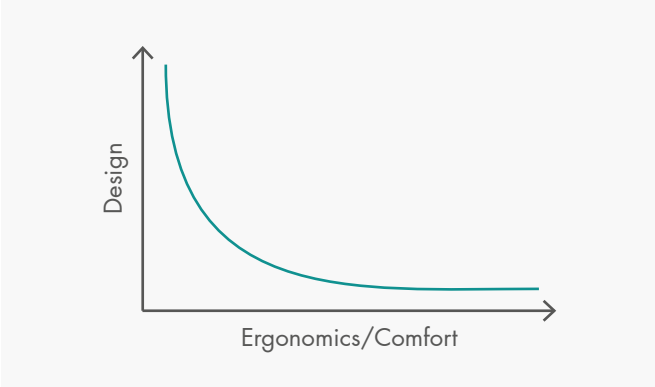


Figure 1: Decisive target variables for the design of a seat in a vehicle

Figure 2: Comfort model based on Zhang[1]

Depending on the design specification, the individual variables are weighted, safety, of course, is always given the highest priority. Trade-offs can certainly arise between other variables, as exemplified by Zhang's model[1] for the topics of design and comfort.



„A sports car is focused on design, which may mean that less weight is given to comfort and ergonomics may be given less weight."

Heiner Bubb, until 2009 Professor of Ergonomics at the TU Munich and a leading expert in vehicle development.

If one takes into account the new design possibilities as well as the changing requirements of the occupants, many questions arise that will greatly change the development process and the target:

- What should vehicle seating look like in the future?
- What are the expectations of the occupants?
- What functions will the interior have to fulfill in the future?

[1] Luian Zhang, Martin G. Helander and Colin G. Drury: Identifying Factors of Comfort and Discomfort in Sitting, in: Human Factors: The Journal of the Human Factors and Ergonomics Society, 1996 38: 377

At present, there is still no clear picture of the future interior. Of course, there are various concepts from OEMs, tier 1 suppliers and independent institutes.

Most of them use the additional free space to increase occupant comfort while retaining the original structure. Other approaches focus more on changing the function. In this case, the interior assumes the function of a possible workplace or a space for interpersonal communication.

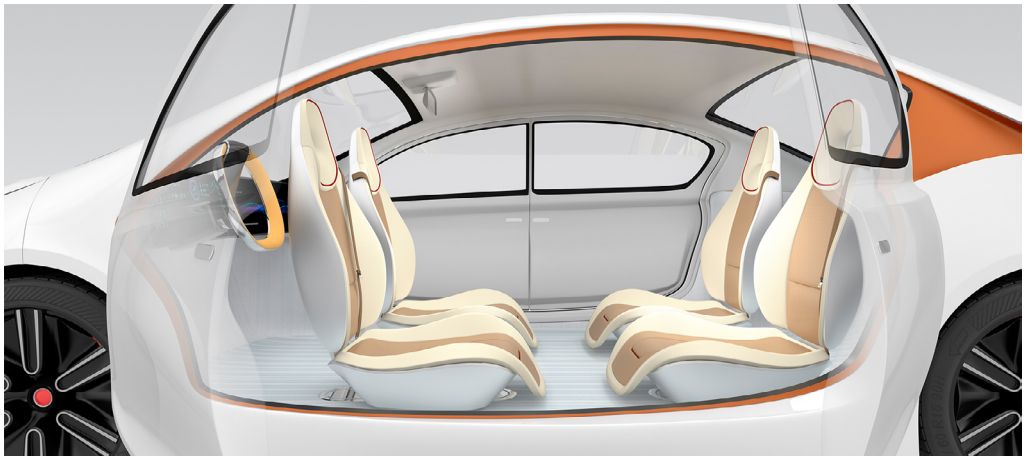


Figure 3: Fictitious example of novel interior concepts, source: iStock

Digitization – Developing Seats More Efficiently

One possible answer to future challenges is the end-to-end digitization of development processes. Automotive OEMs are already fully under way to digitize their development processes, but in our experience the area of seat development is still lagging behind. Here, too, many cost benefits could be realized by combining purely virtual designs with digital seat comfort data. and can thus be reliably evaluated from pre-development to the final tool release.

But what possibilities do current tools offer for investigating the topic of seating in the future using digital approaches, and what aspects need to be taken into account? If we look at current processes during development, then a breakdown into the following areas is possible:

- Design: product design with regard to visual appearance
- Safety: design of the seat structure and safety features, e.g. in accordance with legal requirements
- Ergonomics: Adaptation of seat and possible settings to vehicle interior
- Comfort: design of structure and upholstery for comfortable static and dynamic seating
- Acoustics: design of interior and materials to optimize sound impact

Currently, these issues are largely considered separately, even though they all simultaneously influence the occupants' subjective feelings. The individual departments must exchange and coordinate information. In addition, there can also be problems with communication, since not everyone uses the same technical jargon. The central element for all considerations is the occupant. In the safety area, for example, the impact of a collision is analyzed by using dummies such as the Hybrid III family. In contrast, the evaluation of static and dynamic comfort is usually carried out with test subjects to enable subjective assessments.

In addition to these examples of experimental studies, there are also corresponding counterparts from the virtual world. The basis of these methods are models of the human body. The best-known models are THUMS (Crash, www.tuc-project.org), RAMSIS (Ergonomics, human-solutions.com), CASIMIR (Comfort, www.woelfel.de) and AnyBody (In- & Egress, www.anybodytech.com).

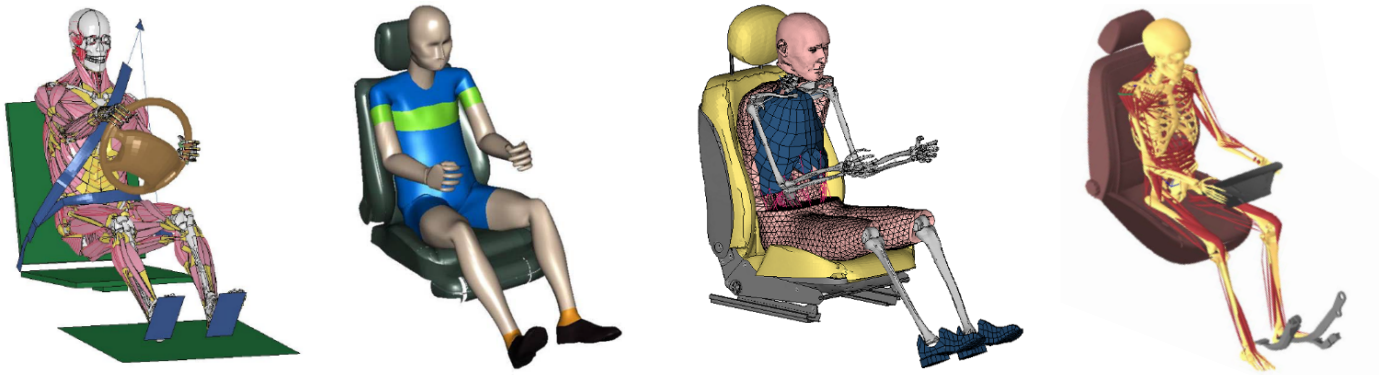


Figure 5: Numerical human models that help with end-to-end digitized seat development: THUMS, RAMSIS, CASIMIR and AnyBody.

In order to minimize the computational effort, the models are adapted in their level of detail and in their numerical structure to the subsequent application. For the crash and comfort analyses, finite element models are normally used, which can also include details such as internal organs or the lumbar spine. can be included. In the field of ergonomics, on the other hand, only models based on geometries are used.

Mechanical properties are usually not considered here. Due to the use of digital human models, the individual disciplines can interact with each other via appropriate interfaces and exchange information.

The first steps in this direction have already been implemented in the UDASim research project, which was funded by the German Federal Ministry of Education and Research (BMBF) and led by Wölfel, with an interface for anthropometry, posture and position.

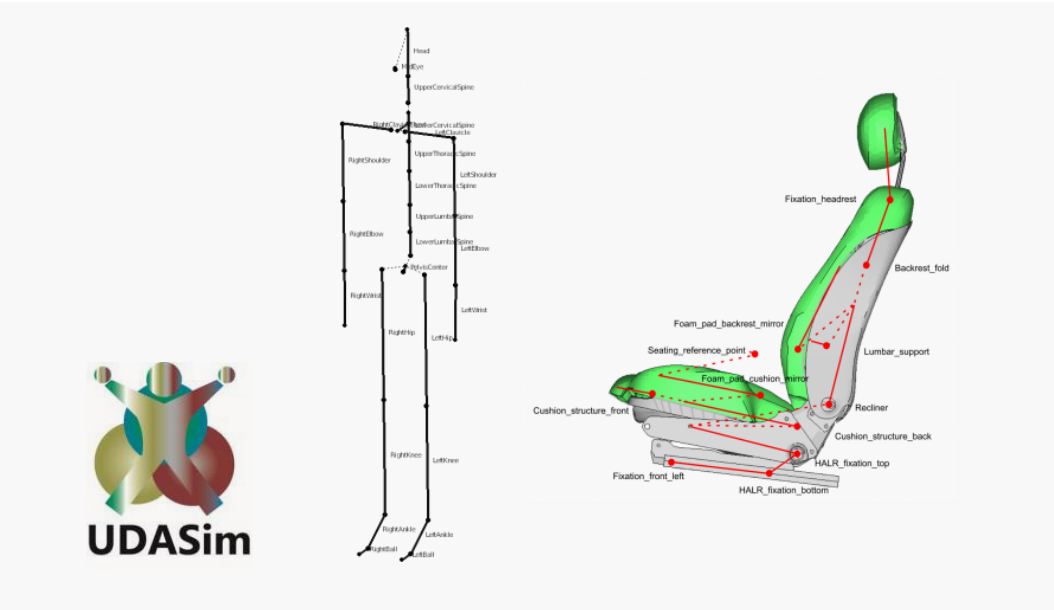


Fig. 6: Standardized model for human posture and anthropometry as well as seat adjustment, source: Wölfel

By means of a standardized text file, information can now be transferred directly between RAMSIS, CASIMIR and AnyBody. Communication between the individual departments is thus simplified, accelerated and less error-prone. Development times can thus be significantly shortened thanks to an interactive and parallel approach to development. In addition, all aspects that ultimately influence the interaction between occupant and vehicle are considered in one process. Separate consideration of individual variables such as crash and comfort is no longer necessary. Augmented or virtual reality can also be used in the development of a completely new interior.

Customizing – Individualization of Products

So-called „customizing" will be an important alternative to standardized products in the future, as new manufacturing processes such as additive manufacturing make it possible to create individual solution.

According to a survey by supplier Adient published at the IAA 2015, up to 30 percent of all new car buyers in Germany plan to use customization services to personalize their vehicle. This trend is likely to have intensified in recent years, as customizing has now reached the end customer in many product fields.

Manufacturers have accordingly recognized this development as a potential growth market. At the IAA 2015, Adient had already presented an inkjet printing process for seat covers that can produce „batch size 1" as well as in series. The creation of individual seat covers should thus be possible without significant additional costs.

Figure 9: Exemplary lattice structure, source: OECHSLER AG

In the meantime, however, customizing extends beyond visual effects. New, 3D-printed materials – so-called lattice structures – enable new design degrees of freedom in material properties. Compared to classic PU foams, they can be used to create completely individualized seats or seating experiences. A company that has extensive competence and know-how in the design of these lattice structures is the automotive supplier OECHSLER AG from Ansbach, Germany. In order to resiliently test novel concepts and materials before they reach the prototype stage and to make the process more efficient, OECHSLER has used the CASIMIR/Automotive software developed by Wölfel.

In CASIMIR/Automotive, additively manufactured structures and their material parameters can be mapped, simulations of seating comfort can be carried out, and reliable results can be obtained without even having to write a workshop order for a prototype. This also eliminates the need for subjective and lengthy tests with test persons.

Specifically, the project involved comparing different materials for seat cushions:

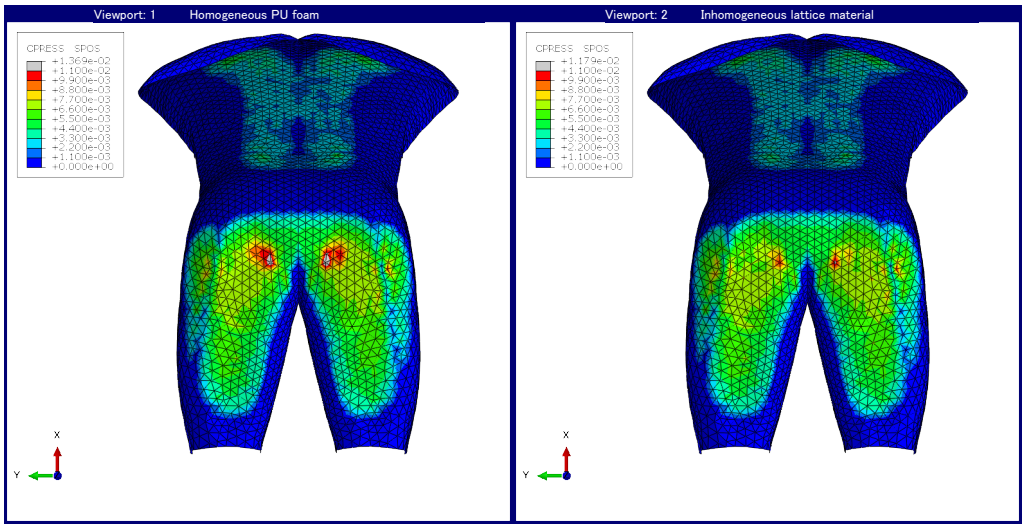


Figure 10: Example comparison of seat pressure distribution of a seat cushion made of PU foam (left) and inhomogeneous lattice structure (right) for occupied seat with m50 human model, source: Wölfel.

The study showed that for the different percentiles, the seat with inhomogeneous lattice material has a more even pressure distribution, resulting in lower load peaks at the ischial tuberosities and a more comfortable seating experience.

In addition, the engineers found in the test that by specifically adjusting the material parameters, the overall height of the seat cushion can be significantly reduced and thus the amount of material used is much smaller compared to classic foams.

OECHSLER is thus helping its customers to gradually achieve the lightweight design goals of future vehicle generations – while at the same time improving individual seat comfort.

Abstract

Autonomous driving and e-drives will change mobility very significantly. In the process, interiors and the functions integrated in them will have to be completely redeveloped. Manufacturers of innovative and creative solutions that offer customers an individual environment for work and lifestyle will gain a competitive advantage. In order to play through different variants and potential, digitization of other areas of automotive development is essential. Only the use of virtual methods makes it possible to map the growing number of variants in less time and at lower cost.

Currently, an evaluation of crash consequences, comfort and ergonomics is already possible using digital approaches such as CAE and CAD. But the decisive factor for comprehensive interior and seat development is the inclusion of all these influencing factors along the entire development chain, without isolated data silos and processes impeding a holistic evaluation – after all, the end customer does not have a selective perception when using the vehicle either.

With its CASIMIR/Automotive software solution, Wölfel offers a building block for this digital process and already has interfaces to the field of ergonomics (RAMSIS and Anybody). Currently, the integration into existing workflows of customers is taking place. Further interfaces, such as those for vehicle dynamics (Ride) or acoustics, will follow in the future in order to achieve the goal of an end-to-end digital process chain for the development of tomorrow's mobility.

Your contact at Wölfel

Let's talk about digitized and individualized seat development. I look forward to hearing from you.

Dr.-Ing. Georg Enß
+49 40 524715-262
enss@woelfel.de

What moves Wölfel?

Vibrations, structural mechanics and acoustics – this is the Wölfel world. Here we are experts, this world is our home. More than 120 employees daily do their best for complete satisfaction of our customers. For more than four decades we support our customers with engineering services and products for the analysis, prognosis and solution of tasks in the fields of vibrations and noise.

Are vibrations really everywhere? Yes! That's why we need a wide variety of solutions!
Whether it is engineering services, products or software – there is a specific Wölfel solution to every vibration or noise problem, for example

- simulation-based seismic design of plants and power stations
- measurement of acoustic emissions of wind turbines
- universal measuring systems for sound and vibrations
- expert reports on noise immission control and air pollution forecasts
- dynamic occupant simulations for the automotive and aviation industry
- and many other industry-specific Wölfel solutions …

Wölfel-Group
Max-Planck-Straße 15 / 97204 Höchberg
Phone: +49 931 49708 0 / Fax: +49 931 49708 150
info@woelfel.de / **www.woelfel.de**

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