

PROJECT PURE - THE FREEDOM TO MOVE

Automotive Interior Equipment of the Future 2035

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Abstract In 2018, GRAMMER launched the “PURE” project in order to research and address major megatrends such as autonomous driving, connectivity and digitalization. Working together with an internationally renowned automotive design studio in this project, Strategic Product Planning at GRAMMER is developing the products of the future respecting current and future use cases. Out of these, the “PURE” project mainly concentrates on the core aspects of comfort, ergonomics and safety. Factors such as new spatial awareness through the freedom to move, the avoidance of motion sickness, the modularity of interior components, sustainable materials, new functions and the mobile workplace are being explored in detail to prepare for the interior of the future in 2035. The findings from these investigations, coupled with existing knowledge, are being combined in the “PURE” project to create a unique user experience for people ‘on the move’. What is certain is that the interior of the future will be vastly different. The market and also OEM customers will be placing high demands on vehicle industry regarding interior functionality, mechatronics and sustainable materials. GRAMMER wants to be fully prepared to address the requirements of future interiors. The findings from the PURE project are applicable across all GRAMMER divisions, as new developments in autonomous driving are not confined to the automotive sector, but increasingly appearing in commercial vehicles as well.

Keywords Freedom to move, avoidance of motion sickness, new spatial awareness, PURE, perceived quality

1 Introduction: Future mobility will change the way we think *Car*

It is without no doubt that today, although we see an ever growing amount of people mover concepts being presented by the transportation value chain (mainly based on new component system architecture), we observe the start of a new dawn regarding drissenger*¹ comfort as part of a total mobility ecosystem. *The way we think car* will change into the freedom to move and the perceived quality of comfort when *not* driving. The ingredients, however, that make up this new recipe of comfort need to come all together in a holistic comfort experience that makes a real difference. For this, the project called “PURE” was initiated at Grammer AG. GRAMMER is developing a concept for catering to future mobility together with an internationally renowned automotive design studio, mainly concentrating on the core aspects of comfort, ergonomics and safety. In the end, this may take the

¹ Driver/passenger

form of a physical show car, similar to the “Vision in Design” VIP program developed by the Technical University of Delft or the BMW Group’s “Fix-Stern” program. Its target is to design a compelling mix of comfort features that will lift the mobile community to a next level. Referring to perceived quality and the definition of comfort below, several factors will be combined: the freedom to move in the seating area, visual spatial awareness of the interior lay-out with the help of ambient lighting and last but not least proprioception control and advanced acclimatization for avoidance of motion sickness

1.1 Perceived Quality

The product development process of the “PURE” project follows the usual GRAMMER AG development process, which has defined “perceived quality” as its guiding theme. This refers to the fact that products are developed and optimized on the foundation of understanding their users and the range of use cases, from which design requirements are deducted. The definition of perceived quality is “a positive user interaction with the product in all relevant use cases”. A diversification of the activities in vehicles is expected for drissengers in manual and autonomous driving modes. These current and future use cases have formed the basis for the “PURE” concept.

Perceived Quality: a positive user interaction with the product in all relevant use cases



DESIGN	ERGONOMICS	USABILITY
<p>Creates and refines product design concerning styling, visual comfort and design for usability.</p> 	<p>Develops perceived quality methods, handles complete scope of comfort testing and validation.</p> 	<p>Collects user information for product development. Configures products to current and future use cases.</p> 

Fig. 1 Guiding Theme Perceived Quality

For achieving perceived quality, the areas design, ergonomics and usability contribute and cooperate. The Design department creates and refines product design concerning styling, visual comfort, and design for use. Ergonomics handles perceived quality methods development and the complete scope of comfort related testing. Application comfort refers to the configuration of the product to the specific use case(s), for which usability delivers the applicable user information. Targets of the product development process concerning perceived quality are to provide a positive product interaction in all details, user comfort and to minimize drissenger stress and strain by good product design.

1.2 Comfort Definition

When humans interact with a product, they perceive it through sensory information by several channels simultaneously. Experiencing comfort in this interaction is the result of internal human computing of this sensory input into a holistic impression in a fluid process over interaction time. Comfort will be experienced only if all aspects of the product are able to achieve a good level. Human beings compute this holistic interaction rating with little conscious effort, and generally with low awareness for its components. However, if one aspect comes to the attention of the user and becomes prevalent within the overall impression, it will dominate the comfort rating. This can occur in either direction: The negative occurrence has been named “limiting comfort factor”, entailing that the holistic comfort experience cannot be better than its weakest aspect. The positive occurrence can be referred to as the “wow-factor” of a product, exceeding the expectation of the user. Thus, experiencing comfort encompasses all human senses and can be defined as “an overall positive user interaction experience with a product”.(1) The “PURE” project respects the holistic interaction by working on optimizing visual, haptic and postural comfort to achieve an overall positive user experience in the context of automated driving.

2 PURE Expectations

Designing the visual, haptic and postural aspects of interacting involves thinking about visual details and coherence, haptic experience for the different elements and the orientation of users in space when entering “PURE” car interior of the future.

2.1 Spatial awareness

First of all we have to place the human into the right spot in the interior (mostly built up as a rectangular cubical space). Figure 2 shows a four-seat set-up and figure 3 shows a two-seat set-up along the interior diagonal.(2)

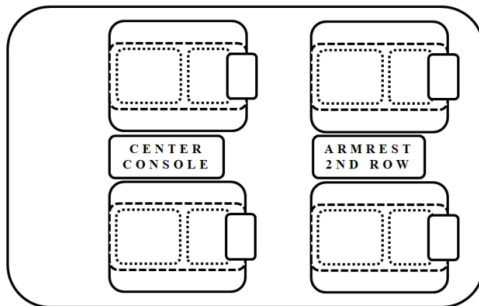


Fig. 2 Normal cockpit lay-out autonomous driving

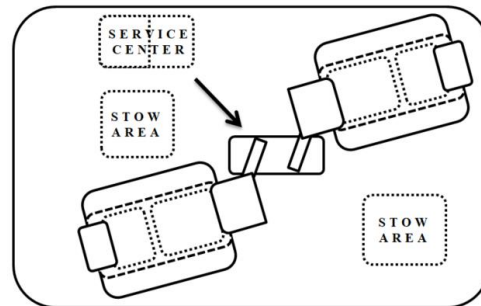


Fig. 3 PURE patent pending cockpit lay-out autonomous driving

To ensure total spatial awareness it is of highest importance to place people in the corner space envelope to support their cognitive ability for best grasping the interior physical appearance. In comparison to Fig 2, where front row passengers only perceive the interior partly because of forward viewing⁽⁸⁾, and second row passengers only have a limited view on the interior because of front seats blocking their view, in Fig 3 a passenger has the cognitive ability to visually comprehend the interior space set out by its geometrical boundaries and the open space in the middle. Spatial perception today is defined as the ability to perceive spatial relationships in respect to the orientation of one's body despite distracting information⁽³⁾. This is in itself the basic condition to fulfil spatial enjoyment and to counteract motion sickness.

The colour scheme of the interior was designed to give an impression of safety and lead the view to key elements by working with light and dark colour-coordinated tones. Haptic properties support the functionality of the elements, soft for body supportive zones, sleek for panelling, and sturdy for storage.

2.2 Freedom to move

In order to ensure healthy dynamic sitting posture modelling⁽⁴⁾ in car seating for all PURE use case scenarios *at all times*, GRAMMER AG has looked at its off-road product portfolio and will re-use the concept of turnable-moveable seat backrests, active multiaxial suspensions and seat pivot modules. Converging these seat components into a unified mechatronic system architecture will enable the freedom to move-rotate upper body torso whilst remaining in close contact with the backrest cushion, even buckled up in an ABTS² configuration. Together with a central seat pivot point the drissenger is able to turn the seat and the backrest to ensure a comfortable turning scenario. It also allows for more freedom to move your body even when a suspended seat is in zero gravity position. The seating system (seat +active suspension) will no longer be a fixed piece of interior furniture, but will evolve towards a dynamic skeleton-like extended body support. One geometrical condition: the roof line has to be high enough to enable seat positions for all use case scenarios.

2.3 Motion sickness and how to reduce it

The symptoms of motion sickness appear when the central nervous system receives conflicting messages from the sensory systems: the inner ear, eyes, skin pressure receptors and the muscle and joint sensory receptors report conflicting information. Roughly one-third of the population is highly susceptible to motion sickness, and most of the rest may get motion sickness under extreme conditions. Travelling in cities with tight curve radii in automated conditions and fixating something other than the street counts as an extreme condition. Studies also indicate that women are more likely to be affected than men⁽⁵⁾. There is some evidence that people with Asian ancestry may suffer motion sickness more frequently compared with people of European ancestry⁽⁶⁾. Last but not least low frequency (<0,4 Hz) high amplitude vibrations cause more motion sickness than frequencies > 1 Hz⁽⁷⁾. This last argument was the one of the motives to start the PURE project.

² “All belts to seats“

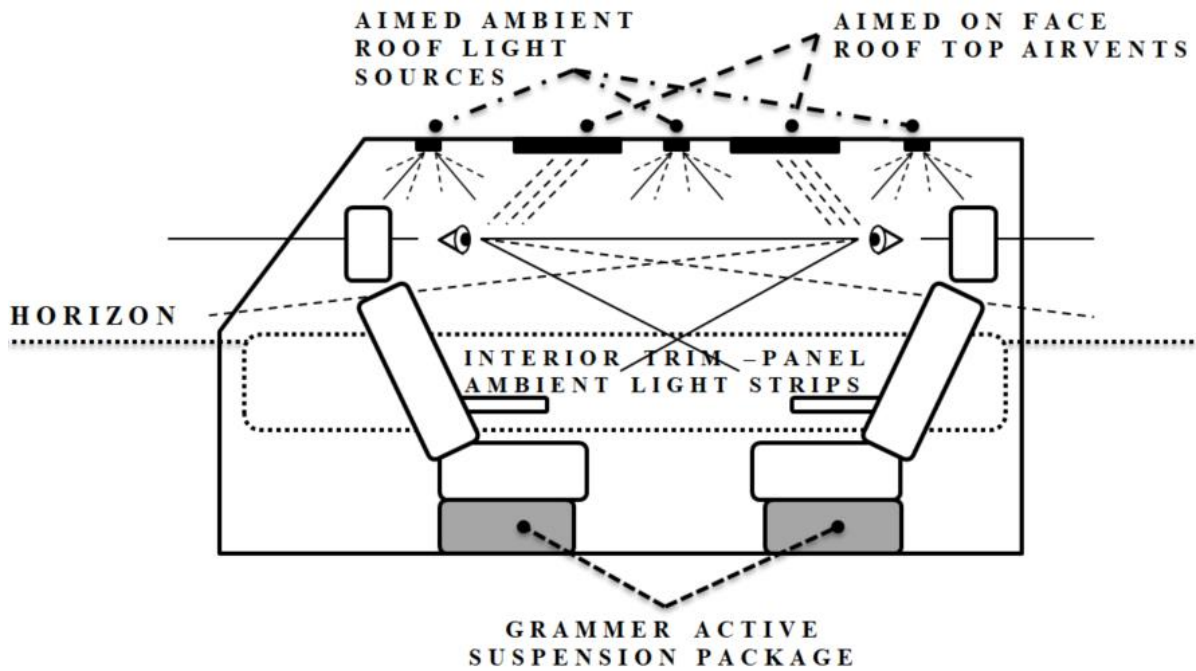


Fig. 4 PURE patent pending cockpit lay-out for reducing motion sickness

Reduction of motion sickness, whilst driving, should address the following topics:

- **Reduced head dynamics through seats with active suspension**
 With multi-axial active suspension under the seat pan most high frequency vibrations are cut off and very low frequencies with high amplitude are dampened. Lateral G-forces (when changing lanes-driving off the highway) are counteracted with horizontal suspension actuators serving to keep the passenger head as still as possible whilst the sagittal body plane might tilt some degrees. Also people not suffering from motion sickness will benefit from active seating due to the fact that their bodies are isolated from the vehicle movement. Even in zero gravity seat positioning, active suspension will reduce further head dynamics
- **Individual Vibration threshold control of the active suspension module**
 Every individual experiences vibration spikes from the surrounding environment in a different way. By enabling control over the threshold of 'incoming' vibration we achieve two goals: one is an effective configuration that suits the passenger proprioception level best and the second is that subjective control over environmental parameters affecting their own body comfort has a positive effect and improves their mental state.
- **Active individual acclimatization**
 Increased air flow on the face of the passenger can help to reduce motion sickness
- **Ambient lighting**
 The goal is twofold: coloured light strips should indicate change of motion (de-acceleration) and coloured aimed ambient lighting should positively influence passengers' mental state⁽⁹⁾.

The unique combination of spatial awareness, individual vibration control of the active suspension, active suspended seating to minimize head dynamics, increased air ventilation, coloured led light strips pre-indicating movement and aimed ambient lighting working on your mood make up the complete counter action to reduce motion sickness in such a way that automated travelling can be experienced without nausea.

3 PURE Learnings

From the range of research at Grammer AG concerning comfort, ergonomics and safety, aspects of visual and haptic comfort as well as spinal health and load reduction for drissengers, and comprehensive understanding of the human product system interaction were applied in the “PURE” project. Its target is to bring together the findings from commercial vehicle applications and the current expectations in automotive contexts to generate a future-proof concept ensuring perceived quality, comfort and the freedom to move in automated driving contexts.

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