SÅNÄTT

AR TRIGGER

SÅNÄTT

HEAVYWEIGHT IDEAS. LIGHTWEIGHT SOLUTIONS.

“Coming together is a beginning; keeping together is progress; working together is success.”

-HENRY FORD-

SÅNÄTT

HEAVYWEIGHT IDEAS.

EDITOR - MEGAN TYNAN-O'MAHONY

LIGHTWEIGHT SOLUTIONS.

FFI

FORDONSSTRATEGISK FORSKNING OCH INNOVATION

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SÅNÄTT

"...developing a mutually beneficial way of working with suppliers..."

SÅNÄTT is a collaborative project driven by the common goal of strengthening the competitiveness of the Swedish automotive industry through lightweight innovation. Academics, automotive suppliers and one vehicle manufacturer collaborated in the research and development of design concepts aimed to cost effectively reduce the weight of a classic family saloon by 20-40%.

Having just become independent from the GM group, SAAB initiated the project in 2010 in pursuit of a new product development method. This method was to fulfil the industry's need to include suppliers from the early stages of design and benefit from collaborative innovation and strategic knowledge.

Recognising the potential in the project, FKG (Scandinavian Automotive Supplier Association) and Innovatum, a government sponsored organization aimed to bridge industries and academia; saw an opportunity to support SAAB while simultaneously improving the climate of the Swedish automotive industry. This intention to promote the industry as a whole was reinforced when Volvo Car Group assumed the OEM role in the project.

While the aim of the initiative was to develop lightweight solutions, which would comply with recent changes in legislation that demand severe lowering of emissions, SÅNÄTT also targeted the organisational framework within which the industry develops automobiles today.

Typically, product development is done via a tier structure with most of the initial and crucial work being carried out by the OEM, while their suppliers are brought into the picture much later on, thereby hindering potential optimisations or implementations of innovations. With this project the aim was to have all parties involved from Day 1.
Furthermore, SÅNÄTT targeted the collaborative aspect of the process to enhance the Swedish automotive industry and set the foundations for future cooperative business ventures.
Two advisory groups were established to guide six teams who were each focusing on specific system areas within current automotive architecture. The first group, known internally as AT1, took on the project management role of the project, ensuring that the collaboration ran both efficiently and dynamically. The second group (AT3) supported the teams from a technical perspective, keeping the collaborations in line with complete-vehicle development requirements, which ranged from future manufacturing techniques and material innovation to NVH (noise, vibration and harshness reduction). These six system areas were: Seats, Chassis, Underbody, Cockpit, Roof and Doors.

The project had a unique toolbox of development methodologies that included Concept Generation, Value Assessment, Systematic Design, Idea to Innovation, Making Business Together and Group Dynamics. These modules were facilitated and coached by a number of academic partners who ensured that the process driven collaboration achieved credible innovative results.

"Concept Generation" conducted by Dr. Lars Almefelt, Chalmers University of Technology, was comprised of two steps. The first consisted of understanding and utilising the competence and expertise of each participant to develop a matrix of creative ideas. For the second step, the teams were asked to combine ideas to lightweight concepts for three different levels:

- Level one was 'realistic', this concept could be developed today if the prerequisites were in place
- Level two was 'near future', this concept needed research and development but was still possible.
- Level three was 'futuristic level' this concept was far beyond the capabilities and expertise of the present day automotive industry.

"Value-based Design" was directed by Professor Tobias Larsson from Blekinge Institute of Technology. During this phase, the participants were to consider the value of every concept from different perspectives, such as the driver or the dealer, rather than simply from an engineering point of view. These ideas were then gathered and the project management team proposed a structure for the teams to work on during the next phase of the project.

"Systematic Design" was run by Dr. Anders Claesson from Chalmers University of Technology. This was the actual design phase of the project. Anders had the teams work by the principles of Systems Engineering along with the process of "Slow Development", which involves evaluating, refining, iterating, reflecting and maturing their designs. This aspect of the project was coordinated by AT3, who supported the overall interaction between the teams.

The "Idea to Innovation" stage of the project was run by Prof. Tobias Larsson and PhD candidate Massimo Panarotto, from Blekinge Institute of Technology. It was comprised of a number of workshops focusing on value driven design, which were aimed at giving the teams the necessary tools to distinguish innovation from novelty within their concepts and therefore understanding their true value.

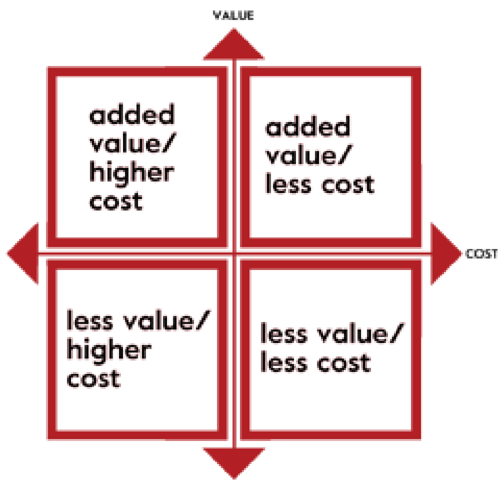
"...emphasis on creating a work culture based on trust and structure."

"Making Business Together" was led by Prof. Magnus Klofsten, from the University of Linköping. This phase continued the refining process achieved within 'Idea to Innovation' and further developed the teams' concepts into viable commercial solutions for the industry, finalising the transition from idea to business case.

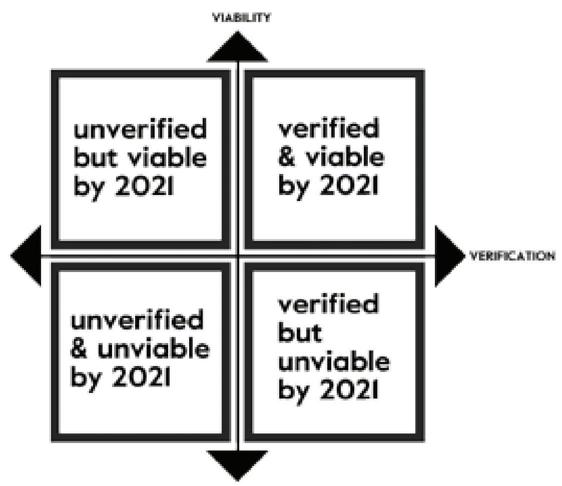
Possibly the most defining approach was that of "Group Dynamics" which was conducted by Anni Tysk, a social psychologist from the University of Skövde. Anni followed the teams, assessing the group dynamic and identifying their strengths and weaknesses. She emphasised the importance of creating a work culture based on trust and implementing a structure that supported the teams to fully understand the importance of cooperation.

The impact 'Group Dynamics' had on the team's performance was a result of the strategic decision of involving Anni in the project. Aside from the technical aspects of vehicle development, her work ensured the quality of the collaboration from a work culture perspective and has set SÅNÄTT apart from other research projects, creating a legacy of its own.

COST/VALUE MATRIX



TRUST MATRIX



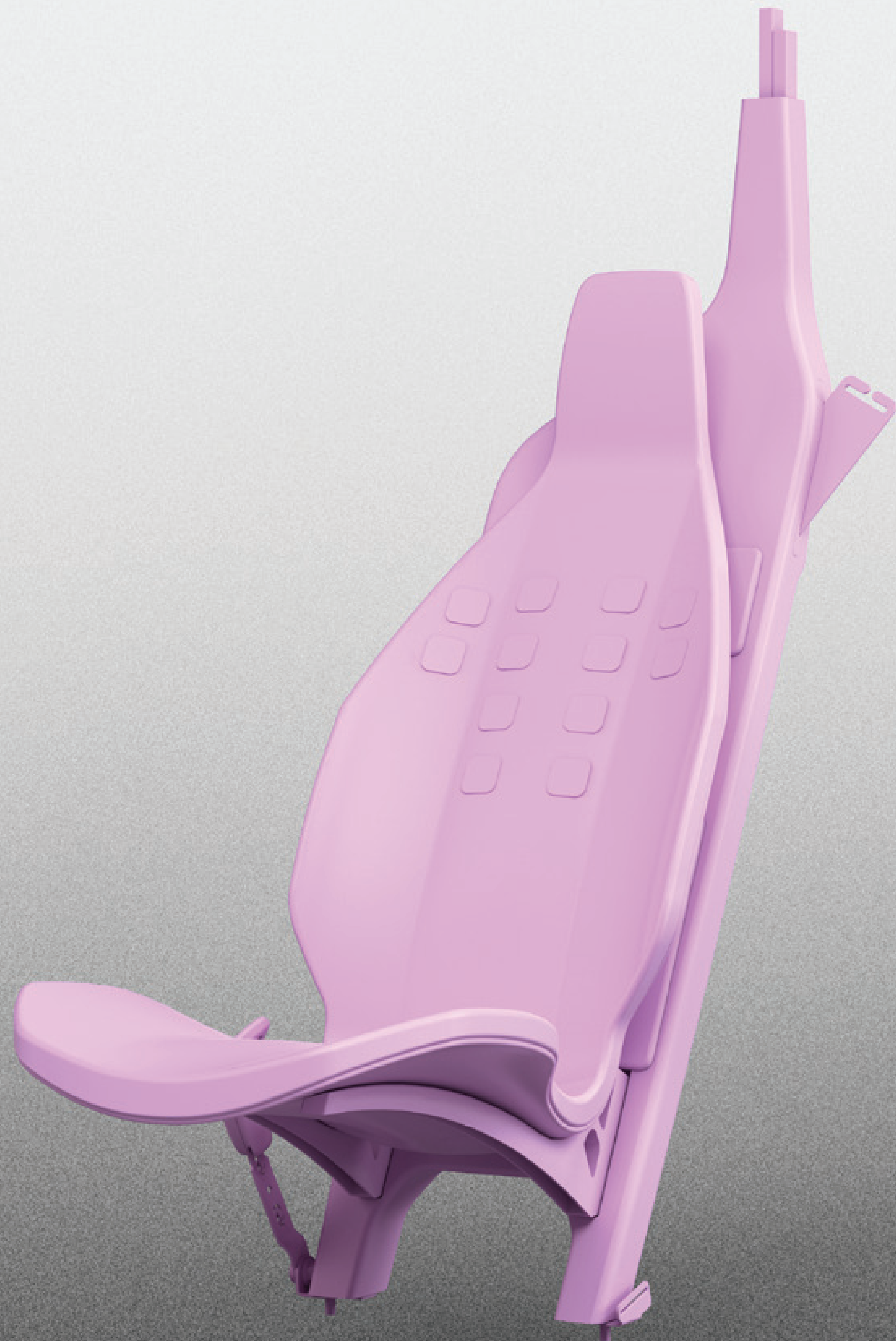
A keen effort was made to create a balanced workplace that was not only process driven but which also kept the teams working outside of their comfort zones. The conscious decision to stay away from conventional design techniques allowed the participants to question not only established requirements but also the choice of design solutions typically used in the automotive industry.
The concept of value driven design and the concern with credibility pushed them to investigate lighter, cost-efficient solutions that are lean-manufacturing focused. Another aspect that became essential in each of the team's successes was the concept of integrated functions, which is a clear result of early collaboration.

In order to assess the concepts credibility in terms of feasibility, at a set time period, and the level of verification Fredrik Svensson, Volvo Car Group, developed "the Trust matrix", which all teams used to judge the concepts developed.
Volvo Car Group also created a Cost Matrix, analyzing the economic value and the customer value, in terms of functionality. The economic value is measured in production cost by 2020+.

"SÅNÄTT has revolutionized the way we will work in the future."

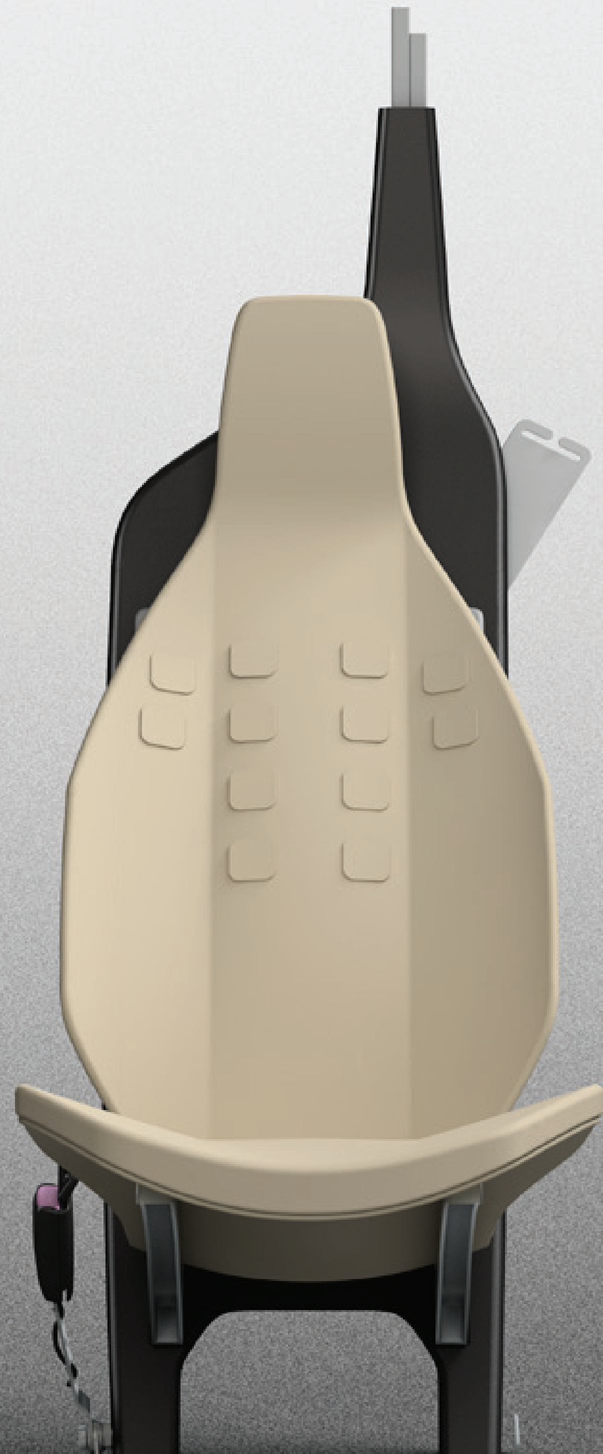
The journey of SÅNÄTT has provided a valuable insight into the way research projects can be run within the automotive industry. Important networks have been forged over the duration of the project resulting in spin-off projects, patented concepts, future research areas and new business deals. Having redefined the standards of industrial collaboration, SÅNÄTT laid out an environment where its participants - all of whom are experienced and successful in their respective fields – have learnt to create, trust, contribute and mentor. In their own words: "SÅNÄTT has revolutionized the way we will work in the future."

SEAT



The seat is the users post for the entirety of their journey, be that a cross-country trip or a local errand. Either way, comfort is key. The seat must also be safe enough for all passengers to be protected in the event of an accident. Thus, this new design should reflect the particular attention, which is placed on the safety of the head and upper-body.

One reason that seat structures tend to be heavy is because their one-point structure requires strong fastening. However, if the weight were to be distributed into multiple fixed joints then that could provide the same protection. Following from that, if it could be predicted where the passengers heads would be positioned at all times then improved safety measures could be taken.
It was from this aspect of safety consciousness that the team began to explore what was to become the new design and the basis of the 'fixed-eye position'. This concept pertains that regardless of the passengers size or weight, their head should always come to the the same position, thereby allowing for more accurate safety measures for all of the passengers', but also more localised determining of the drivers interaction with their driving environment.



The innovative solution proposed for this was a seat fixed to a vertical structure that would adapt to each driver's height and weight. The vertical structure is attached to larger-lightweight frame that gives support to the entire car structure. The frame distributes the weight via multiple connection points to the body structure thereby enabling a lightweight seat framework.

It is also important that the seat be comfortable. The team collaborated in designing a seat that moulds to the pressure being applied by the occupant's body, ensuring maximum comfort. The idea of bringing the heating/cooling system closer to the driver also engaged the team's attention and innovative talents. By utilising conductive fabric that heats when in contact with the passenger's body, along with air evacuation that moves around the seat profile, this vision was actualized. Not only do these new concepts aid ergonomics within the car, they also reduce the conventional fuel demand to power these functions.

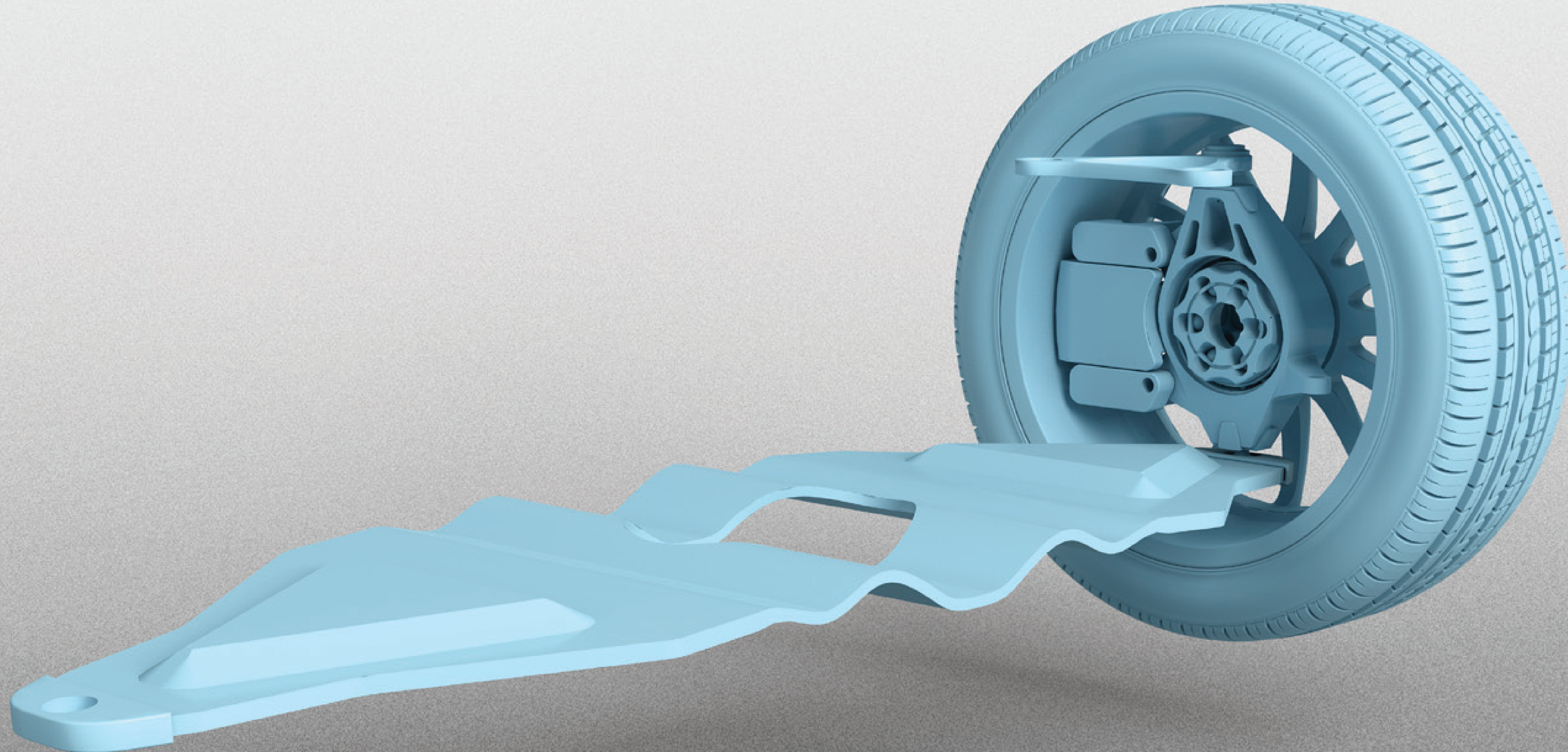
In addition to the comfort element, the new lightweight seat frame makes for a more cost-effective seat structure when compared to a traditional seat. The concept used in the front is the same as that used in the rear, which means less development and manufacturing cost. It also means that less material is being used overall.

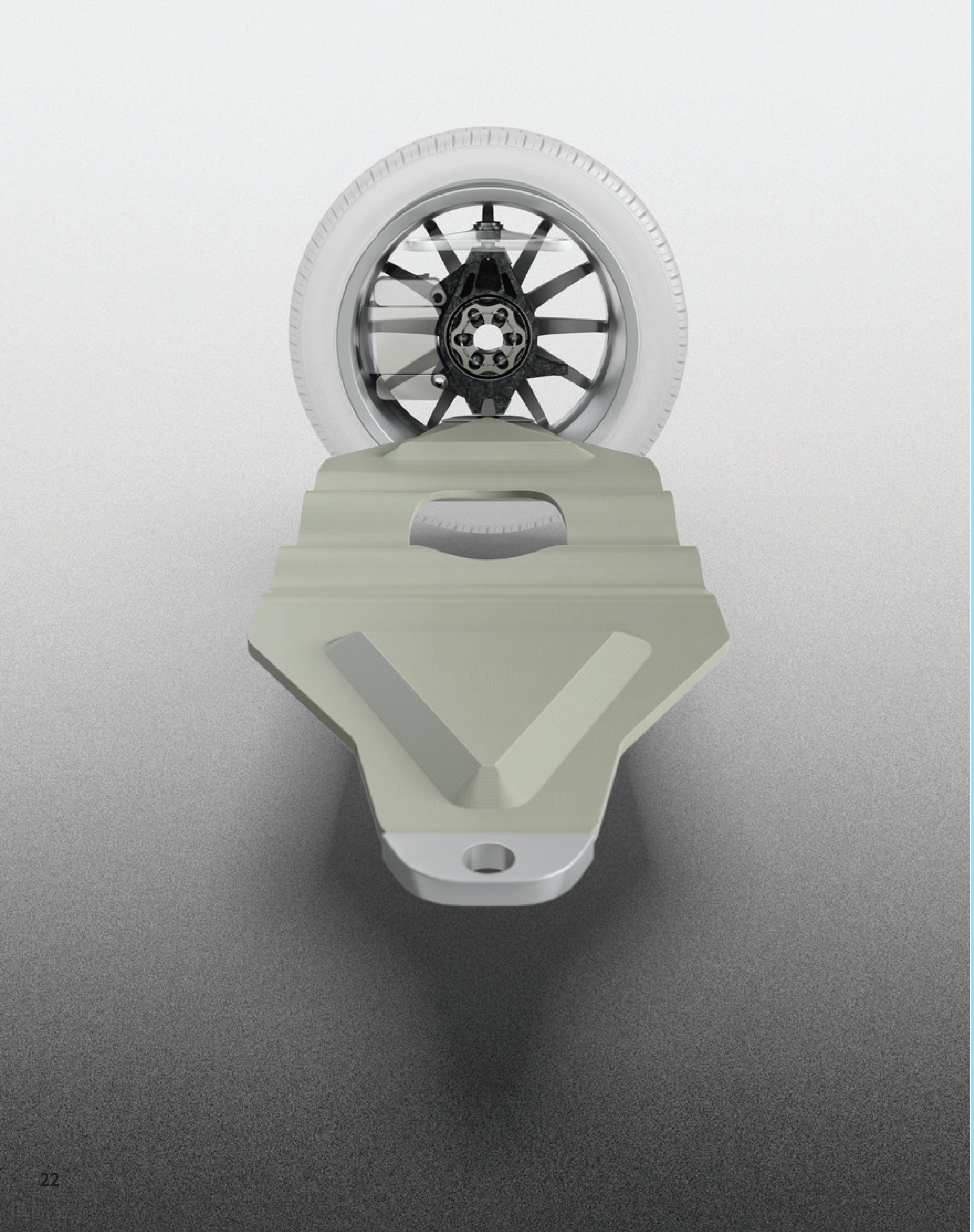
When analysed in the Cost Matrix, the new design has a higher value, with a higher cost. The multiple improvements such as the enhanced safety features amounts to the concept having more value that its reference. However, because of the material used and the innovative nature of the structure assemblage it is relatively costly to produce.

In terms of the Credibility Matrix, the availability of materials and the safety features mean that the seat structure is not yet verified, but is estimated to be industrially feasible by 2020+.

Result: an estimated 45% reduction in the weight of the seat structure.

CHASSIS

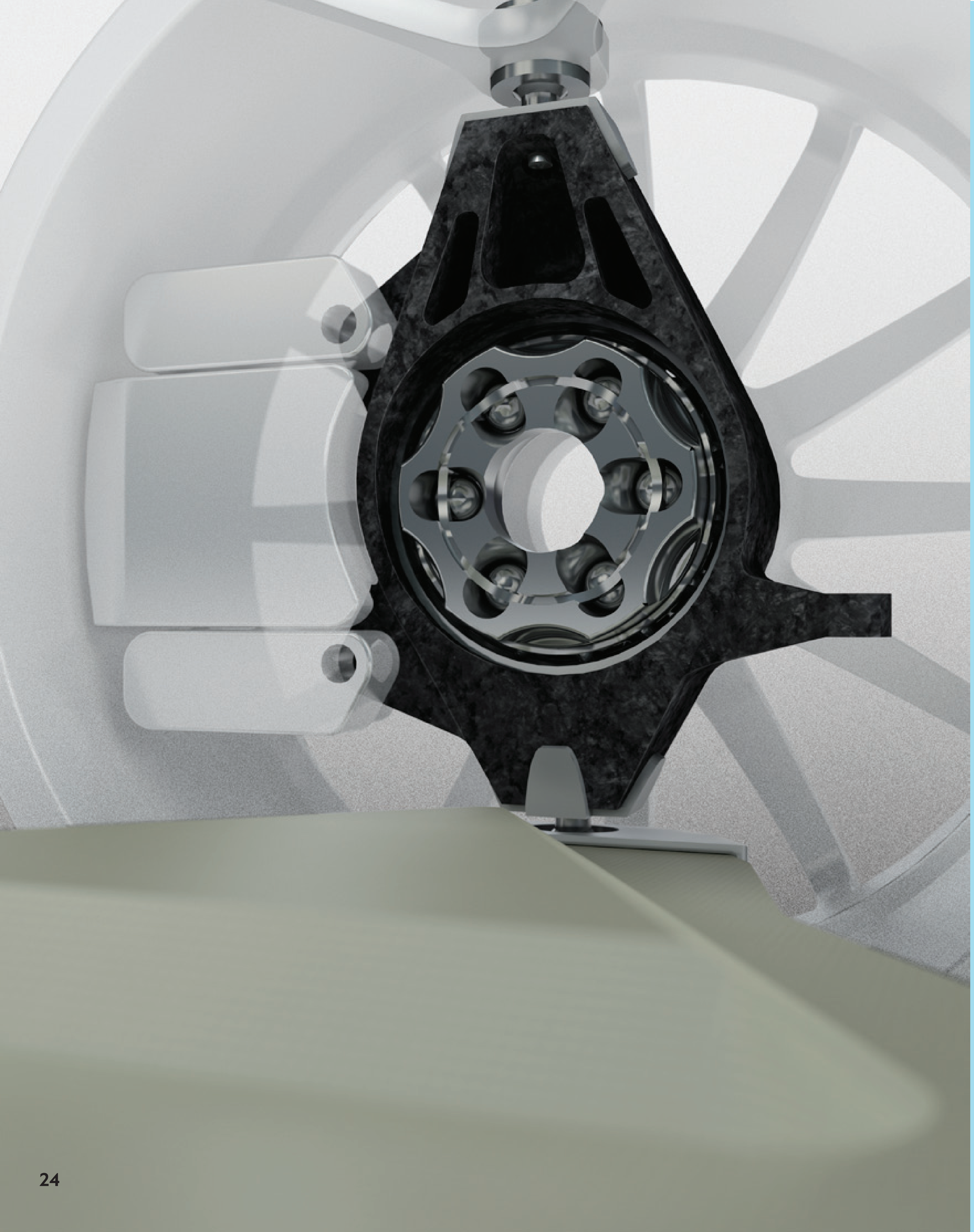




The chassis structure is in essence a frame upon which many individual components are attached. The redesigning of such a structure lead towards the investigation of how to integrate as many of these separate components as possible.

The challenge for the chassis team lay not only in redesigning a chassis system that was multi-functional, but also one that fulfilled the high demands on dynamics (handling and steering), ride comfort and NVH (noise vibration and harshness) performance and its design has a determining impact on the safety of the vehicle. In addition to these, the new system must also be cost efficient not only in terms of the material used, but also in terms of manufacturing and assembly.

This mindset was applied in the reconstruction of the front axle. The design resulted in integral components such as the transversal leaf spring arrangement that replaces coil springs, lower control arms and the roll stabilizer. This results in a weight saving of almost 10kgs, in one axle alone.



Another integral component in the front axle is the knuckle. The team explored how much lighter they could make the system when other components were integrated and lightweight materials were used. This resulted in a design incorporating a CFRP (Carbon-fibre-reinforced polymer) knuckle with integrated bearing outer raceway, attachment reinforcements for upper and lower ball joint and insets for caliper and steering arm attachments. Finally, they used a continuous-velocity-joint, which is positioned inside the wheel bearing.

For the rear axle, the team evaluated thirteen different concepts using multi-body simulations. Each was assessed on ride and handling performance, cost and lightweight properties before finally choosing the Quadra link concept.

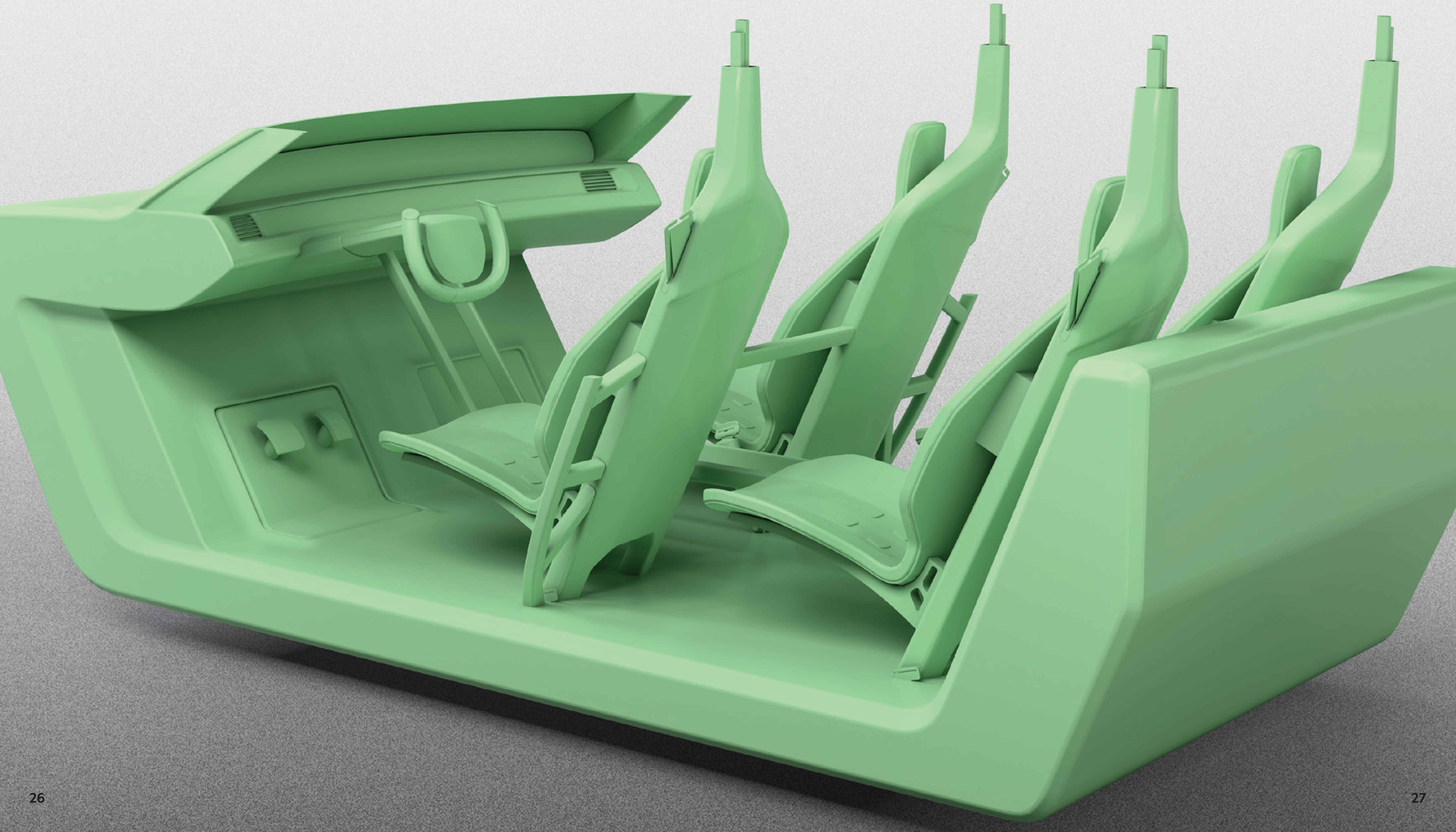
To assure ride and handling performance over the large relative weight span a gas-hydraulic levelling system was chosen. This function minimizes air drag and reduces light beam fluctuations, which in turn removes the need for headlight angle adjustment.

When analysed in the Trust Matrix the functionality of the different concepts has been verified by means of multiple simulations with the front axle estimated to be feasible for implementation by 2020+.

In terms of the Cost Matrix, the new Chassi Structure has added value at a higher cost. The improvement made to handling and safety performance of the car adds a significant amount of value. The cost of the rear axle is estimated to be lower than the benchmark, while the cost of the front axle is relatively higher due to the material and process costs.

Result: over 50% reduction in the weight of the redesigned elements.

COCKPIT



The Cockpit is an extremely important area of the vehicle as it is from here that the driver controls the car. The ergonomic climates in most cars today are often over-crowded, making it uncomfortable for the driver and occasionally stressful. Redefining the driver's experience was the focus for the cockpit team.

Quite early in the project, it was decided that the cross car beam be placed behind the seats as opposed to in the cockpit where it is traditionally positioned. Along with this, was the 'fixed-eye position' brought by the seat team. These features inspired complete redesign of the cockpit area, beginning with the concept of an adjustable steering wheel and adjustable pedals to accommodate the new seat structure.

Repositioning the cross car beam created the potential to reduce the size of the instrument panel. From here, they were also presented with the opportunity to create an entirely electronic information panel with voice and gesture control. The benefit of giving voice and gesture control for subordinate functions, such as the radio, is that it allows the driver to concentrate on driving safely. It also frees the designer from having to place controls within the drivers reach, thereby opening the cockpit up to an entirely different architecture.

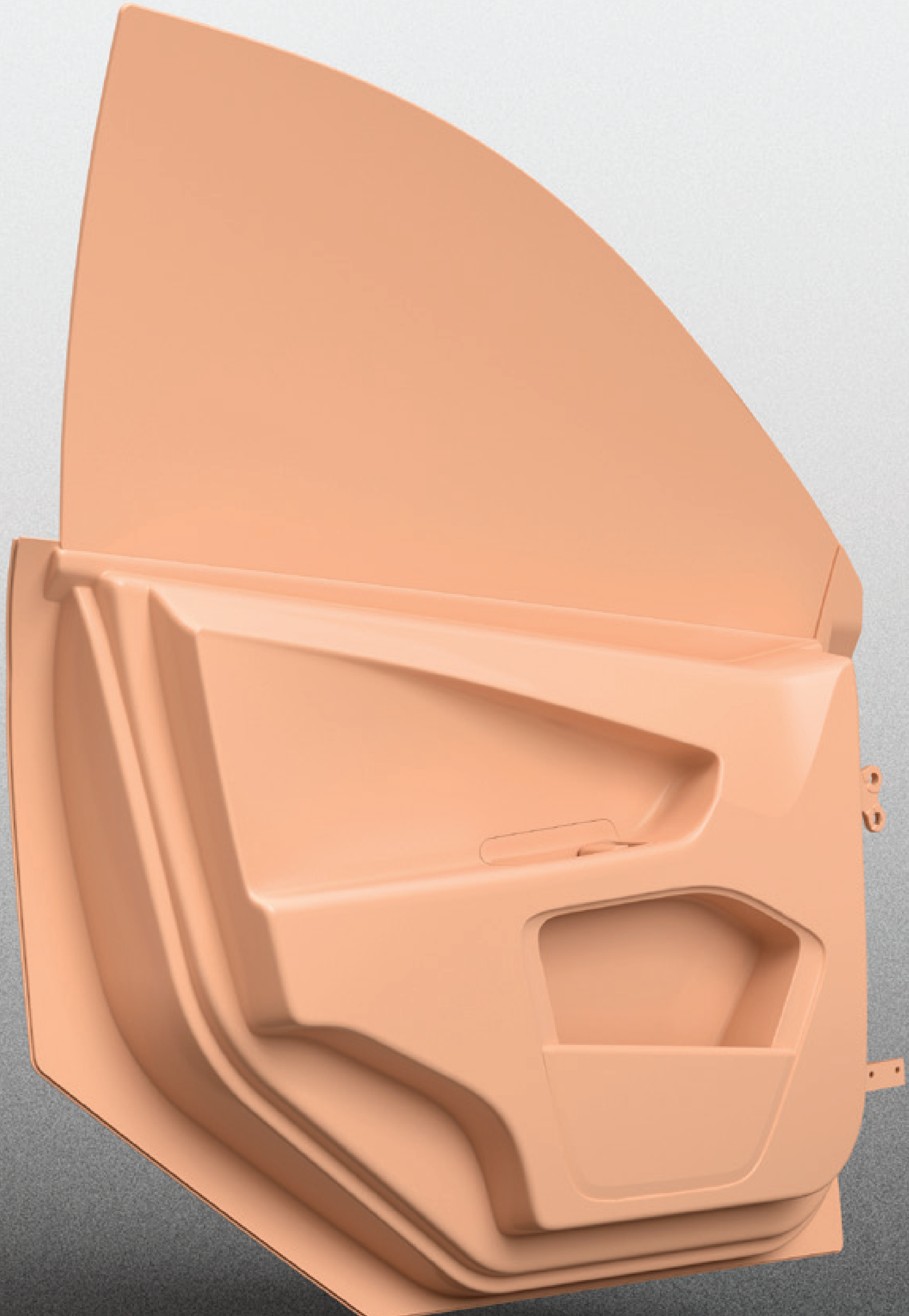
Downloadable smartphone apps and future mobile phone development will also be available to remotely control the car's functions. This remote control via mobile allows a new way of thinking, e.g. pre-warming/ cooling, defrosting while eating breakfast or before leaving the office. The use of heated glass makes for almost instantaneous demisting and defrosting, which leads directly to a more compact HVAC system that can be repositioned to sit in the floor rather than weighing down the instrument panel.

When analysed in the Cost Matrix, all of this allows for an ergonomic environment as the cockpit is stripped down to its essentials creating a clean, stress-free driver experience, which adds value to the car at a higher cost.

In terms of the Credibility Matrix, the concept is yet to be verified but it estimated to be industrially feasible with introduction by 2020+.

Result: almost 40% lighter.

DOOR



The door of a vehicle has a particular role to play, as it is the first experience a driver will have with their new mode of transport. With this in mind, the team wanted to design a door that was reflective of the SÅNÄTT essence: a lightweight door, which would act as the portal to a new driving experience.

In the past 20 years very few changes have been made to the vehicle doors apart from higher protective functions and the introduction of electric windows. It was from this starting point that the team evaluated which functions their design should feature. They came up with two extreme ideas of how to achieve this. The first proposal was a car, which had integrated structural functions for the car body, thereby reducing the mass of the complete vehicle. The second was to eliminate many of the components, stripping the door to its essentials.

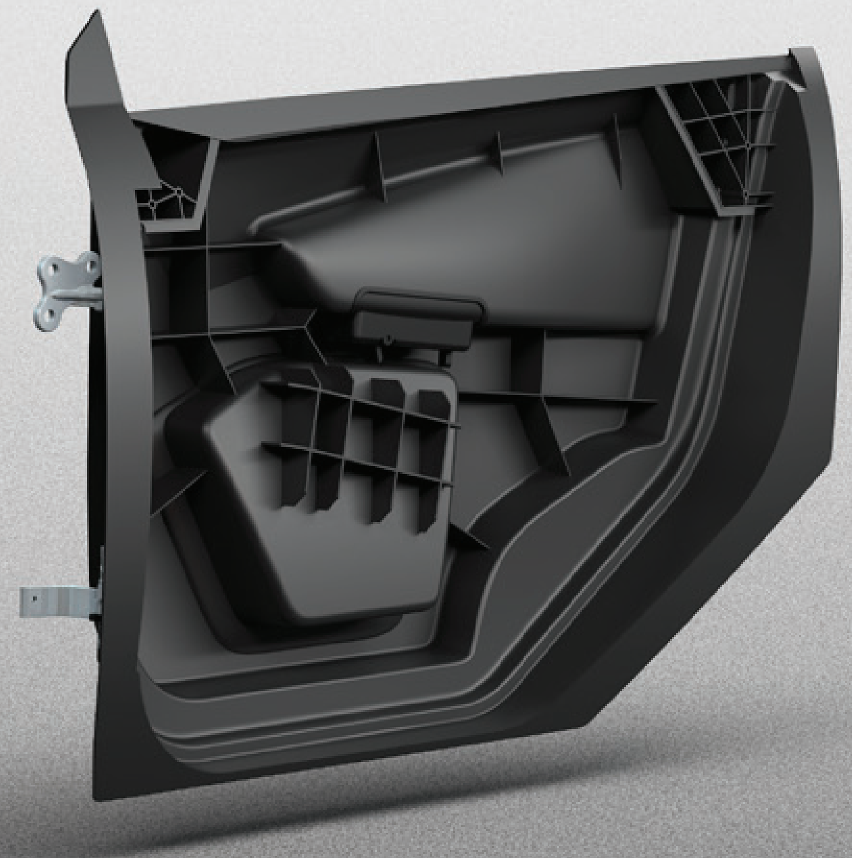
From the user's viewpoint, an extremely heavy door - though multi-functional - is not very appealing. Additionally, it is not very congruent with the lightweight technological approach that SÅNÄTT was based on. Thus, the team made the decision to evaluate each component of the door, to isolate and identify how each contributed to the overall mass. The overarching consideration in design is that though lightweight, it must retain high safety requirements.

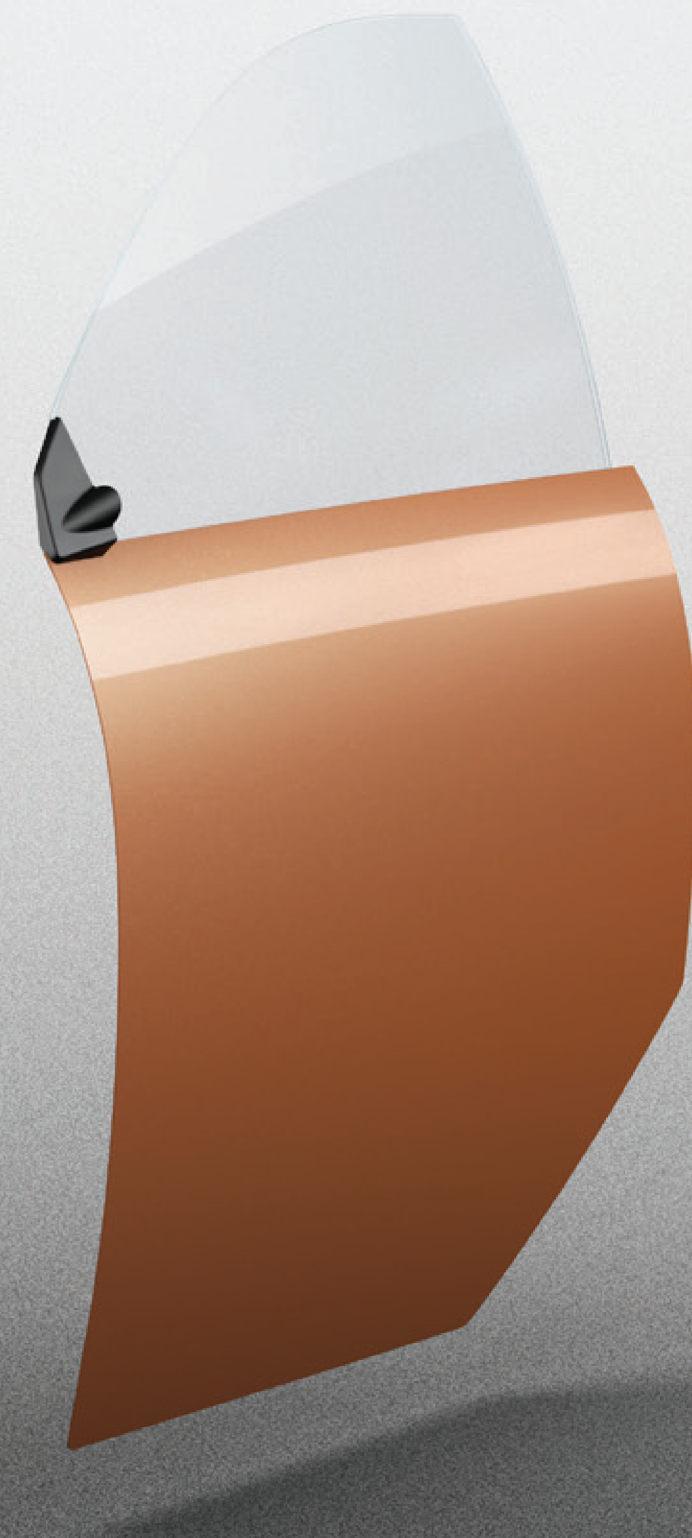
The continuous evaluation led to the decision to remove the window-elevating feature. Doing this created the possibility of reducing the thickness of the door while simultaneously enabling improved aerodynamics. Future opportunities to replace materials in the window were made by the simple act of no longer having to raise the window. Furthermore, the decision would also allow for the crash beam to serve as fastening for both hinges and locks.

The new door design also incorporates its own base and carrier, consequently cancelling the need for the door's own steel carrier and reducing the weight. They used reinforcing composites comprising a double injection combined with foam in order to achieve sufficient rigidity and viability to build the door.

As a result of the team's creative focus on the functions of the door, a new concept in door design was born: a door that does not have a steel frame around the window. By foregoing the weighty steel frame, the door fits directly into the bodywork with the use of sealing strips, similar to those used on convertibles.

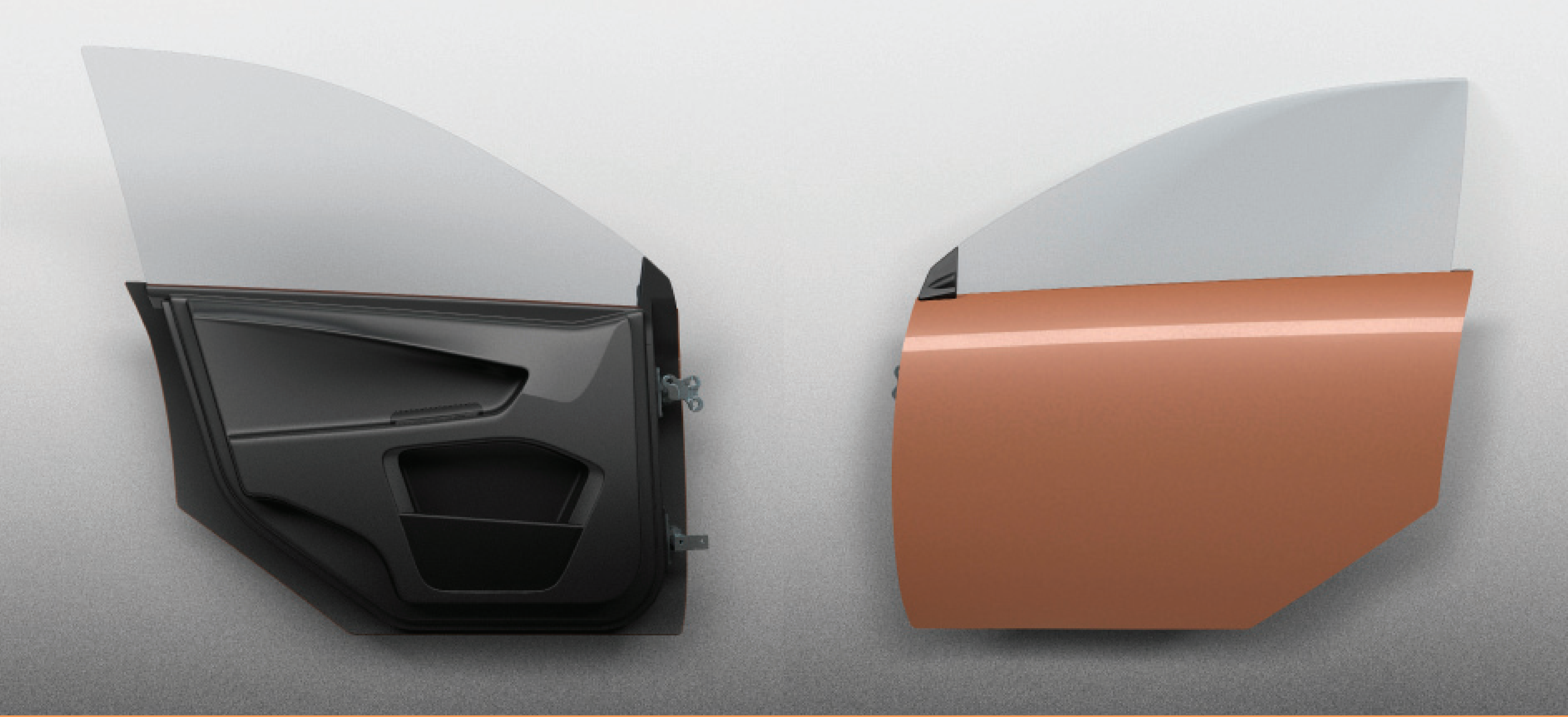
Though many of the heavy components were already removed, even the "plastic basin" can be quite cumbersome.



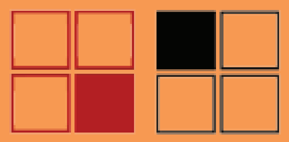


For this reason, they chose to use a new type of sandwich material called Hybrix which is composed of stainless steel sheets and thin layers of sheet metal combined with a polymer (standing fibres), which gives the required stiffness.

The conceptual change in door design and construction has two significant benefits: weight and costs are cut due



to reduced assemblage. The static window also comes with many weight benefits the first and most obvious is that there is now no need for the window elevation motor. Then the use of polymer in place of glass; and lastly, as the door fits into the car structure, there is no need for wet/dry zone sealing. When analysed by the Cost Matrix, the removal of the window elevation function makes the door less valuable than its benchmark, on the other end, it is estimated to cost almost 20% less.



In terms of the Trust Matrix, it has yet to be verified, but due to its relatively low assemblage and the availability of the materials used, the design is estimated to be feasible by 2020+
.
Result: over 40% reduction

UNDERBODY

In essence the underbody is the backbone of the car and therefore it is one of the largest components of a vehicle. It serves a multitude of purposes ranging from NVH insulation to global stiffness, but its most important function is its role in passenger safety.

NVH is regularly considered very late in car design, many components such as damping mats are added which makes it extremely heavy. As the brief was lightweight focused, the team realized they would have to develop an entirely new concept. If the damping mats were to be removed, then they would have to insulate the car another way.

The search led to the idea of incorporating the floor into the support system for components traditionally located elsewhere. In order to create a floor concept that can support the idea of integration the team would have to strategize a way to distribute the load. From here, the concept of the “double floor” originated that is based on the idea of two beams supporting separate loads, which are bound together by a sill on either side.

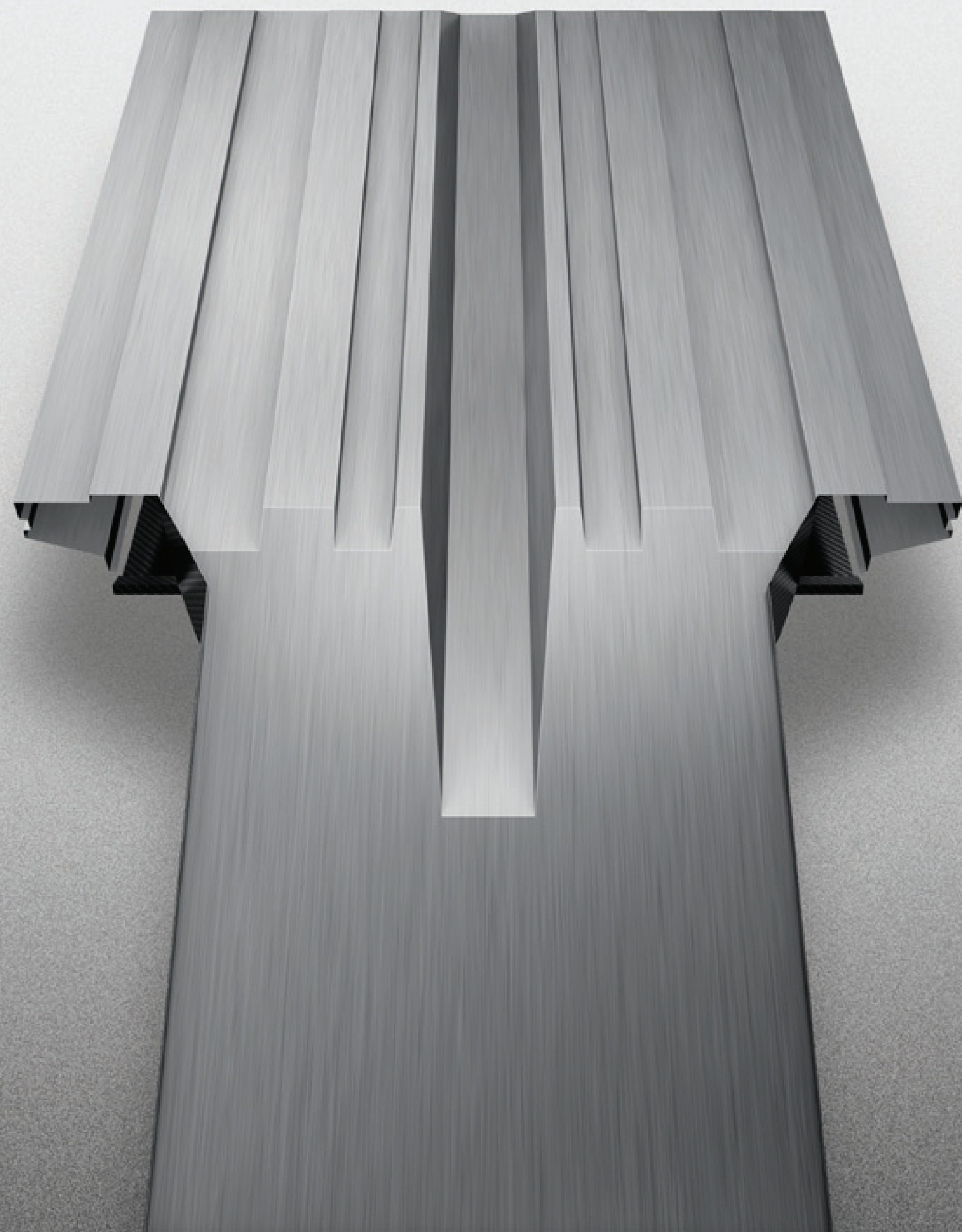
The upper portion is optimized for a lateral load, while the lower portion is optimized for longitudinal. The construction of these provides high torsional rigidity that in turn supports the global stiffness of the body absorbing and distributing crash loads. The centre of gravity is also lowered with this more even weight distribution, which improves both safety handling and performance.

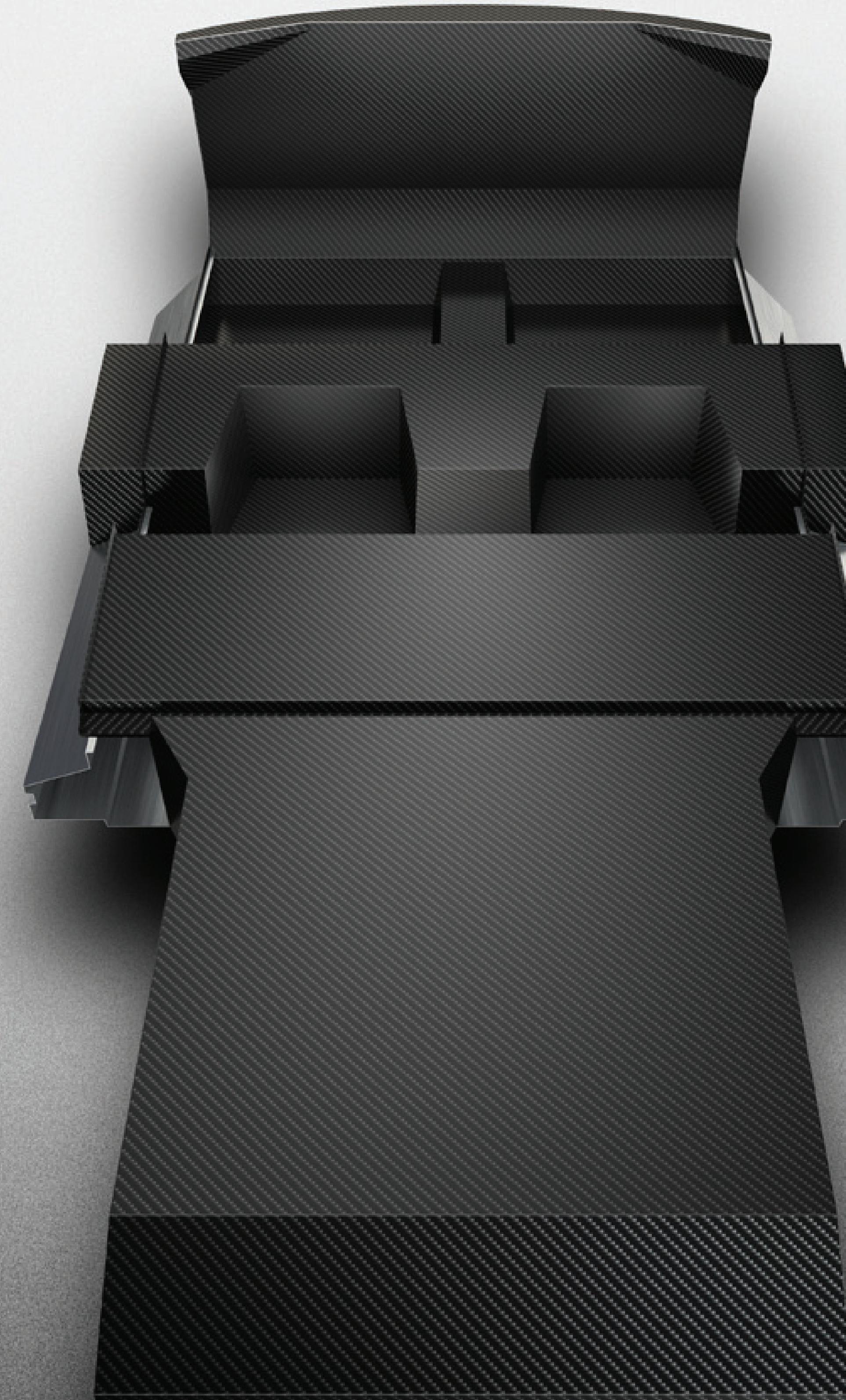
Traditional car floors consist of a single material that is stiff and lightweight “membrane”, which frequently results in high levels of sound and vibration. The double-floor concept configuration and material choice results in greater stiffness and better insulation with a significantly lower weight. The pocket created between the floors allows for the integration of features (batteries, fuel tank, HVAC etc.), while allowing for a flat under-side, which improves aerodynamics.

This new Underbody design has been verified to be feasible by 2020+, in the Credibility Matrix. It did so by meeting the standard of NVH performance, the improvement of global stiffness and by use of production methods that are already available.

By the Cost Matrix, it has also added value to the component due its lightweight and safety properties. In present conditions, however, the added value comes at a relatively higher cost.

Result: 48.5% reduction





ROOF

The concept of modularization was the focal point of the roof team's design process. Not only does it enable more efficient production, it also creates the opportunity for integration of parts such as sun cells, ventilation fans, electronics and other interior parts. Furthermore, it reduces the number of fasteners on the vehicle body and allows for a more efficient way of manufacturing the rest of the car structure due to better access and favourable geometry.

One inspiration source from early in the project was a conceptual idea called "Semlan" where the windows were replaced by displays. This idea helped the team to think about the structural benefits of removing the rear window. A screen connected to a rear camera, which replaced the window in the final design.

In terms of lightweight technology, the most obvious choice to use is carbon fibre. However, as it is a relatively expensive material it must be used creatively. Another issue that arises when using carbon fibre is that it requires new damping/ insulation techniques in order to achieve the required noise levels. To address this, the team developed a concept for lightweight material using a sandwich structure composed of carbon fibre, rubber damping mats and viscoelastic tape.

The high standards set to achieve a class "A" surface and finish can often result in the addition of several layers of material, which add unwanted weight. To prevent this, a carbon fabric based on Spread Tow reinforcement was utilized, which results in the desired finish. Another way to handle the quality demands on the surface is to use a foil coating in place of a traditional paint finish.

Similar foil coatings are often used on commercial cars such as taxis. They are easy to apply, durable and are continuously developed in order to provide the industry with a foil that matches the performance of paint.

A chemically strengthened glass, similar to that used in mobile phones, along with a noise absorbing material was chosen for the windscreen. This combination reduces the weight of the windscreen by roughly 50% without compromising the acoustic performance of a typical windscreen. In addition to this, a reflective coating was added to reduce the heat of sunbeams. This coating also helps to reduce the load on the climate control system.

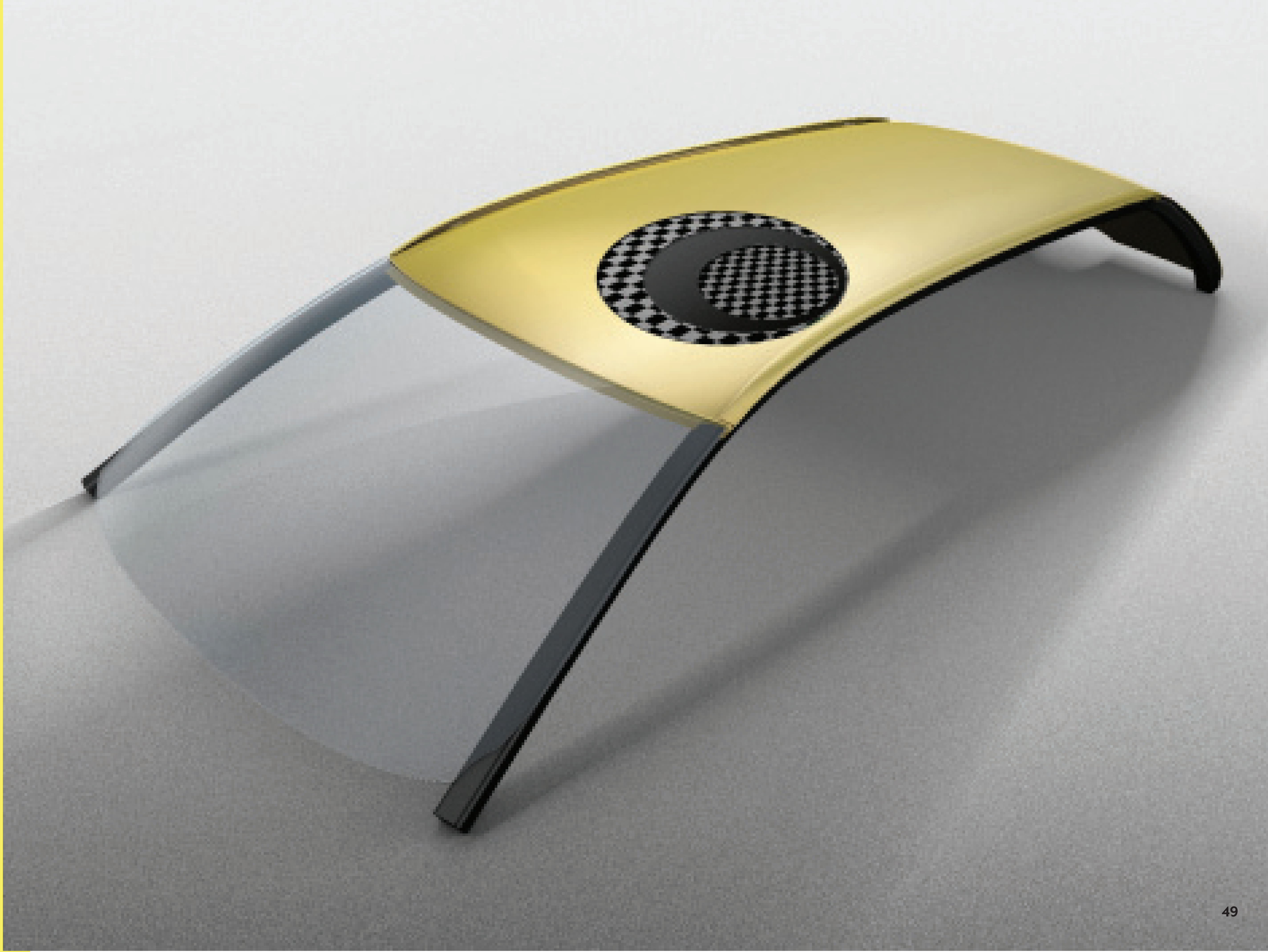
The stress on the climate system is also reduced by the carbon fibres used in the roof construction, which increase its insulation properties. In combination with a system for passive ventilation, the climate control system can ultimately be downsized and less fuel will be required to regulate the temperature within the car.

Finally, as both the foil and the windscreen contain dirt-repelling components, the need for washing the car is reduced along with the bonus effect of reducing the size of the washer fluid containers.

Due to the improved insulation, NVH performance and the lower centre of gravity the new roof design has a higher value and higher cost to produce when analysed in the Cost Matrix.

When measured by the Credibility Matrix, the new Roof panel has been verified and is estimated to be industrially feasible by 2020+

Result: over 50% reduction.



All participating partners:

PROJECT MANAGEMENT
FKG - Scandinavian Automotive Supplier Association
Innovatum
Chalmers University of Technology
Volvo Car Group

FACILITATORS
Blekinge Institute of Technology
Chalmers University of Technology
University of Linköping
University of Skövde

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