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USING COMPOSITE MATERIALS FOR DASHBOARD DESIGN OF AN ELECTRIC CAR

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Abstract: *The paper presents a dashboard made integrally of composite materials designed for an electric car with two passengers. There are presented and analyzed the possibilities of realization of the dashboard, as well an optimized model of the dashboard that can be made entirely of composite materials.*
Key words: *composite materials, dashboard design, electric car, micro car*

1. INTRODUCTION

Composite materials are used in dashboards, especially for sports cars or luxury cars. It is usually used to cover he dull portions of the dashboard (Figure 1) with more of a decorative role, but it can also be found on other elements inside the passenger compartment, such as the steering wheel, the gearshift or the interior of the doors.

Fig.1 Composite material on Tesla Concept dashboard [1].

Fig. 1 BMW Car Dashboard Design [2].

The dashboard design is a subject approached from various points of view like:

- Usability - use of automotive user interface technology, and specifically, to explore the instrument panel (IP) display design to help attract and manage attention and make information easier to interpret [3],
- Fabrication technology – starting with design of injection mold [4], influence of manufacturing constraints on the topology optimization of an automotive dashboard [5],
- Ergonomics - in terms of driving safety and accessibility to the dash board control elements [6],

and others.

In designing and optimizing dashboards various tools are used such as: design evaluation model (DEM) and analytic hierarch process (AHP) [6], augmented reality [7], topology optimization (TO) [5], TRIZ method and Multi Criteria Decision Method (MDCM) [8].

In this paper we propose an analysis of the possibilities of realizing a dashboard entirely of composite materials.

2. 96BG E-CAR CONCEPT

The 96BG concept is a small electric car designed to be used in crowded cities, designed for day-to-day activities and has two seats to meet a wide range of users. The design is a modern one, as can be seen in the figure below, the shapes used in its 3D modelling are adapted to the FPR parts manufacturing technology.

Fig. 2 96BG E-CAR concept.

3. DESIGN ALTERNATIVES

Most composite dashboards are mare of a single piece and are conceived as spare parts, copying the design of an existing dashboard.

Fig. 3 Dashboard made of composite material [9]

In this paper three design variants will be presented (see Figure 5), differentiated by the method in which the dashboard will be assembled. For each method the strengths and weaknesses will be highlighted, extracted from a SWOT analysis.

In the first concept the dashboard is made from a single piece, in the second one there is a part that can be considered the cover for the other components, and in the case of the third concept components are mounted one above the other.

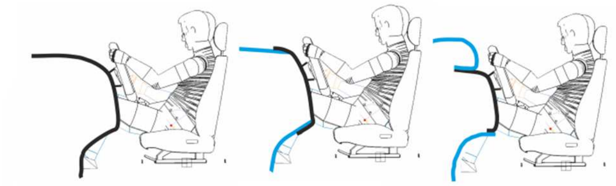

Fig. 4 The three concepts analysed

3.1 Concept 1

The first option in designing a dashboard is to do it in from one piece (Figure 4).

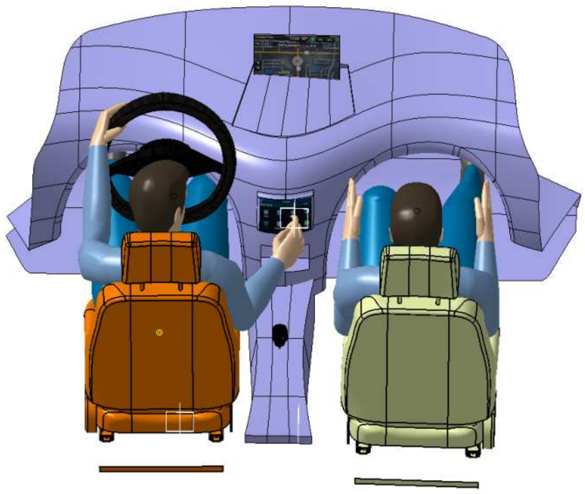

Fig. 5 Design 1

Using the SWOT analysis presented in Figure 7, a number of problems have been identified with the design of the mold and its assembling into the vehicle. By making one-piece dashboard, the sounds created by wearied-out plastic under stresses are eliminated. As a weakness we can recall the difficulties that may arise during the assembly process, the piece being too large or the high cost and the complexity of the dashboard mold.

3.2 Concept 2

Concept number two (Figure 8) involves building a three-component dashboard, one of which covers the other two (or more) components. On this top cover are mounted the panel of instruments and the ventilation holes.

Fig. 6 SWOT analysis

Fig. 7 Concept 2

The advantage of such a model is the decrease of the molds complexity for the main part and a simplification of the maintenance operations. There are more molds required to make the two extra pieces though. The first piece comes under the windscreen; it will hold the dashboard in place and may have a role in demisting the windshield. The second piece comes under the dashboard; it supports it from beneath and has an aesthetical and functional role in delimiting the space for the driver's and passenger's legs. If it's necessary control elements can be fitted with control buttons and nos.

3.3 Concept 3

This concept involve the mounting of two pieces on top of each other, so the lower part acts as a support, it can be fitted with ventilation holes and various controls and control elements, nobs. The upper part may also contain ventilation holes and on-board instruments.

Fig.8 Concept 3

By removing the upper part of the dashboard assembly during maintenance operations, the mechanics have direct access to the components that normally are inaccessible in the case of a classic dashboard without removing it. In the case of Concept 3, two molds would be needed to manufacture it, but the resulting shapes and the design lines could be more complex than a one-piece dashboards'.

4. MANUFCATURING TECHNOLOGY

In the embodiment shown in Figure 10 for the manufacturing of the dashboard it is possible to use a composite material reinforced with glass fiber or carbon fiber / epoxy matrices. The use of these materials leads to the reduction of the components' mass, as an essential condition to increase the autonomy of the electric vehicle. The chosen layer architecture is [+-45/0-90/]. Carbon fiber layers are Twill fabric type 240g/m2.

For a variant where the product requires enhanced rigidity characteristics, a sandwich structure is proposed with two layers of 240g / m2 Twill carbon fiber fabric as outer layers.
Layer configuration [+-45/0-90/]. Between the two layers of carbon fiber, the core of the sandwich structure will be made of 1 mm Coremat or 2 mm of Rohacel.
In the area where it is possible to insert the airbag, the structure will be made up of two layers of 90g/m2 plain carbon fiber fabric ad +-45 degrees. This will be available only on the outside of the dashboard. In the middle will be kept the 2 mm thick Rohacel structure. The structure will not be doubled by another wall inwards. This will allow a slight damage to the outside surface to allow the impact cushion to come out in case of an impact, when the charge of the airbag detonates.

Fig. 9 The two-piece dashboard

The outer shape of the dashboard for the chosen configuration allows the components to be made in two separate molds. The upper part, marked 1, in Figure 10 can be manufactured in a concave mold. This does not require an additional separation plane. It can be easily extracted from the mold, and the fabric can be applied to the entire surface without the need for cuts or cut-outs. These could optically influence the outer design of the piece. Cut-outs for the vent holes will then be cut in the pre-set positions. From the molds' point of view regarding the manufacturing, the proposed solution is to use epoxy blocks processed on CNC centers as material. This is the fastest solution for making composite prototype parts and offers a good surface finish in a relative short time.

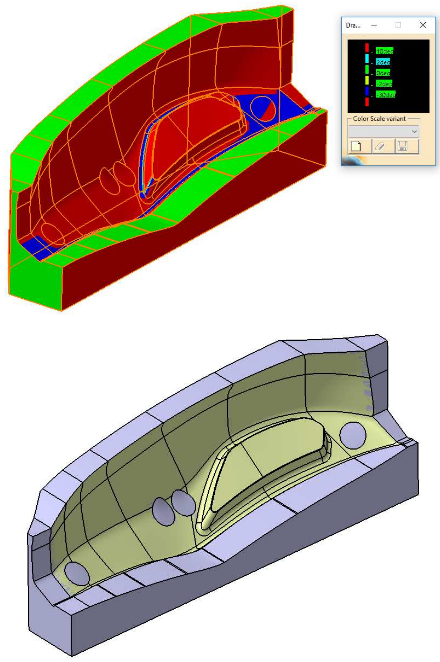

Fig. 10 Concave moulds for the dashboard

The lower part of the dashboard, marked 2 in Figure 10, is made of the same material and can be made in a separate cavity mold. Thanks to its generous shape, it allows to be produced from one piece. The fastening of the two parts is done with screws on the inside, which allows a rigid assembly. A gasket is proposed to be used between the two components to reduce the noise occurred in the joint area of the rigid components while the vehicle is in motion.
The modular design of the dashboard, in addition to adopting a simpler solution for the composite parts, offers the possibility of a high degree of interchangeability of components. This solution allows to change the upper part and use another design. When using right-hand drive vehicles, only the upper part of the dashboard must be changed. Often, interventions for repairs occur in the interior area of the dashboard. Using this concept, by removing one of the parts the workers have easier access to the interior elements of the dashboard.
In the mounting areas of the dashboard onto the chassis, metal plates (in which the holes will be applied) will be integrated between the layers of composite materials. Metal inserts are designed to prevent damage of the composite material (with anisotropic properties), the

mechanical stress being absorbed by a homogeneous material (metal).

5. CONCLUSION

Making a composite dashboard is a feasible solution, which can be made in several design variants. In this paper are presented three versions of a dashboard, chosen so that in technological and functional aspect to fulfil all the functions of a classic dashboard. The major advantage of a dashboard made of composite materials is its weight, which is easier than a classic one with at least 60%. A possible problem is the overheating of the dashboard in the summer, when the car is exposed to direct sunlight and the dashboard if it's not covered in any other type of materials similar to those used on a classic dashboard. The cost of manufacturing of a composite dashboard is lower than in the case of a classic one, but the operation cannot be automated. The finishes used may be the same as those used for a classic dashboard. Reduced weight is an advantage for electric cars where the cars' autonomy is directly influenced by their weight.

6. ACKNOWLEDGMENTS

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Utilizarea materialelor composite pentru proiectarea bordului unei masini electrice

Rezumat: Lucrarea prezinta un panou de bord realizat integral din material composite, proiectat pentru o masina electrica cu doi pasageri. Sunt prezentate si analizate posibilitatile de realizare a panoului de bord, precum si un model optimizat al bordului care poate fi realizat in intregime din materiale composite.

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