

INTEGRATED SYSTEM FOR IMPROVING THE VISIBILITY THROUGH THE SIDE WINDOWS OF THE MOTOR VEHICLES

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Abstract. This study presents an innovated idea that includes the development and implementation of an integrated system to improve visibility through the side windows of the motor vehicles. In our days, one important thing is the security of passengers and drivers, especially when their job is closely related to driving a motor vehicle. Therefore, the visibility through these windows, in particular in adverse rain or snow conditions, is very important to ensure the safety of the driver and passengers. To ensure the increased visibility, the system must be also sealed and easy to operate to comply with all current rules and regulations.

Keywords. UE Regulations, innovation, mechanics, motor vehicles, safety, security.

1. Introduction: Analysis of the characteristics for the vehicles side windows (UE Regulations)

This article aims to provide innovation in the automotive field by implementing a new system on the market, a system that reduce traffic problems created due to the low visibility through the side windows of a vehicle in adverse weather conditions, dust or too much pollution. For this study, a comprehensive analysis of a technical solution developed resulting a hybrid solution from the combination of two technical solutions analyzed.

Due to our days, one important thing is the security of passengers and drivers, especially when their job consists into driving a motor vehicle. Therefore, the visibility through these windows, in particular in adverse rain or snow conditions, is very important to ensure the safety of the driver and passengers. To ensure the increased visibility, the system must be also sealed and easy to operate to comply with all current rules and regulations. Therefore, in a very crowded city such as major capitals, even Bucharest, the speed of travel from point A to point B must be very fast, even under rain conditions, therefore, it requires high visibility through the side windows.

In Europe, in order to approve all new vehicles, they should comply with the standards of European depollution rules (EURO). Part of this process includes also the standards of vehicles emissions control.

Optimization strategies that reduce the effectiveness of emission control technologies can be attributed to commercial choices made by car manufacturers in order to achieve different objectives, such as reducing fuel consumption, increasing user comfort, reducing costs using cheaper components or addressing design constraints. These objectives aren't covered by derogations from the prohibition on the use of defeat devices.

Thus, according to paragraph 11.10. from 18.12.2001 of the 'Regulations and technical rules in road transport', the windscreen wiper and watering devices must comply for motor vehicles of category M1 with the technical conditions laid down in Directive 78/318/EEC, the last amended by Directive 94/68/EC [1].

The equipment for defusing and de-icing the windscreen for the motor vehicles of category M1 (light vehicles) and other glazing must prevent the driver's visibility to be obstructed forward and through rear-view mirrors in accordance with the technical conditions of Directive 78/317/EEC [1].

The EU Regulation regarding the sound level of motor vehicles introduces a new test method for measuring noise emissions, reduces the noise limit values currently in force and includes additional noise emission provisions in the approval procedure.).

2. System development characteristics




In a very crowded city, such as major capitals, even Bucharest, the speed travel from point A to point B must be very fast, even under rain conditions, therefore, it requires high visibility through the side windows.

In order to improve the visibility through the side windows of a motor vehicle, complying with the conditions imposed by the European (EURO) pollution rules, characteristic of reducing noise pollution and exhaust emissions from motor vehicles, the following main conditions have been identified:

- increased visibility through mirrors/lateral windows when it rains or snows;
- permanently clean side window;
- increased visibility on the vehicles side mirrors;
- compliance with the abovementioned regulations;
- the system must be easy-to-operate;
- the system mustn't affect the model or aerodynamics of the vehicle;
- reduced risk of road accidents;
- increased safety for road traffic users.

Therefore, the system must meet the needs of passengers in order to increase their level of safety. These needs are presented in the below table:

Table 1 Passengers needs analyses

Passengers needs	Results
Angle of vision in the side mirror and opacity of the glass	<p style="text-align: center;">≈ 30%</p> <div style="display: flex; justify-content: space-around; align-items: center;">    </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 5px;"> Exit 30 km / h 50 km / h </div>
Drying surface	Approximately 30% of the window
Precipitation volume	Moderate rain 0.25 mm and 4 mm / hour and heavy rain 50 mm / hour
Design	<ul style="list-style-type: none"> • Does not affect the vehicle model • Does not affect the aerodynamics of the vehicle

In conclusion, in addition to all the conditions it must meet, the product should be more efficient than the existing competing products.

In order for this to be possible, an analysis of the competition has been effectuated, as is presented in the table below:

Table 2 Competing products analysis

Product name	Description	
Cheddars	Advantages	Disadvantages
	<ul style="list-style-type: none"> • better air circulation in the passenger compartment • prevents condensation from forming on the side windows when it rains 	<ul style="list-style-type: none"> • Unfriendly design • deforms over time due to high temperatures
Anti-rain solutions	Advantages	Disadvantages
	<ul style="list-style-type: none"> • Throws snow and rain • Keeps the windows clean 	<ul style="list-style-type: none"> • Permanent maintenance • opacity after a certain number of cycles
Sealing garnitures	Advantages	Disadvantages
	<ul style="list-style-type: none"> • Sealing and protection • Noises reduction 	<ul style="list-style-type: none"> • Manually operated • Insufficient wash

In conclusion, the proposed system will be much more efficient than all three competitors presented above.

3. Concepts definition

First, the area to be used must be determined. There are three types of possible leaders:

- Mannequin 5 %;
- Mannequin 50 %;
- Mannequin 95 %.

For each of these three cases, the angle of view through the side window must respect the ergonomics and security rules.

In the view of the above-mentioned rules, the results obtained were calculated and stated that this product must occupy an area of about 54% of the side window (Fig. 1).

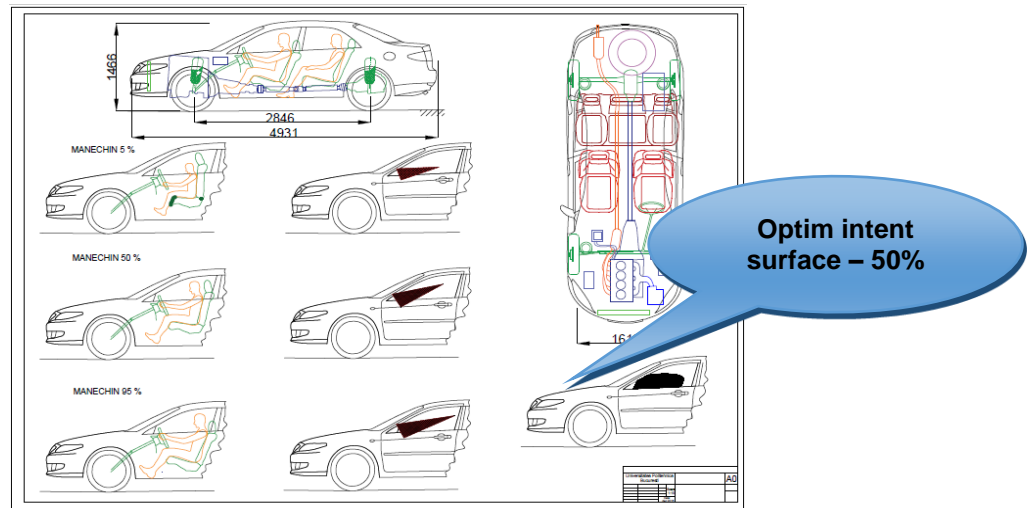


Fig. 1. Intent surface

After this analyzation, three technical solutions were analyzed meeting the requirements.

3.1. Concept 1: solution- windscreen- classic nozzle:

The operating principle for this solution consists in a sealing seal washing the window with the help of a motor mounted on the door. The sealing will wash the glass to remove traces of rain and to ensure visibility and safety of passengers, as can be seen in Figure 2 and table 3.

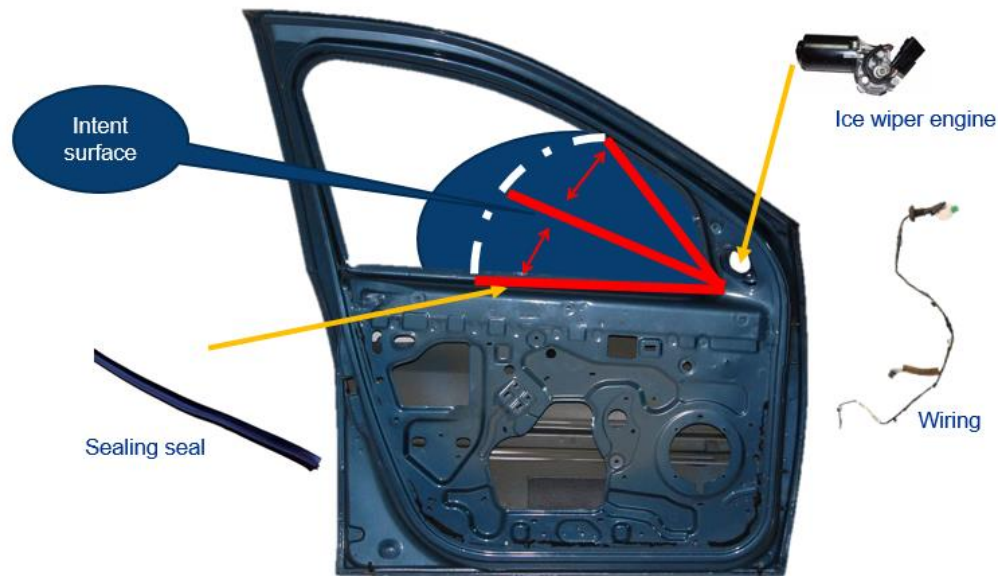


Fig. 2. Concept 1

Table 3 Macro definition concept 1

Characteristics	Sealing seal	Ice wiper engine	Wiring
Masse (kg)	0.14	0.75	0.28
Material	>PP-SEBS-PP30T<	>AS9U3;PBT-PET-GF30<	Electric component
Dimension (L x h x l)	783 x 22 x 22	172 x 141 x 168	-
Quantity	1	1	1

3.2. *Concept 2: Washing the glass without cleaning:*

The operating principle for this solution consists of a sealing seal washing the window with the help of a motor mounted on the door, as can be seen in Figure 3 and table 4.

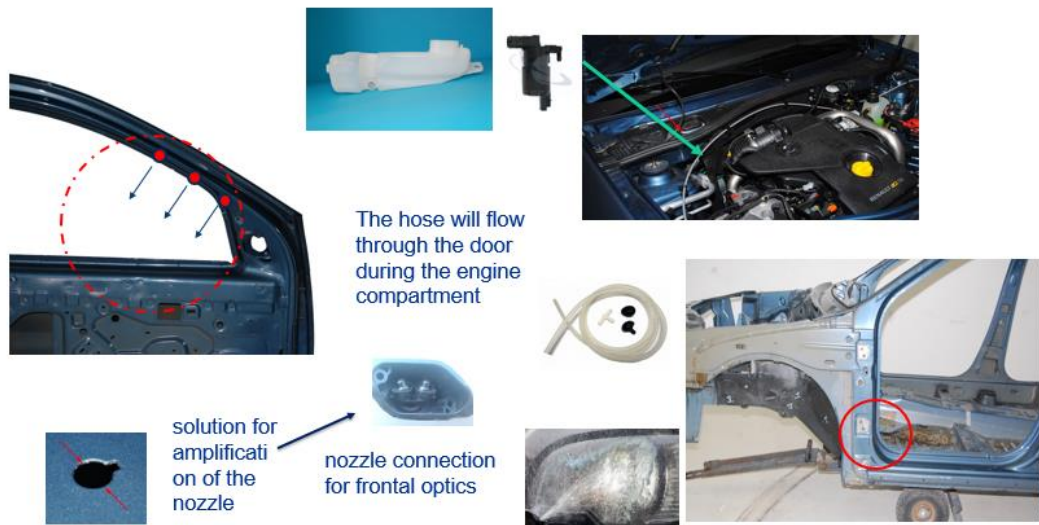


Fig. 3. Concept 2

Table 4 Macro definition concept 2

Characteristics	Windscreen washer pump	Windshield liquid hose	Nozzle for windscreen fluid
Masse (kg)	0.09	0.065	0.004/pc
Material	Metal and plastic	Elastomer	Plastic
Dimension (L x h x l)	64x90x43	Length 2150	34x35x15
Quantity	1	1	2

3.3. Concept 3- air pressure on the window:

The operating principle of this solution based on the use of two air nozzles that sprays air on the window, eliminating raindrops. The air pressure from the compressor mounted on the door will remove raindrops out of the window, as can be seen in Figure 4 and table 5.

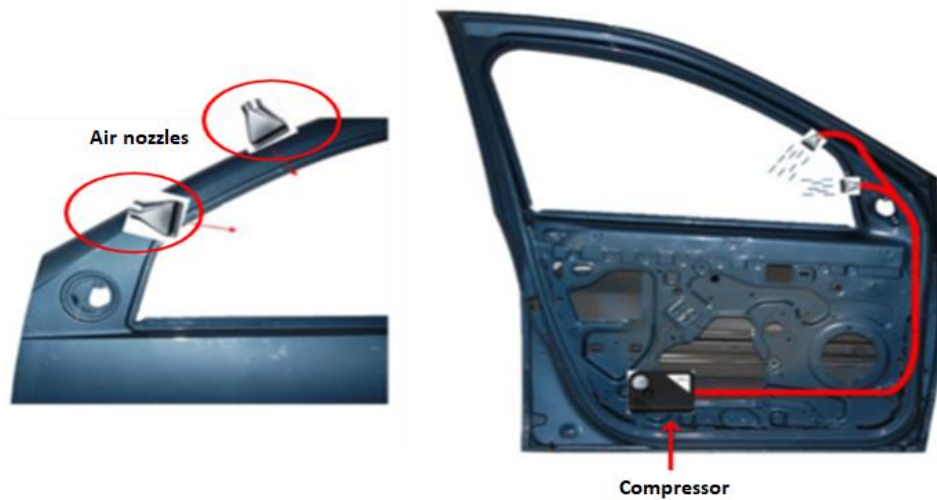


Fig. 4. Concept 3

Table 5 Macro definition concept 3

Characteristics	Air compressor	Air nozzles	Air hose	Wiring
Masse (kg)	0.8	0.08	0.065	0.28
Material	Electric component	Plastic	Elastomer	Electric component
Dimension (L x h x l)	155 x 122 x 52	185 x 75 x 129	Length 1500	-
Quantity	1	2 or 3	1	1

To choose the best solution was made an analysis, as it can be seen in the table below (table 6). In the first column are the criteria, in the second column is characterized the importance of the criteria. For each solution, were provided marks from 1 to 8, 8 being the most favorable, and 1 least desired. Final results were obtained multiplying by k, and have been added to the last column for each solution. The solution with the biggest mark was chosen as the final solution.

Table 5 Choosing concept

Criteria	K	Concept 1		Concept 2		Concept 3	
		Mark	Score	Mark	Score	Mark	Score
Weight	5	8	40	6	30	6	35
Volume	5	5	25	6	30	4	30
Drying surface	4	8	32	7	28	6	16
Drying time	3	5	15	7	21	4	18
Side windows opacity	4	7	28	6	24	6	16

Open/close speed	2	4	8	6	12	5	12
Consumed energy	4	6	24	7	28	4	20
Operating temperature	4	7	28	3	12	4	16
Action speed	3	6	18	5	15	4	12
Precipitation volume	2	7	14	5	10	3	8
Water particle diameter	5	6	30	4	20	6	15
Utilization time	3	7	21	6	18	6	18
Appearance	2	4	8	7	14	6	12
Total		291		262		228	

In order to respect the needs exposed, after analyzing all the competing products and the concepts validations, a hybrid solution was chosen between concept 1 and concept 2.

4. Technical solution definition

The technical characteristics established for the system are shown in the table below:

Table 5 Technical characteristics of the product

Technical characteristics			
Parameters	Level	Flexibility	Flexibility class
Weight	2 kg	± 1 kg	0
Volume	$0.5 m^3$	$\pm 0.1 m^3$	1
Drying surface	54%	$\pm 2\%$	1
Drying time	6 sec	± 2 sec	1
Side windows opacity	95%	$\pm 5\%$	1
Open/close speed	5 sec	± 1 sec	2
Consumed energy	192 W	± 5 W	1
Operating temperature	1 - $60^{\circ}C$	$\pm 2^{\circ}C$	4
Action speed	170 km/h	± 10	2
Precipitation volume	16÷50 mm/h	± 2 mm/h	1
Water particle diameter	1 ÷ 5 mm	± 2 mm	3
Utilization time	10 years	± 3 years	2
Appearance	-	-	1

All the necessary components to carry out the product testing (fig. 5) have been assembled on a system as shown in Figure 6, as can be seen below:



Fig. 5. System components

The system designed was mounted on a vehicle as shown in Figure 6. The vehicle where was implemented the product is a Suzuki SX4 S-Cross.



Fig. 6. The system physically implemented on a Suzuki SX4 S-Cross

5. Conclusions

During the PhD thesis from the “Politehnica” University of Bucharest, a scientific research was carried out, consisting in the understanding of management and implementation of a complex projects through development of a new innovative product.

For this research, a comprehensive analysis of a feasible technical solution has been developed, a hybrid solution resulting from the combination of two technical solutions analyzed.

A competition analysis has been done in order to be able to choose the optimal model for the system development.

The main functions of the product were identified and a fast analysis was carried out, resulting the optimal technical solutions and validating a hybrid solution, a combination of solutions 1 and 2, having as components a tightness gasket and one nozzle for windscreen fluid.

For the resulting solution, 3 types of nozzles were tested for each concept where the model was then optimal Sealing seal + water nozzle.

Therefore, to improve visibility through the side windows of a motor vehicle, respecting the conditions imposed by UE Regulations characteristics of reducing the risk of road accidents and the exhaust emissions of motor vehicles, the following conditions have been identified:

- increased visibility through mirrors/lateral windows when it rains or snows;
- permanently clean side window;
- increased visibility on the vehicles side mirrors;
- compliance with the abovementioned regulations;
- the system must be easy-to-operate;
- the system mustn't affect the model or aerodynamics of the vehicle;
- reduced risk of road accidents;
- increased safety for road traffic users.

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